Population–Development–Environment in Namibia

Background Readings

Edited by Ben Fuller and Isolde Prommer

University
of Namibia
Multidisciplinary Research and Consultancy Centre

IIASA International Institute for
Applied Systems Analysis

Cover photos by Geert Van der Eecken; from top to bottom:

1. Mother with child: Kavango region near Rundu city (January 1995)
2. Rock paintings at Twyfelfontein, Kunene region (November 1992)
3. Welwitschia mirabilis, Erongo region (November 1992)

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Population-Development-Environment in Namibia Background Readings

Ben Fuller and Isolde Prommer, Editors
bfuller@unam.na
prommer@iiasa.ac.at

Approved by

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NAMIBIA

ANGOLA

ZAMBIA

Kunene R.

Ruacana • Oshikango

③

Rundu

Katima Mulilo •

Kavango R.

⑥

Zambezi R.

Opuwo •

Oshakati •

① ②

④

⑤

Namutoni •

Ngoma •

Sesfontein •

Tsumeb •

⑦

Grootfontain •

Tsumkwe •

Okavango Delta

Outjo •

Khorixas •

⑧

Okakarara •

NAMIBIA

Omaruru •

⑨

⑩

Okahandja •

Gobabis •

Buitepos •

Swakopmund •

Arandis •

⑬

WINDHOEK

Walvis Bay •

BOTSWANA

Rehoboth •

Aranos •

⑪

Mariental •

Maltahöhe •

Tses •

Bethanien •

Keetmanshoop •

Lüderitz •

⑫

ATLANTIC OCEAN

Karasburg •

Warmbad •

Oranjemund •

Orange R.

SOUTH AFRICA

SER - Socio-Ecologial Regions, as defined for the PDE Project. For details see Introduction.

SER A:		**SER B:**		**SER C:**		**LEGEND:**
1	Omusati	7	Kunene	13	Komas	____
2	Oshana	8	Otjozondjupa			Administrative Region
3	Oshangwena	9	Omaheke			• Cities
4	Oshikoto	10	Erongo			Rivers
5	Kavango	11	Hardap			
6	Caprivi	12	Karas			

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Foreword

Namibia is a young country with great development opportunities and some serious challenges. It is unique in many respects and shares important features with other countries in the southern African region. This caught the attention of an international group of scientists at IIASA, who are dedicated to the scientific analysis and better understanding of the relationship between population change and environmental factors, which is both a highly complex and a highly ideological issue. We decided to approach this difficult issue through a series of in-depth case studies that should serve a dual purpose: contribute to the more general understanding of the nature of population–environment interactions and at the same time produce a scientific tool (model) that assists local scholars and planners to assess the long-term consequences of alternative scenarios/policies in the context of sustainable human development.

IIASA was very fortunate to find in the Multidisciplinary Research and Consultancy Centre of the University of Namibia a highly competent and motivated partner to jointly carry out this challenging in-depth study on Namibia. We are also grateful for the financial support provided by the European Commission (DG Development). This allowed for an active interaction that has already resulted in many products and is expected to yield many more fruits in the future as the approach of applying multidisciplinary science-based models is expected to further impact on the discussion about alternative sustainable development policies.

The project on Namibia, which has been carried out simultaneously with a similar project on Botswana, is now nearing the end of its three-year term. The main scientific output will be a refereed book tentatively titled "AIDS, Diamonds and Water: Modeling Population and Sustainable Development in Namibia and Botswana." Since not all of the rich materials collected for Namibia under the project can be included in this book, it was decided to publish some of the other materials in the present collection of background papers, jointly published by IIASA and UNAM, and edited by Ben Fuller of UNAM and Isolde Prommer of IIASA.

I would like to take this opportunity to thank all the people at UNAM, IIASA and elsewhere who have contributed to the project in different forms. It has been a pioneering effort, since not much has been published on population, development and environment in Namibia. I am sure that the unique collection of materials in this compendium will prove to be very useful to people interested in Namibia, both within the country and around the world.

Wolfgang Lutz
Leader, IIASA Population Project
May 2000

Acknowledgements

About the Contributors

(in alphabetical order)

Mr. Oladele O. Arowolo
15 Hahnemann Street, P.O. Box 96112
Windhoek, Namibia
e-mail: arow@iafrica.com.na

Prof. Arowolo graduated from the University of Ibadan, Nigeria, with a major in geography (minor in sociology and economics), and obtained his Masters and PhD in demography at the University of Pennsylvania, USA. He has taught at several universities in the US (Rutgers University, Temple University), in Nigeria (University of Ibadan; University of Ife; and Lagos State University) and at Addis Ababa University in Ethiopia. He has served as external examiner for undergraduate and post-graduate programs at the University of Jos, Nigeria; University of Lagos, Nigeria; Regional Institute for Population Studies, University of Ghana, Accra; and University of Botswana, Gaborone. He joined the United Nations International Labour Organization, Geneva, as Chief Technical Adviser in population planning and policies (1988-1999) to UNFPA-funded country projects on population policy formulation and on program development in Ethiopia; Kenya; and Namibia. All of these projects demanded expertise in institution building, technical assistance, training of national professionals, developing research agenda and conducting research on aspects of population and development, publishing reports, project monitoring and evaluation. As a university teacher and researcher, his main areas of concentration included demographic techniques, population and development interrelationships, fertility and mortality, and population dynamics, migration and urbanization, and social research methods; quantitative and qualitative methods. He is now a private consultant in population and development. His current research interests include population and development, return migration and problems of reintegration.

Mr. Rob Blackie
Senior Researcher in Economic and Treasury Policy
Parliamentary Office of the Liberal Democrats
London, UK
e-mail: rob_blackie@hotmail.com

Mr. Blackie earned a degree in history and economics at Oxford University, followed by a Masters in development studies at the London School of Economics. He held an Overseas Development Institute Fellowship while working for the Namibian Ministry of Environment and Tourism as an environmental economist (1996-98). He then worked for a variety of organisations including UNDP in Namibia and the Institute of Development Studies in the UK. His work has involved research on health and education economics, decentralisation, small and medium enterprise support, poverty and governance. He is currently Senior Researcher in Economic and Treasury Policy for the Parliamentary Office of the Liberal Democrats, a British political party.

Mr. Andrés A. Buenfil
Center for Wetlands
University of Florida
Gainesville, Florida, USA
e-mail: abuenfil@grove.ufl.edu

Mr. Buenfil is a PhD candidate in the Environmental Engineering-Science Department at the University of Florida. He has a Master of Engineering degree from the University of Florida, and a Bachelors degree in civil engineering with a minor in anthropology from the University of South Florida. He holds a Graduate Assistance in Areas of National Need Fellowship from the US Department of Education. In the summer of 1998 he was selected to participate in IIASA's Young Scientists Summer Program. His research interests include ecological engineering, wetlands ecology, ecological restoration, energy analysis, and systems ecology. He was born in México City.

Mr. Alan T. Critchley
Multidisciplinary Research and Consultancy Centre
University of Namibia
Windhoek, Namibia
e-mail: acritchley@unam.na

Prof. Critchley is the Head of the Life Sciences Division and Deputy Director of the Centre. He received his BSc (Honours) and PhD from Portsmouth Polytechnic, UK. A marine biologist by training, he has many diverse interests in the sustainable utilisation of marine resources. Amongst these include such diverse interests as integrated mariculture as a sustainable post coastal mining activity, and the use of biologically active extracts from seaweeds. He is involved in the successful development of AfriKelp, a commercial product from Namibian seaweeds.

Mr. Robert K. Davis
Institute of Behavioral Science
University of Colorado
Boulder, Colorado, USA
e-mail: davisrk@spot.colorado.edu

Currently a Senior Associate at the University of Colorado's Institute of Behavioral Science, Prof. Davis served as Assistant Director for Economics in the US Department of Interior's Office of Policy Analysis from 1976 to 1985. With degrees in agriculture, agronomy, public administration and economics (MPA and PhD, Harvard University) Davis has specialised throughout his career on the economics of natural resource management, with emphasis on water resources, fisheries, wildlife and rangelands. He has authored major studies of water resource economics and policy, including a book written for Resources for the Future, Inc. and is co-author of a recent evaluation of the Southern Okavango Water Resource Development Project in Botswana. From 1967-1970 he worked in Kenya, serving first as Ford Foundation economic advisor to the Kenya Ministry of Tourism and Wildlife and subsequently as Visiting Senior Research Fellow at Kenyatta University's Institute for Development Studies. From 1976 to 1987 he was involved in studies of US Bureau of Reclamation programs, revision of the US Principles and Standards for Water Resource Project Evaluation and the conflict between the Snail Darter and Tellico Dam. He is internationally experienced in wildlife, national parks and biological diversity issues. His recent research interests, consultancies and writings have focussed on rangeland and wildlife management policies in the western USA and Australia. Currently he is on the team of a USAID funded study of the livestock-wildlife-pastoralist interaction in East Africa.

Mr. Bruce Frayne
Department of Geography
Queen's University
Kingston, Ontario, Canada
e-mail: 8gbf@qlink.queensu.ca

Mr. Frayne is a Research Affiliate with the Social Sciences Division of the Multidisciplinary Research and Consultancy Centre at the University of Namibia, and a PhD candidate in the Department of Geography at Queen's University, Canada. He has produced more than twenty research publications on a range of development issues in Namibia and South Africa, although his focus is on urban and regional planning. Significant publications include his book *Urbanisation in Post-Independent Windhoek* (Capital Press, Windhoek, 1992), and a chapter in *On Borders: Perspectives on International Migration in Southern Africa* (edited by David McDonald, SAMP/St. Martin's Press, New York, 2000).

Mr. Ben Fuller
Multidisciplinary Research and Consultancy Centre
University of Namibia
Windhoek, Namibia
e-mail: bfuller@unam.na

Dr. Fuller is Head of the Social Sciences Division of the Multidisciplinary Research and Consultancy Centre at the University of Namibia. He has over 13 years of research experience in Namibia, and has produced over 50 publications on Namibia. These

publications cover a wide array of topics from education to HIV/AIDS to housing, all of which are focused largely on development issues. His main interests, however, include land management and land tenure, community based natural resource management and poverty.

Ms. Lauren E. Hale
Princeton University
Princeton, New Jersey, USA
e-mail: lehale@princeton.edu

Ms. Hale, from northern Virginia, is currently working towards her PhD in public policy at the Woodrow Wilson School with a concentration on population studies through the Office of Population Research at Princeton University. In particular, she is studying the relationships between environment and health, as well as college composition within the USA. She received her undergraduate degree in 1998 from Harvard University, where she studied environmental science and public policy, and wrote her Senior Honors Thesis on the development of the Namibian marine fisheries management. She participated in IIASA's Young Scientists Summer Program in 1996, and was awarded the Peccei Scholarship, enabling her to return the following year for a three-month period to continue her work.

Mr. Lazarus Hangula
Multidisciplinary Research and Consultancy Centre
University of Namibia
Windhoek, Namibia
e-mail: lhangula@unam.na

Prof. Hangula is a Senior Research Fellow at, and Director of, the Multidisciplinary Research and Consultancy Centre at the University of Namibia.

Mr. Dirk Hansohm
Namibian Economic Policy Research Unit
Windhoek, Namibia
e-mail: dhansohm@iafrica.com.na

Dr. Hansohm is Director of the Namibian Economic Policy Research Unit in Windhoek since 2000. He is an economist and has worked with NEPRU since 1994. He is also a member of the National Planning Commission. His areas of specialisation include economic policy, macroeconomics, industrial policy, trade (particularly in services) and regional integration, poverty, labour and small enterprise promotion. Previously he has worked at the University of Bremen, where he co-ordinated the establishment of a post-graduate course on *Small Enterprise Promotion and Training* and organised courses for policy makers in economic policy reform options. He did research and worked for international organisations in Nigeria, Sudan and Zimbabwe. His publications include

two books: *Small Industry Development in Africa. Lessons from Sudan* (Hamburg/Münster: Lit 1992) and, together with Robert Kappel, *Schwarz-weiße Mythen. Afrika und der entwicklungspolitische Diskurs* (Hamburg/Münster: Lit 1993).

Mr. Jan D. van Harmelen
Special Projects Manager
Multidisciplinary Research and Consultancy Centre
University of Namibia
Windhoek, Namibia
e-mail: jdvanh@iafrica.com.na.

Mr. van Harmelen had a successful business career before transferring to academia. He has the important and specialised responsibilities of interfacing between academic research and the business community with practical application and implementation of sustainable environment projects. Current interests include the design, development, implementation and promotion of integrated biosystem projects in Namibia. These include the high profile Tunweni Brewery and the Ujams projects.

Ms. Molly E. Hellmuth
Population Project
IIASA
Laxenburg, Austria
e-mail: hellmuth@iiasa.ac.at

Ms. Hellmuth joined the Population Project at IIASA in July of 1997. She is presently developing a methodology to model the seasonal fluctuation of water supply and demand in southern Africa, due to increasing population, development and climate change and variability. At the same time she is continuing her PhD work with the University of Colorado. Ms. Hellmuth received her Bachelors degree in hydrology in 1995 from the University of Minnesota and her Master's degree in water resources engineering and management from the University of Colorado. Ms. Hellmuth's primary fields of interest are water modelling, climate change impact assessments, and efficient and sustainable water management strategies.

Mr. Oddvar Jakobsen
United Nations Development Programme
Dar es Salaam, Tanzania
e-mail: oddvar.jakobsen@undp.org

Mr. Jakobsen has a MBA from the Norwegian School of Economics and Business Administration. He is a Deputy Resident Representative of UNDP, and has been assigned to UNDP offices in Windhoek, Dar es Salaam, Harare and Accra. He is a contributor to various editions of the *Namibia Human Development Report*. His research includes economic development and child nutrition in rural Africa.

Mr. Wolfgang Lutz
Population Project
IIASA
Laxenburg, Austria
e-mail: lutz@iiasa.ac.at

Dr. Lutz, Leader of the Population Project since 1992, joined IIASA in October 1985 to work on family demography, fertility analysis, and demographic models. He studied statistics at the University of Vienna and received his PhD in demography from the University of Pennsylvania, USA. In 1988, he was awarded the "Habilitation" in demography and social statistics by the University of Vienna, where he is adjunct professor. His present scientific interests lie in population projection, the interaction between the population variable, socio-economic development, and the natural environment. He is presently serving as Secretary General and Treasurer of the International Union for the Scientific Study of Population (IUSSP). He is the author and editor of 12 internationally refereed books and more than 100 articles.

Mr. Fergus J. Molloy
Department of Biology, Faculty of Science
University of Namibia
Windhoek, Namibia
e-mail: fmolloy@unam.na.

Dr. Molloy received his BSc (Honours) from University College Galway, Republic of Ireland, his MSc from the University of Natal, South Africa, and his PhD from the University of Cape Town, RSA. Trained as a marine biologist, he worked for the Namibian Ministry of Fisheries and Marine Resources in Lüderitz. He is now a Senior Lecturer at the University of Namibia. His varied interests include seaweed biology and their commercial utilisation and production. Recent research successes are in the field of mushroom cultivation, especially using waste products from the brewing industry as a substrate for mushrooms as part of ZERI-related activities in Namibia.

Mr. Keto E. Mshigeni
Pro-Vice Chancellor, Academic Affairs and Research
University of Namibia
Windhoek, Namibia
e-mail: kmshigeni@unam.na.

Prof. Mshigeni received his BSc from the University of East Africa (Dar es Salaam University College), and his PhD from the University of Hawaii, USA. He chairs the United Nations University International Scientific Advisory Council on Zero Emissions Research and Initiatives, as well as the Agricultural Sciences Committee for the Third World Academy of Sciences. He is also the UNU/ UNESCO Africa Chair for pioneering ZERI activities in Africa. He is Editor-in-Chief of *Discovery and Innovation*. He successfully pioneered the introduction of farming the red seaweed *Eucheuma* in

Tanzania. His interests include the cultivation and utilisation of seaweeds, issues on science and technology for sustainable development and environmental management in Africa.

Mr. Daniel O. Okeyo
Department of Biology
University of Namibia
Windhoek, Namibia
e-mail: dokeyo@unam.na

Prof. Okeyo is Head of the Department of Biology at the University of Namibia, and Associate Professor at the Department of Zoology at the Kenyatta University in Nairobi, Kenya. His current research includes river fish diversity and systematics (with a broad aim of filling the existing gaps in knowledge about riverine fish of the East Coast Province - Ethiopia, Somalia, Rwanda-Burundi, Uganda, Kenya, Tanzania, Eritrea, Djibouti, Malawi, Mozambique, Zambia and Zimbabwe); basic research in wetlands (freshwater and marine) and inland fisheries (with an aim to establishing small-scale industries from artisanal and aquacultural fisheries); environmental impact assessment of the zoology (invertebrates, amphibians, reptiles, small mammals) of the Epupa Hydropower Scheme project sites; limnology and ecology of Goreangab environs; aquaculture in a Zero Emissions Research Initiative industrial set-up system. He is a member and a consultant of several African professional and scientific societies, institutes and organisations. His publications include research reports, journal articles, book chapters, and monographs on fisheries, aquaculture, biodiversity and environmental impact assessment in Kenya and Namibia.

Mr. Wade Pendleton
Anthropology Department
San Diego State University
San Diego, California, USA
e-mail: wpendlet@mail.sdsu.edu

Prof. Pendleton is Professor of Anthropology at San Diego State University. During the last ten years he has worked on about thirty development projects in Namibia through the Namibian Institute of Social and Economic Research as well as its successor, the Social Sciences Division of the Multidisciplinary Research and Consultancy Centre of the University of Namibia. He also taught in the Sociology Department at UNAM. His many publications on Namibia include research reports, book chapters, and several monographs on Katutura, Windhoek's African township.

Ms. Isolde Prommer
Population Project
IIASA
Laxenburg, Austria
e-mail: prommer@iiasa.ac.at

Ms. Prommer graduated from the Department of Landscape Planning and Bioengineering at the University of Agricultural Sciences in Vienna in 1996, and is currently in the PhD program. She has professional experience in environmental impact assessment, in urban, regional and community planning, as well as in international planning competition. In 1997 she participated in IIASA's Young Scientists Summer Program. Ms. Prommer is now a Research Assistant in the Population Project at IIASA. In 1999 she became a member of the Young Integrated Assessment Network at the International Centre for Integrated Studies (ICIS) in Maastricht, the Netherlands. Her research interests are population and agriculture, impacts of HIV/AIDS on farming systems, subsistence farming, agrarian reform, and gender and environmental issues in developing countries.

Ms. Riikka Shemeikka (nee Raitis)
Population Research Unit, Department of Sociology
University of Helsinki
Helsinki, Finland
e-mail: riikka.shemeikka@helsinki.fi

Ms. Shemeikka received her Masters degree in geography at the University of Helsinki, Finland, specialising in geography of the developing countries. The topic of her thesis was "Population growth and fertility in Kenya and a case study of the Taita-Taveta district." In 1991-1992 she worked as a researcher in the Department of Sociology, University of Helsinki, in a research project on women's work and life in Finland during World War II. During 1992-1993 she worked in the Prime Minister's Office in Finland as a researcher, preparing a report on Finland's future developments and options. She also worked as a part-time assistant lecturer in the Department of Geography, University of Helsinki. During 1994 she worked first as a researcher in a project on population development in northern Namibia, and then as a full-time lecturer in demography at the Department of Sociology, University of Helsinki. In 1997 she joined the Population Project at IIASA to work on population, development and environment in Botswana, Namibia and Mozambique. She is currently working on her doctoral thesis on nuptiality and fertility in northern Namibia at the Population Research Unit, University of Helsinki, while on parental leave from graduate school.

Mr. Grant Wardell-Johnson
Australian School of Environmental Studies
Griffith University, Nathan Campus
Brisbane, Australia
e-mail: g.wardell-johnson@mailbox.gu.edu.au

Dr. Wardell-Johnson has extensive research interests in sustainable ecosystem management. He lectured at the University of Namibia from 1996-1998, during which time he travelled widely in southern Africa. His research interests while at UNAM include the sustainable management of mopane woodland. Prior to his work in Africa, he was a Senior Research Scientist on the sustainability of eucalypt forest ecosystems in south-western Australia. His current research interests include an assessment of the link between ecological and cultural sustainability. He is also interested in processes driving spatial patterns in the distributions of eucalypts, and biodiversity patterns across forest ecotones. He has published widely on the sustainable management of forest ecosystems, having written more than 40 papers and book chapters as well as numerous articles in popular science magazines in this area. Dr. Wardell-Johnson currently lectures in the Australian School of Environmental Studies at the Nathan Campus of Griffith University in Queensland, Australia.

List of Acronyms and Technical Notes

AIDS - Acquired Immune Deficiency Syndrome; the last and most severe stage of the clinical spectrum of HIV-related diseases

ARC - Annual runoff coefficient

ASFR - Age-specific fertility rate

ASMR - Age-specific mortality rate

CAWMP - Central area water master plan

CBNRM - Community-based natural resources management

CEVA - Centre d'Etude et de Valorisation des Algues, Pleubian, France

CMA - Common monetary area

CPUE - Catch per unit effort

CSO - Central Statistics Office

DEA - Department of Environmental Affairs

Dependency ratio - Population aged less than 15 and over 64 (dependent population), divided by the population aged 15 to 64 (productive population)

DRFN - Desert Research Foundation of Namibia

DWA - Department of Water Affairs

EA - Environmental assessments

EBP - Emergy benefit to the purchaser

EEZ - Exclusive economic zone

EIR - Emergy investment ratio

ELR - Environmental loading ratio

ENSO - El Niño-Southern Oscillation

ENWC - Eastern National Water Carrier

ESI - Emergy sustainability index

EU - European Union

EYR - Emergy yield ratio

FAC - Fisheries Advisory Council

FAO - Food and Agriculture Organisation of the United Nations

FFI - Freshwater Fisheries Institute

GDP - Gross domestic product

GEF - Global Environmental Fund

GIS - Geographic(al) information system

GRN - Government of the Republic of Namibia

GRP - Glass reinforced pipe

HDI - Human development index

HIV - Human Immunodeficiency Virus; a retrovirus that damages the human immune system thus permitting opportunistic infections to cause eventually fatal diseases. The causal agent for AIDS

HPI - Human poverty index

IATCP - Inter-Agency Technical Committee on Population

IBRD - Internal Bank of Reconstruction and Development, a World Bank Group, information at http://www.worldbank.org/html/extdr/backgrd/ibrd/

ICNAF - International Commission for North Atlantic Fisheries

ICSEAF - International Commission for the South East Atlantic Fisheries

IFAD - International Fund for Agricultural Development

IPCC - Intergovernmental Panel on Climate Change

IUCN - International Union for the Conservation of Nature

J - Joule

LRAC - Land Reform Advisory Commission

LSA - Lower South Atlantic

MAWRD - Ministry of Agriculture, Water and Rural Development

MCM - Million cubic meters

MET - Ministry of Environment and Tourism

MFMR - Ministry of Fisheries and Marine Resources

MFPP - Mahenene Fingerling Production Ponds

MHSS - Ministry of Health and Social Services

MLHRD - Ministry of Labour and Human Resources Development

MLRR - Ministry of Lands, Resettlement and Rehabilitation

MRCC - Multidisciplinary Research and Consultancy Centre of the University of Namibia (before 1999 known as Multidisciplinary Research Centre - MRC)

MWRA - Married women in the reproductive ages, 15-49 years

Mya - Million years ago

MYS - Ministry of Youth and Sport

N$ - Namibian Dollar

NACPSD - National Advisory Committee on Population and Sustainable Development

NAMWATER - A parastatal water supply agency

NAPCOD - Namibian Programme to Combat Desertification

NDHS - Namibia Demographic and Health Survey

NDP1 - First National Development Plan

NEPRU - Namibian Economic Policy Research Unit

NGO - Non-governmental organisation

NPC - National Planning Commission

OKACOM - Okavango River Basin Commission

PDE - Population-development-environment

PIEC - Population, information, education and communication

PLAN - People's Liberation Army of Namibia

PPU - Population Planning Unit

PTO - Permission to occupy

RDC - Rural Development Centre

RLB - Regional land board

SACU - Southern African customs union

SADC - Southern African Development Community

SAINT - Southern African INTegrated Model (developed by IIASA)

SDC - Sustainable Development Commission

Sej - Solar emjoules

SER - Socio-ecological regions of Namibia

SER A: Caprivi, Ohangwena, Kavango, Omusati, Oshana, and Oshikoto

SER B: Erongo, Hardap, Karas, Kunene, Omaheke, and Otjozondjupa

SER C: Khomas

SSA - sub-Saharan Africa

SSD - Social Sciences Division, Multidisciplinary Research and Consultancy Centre, University of Namibia

SSP - Safer sex practices

STDs - Sexually transmitted diseases

SWAPO - South West African People's Organisation

TAC - Total allowable catch

TFR - Total fertility rate

TNDP - Transitional National Development Plan

TTO - Technology Transfer Office

UNAIDS - Joint United Nations Programme on HIV/AIDS

UNAM - University of Namibia

UNCLOS - United Nations Convention on the Law of the Sea

UNCTAD - United Nations Conference on Trade and Development

UNDP - United Nations Development Programme

UNDPI - United Nations Department of Public Information

UNEP - United Nations Environment Programme

UNESCO - United Nations Educational, Scientific and Cultural Organisation

UNFPA - United Nations Population Fund

UNIDO - United Nations Industrial Development Organisation

UNIN - United Nations Institute for Namibia

WRA - Women in the reproductive ages, 15-49 years

WRI - World Resources Institute

WTO - World Trade Organisation

WWF - World Wildlife Fund

ZACPLAN - Zambezi River Basin Commission

ZERI - Zero Emissions Research and Initiatives

Kavango or Okavango

Due to the colonial history of Namibia, several names changed in every political period. During German colonial time and the South African annexation period, the area was officially known as Okavango/Okavangoland and the river as Okavango. After independence the native population has been protesting against the use of the prefix 'O' which is not common in their five local languages. In 1998 the Namibian government decided to respect the local culture. In respect thereof the government of the Republic of Namibia declared "Kavango" as the official name. This publication is therefore using Kavango, except for quoted references and the Okavango Delta. The Okavango Delta is under the authority of Botswana, the native population uses the prefix 'O' and it is officially named Okavango Delta.

Kunene, Cunene or Canaan

The second name, which could lead to confusion, is Kunene, Cunene or Canaan. They are synonymous, and we are using the first one throughout all sections.

INTRODUCTION

Ben Fuller and Isolde Prommer

1 Overview

The papers in this compendium represent a preparatory stage in the creation of a population-development-environment model for Namibia. As will be explained in the following section, this model requires information beyond lists of statistics. It is necessary to understand the reasons for the current state of affairs so that the scenarios made by the model are understood within a broader context. Also important is an understanding of the policy framework which will govern the activities of each sector. Legislation, policies and practical programs need to be understood so they too can be appropriately considered in the model.

It is with these aims in mind that the respective authors were asked to contribute their knowledge of Namibia to this project. As the model began to coalesce, it became clear that the background papers themselves deserved more than just a supplementary role. Together they present a reasonable body of information about different aspects of Namibian society. Given that the literature on Namibia is sparse and often contained in unpublished reports, these papers, many of which draw their information from this hidden or 'gray literature,' deserve to see the light of day in the form of this collection.

In the pages that follow, a brief description of the PDE model and its components is presented, after which, the focus will shift to specific issues which relate to Namibia.

2 Population, Development and Environment

Studies of population and sustainable development have a long and distinguished tradition at IIASA. At present the Population Project at IIASA (http://www.iiasa.ac.at/Research/POP/) has more or less completed the latest three PDE case studies on Botswana, Namibia and Mozambique, following earlier studies on Mauritius, Cape Verde and the Yucatán Peninsula.

2.1 Overview of the PDE concept

Due to the well-known shortcomings of comprehensive global models of the "Limits to Growth" type (Sanderson 1994) which became evident in the late 1970s, the IIASA team chose to focus their comprehensive modelling efforts on the regional and country level in order to better capture the specific forms of the complex population-

environment interactions. The PDE approach is designed to gain a deeper understanding of the population-development-environment-puzzle. The objective of the PDE projects are, in general terms, to study the complex interactions between population change, socio-economic development, and the physical environment with the help of computer information systems, namely, programming dynamic interdisciplinary models for studying **possible and potential** future developments.

As IIASA is not the only research organisation working in the population-environment field, their contributions towards designing specific easily adaptable models to different local, regional or national conditions are pioneering. For instance, the current Africa project (PDE in Botswana, Namibia and Mozambique) shows clearly that the problems in every country are different, composed of different climates, resources, agro-ecological zones and productivity (carrying-capacity), political systems, history, cultural background as well as other socio-ecological concerns. This country-specific complex system of population-development-environment interactions makes the need for flexible and easily adaptable computer models evident.

The IIASA general PDE approach, shown in Figure 1, is organised in three concentric circles, with population and development embedded in the environment (see Lutz 1994).
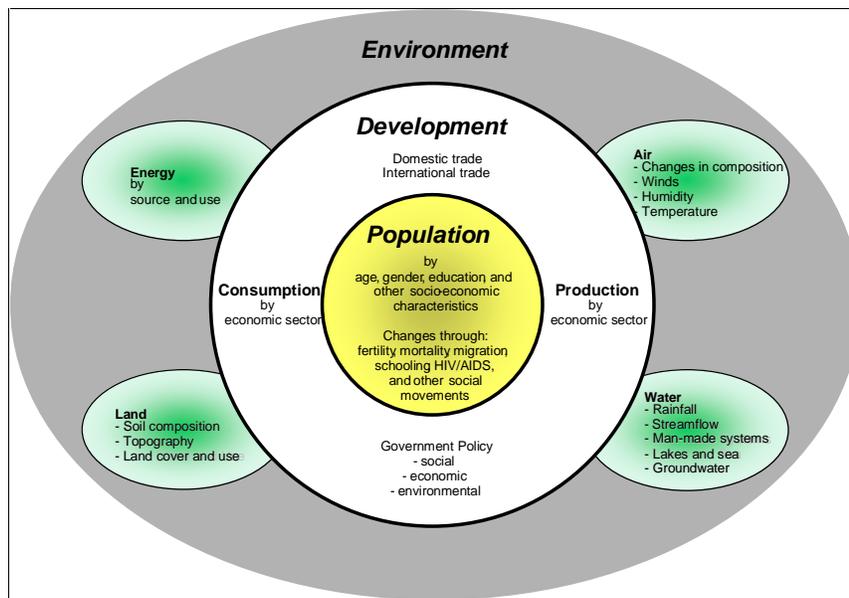
Figure 1. The general PDE approach. Source: Lutz (1994:215).

This concept differs from many other conceptualisations where the three factors population, development and environment are shown as boxes and inter-connected with arrows. But since the human population is not independent of, but part of the biosphere, the concentric circles are considered a more adequate representation. For instance, basic PDE questions are: How may human activities change the environment and vice versa, and to what degree? What policies can improve certain aspects of population-development-environment interactions?

Integrated assessment models try to quantitatively describe as much as possible the cause-effect relationships of a specific issue, and the inter-linkages and interactions among different issues. To represent complex systems the model must be reduced and simplified to key variables. The "simplification" is not only necessary because of the dependency and availability of data, but also to make the model *per se* more understandable and comprehensible. In addition, the model has to be designed in a way that is transparent and user-friendly, so that users will be able to run different scenarios without long-term software training. This is of importance for testing several assumptions by politicians, decision makers and other scientists. Because of the complex design of the model, the change of one single parameter could change the results in a stronger way than assumed and/or expected.

Due to the dependency on data, one important constraint of modelling is either the lack or non-availability of data and the limitations for incorporating qualitative information, which is, for instance, collected with participatory methods and traditional interviews.

In summary, even a simplified but integrated model can provide a helpful guide to complex issues and complement highly detailed models that cover only some parts of complex phenomena. The major strengths of integrated models are, for instance, in exploring interactions and feedback; helping to identify uncertainties and lacking knowledge; and being a helpful tool for the communication of complex issues. On the other hand, the model has obvious weaknesses. For instance, the accumulation of uncertainties and the high aggregation of data make some practical applications difficult. Also, the models depend on many preconceptions, since the modellers determine which variables are reported and how, and which objectives are optimised and how.

The computer dynamic simulation model used as a communication tool can be a helpful "translator" for closing the gap between the scientific and political language. IIASA PDE projects always had this policy component. Experience shows that for many policy-related questions, the short-term effects are of much more importance than the long-term ones. Hence, especially user-friendly computer models can be a helpful tool for assessing different assumptions and alternative policies by incorporating easily actualised data, running different scenarios, and changing time horizons without problem. Hereby, possible short-term effects can be shown without losing the long-term horizon. As a chart or as line diagrams, the output is easy to understand and interpret.

As explained earlier, one of the weaknesses of computer models is the limitations in using qualitative data in a quantitative systems approach. Besides other helpful tools (for instance, participatory methods such as focus groups), contributions written by local scholars, by NGO staff and by policy makers are important. Experience from earlier studies shows that the addition of a descriptive part complements and improves the model in a qualitative way. It has also become apparent that bringing together scientists with different backgrounds and working experiences may lead to the establishment of interdisciplinary discussion platforms which probably might not have had happened otherwise and is useful beyond the scope of this modelling exercise.

2.2   The Namibia PDE project at IIASA

The project "Evaluating Alternative Paths for Sustainable Development in Botswana, Namibia and Mozambique" (1997-2000) follows a tradition of case studies within the general PDE approach. The papers included in this compendium build on this tradition.[1] Based on workshops held at IIASA in 1997 and 1998, and several other contacts and meetings in Namibia, a stock of information and analysis has been compiled which is being reported here.

The PDE model[2] for Namibia consists of three modules: **population**, **economic** and **water**. This compendium of background papers will follow the same structure.

Scenarios can be run by each single module, or integrated. The following summary of the PDE model gives a short, easily readable and understandable description of the models without any technical details. Detailed information on each single model, the indicators, environmental conditions, population indicators, economic indicators, defined scenarios, the methodology and technical termini will be described in the forthcoming scientific book with the tentative title "AIDS, Diamonds and Water: Modeling Population and Sustainable Development in Namibia and Botswana" (edited by W. Lutz and W.C. Sanderson).

The **population model**[3] is designed to make scenario-based population projections for countries with high HIV prevalence rates. It is a multi-state population projection model that classifies the population by age, sex, educational status and HIV status. It makes use of all data available and corrects the data for biases. Scenarios that have been tested using the model include: (i) a perfectly effective vaccine that stops all spread of HIV as of January 1, 2001; ii) changes in risky behaviour both across cohorts and over time; iii) the use of medicines to reduce the transmission of HIV from mother to child; iv) the use of medicines to increase the life expectancy of people with HIV; v) the effects of a drought that lowers water quality and leads to higher rates of water-borne diseases; and vi) differential behavioural changes across education groups.

The **water model**[4] is modelled at two different levels, on a regional scale and on a case study scale. The time horizon for the model is 1993 to 2020. On the regional level the country was divided into three socio-ecological regions (Figure 2) based on the existing demographic and hydrological characteristics of the country (for the

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[1] The majority of the IIASA PDE publications can be ordered through IIASA or downloaded directly as PDF or PS files from the IIASA Home Page: http://www.iiasa.ac.at.

[2] All modules of the PDE model are written in Vensim, which is a dynamic system modelling software developed at the Massachusetts Institute of Technology (MIT), USA.

[3] The group of modellers consists of: (i) W.C. Sanderson (co-ordinator), Department of Economics, State University of New York at Stony Brook, USA, and IIASA; (ii) P. Kibuuka, Development Bank of Southern Africa, Republic of South Africa; (iii) K. Packirisamy, South African Department of Housing and Local Government, Research Development Section, Republic of South Africa; and (iv) A.B. Wils, Vassar College, New York, USA.

[4] The water model was designed by "the water team": (i) K.M. Strzepek (co-ordinator), Head of the Department of Civil, Environmental and Architectural Engineering, University of Colorado at Boulder, USA; (ii) M.E. Hellmuth (responsible for the water-balance model and groundwater model), IIASA and the University Colorado at Boulder, USA; (iii) A. Holt (water demand in Botswana), Stockholm Environment Institute, Boston, USA; (iv) N. Mladenov (water quality model in Botswana), University of Colorado at Boulder, USA; (v) D.N. Yates (expertise input and involvement in Mozambique model), University of Colorado at Boulder, USA.

hydrological characteristics see contribution by M.E. Hellmuth and the Introduction of this volume). The studies within Namibia assess the water resources for the Okavango Delta and the capital city of Windhoek. The discord between Namibia and Botswana over the development of the water resources of the Kavango River, and the uncertainty of future development of the tributaries to the Kavango River by Angola, present interesting policy questions. Namibia is considering extending the Eastern National Water Carrier to allow withdrawals from the Kavango River. This would augment the water supply for the urban area of Windhoek. The question is posed whether the ENWC, in its existing state, will be adequate enough to supply water to Windhoek for the next 20 years. Additionally, the North-South Carrier will soon be in operation in Botswana, at the Phase 1 level, in order to augment the water resources for the urban area of Gaborone. The question is posed whether the North-South Carrier, in its existing state, will be adequate enough to supply water to Gaborone for the next 20 years.

The following water resource scenarios were considered: (i) no change in climate; (ii) climate change scenarios based on the IPCC Reports; (iii) drought scenarios; (iv) human induced changes (construction of dams, groundwater well fields and others). The drought scenarios take the lowest five-year precipitation series in recorded histories and apply them to the climate series from 2000-2005, 2005-2010, 2010-2015 and 2015-2020.

The **economic model**[5] is comparatively simple. It is composed of three sectors: (1) mining and manufacturing, (2) livestock and agriculture, and (3) everything else. The mining and manufacturing sector allows us to recognise explicitly the importance of mining and manufacturing exports as driving forces. Putting the livestock and agriculture sector into the model allows us to consider the effects of past EU policies on livestock exports and future livestock and agriculture policies that might be built into the reformation of the Lomé Convention. The third sector is comprised of a set of products and services that are not internationally tradable, like government services.

Beside the mentioned contacts, visits and workshops, both at IIASA and at UNAM, another important goal of the PDE project is human capacity building. Modellers from different countries[6] conducted a two-week training course on Computer Modelling on Demographic, Economic and Environmental Interactions, hosted at the Centre of Population Studies, University of Pretoria, from 4-15 January 1999. The aim of the course was to train civil servants and students from the region in the methods of systems analysis as applied to population-development-environment interactions. Participants learned how to use the existing models for policy analysis and how to develop models themselves. Five persons from Namibia participated successfully at the training course:

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[5] The group of economic modellers consists of: (i) W.C. Sanderson, Department of Economics, State University of New York at Stony Brook, USA, and IIASA; (ii) A.B. Wils, Vassar College, New York, USA; and M.E. Hellmuth, IIASA and the University Colorado at Boulder, USA.

[6] The course was guided by three senior trainers: W.C. Sanderson, Department of Economics, State University of New York at Stony Brook, USA, and IIASA; K.M. Strzepek, Head of the Department of Civil, Environmental and Architectural Engineering, University of Colorado at Boulder, USA; Carel van Aardt, Centre for Population Studies, University of Pretoria, Republic of South Africa. They were assisted by three training assistants: M.E. Hellmuth, IIASA and the University Colorado at Boulder, USA; N. Mladenov, University of Colorado at Boulder, USA; K. Packirisamy, South African Department of Housing and Local Government, Research Development Section, Republic of South Africa.

Ms. Florette N. Fleermuys (DEA), Ms. Martha Naanda (UNAM), Ms. Ndeyapo Ndalikokule (UNAM-SSD), Mr. Martin Shapi (UNAM), Mr. Petrus Shuuya (MET).

2.3   UNAM involvement

In 1997 the University of Namibia was contacted by Wolfgang Lutz of IIASA about possible participation in this project. Dr. Lutz was directed to the Multidisciplinary Research Centre (at the end of 1999, renamed the Multidisciplinary Research and Consultancy Centre). After some discussion, the MRCC decided to host the Namibian component. The main task assigned to the MRCC was to contact relevant researchers in a variety of different fields to draft papers and inputs for the PDE process. Initially this took place within the faculties of UNAM, but was later expanded to include recognised experts working in other organisations. As such, representatives from government, non-governmental organisations and international multilateral organisations were recruited.

Throughout the course of the research, the MRCC hosted a number of IIASA staff who came to consult with the various authors as well as officials in government and bilateral organisations. As a result of these exchanges a large number of young Namibian research staff at the MRCC had the opportunity for both formal and informal contacts with professional research staff from IIASA. IIASA staff introduced the concept of modelling to our junior staff and demonstrated the Vensim software. Long after IIASA staff had returned to Vienna, our younger researchers could be seen drafting and debating models they themselves had developed for their own use.

3   PDE Issues in Namibia

When trying to define sub-regions, scientists are faced with ubiquitous problems of interdisciplinary studies, namely, that social information tends to come by administrative units (countries, regions, counties), whereas ecological regions follow climatic, hydrological, soil type, vegetation, topographic, and geological determinants that usually do not stop at administrative borders. A simple pragmatic solution would be to choose one unit of analysis at the expense of the other. An interdisciplinary analysis that aspires to study both the socio-economic and ecological dimensions in some depth cannot make a simple choice of this sort. While it may be possible to estimate the number of people living in a certain ecological zone by remote sensing, this method has its limits in terms of knowledge of the demographic and socio-economic structure of the population. This information is derived by census or survey data, which are analysed by administrative units. On the other hand, hydrological and groundwater systems cannot be meaningfully modelled by political boundaries. At first glance, it may seem that the ecological determinants are not taken into consideration by looking at the map. It is finally a division based on administrative boundaries, but the water supply model within the current Namibia project includes the water supply based on hydrological water basins and scaled to the administrative units (Lutz 1997; Batllori *et al*. 2000).

This concept, which was developed specifically for the Yucatán Peninsula, presents a useful addition to PDE analysis and to integrated assessment in general.

Significant efforts were made to define the appropriate regional level of analysis, and extensive discussions were held during the workshop at IIASA in July 1997 (attended

by planners, politicians and scientists from Namibia, IIASA and other institutions). In defining the socio-ecological regions, hydrological basins or geo-hydrological units in Namibia were considered in conjunction with the different socio-economic and demographic processes taking place in such units and sub-units. Based on the major issue of water constraints, population patterns, and regional differences of socio-economic distribution of the population, Namibia was divided into three SERs (see Figure 2 and Table 1).

Figure 2. Socio-ecological regions, Namibia.

Table 1. Selected determinants for the socio-ecological regions, Namibia.

SER	Administrative Regions	Region	Population (1991)[a]	Area (km² and % of total area)[a]	Pop density in pers./km² (1991)[a]	Sex ratio (men/100 women, 1991)[a]	Average per capita annual income[c]
A	Caprivi, Ohangwena, Kavango, Omusati, Oshana, Oshikoto	Communal land tenure	840,434 (60%)	115,827 (14%)	7.3	85.4	N$ 1,550
B	Erongo, Hardap, Karas, Kunene, Omaheke, Otjozondjupa	Mainly commercial land tenure	402,415 (28%)	669,729 (81%)	0.6	110.8	N$ 4,545
C	Khomas	Metropolitan area	167,071 (12%)	37,590 (5%)	4.4	110.5	N$ 11,359

SER	TFR (1991)[a]	< 5 mortality rate per 1000 live births (1991)[a]	HIV-prevalence rate among pregnant women (1996)[b]	Age 6 years and older who never attended school (1991)[a]	Languages spoken[a]	Average annual precipitation (in mm)[d]
A	6.5	93	Oshakati 22.4%, Onandjokwe 17.4%, Engela 17.6%, Rundu 8.4%, Andara 10.5% Katima Mulilo 24.2%	22%	Oshiwambo Languages73% Kavango (RuKwangali, RuGciriku, Mbukushu) 15% SiLozi 8%	from west to east 350 - 650
B	5.1	86	Swakopmund 17.4% Opuvo 3.4%	27%	Nama/Damara 33% Otjiherero 12% Afrikaans 20% Oshiwambo languages 13%	from south-western to north-eastern corner 50-550
C	4.1	50	Windhoek 16.0%	12%	Afrikaans 29% Oshiwambo languages 27%, Nama/Damara 21%, Otjiherero 10% German 4%, English 4%	from west to east 50 - 375

a   1991 Population and Housing Census, Walvis Bay not included (GRN/NPC 1994)
b   Ministry of Health and Social Services (MHSS 1993)
c   National Household and Expenditure Survey 1993/1994
d   Links dataset (New et al. 1999), details in M.E. Hellmuth in this volume

The sub-region SER A in the north is the most densely populated region and the most humid area of the country. Along the northern border to Angola one of the three perennial rivers, Kavango, is in discussion for extracting water for the fast growing capital of Windhoek in the arid centre of the country. The average annual precipitation is unequally distributed over the year, characterised by a dry and rainy season. Further, the country, not only this region, is faced frequently with the negative effects of drought years. The land tenure system, a result of the colonial history, refers mainly to communal land tenure, combined with small-scale rainfed farming. These adjunct administrative regions have the highest fertility rates and child mortality rates, the lowest educational level and income per capita, and a lack of men, which is a sign of rural male out-migration.

SER B, the arid part of Namibia is the less densely populated region due to the low carrying capacity. Most of the area is within the freehold tenure system in addition to a few small "homeland" areas. This region consists of the Namib Desert and the complete coastal area, which is famous for its endemic vegetation and wildlife. The only deep-sea port of Namibia, located east of the capital Windhoek, is Walvis Bay. Both Swakopmund and Walvis Bay are important for the development of the Namibian fishery industry (see L.E. Hale in this volume). Diamond mines, an important industry for the country's development in general, are located in the south-western part of Namibia (Sperrgebiet). The complete region has only two perennial rivers: Kunene River at the Angolan border in the north and Orange River at the South African border in the south.

SER C, Khomas region including the capital Windhoek (which is analysed in a separate case study in the forthcoming publication, edited by Lutz and Sanderson), is faced with increased in-migration. The fast and unplanned migration (see Pendleton and Frayne in this volume) puts pressure on the scarce natural resources in the receiving area, especially the safe water supply. The socio-economic determinants are therefore different. This region has the lowest fertility rate, the highest level of education, and the highest standard of living.

Regional disparities have their roots in the country's colonial history, particularly the policy of ethnic separation. The challenge of equal regional development is even more severe as the majority of the population lives in the northern regions. The Namibian government is aware of the regional development problems and is working toward policy solutions.

3.1   Environmental issues and constraints

Namibia covers an area of over 800,000 km^2, and has a population of approximately 1.7 million people. This means a population density of about two people per km^2. On the surface, it might appear that concerns over population and environmental trends might not be necessary. But this appearance is only skin deep. Namibia is one of the driest countries in sub-Saharan Africa. Two major deserts (the Namib Desert along the coast and the Kalahari Desert in the south-eastern part of the country) fall within its territory. The only perennial rivers in the country are along the northern and southern borders with Angola and South Africa respectively. Rainfall is low – well below 700 mm per

annum for most of the country – and unpredictable, a situation which leads to frequent and localised droughts. Environmental productivity is low.

Sustainable use of its resources is a critical matter for Namibia. Eleven years ago, the drafters of the Namibian Constitution recognised this fact, and included the provision of sustainable use of the environment into the text of the fundamental law. As such the debate about long term use of the environment has been shifted away from whether or not this is a good thing, to how this can best be implemented. The past ten years have seen a series of laws and policies in support of sustainable use proposed and implemented. Yet, it must be kept in mind that the country suffers from wasteful policies and practices left over from the colonial period.

Water is an overriding issue for the country as there is concern expressed in many sectors of the society about the availability of water for human consumption in succeeding generations. Agriculture has a mixed outlook. In certain key niche markets, such as grapes and dates, the potential for production is vast, provided that sufficient water resources can be developed. In more traditional sectors, such as stock farming, the outlook is clouded by the dependence on highly variable and unpredictable rainfall patterns. Frequent droughts and years of insufficient rainfall can destroy browns and graze forcing many farmers off the land.

Sectors such as fishing and mining are largely extractive and could be depleted if not properly managed. Some fisheries stocks already show signs of depletion. In the mining sector the past decade has seen a major shift in diamond mining away from on-shore operations in the rich deposits along the coast, to high tech exploitation of diamond fields beneath the ocean. One major mine in Tsumeb has closed, while others may be nearing the end of their lifespan.

Tourism is a major resource, and the growth of this sector has been rapid since 1990. Tourism, however, is most sensitive to practices of sustainable use because the major draw for tourists is wildlife. Wildlife needs to be managed so that their numbers are sufficient to draw visitors, but at the same time their numbers are not so large that they come into conflict with human populations.

3.2   Development and population issues

Due to policies of apartheid which were implemented throughout much of the century, Namibia is still two societies in one. There is a minority of the well off, and a large majority of the poor. Prior to independence these two groups were largely determined by race. Today, there has been an emerging non-white elite which has joined the ranks of the well off. Still, Namibia's Gini Coefficient, a measure of economic disparity, is one of the highest in the world at around 0.70%. Another disparity is geographic. Before independence the country was divided along racial lines and the bulk of services and infrastructure was developed in the area reserved for whites. Yet, the majority of Namibia's population lived outside this area.

Over the past decade, the government has had to address this disparity by investing heavily in basic services such as roads, electricity, water infrastructure and facilities such as schools, police stations, government offices and housing. These have often been

the prerequisites for social and economic development which can assist the country's impoverished majority.

Population policies and fertility patterns are more closely described in the papers by O.O. Arowolo in this volume. At first glance there is a clear relationship between total fertility rate and other parameters: the lower the TFR, the higher the per capita income, the lower the illiteracy rate, and the higher the educational level (UNDP/AIDS 1997; UNDP 1998, 1999). The major goal of Namibia's population policy is to contribute to the improvement of the standard of living, quality of life, and family planning.

The differences between regions are remarkable, not only for the so-called "development" parameters, but also for employment possibilities. This is evident by a simple analysis of migration data. Wide regional differences are also found in the land tenure systems (more detailed information in L. Hangula's paper in this volume).

In addition to the regional differences, there are broad urban to rural differences and intra-regional differences. But the differences between language groups are more evident than those between regions. The highest standard of living is among German, English and Afrikaans speakers, and the lowest among Saan, Rukavango and Lozi speakers.

In summary, the northern part of Namibia has the lowest per capita income, the highest total fertility rate, a communal farming tenure system, the lowest secondary or higher education rate, the highest illiteracy rate and the highest migration rate. This region, with its high natural resource potential (excluding diamond mining, which is mainly located in the south-western part of the country), is the poorest and least developed part of Namibia, and home to the majority of the Namibian population.

A widespread concern in Namibia and sub-Saharan Africa is the HIV/AIDS epidemic and the high rates in Namibia. The IIASA project developed a new methodology for adjusting observed prevalence rates from Sentinel Surveillance Surveys for the different sources of bias and for using the corrected data to project future populations. Another model for population projection including HIV/AIDS was developed by O. Jakobsen (see this volume) during his work at the UNDP (UNDP/AIDS 1997). A key challenge of the PDE Namibia model is the assessment of longer term implications of the AIDS epidemic on future population and sustainable development.

4   Structure and Purpose of the Volume

This collection of background papers is divided into three sections: environment, development and population, the three components of the PDE model. We start off with environmental issues, because Namibia's environment is both a limitation and a resource for addressing the major developmental needs of the country. Namibia's natural resources are a major source of wealth which, if used wisely, can provide the economic base for development. Since independence a number of efforts have been undertaken to address the needs of development in the country. Many of these relate to sustainable use of the natural environment. As in many areas of the society, there has been the need to first elaborate policy and later draft, promulgate and implement enabling legislation. For many, this process has at times been perceived as torturously slow, but it has been necessary because a new institutional framework had to be created

out of the ashes of apartheid. There is a need for policy formulation and legislation, but there are other factors which loom over Namibia's future.

The section on environment begins with a paper by Wardell-Johnson, which focuses on biodiversity, but which also provides a broad overview of the environmental challenges facing the country. Two papers on water follow. Water is perhaps the most common limiting resource in a country with perennial rivers only on its northern and southern borders. Hellmuth provides a general discussion on the issue of water resources, while Davis examines the different strategies of water use which the country may follow. Hangula contributes with a paper on land reform. As noted above, Namibia was divided according to race during the colonial period. Indigenous Namibians were forced off land to which they had valid claims and moved into marginal areas. As a result, the issue of land, as in other SADC countries, is emotional and potentially volatile. While Namibia is often associated with deserts and an arid climate, its marine resources are plentiful. The role of fisheries has grown to prominence in the economy. Hale examines the marine fisheries in Namibia's exclusive economic zone, while Okeyo provides insight into the often neglected fresh water fisheries.

In the development section, Blackie examines the policies on sustainable development which have been created in the first decade of independence. Namibia has a constitutional imperative to use its natural resources in a sustainable manner. A major aspect of this imperative has been to place the onus of resource management into the hands of the principle users. A corollary has been to make the principle users also the direct beneficiaries. While this may appear simple on the surface, actually doing so has required the erasure of decades of apartheid legislation and on-the-ground practice. Shemeikka follows with a paper on education, which is arguably Namibia's greatest achievement in the past decade. Education, which was largely restricted to whites under apartheid is now available to all. Hansohm looks at different pathways which Namibia could follow in developing long-term economic strategies. Because Namibia is still a young country, it is in a position to determine which way it wants to go with regard to developing its economy. Buenfil provides an interesting analysis on the costs of water development for the country. Certainly, water is required for whatever social and economic developments are to take place. Currently, Namibia has a choice over the long term pathways it wants to take to provide water for its population over the next decades. Critchley *et al.* examine efforts by the University of Namibia to develop new industries and products from the country's resource base. This is an effort on the part of the University to wed academic research with the needs of a developing country.

The section on population begins with a chapter by Arowolo on the formulation of a policy. Prior to independence the amount of data on population dynamics was thin. Namibia was faced with some immediate problems, notably the high rate of population growth and the peril of the HIV/AIDS epidemic, which resulted in the re-organisation and creation of administrative units, which are co-operating with local and international NGOs and other institutions. Arowolo follows with a chapter on fertility in Namibia, where he analyses the relationship between fertility and selected socio-economic factors. Pendleton and Frayne contribute with an examination of migration within the country. The growth of urban centres, most notably the capital Windhoek, could have serious long term effects on resources if the rate of immigration from the countryside to the cities is neither slowed nor reversed. Lastly, Jakobsen provides a model for studying the impact of HIV/AIDS in Namibia. This crucial topic also features prominently in the

companion volume to this work. HIV/AIDS will be perhaps the single defining factor of development not just in Namibia, but in most of Africa over the next few decades.

5   Outlook

Preliminary working versions of the model are being used in Namibia and Botswana and were the basis of the southern African training workshop held at the University of Pretoria early in 1999. The models will be finalised at IIASA in 2000. They will then be implemented at the home institutions in Namibia and Botswana and serve as the tool for science-policy dialogues in the countries.

During a series of meetings in the southern African region in late 1999 it became apparent that there is great demand for an expansion of this kind of analysis in the region. This expansion is seen desirable both in a spatial sense (to include South Africa, Zimbabwe and Lesotho in the study) as well as in a temporal sense (to establish this interdisciplinary model-based analysis of alternative development option on a more sustainable basis, i.e. to create more permanent networks and/or institutions). It is planned to discuss the possible expansion of the activities of this project in an international workshop in Brussels in September 2000 in order to facilitate the participation of a larger number of representatives of the African collaborating institutions, of other interested participants from southern Africa, representatives of the European Commission and of international development agencies.

Further, it is necessary to mention the growing interest in the project from a wide range of institutions and organisations, for example in methodology, data information and contacts. There are many avenues that have been taken to promote the distribution of information about the PDE Project. These include conferences, university seminars (this can be interpreted in terms of human capacity building), informal meetings, mutual information "sharing sessions" and finally, through our informative web page. There has been a substantial amount of requests for information on our work, on data information, on computer modelling training courses and workshops, up to volunteer co-operation from individuals working in related projects.

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PART I. ENVIRONMENT

BIODIVERSITY AND CONSERVATION IN NAMIBIA INTO THE 21st CENTURY

Grant Wardell-Johnson

Abstract

A review is provided of the future prospects for the conservation of biodiversity in Namibia to the middle of the 21st century. I consider the biodiversity of Namibia within a biophysical and social environmental framework. Namibia is a large, semi-arid to arid country in the south-western region of southern Africa. It includes some of the most distinctive of the world's desert-dwelling biota with very high levels of endemism and high congruence among several major groups. Major environmental changes are expected with increasing demands on the natural environment. It will be increasingly necessary to maintain components of the varied traditional management systems if biodiversity and environmental condition are to be maintained. The future of Namibian biodiversity will depend on adopting governance systems that strengthen local-level mechanisms and institutions, and strengthening the links between knowledge generation, resource users and policy makers.

1 Introduction

Biodiversity describes the variety of life on earth. It includes genetic diversity, species diversity, and ecological diversity, and is the totality of genes, species and ecosystems in a region (WRI *et al*. 1992). It is the basis for human survival and development (Tilman *et al*. 1994; Ehrlich 1994). The necessity to actively maintain biodiversity has been recognised as the rates of environmental change and degradation have increased rapidly in recent decades (IUCN *et al*. 1980). At the same time, the links between biodiversity loss, ecosystem decline and the demise of human populations have also been established (Ponting 1991; Tilman *et al*. 1994; Ehrlich 1994; Hilborn *et al*. 1995). Therefore, the social aspect of biodiversity conservation is perhaps the most critical component of the interaction between environment, population and development. This chapter therefore takes a broad view of the role of biodiversity and Namibian development into the 21st century by considering the biodiversity of Namibia within both a biophysical and social environmental framework. I provide an overview of the distinctive biophysical environment, examine interactions with the socio-economic environment and conclude by examining the opportunities for conserving the Namibian environment.

2   The Biophysical Environment

Namibia is a large, semi-arid to arid country in the south-western region of southern Africa. It is a land of great contrasts in physical environment, and includes some of the most distinctive of the world's flora and fauna. This section provides an overview of the distinctive biophysical environment of Namibia.

2.1   Geographic setting

Namibia covers an area of about 824,000 km^2 on the south-western coast of Africa between latitudes 17.5^0 and 29^0 south. The central part of a cross section through southern Africa along the Tropic of Capricorn (including eastern Namibia) is slightly lower in altitude than the margins and forms the large Kalahari Basin. The Drakensberg in the east, and the high plateau of Namibia in the west, are raised and form a steep escarpment towards the coast. In the south the high plateau slants downwards in a number of steps. Thus Namibia is dominated by an escarpment along the western side of the country which forms a transition between the narrow coastal desert (about 100-150 km wide) and the flat inland plateau at 1000-1200 m. Several mountain chains include peaks over 1800 m (Figure 1).

Figure 1. Simplified topography and major rivers of Namibia showing place names mentioned in the text. After Jarvis and Robertson (1997); Curtis *et al*. (1998).

The distribution of pre-Tertiary rocks divides the country roughly into three. The Damara Sequence (900 to 545 Mya) underlies most of the northern half of the country. The southern half is divided along an approximate north-south line into a western third underlain by rocks older than about 600 Mya and an eastern two-thirds underlain by the Nama Group (600 to 500 Mya) and Karoo Sequence (310-70 Mya). Older rocks are exposed in the far south of this latter portion. Tertiary deposits of the Kalahari Sequence cover large areas in the eastern and northern parts of Namibia. Tertiary sands, deflation scree and fluviatile deposits of the Namib Desert cover much of the coastal region.

The Namibian massif is a major tectonic uplift. The great escarpment is parallel with the coast. The initial building of the scarp was a major post-Gondwanan event but its altitude did not exceed 600 m. A subsequent period of erosion extended some 80 million years from the Cretaceous to the mid-Tertiary. During this period, the escarpment gained height as it retreated by scarp erosion into the more elevated inland landmass. Since the separation of Africa from Gondwanaland, the coastal rim of the southern subcontinent has been subject to successive elevations and subsequent coastal abrasion. The most striking feature of the early post-Gondwanaland geomorphology has been the prolonged denudation of the massive Tertiary plain, remnants of which are to be found in the basaltic caps of the Khomas Highland. Southern Africa was not subject to glacial activity during the last glaciation (Werger 1978, 1986; Walter 1986).

Namibia is the most arid country south of the Sahara. Because of its latitude, southern Africa is exposed in summer to the easterly trade winds. They carry moisture-laden air masses from the warm Mozambique Current off the east coast of Africa. Most of their moisture is precipitated as these winds rise on the slopes of the Drakensberg. Precipitation decreases progressively towards the west. The cold Benguela Current off the west coast of Africa has a moderating effect on regional weather patterns, leaving the Namib as a rainless desert. Rainfall increases from the south-west to the north-east of the country, varying from an annual average of less than 50 mm in the Namib Desert to 700 mm in the north-eastern Caprivi Strip. Summer rains occur in the form of convectional thunderstorms over the major portion of Namibia, but episodic winter rainfall occurs in the south-western Namib. (Ashley 1994; Byers 1997; see Figure 2).

Rainfall is not only low, but also variable. Rainfall variability is inversely proportional to the mean annual rainfall (van der Merwe 1983; Figure 2). This variability is about 30% in the north and about 70% in the south and west. In addition to this negative correlation between the amount of rainfall and its variability, rainfall variation is also negatively correlated with latitude, so dry tropical systems are among the most variable on earth. Rainfall variation also increases in regions influenced by sea surface temperature anomalies associated with El Niño-Southern Oscillation patterns. Tropical and ENSO effects lead to parts of southern and eastern Africa having co-efficients of variation greater than 33%, even in areas receiving more than 1000 mm per annum. Thus, these effects can dominate the typical correlation between increasing total precipitation and decreasing precipitation variability (Bakun 1995). In addition to low, variable rainfall, most falls in short intense episodes so that infiltration is often very low (Jansson 1991; Brown 1992; Byers 1997).
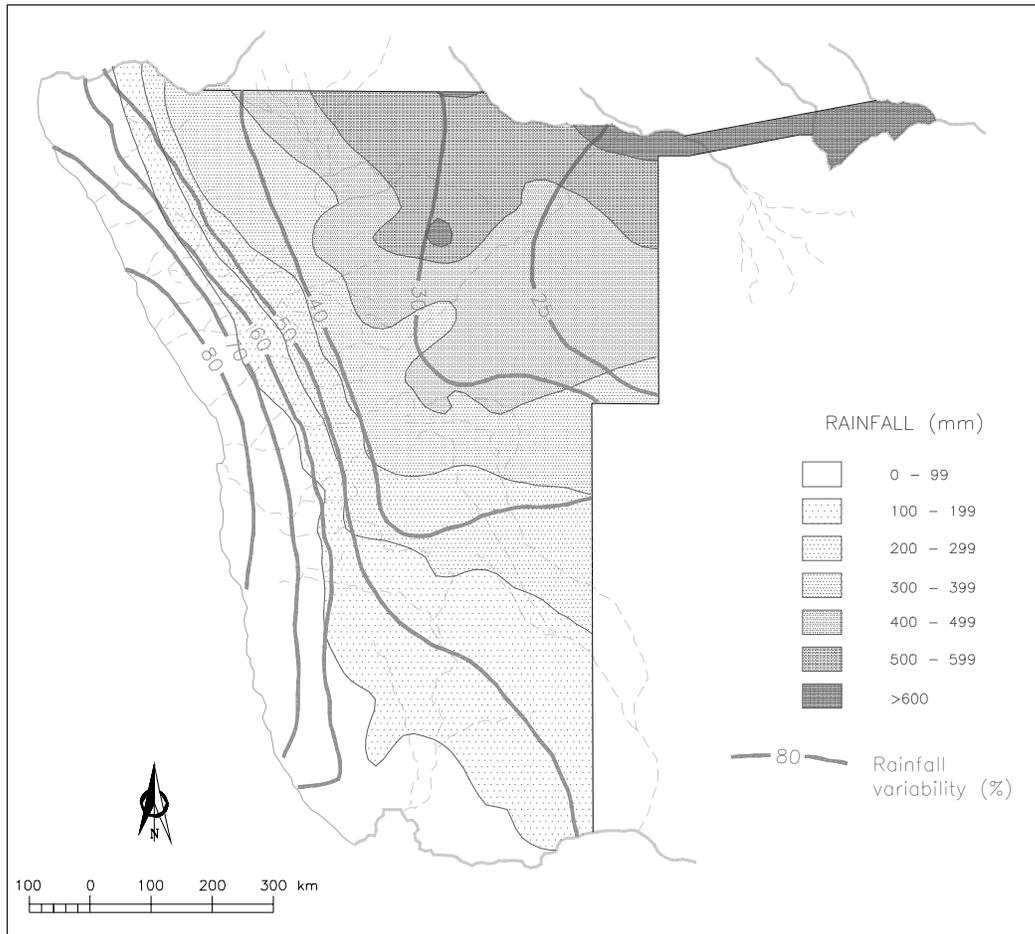
Figure 2. Mean annual rainfall and rainfall variability in Namibia. After van der Merwe (1983); Byers (1997).

    The only perennial rivers in Namibia are found along the northern and southern borders (Figure 1). The Kunene and Kavango Rivers form the northern border with Angola, while the Kjwando, Linyanti, Zambezi and Chobe form the borders with Botswana and Zambia in the north-east. The Orange River, the largest river in southern Africa, forms the border with South Africa in the south. The headwaters of all these rivers are in other countries. Most of the interior catchments are characterised by ephemeral rivers, which flow following heavy rains in the interior highland headwaters of their catchments (Jacobson *et al*. 1995). The northern border area, west of the Kavango River and east of the Kunene, is very flat and is traversed roughly from north to south by numerous seasonal rivers whose waters originate in Angola. These rivers include the Cuvelai, the Caundo and the Etaka. The drainages of these rivers converge south of the Namibian border, near Lake Oponono, and from here the Ekuma River flows into Etosha Pan.

2.2   Terrestrial biomes and vegetation types

Although there is no detailed map or overall analysis of the vegetation types of Namibia equivalent to that of South Africa (see Rutherford and Westfall 1986, 1994), several generalised vegetation maps have been prepared. Giess (1971, reprinted 1998) divided the vegetation of Namibia into three main groups, deserts (16% of the country), savannas (64%) and woodlands (20%). He recognised 15 main vegetation types (five deserts, eight savannas and two woodland types; see Figure 3) and provided a map at 1:5,000,000 scale, a brief description of the vegetation structure, distinctive physical characteristics and the most important plant species in each. For example, Mopane Savanna, one of Giess's 15 vegetation types, occupies the north-western part of the country inland from the Northern Namib vegetation type. Mopane Savanna is so named for the characteristic species, *Colophospermum mopane* that may occur as a shrub or tree depending on local conditions. Giess (1971) lists 14 species of *Commiphora* and 23 species in the family Acanthaceae associated with this vegetation type and suggested that it is closely related to the Mountain Savanna which it abuts, and with which it has many species in common. Eleven avi-vegetation zones have also been defined (Jarvis and Robertson 1997). Some of the boundaries of these zones coincide with Giess's (1971) vegetation types. However, three desert and three savanna vegetation types were each combined, and the Escarpment Zone was considered inland of the Desert Zone to Angola. A Kavango type was also defined to recognise the distinct wetland environment of eastern Caprivi.

There are four natural vegetation biomes in Namibia (Hilton-Taylor and Le Roux 1989; Hilton-Taylor 1987; Jürgens 1991; Figure 3). These include two winter rainfall zones, the Succulent Karoo which is more or less equivalent to Giess's (1971) Desert and Succulent Steppe-Winter Rainfall Area, and the Nama Karoo which is more or less equivalent to Giess's (1971) Dwarf Shrub Savanna. The two summer rainfall zones are the Savanna and Namib Desert, which include the remainder of Giess's (1971) types. The biota, particularly the floras, of the winter and summer rainfall zones are quite distinct from one another. There is a general coincidence of rainfall and vegetation type (Figures 2 and 3). The variability in rainfall means that the amount of standing vegetation varies considerably from year to year. Thus, the carrying capacity of terrestrial ecosystems also varies. This variability also plays a major role in Namibia's wetland ecosystems, many of which are ephemeral and only occasionally flooded or wet.
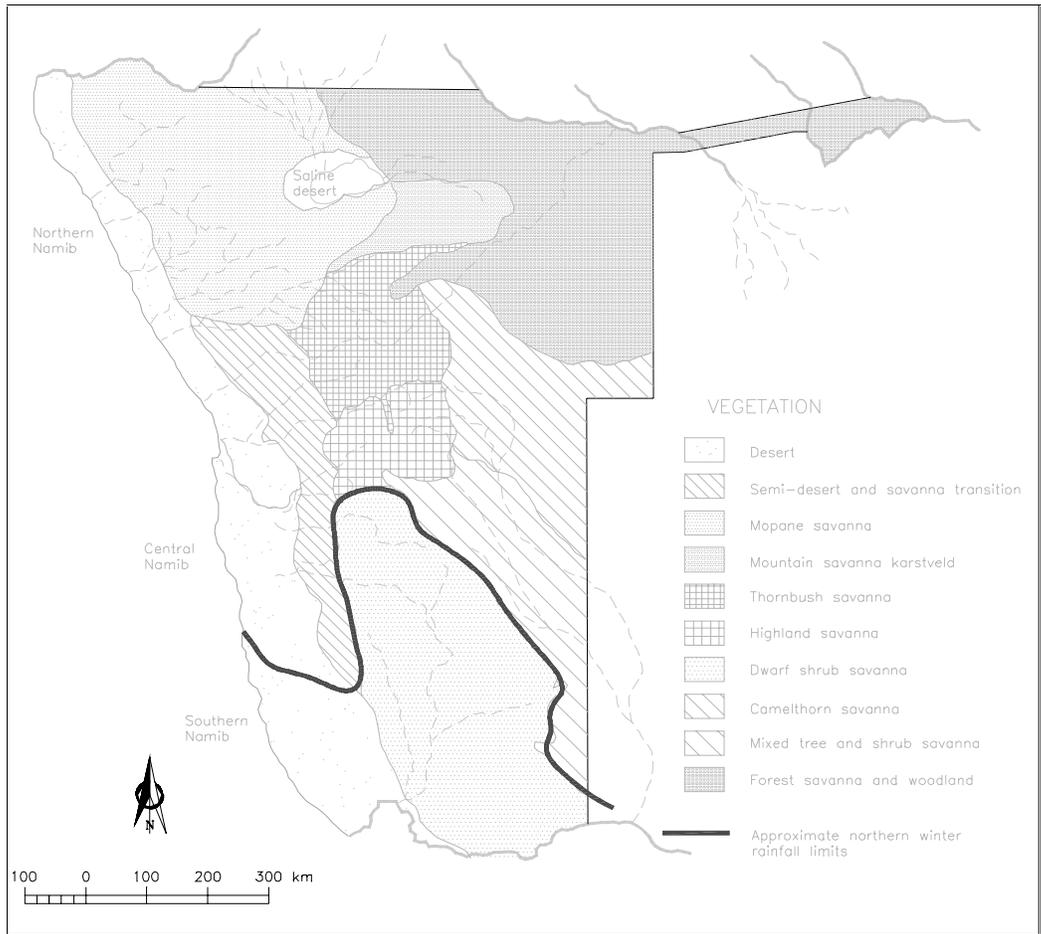
Figure 3. Main biomes and vegetation types of Namibia. After Giess (1971); Jarvis and Robertson (1997). Only 14 of Giess's types are shown, as Riverine Woodland cannot be mapped at this scale.

2.3 Wetland ecosystems

Wetlands[1] comprise about 4% of Namibia and are the most productive and biologically diverse ecosystems. They include springs and ephemeral wetlands, artesian springs supporting small perennial pools and streams, ephemeral rivers, the oshanas of northern central Namibia, and the floodplains of the perennial border rivers (Curtis *et al*. 1998). These wetlands are all of biodiversity significance since they include relatively high levels of species richness and high levels of endemic taxa, including insects, crustaceans and frogs. They also provide drinking water for many terrestrial vertebrates, such as lions, hyenas, and baboons that would otherwise be much more restricted in their distribution. The northern rivers hold the bulk of the biodiversity within the aquatic ecosystems of Namibia (Curtis *et al*. 1998). Ephemeral rivers act as linear oases (Jacobson *et al*. 1995). Although there is no surface water, considerable quantities of

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[1] Wetlands are the interface between aquatic and terrestrial ecosystems, whether permanently or ephemerally inundated with fresh or salt water (Simmons *et al*. 1991).

water are held at depth in the beds of most of these rivers. Deep-rooted trees tap directly into this supply providing the resources for diverse communities.

Although the estuaries of most of the western ephemeral rivers are sanded up, some support wetlands of great importance to water birds. For example Sandwich Harbour is a 5 km^2 wetland fed at least partly by subsurface freshwater, that supports some 70,000 wetland birds. The wetlands at Walvis Bay, which include the Kuiseb estuary, extend over some 35-40 km^2 and support migratory birds as well as more than half of southern Africa's flamingos (du Toit and Squazzin 1995).

Namibian ecosystems include many alien organisms, many of which are associated with wetlands and some of which pose severe threats to one or more aspects of continued functioning or biodiversity of these systems (e.g. *Datura innoxa*, *Prosopis* sp. and *Nicotiana glauca*). In western Namibia, most invasive plants occur in riverbeds and/or at water holes (where they are spread by floodwaters or animals) because these are the only places where permanent water occurs below the surface (Brown *et al*. 1985).

2.4   Marine and coastal ecosystems

The Benguela Current influences the entire coastline of Namibia and brings cold Antarctic water into warmer subtropical regions. Seasonal southerly winds induce up-welling at the coast, providing an abundant supply of nutrients which promote extensive blooms of phytoplankton, rich resources of zooplankton, and an abundance of fish. They support some of the highest concentrations of marine life in the world. The Benguela Current ecosystem off the Namibian coast has one of the highest primary production rates in the world so that marine resources are one of Namibia's most important renewable natural resources (Sakko 1998).

Productivity of the Benguela ecosystem is characterised by large inter-annual and inter-decadal variability, favouring the persistence of few, generalist species. Stocks of fish such as pilchard and anchovy exhibit marked fluctuations in abundance associated with these changes. Abundant fish support large populations of seabirds and marine mammals. Bivalves such as mussels and oysters, and crustaceans such as lobsters and crabs are also abundant in these rich waters (Sakko 1998).

2.5   Terrestrial communities

The environmental profile of Caprivi (Mendelson and Roberts 1997) is the first attempt to provide a regional pattern of the vegetation or the biota for any region of Namibia. However, there have been several smaller studies that have provided local vegetation maps for some areas, particularly protected areas such as national parks (e.g. Daan Viljoen Nature Reserve: Kellner 1986; Namib Desert: Robinson 1975; Waterberg Plateau: Jankowitz 1983; Etosha: Tinley 1971, Le Roux *et al*. 1988).

Mendelsohn and Roberts (1997) divide and map the Caprivi as six land types and vegetation communities. These are further divided into 36 different units. The extensive Kalahari sands and the rivers with associated floodplains, channels and deposits are the two major features shaping this landscape. Within the major communities, they

recognised units reflecting the differences in the availability of important plant resources using satellite imagery and aerial and ground surveys to provide an overview of the dominant plant species and communities. For example, one of their vegetation types was classed as mopane woodland. Although it is generally noted that there is only limited obvious variation within mopane woodland (see Timberlake 1995; Flower *et al*. 1999), Mendelsohn and Roberts (1997) identified seven vegetation units within mopane woodland. Hence, although mopane woodland is generally recognised as being relatively uniform, this may be because it occurs in a generally topographically subdued landscape. There is yet to be a thorough examination of the biophysical variation across any of the vegetation types of Namibia despite the variation in productivity and sustainability likely in many such areas (see Flower *et al*. 1999).

2.6   Species patterns

A detailed knowledge of the flora and fauna of Namibia is far from complete, with some areas only explored biologically at the most cursory level (e.g. Kaokaland, Kavango). However, an excellent overview of major groups has recently been provided through the work of the Biodiversity Task Force of Namibia (see Barnard 1998).

An up-to-date flora of Namibia is yet to be prepared. Nevertheless, Namibia is not only a floristically diverse country, but also includes many highly distinct taxa of international significance. Southern Africa includes almost 10% of the world's flora with over 23,400 vascular plant taxa (Arnold and De Wet 1993; Cowling and Hilton-Taylor 1994). This floristic diversity is concentrated in eight distinct hotspots[2] including two in Namibia, the succulent Karoo and Kaokoland (Cowling and Hilton-Taylor 1994). Species richness is not even throughout the region, one-third of the region's flora being found in 4% of the land area (Rebelo 1994). The Cape hotspot is the world's richest centre of floral diversity with 8600 taxa. The Succulent Karoo, which occurs partly in Namibia, is also relatively rich with 4750 taxa (Maggs *et al*. 1998).

At least 4334 vascular plant taxa (including 206 naturalized aliens) are recognised as occurring in Namibia (Maggs *et al*. 1998). This is an increase of 1134 taxa from Merxmuller (1966-1972), the most recently published flora to include descriptions and diagnostic keys. The vascular plant taxa recognized by Maggs *et al*. (1998) include 61 indigenous species of ferns in 19 genera and 12 families. Among the Angiosperms, the monocots include 968 indigenous species in 129 genera and 33 families, with the Poaceae (422 species) being the dominant family. The eudicots and other non-monocotyledonous flowering plants include 3010 indigenous species in 730 genera and 124 families with the Asteraceae (385), Fabaceae (377), and Aizoaceae (177) being the dominants (Maggs *et al*. 1998). Despite the relative aridity of Namibia, many non-vascular plants have also been recorded. For example, 91 species (46 genera in 21 families) of mosses and liverworts and seven species of stoneworts have been recognised by Maggs *et al*. (1998).

Concentrations of plant species richness are found in the Succulent Karoo, Kaokoland, Otavi highlands/Karstland area, Okavango Basin and Khomas highlands

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[2] A hotspot is considered an area with high species richness, high levels of endemism and to have been subject to, or under threat from large-scale habitat modification and transformation (Myers 1988).

(Maggs *et al*. 1994, 1998). At least 687 vascular plant species (17%) are endemic[3] to Namibia with a further 275 as Namib Desert endemics shared between the Kaokoland and southern Angola (75 spp.) For example, *Acanthosicyos horridus*, one of at least 46 species of the family Cucurbitaceae occurring in Namibia, is associated with the southern, central and northern sand seas, ranging into Angola. Similarly the relictual *Welwitschia mirabilis*, the only Gymnosperm in Namibia, occurs in the Namib from the Kuiseb River, northwards into southern Angola. Of the 687 endemics, 180 occur in the Succulent Karoo of the southern Namib Desert, while nearly 200 near-endemic taxa occur between the Succulent Karoo and north-western South Africa. This area includes particularly striking diversity of leaf succulents in the family Aizoaceae (Van Jaarsvelt 1987), including many infraspecific taxa (e.g. within the genus *Lithops* – Maggs *et al*. 1998). This is widely recognised as a high percentage of endemism for an arid region (Major 1988; Cowling *et al*. 1989). In the region, only South Africa (70%) and Angola (24.3%) surpass Namibia in terms of plant endemism (Cowling *et al*. 1989).

The rivers of northern Namibia drain the wetter areas to the north of Namibia and contribute many tropical species of invertebrates and small vertebrates to Namibia's wetlands. At least 778 species of macro-invertebrates representing eight phyla have been noted from Namibia (Curtis *et al*. 1998). These include 81 endemic species. R.E. Griffin (1998) provided a summary list of 821 species, 296 genera and 69 families of non-acarine arachnids for Namibia. Spiders are most speciose in the higher rainfall areas, while endemism is highest in the desert regions.

The diversity of Namibian freshwater fish is relatively rich for such an arid country, with 114 species including five endemics and several species confined to one or more of its bordering rivers (van Zyl and Hay 1994). Most species occur in the northern and north-eastern rivers where they are associated with the rich floodplain wetlands of the Kavango and Zambesi catchments.

About 52 species of frogs (including six endemics) have been recorded from Namibia. Although most are known from the periphery, especially the wetter parts of the Caprivi strip, 16 species are found in the Sperrgebiet, confined largely to the Orange River but with some not dependent on the river, relying instead on temporary rain-filled pans. Of the 250 reptile species known from Namibia, at least 59 (24%) are endemic to the country (Simmons *et al*. 1998). Many, particularly lizards, are associated with the rocky terrain of the escarpment zone.

Namibia's extant mammal fauna of 250 species includes 14 recognised as endemic. These endemics occur in the Namib Desert, pro-Namib transition zone and adjoining escarpment (M. Griffin 1998). Namibia supports a highly diverse avifauna of 644 species, including over 90 species endemic to the southern African subregion (Ginn *et al*. 1989; Robertson *et al*. 1998). Approximately two-thirds of the southern African endemics have evolved in association with the arid conditions in the South-Western Arid zone, which includes most of Namibia (Clancy 1986; Harrison and Martinez 1995). Over 150 species of birds are currently classed as endangered, vulnerable, rare or amber in the Namibian Red Data Book (C.J. Brown, personal communication). Thirteen species of birds are regarded as endemic, or near-endemic, to Namibia and most of these

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[3] Endemism set at 100% for plants, insects, arachnids and freshwater fish, 90% for birds, and 75% for frogs, reptiles and mammals (Simmons *et al*. 1998).

have distributions restricted to the north-west of the country (Maclean 1993; Newman 1993; Jarvis and Robertson 1997; Robertson *et al*. 1998).

Namibia has very high levels of endemism for plants, invertebrates, reptiles and frogs, while mammals, birds and fish exhibit levels of endemism below 10% (Simmons *et al*. 1998). However, fish are a special case, as they are primarily found in the rivers that border Namibia. Hence species endemic to these rivers are not endemic to Namibia. For example, 42% of the 15 species found in the Orange River are endemic to that river (Simmons *et al*. 1998). Zones of endemism in major taxonomic groups appear to overlap considerably. Most plant, invertebrate, frog, reptile, mammal and bird species endemic to Namibia occur along and to the west of Namibia's escarpment region. There is also an important area of endemism for succulent plants, reptiles and invertebrates in the Succulent Karoo Biome. Congruence between endemism hotspots, particularly on rocky substrates, is very high for most taxa. This implies broadly similar speciation processes involving spatial isolation at different scales (Simmons *et al*. 1998).

3 Biodiversity and the Namibian Socio-Economic Environment

In this section, I provide a link between biodiversity and the socio-economic environment in Namibia.

3.1 Population and its distribution

Namibia is one of the least densely populated areas of the world with just 1.6 million people or 1.9 people per km^2. The majority of these people (about 60%) live in the northern communal areas. Population is concentrated in the four central regions of the north; Omusati, Oshana, Ohangwena and Otjikoto, which support about half of Namibia's total population (Ashley 1996; IFAD 1992). About 28% of the entire Namibian population live in the oshanas that make up about 1% of Namibia's land area. Densities in this area are up to 100 people per km^2. The population growth rate is estimated to be between 3.1% and 3.3% suggesting a doubling to about 3.5 million by 2020 (Dewdney 1996). The fertility rate is approximately 5.4 (MHSS 1993; Arowolo, this volume [Fertility in Namibia]). Namibia has a very youthful population with about 42% of the population under 15 years old. Most of the population of Namibia is rural, and depends heavily on natural resources for subsistence. Windhoek is the major urban centre with about 150,000 people. There are few other towns of more than 10,000. There has however been a marked increase in urbanisation in recent years. For example, between 1981 and 1991, the population of Windhoek increased by about 46%, Rundu by 911%, and Katimo Mulilo by 3000% (Ashley 1994; Ashley *et al*. 1995).

3.2 Economy

Namibia has a mercantile economy growing at a rate of up to 4% per year and linked strongly to South Africa. It depends heavily on exports of which over two-thirds are minerals. The remainder is livestock and marine-derived products. About 5% of the population earn over two-thirds of the income, with half of the remainder earning a

further 5% (Byers 1997). Most of this economically disadvantaged half of the population live in the far north of the country. Namibia's economy relies almost totally on natural resources, both renewable and non-renewable. The sectors showing the fastest economic growth and long-term potential are those relying on renewable natural resources (fisheries and tourism). In addition, two-thirds of Namibians in rural areas are directly dependent on the soil and on living natural resources for their survival and well being. Namibia's energy resource base can be broadly classified into commercial and traditional forms of energy. Commercial energy resources comprise petroleum products electricity and coal, and amount to about 78% of energy consumption, while traditional fuels (wood, charcoal and animal waste) account for 22%. Traditional fuels, however, are the primary energy source for about 60% of Namibians (Byers 1997).

3.3   Land use and tenure

There are three basic forms of rural land tenure in Namibia, privately owned (45%, chiefly in the southern and central areas), state-owned communal (40%), and proclaimed state land (15%) (Jansson 1991). The latter is designated mainly for conservation and includes national parks, nature reserves, protected areas, and mining (Brown 1992). The privately-owned commercial farmland includes about 6,300 farms owned by about 4,200 farmers and occupied by these farmers, their dependents and employees. These farms mainly occupy the better quality pastoral land of the central savannas and the southern arid shrublands. Over 60% of Namibia's population live as subsistence farmers in communal lands, over 85% of which are located in the north, concentrated in the well-watered areas of Omusati, Oshana, Ohangwena, Otjikoto, Kavango and Caprivi. Most of the proclaimed conservation and diamond mining areas are in very arid and largely unpopulated regions.

3.4   Water and wetland resources

Access to water is the single, dominant, limiting factor in Namibia, both for urban and rural development, and for the region's natural biota. Namibia's water is used mainly for irrigation (42.6%), livestock (25.3%) and domestic purposes (28.1%) (Brown 1992; Ashley *et al*. 1995).

Groundwater accounts for about 57% of recorded water consumption, over 80% of which is used for rural and agricultural purposes (Brown 1992). The groundwater potential is frequently fully committed, and in some cases over-utilised. If abstraction is greater than recharge, environmental changes will occur which ultimately lead to economic loss. For example, mining of water is dropping the water table in the lower aquifers of the ephemeral river systems of western Namibia. The water table at the mouth of the Kuiseb River dropped seven metres to about eight metres below the surface sands between 1974 and 1988 (du Toit and Squazzin 1995). Much of the subsurface water in the riverbeds is replaced seasonally from upstream. However, when these rivers are dammed in their better-watered upper reaches, this water is no longer available downstream. For example, the Kuiseb is dammed by the Friedenau Dam in its headwaters and by about 400 smaller farm dams on its tributaries. Together, these reduce the amount of surface and underground water flow.

Wetland resources are important for the broad-based economic growth of Namibia. Almost three-quarters of Namibia's population live near the northern border where they depend on the resources that these rivers and wetlands supply. Apart from water, these resources also include plants such as grasses for grazing, reeds for thatching, palms, reeds and dye plants for basketry, crops for food, herbs for traditional medicines, trees for building houses and palisade fences, and for fuel. They also include clay for pottery, and wildlife for food and attractions to tourists (Marsh and Seely 1992; Jacobson *et al.* 1995; Cunningham 1985). Except for the most arid desert areas, virtually all of the wetlands of Namibia are degraded to a greater or lesser extent, as a result of abstraction of water for human use, or of over-exploitation of wetland resources, or both. Degradation of water quality by pollution or salinisation are also major environmental changes which ultimately lead to economic loss. Du Toit and Squazzin (1995) suggest that salinisation of the soil is becoming evident in the Kavango and Hardup irrigation areas.

The human populations of the Kavango and Zambezi drainages (and to a lesser extent in the oshanas area of the Cuvelai drainage) rely heavily on fish as a major source of protein in their daily diets (Tvedten *et al.* 1994; MFMR 1995). Of the two systems, the Kavango is under greater pressure because it is smaller and supports a larger human population. Fishing is highly episodic in the intermittently flooded oshanas. However, enormous numbers of fish may move southwards during the large floods, which may occur about once in every four to five years. Although catches can be very high, even massive exploitation has no effect on the parent population. This is because the fish that move into the oshanas do not survive the forthcoming dry. However, conservation of the parent stocks in Angola is critical (Marsh and Seely 1992).

Traditional management of fishing rights involving controlling access of fishing areas is being eroded by pressure on natural resources, by increasing socio-economic stratification and commercialisation, and by the shift of political authority from traditional leaders to the central government. In the eastern floodplain of the Kavango, the management system is still largely traditional, actively implemented and supported by local fishermen. Over-fishing in Caprivi has resulted from a combination of environment changes and increased fishing pressure using modern equipment. In addition, intensive grazing pressure, use of natural resources such as reeds and clay, pollution by pesticides, and physical damage to rivers and floodplains, are all affecting fish habitants. Political and other disputes with Zambia and Botswana exacerbate the problem. The current fish catch from the Kavango may exceed the maximal sustainable yield for the system (Hay 1995).

3.5   Agriculture and rangelands

Extensive livestock production is the major agricultural activity in the commercial farming sub-sector of the economy, contributing about 8% to Namibia's overall economic activity and employing about 8% of the total working population. The contribution of agriculture to rural livelihoods is also very significant. For example, subsistence pastoralism and agropastoralism on communal lands is the main source of income for almost 40% of households in the country and about 68% derive their livelihood directly or indirectly from agriculture and forestry. Most of the land in communal areas is unfenced, and access to grazing is free for the residents within their

community borders. Many illegal fences have recently been erected, and conflict is increasing between fencers and non-fencers (GTZ 1991; EEAN 1992). Traditional leadership was responsible for allocation of land and land management in the past. However, newly established regional authorities lack the capacity and means to perform these functions and there is increasing confusion about land allocation and management in communal areas. Paskin (1995) argues for the creation of fenced private ranches in communal areas as a possible solution to open access and illegal fencing conflicts. However, if the whole of some communal areas is split into private fenced farms, many households would lose access to any land (e.g. more than 66% in the eastern communal areas; EEAN 1992). This would create major food security problems. The costs of erecting such fences will also be very high (GTZ 1991; Flower *et al*. 1999).

Traditionally, many of Namibia's indigenous peoples practised nomadic pastoralism (Jacobson *et al*. 1995). Permanent settlements were limited to the Oshana region, along the Kavango and Zambezi rivers, and near Windhoek's springs (Byers 1997). Present-day populations are larger and more settled, and tend neither to move, nor to suit the sizes of their herds to available vegetation. The traditional groundwater supply in the communal areas has been augmented by the introduction of reliable water supplies, and by large-scale fencing of former grazing reserves. In the absence of new management strategies, these factors limit cattle to an ever diminishing area resulting in a massive increase of grazing pressure in the remaining areas (Marsh and Seely 1992). This loss of flexibility increases the likelihood of biodiversity loss, especially in respect of other competing herbivores (Tapscott 1990; EEAN 1992). Overgrazing and degradation of rangeland around water-points has forced a progressive movement of the farming population into unutilised areas further to the east and north.

Desertification,[4] manifested by localised reduction of plant biomass, plant productivity, and/or plant diversity, is the major threat to Namibia's rangeland resources (commercial and communal). For example, overgrazing and subsequent clearing for land cultivating, wood for fuel, building and carving is occurring along the Kavango River (du Toit and Squazzin 1995). More than 70% of riparian forest may already have been lost from the Namibian section of the floodplain (Brown 1992). The construction of traditional homes and villages in the northern communal lands requires a great deal of wood, though rural people are increasingly turning to alternative materials (Flower *et al*. 1999).

Environmental variability has previously dictated a highly flexible rangelands management strategy. The traditional, transhumant grazing practised by pastoralists prevented land degradation and ultimately desertification. (Seely 1991; Marsh and Seely 1992). A rotational grazing system is still practised by the Ovahimba people in the arid rangelands of the Khumib and Hoarusib catchments of the Kunene Region (Paskin 1995). Range condition in these areas is better than in the other areas of Kunene, despite the usually lower rainfall in these areas. Soil erosion is also much less obvious (Paskin 1995). In communal areas, sedentarisation (setting down of formerly nomadic farmers) is increasing. Thus, transhumance and semi-nomadism will decrease in future, while urbanisation in the communal areas will continue, and migration to urban workplace will increase. Where fences (international, commercial farms, game parks, illegal

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[4] Desertification is land degradation resulting from unsustainable human activities interacting with a dry and highly variable climate in terms of time and space.

fencing, etc.) are erected, farmers are prevented from moving with their animals freely in search of fodder.

Approximately 10-12 million ha of the savanna biome in central and northern Namibia are characterised by dense stands of leguminous species. These sites, which represent about 12%-14% of Namibia, are affected by bush thickening, which prevents effective utilisation of the potential grazing resource (Bester 1996). According to Bester (1996), most of Namibia had its original vegetation characteristics until the 1940s but bush thickening was treated as an ecological disaster by the mid-1960s. However, according to accounts by early European explorers in the area, most areas now considered to be suffering from bush thickening, were already dense thickets by 1851 (see Anderson 1856) or 1863 (see Tabler 1971).

3.6   Marine fisheries and other resources

Overexploitation of fish stocks in the Benguela Current region together with the inherent variability of the system has resulted in major changes of fish species abundance in the region. This has been particularly noticeable since 1982 when there have been major environmental perturbations and changes in the distribution and abundance of the principal harvested species such as pilchard and anchovy. Since 1982, the anchovy stock in the northern Benguela has all but disappeared whereas those off the Cape in the southern Benguela have boomed and declined. The relatively small populations of pilchard inhabiting Namibian waters have recently vanished after a few years of recovery in early 1990s. In contrast, the pilchard population in the southern Benguela has suddenly increased following several years of low availability and decline (Shannon *et al*. 1992; Byers 1997).

Current threats to the sustainable harvesting of marine resources in the northern Benguela Current ecosystem stem mainly from increased environmental variability associated with regional and global climate change (Hulme 1996), and the inability to be able to forecast these events in advance. These factors together with the existing low levels of commercially important small pelagic species such as pilchard and anchovy indicate that future recovery of these stocks to economically sustainable levels could be very slow (Byers 1997; Sakko 1998).

Apart from widespread epizoic environmental degradation caused by naturally occurring events such as deoxygenation of coastal and shelf waters, phytoplankton blooms, and sulfur eruptions, the northern Benguela Current system in terms of industrial pollution and water quality is in relatively pristine condition. On a more local level, however, the direct causes of environmental degradation along the coastal zone originates mainly from harbour activities, fish factory effluent, ship pollution, accidental oil spills, marine diamond mining activities and uncontrolled industrial developments (Byers 1997).

The Cape fur seal occurs in large numbers along the coast of Namibia with about 75% of the African population present in Namibian territorial waters. Since the 18th century, the species has been heavily exploited for their pelts. Populations have recovered in recent years from the low levels at the turn of this century, to a level where controlled exploitation is allowed.

3.7   Historical legacy

The ecological symptoms of environmental problems are often far removed from the ultimate causes of the problems (Byers 1997). The problems typically originate in political systems and social and economic policy (Brown 1996). This itself may be a legacy of historical policies. The legacy of colonialism and apartheid has had a major impact on the environmental[5] threats facing Namibia. These threats that are also often linked include the lack of secure and exclusive tenure over land at the local level, the limited or insufficient intersectoral co-ordination at the national level, and a limited or insufficient human resources and capacity for sustainable planning and management at all levels (Byers 1997). There is also a lack of knowledge and information for sustainable management and/or transfer of knowledge to appropriate people and institutions. Great disparities between different sectors of society and rapid population growth are further threats to the Namibian environment.

The historical legacy of isolationism has had a major impact on the social paradigms in research and development. The climate for scientific research during the colonial period left a legacy of suspicion, reluctance to collaborate or publish and the formation of small empires. Although considerable data was generated in ecology, biogeography and taxonomy, there was little attempt to put this research into a wider social context (Lindeque 1996a). The isolation from the world scientific community prevented co-ordination and synthesis of the data collected. It was often gathered with no management goals in mind, since the majority of the population was considered outside the relevance of the scientific community. Hence, Namibia's scientific community was, and probably remains, too small and fragmented to handle the needs of an effective research program. Key government institutions have shown a reluctance to move forward and in some cases have atrophied since independence. However, relatively new institutions such as the University of Namibia and well-established NGOs such as the Desert Research Foundation of Namibia are increasingly expanding their research interests in the country.

4   Conserving and Managing the Namibian Environment

In this section, I provide a prognosis for the future of biodiversity and the Namibian environment by examining the options for conservation and management.

4.1   Land and resource tenure reform

While rural communities bear the costs of overgrazing, deforestation and excessive water extraction, they are not in a position to reap the benefits of sustainable management of these natural resources. The lack of secure and exclusive rights to land and resources on the communal lands of Namibia must be addressed. Dewdney (1996) argued that the introduction of secure exclusive tenure at the community level is the single most important policy reform needed to prevent degradation. In view of the relatively large area of privately-owned land, it is unlikely that further release of land to

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[5] An environmental threat is any unsustainable environmental trend caused or exacerbated by human activities. Hence, the failure to adapt technologies and practices to live sustainably within a given environmental condition is an environmental threat.

private ownership is viable. The need for integrated land and resource tenure reform to include integrated resources tenure is becoming more widely recognised (Steiner and Rihoy 1995). The conservancy policy and legislation can now enact tenure over wildlife in communal areas. Extending the conservancy approach to key resources such as water, rangelands for grazing, and forest products may also be appropriate. Recent developments provide for a wide range of approaches to management at the local and regional level (see Blackie, this volume).

4.2   Capacity building

Developing intersectional, integrated solutions to environmental problems at the local level requires communication and co-operation between sectoral ministries at the national level. Because of the links between root causes of environmental threats affecting different environmental sectors, addressing the threats will require integrated, cross-sectional planning and management (Brown 1992; Ashley *et al.* 1995; Byers 1997; Blackie, this volume). There is a major need to develop the human resources required to carry out all of the diverse actions required to manage Namibia's environment and natural resources sustainably (Richardson 1998). This must be associated with specific measures to redress the widening economic disparities within the country. Education, training, and capacity building at all levels, from central government to grassroots resource users, will be required. Environmental education that acknowledges the importance of traditional knowledge should provide Namibians with the awareness needed for making sustainable economic choices. This education should also provide the skills, options and incentives for achieving sustainability.

4.3   Water and wetland resources

The key to conserving inland aquatic ecosystems and resources lies in managing water resources sustainably (Bethune 1996). There is increasing encouragement of an ethic of water conservation through realistic pricing, tariff incentives, education and planning in the national interest. It is likely that this will lead to the conclusion that some industries are not cost effective. Others may be relocated to the coast and to the north of the country. Dewdney (1996) recommended that reform of water pricing was one of the most promising of all options for the prevention of desertification. He favoured a rapid introduction of pricing proposals involving full cost recovery in three years for all irrigation and domestic users. He also favoured full cost recovery in four to five years, with a cross-subsidy for lifeline supply for rural users. Importing of water is possible, but subject to major political compromises.

There is a need to monitor water resources, especially the ephemeral rivers, oshanas and river mouths, to protect against over-utilisation and disruption of essential ecosystems. The biological and environmental effects of the interbasin transfers of water within Namibia should be more thoroughly investigated. The long-term changes in climate, including increasing aridity, also need to be better understood if we are to be successful at managing water sustainably (Hulme 1996). Monitoring rainfall and range condition is necessary to allow adjustment of stock populations to current range

carrying capacity. This will be necessary at a large number of stations throughout Namibia.

More research is needed to understand the ecology and resilience of the fisheries of the perennial rivers of north-eastern Namibia (Curtis *et al*. 1998). Monitoring of fish stocks on an annual basis is also needed to recommend sustainable catch quotas to allow for sustainable management. Because all of the northern border rivers are international, fisheries research and monitoring should ideally involve joint efforts with Angola, Zimbabwe and Botswana. As the oshanas fishery depends upon parent stocks in Angola, research and monitoring will involve international co-operation.

4.4 Range management

Rainfall, and hence the availability of fodder is very variable in both time and space in Namibia. This will necessitate adapting to changing fodder regimes whereby feed demands are matched with available fodder sources. Flexible livestock management is needed for tracking environmental variability. Traditional management practices, such as large-scale transhumance, were generally flexible. Policies and programs should support such traditional practices as much as possible. Thus policies against fencing, support for large-scale communal tenure, and the development of mobile clinics, schools and shops to accompany pastoral populations are all likely to minimise the effects of an arid and variable environment.

Existing community-based organisations will need to be strengthened and supported to manage the resources in a sustainable manner for the benefit of the whole community (Richardson 1998). Subsidies for livestock such as drought bridging, restocking after drought and development of water points will have to be removed. Hence a solution will have to be found which enhances the standard of living in communal areas without undermining the resource base. Those regions that are already significantly degraded may have slipped below an ecological threshold, above which it is too expensive to restore them. In contrast, bush-thickened areas remain ecologically functional, despite lower livestock production.

Because bush thickening reduces grass production, it may actually increase the carrying capacity for game and browsing livestock. The development of game utilisation and conservancies on commercial lands has increased species diversity and game populations. It is likely that mixed livestock and wildlife on communal lands, with conservancy rights, should reduce environmental degradation and help maintain habitat and species diversity. Commercial land use is changing to livestock and wildlife production, and to wildlife-based tourism. 70% of the country's big game populations are estimated to occur on these privately-owned farmlands.

The principal wildlife resources of the northern areas lie in Kunene, eastern Kavango and western Caprivi (Ashley and La Franchi 1997; Richardson 1998). Kunene already has tourism based on the local people and the wildlife, which are mainly in the arid western part of the region. The saline grassy plains bordering Etosha Game Reserve are more suitable for wildlife than for domestic stock. In Kavango, farmers are quite negative towards wildlife and would like to see them limited to fenced game areas (IFAD 1992; Rodwell 1995; Rodwell *et al*. 1995). In eastern Kavango, bordering Botswana and Bushman land, the situation is different. The potential for wildlife there is

much greater, due to the fact that the area is almost unwatered and devoid of domestic stock or crop farming. The region is in a generally rich wildlife habitat and consequently farmers rate damage by wild animals as their greatest crop production problem.

International borders often divide a single functioning ecosystem into parts managed by different governments. Communities near Namibia's international borders may benefit from bilateral agreements allowing the movement of wildlife or livestock across these borders. For example, some communities in eastern Caprivi are beginning to plan or develop wildlife-based tourism. The success of this enterprise will depend upon free movement of animals across international borders, from wildlife rich areas in northern Botswana. In the northern central area, traditional herders moved their livestock to pastures in Angola. As with most traditional transhumance, this had an ecologically-sound purpose, and helped prevent overgrazing in the northern communal pastures. With the return of peace in Angola, it may be possible to restore such transboundary movements of stock, although regional co-operation will be required.

4.5   Biodiversity conservation

Namibians are strongly dependent on their living natural resources. About one-quarter of the population is urban, with the remainder living in rural areas where most people depend directly on biological resources, both financially and for essential goods and services (Brown 1996). Development will not be sustainable without sustainable resource use. The sectors of agriculture, fisheries and tourism all depend directly on renewable natural resources, while all sectors of the society require water and the functioning of essential ecosystems. Key sectors with potential for expanding employment are fishing, fish processing and wildlife-based tourism. The long-term future of each depends on wise management of resources. There is clear recognition of the need to conserve ecosystem-scale diversity, the diversity of plant communities, and habitat dynamics and patchiness in arid, variable landscapes.

Namibia signed the Convention on Biological Diversity in 1992, which it ratified in 1997. The national biodiversity program was initiated in 1994 to develop a national biodiversity strategy and action plan for the 21st century (Barnard 1998). Red Data Book lists of rare and threatened species will form an important part of the biodiversity baseline inventory and be the first building blocks of a National Biodiversity Monitoring Program (Lucas and Synge 1978; Ferrar 1989). The Namibian Biotechnology Alliance was also established to develop policy and legislative guidelines for biosafety, biotechnology, and genetic and intellectual property rights. The protection and management of Namibia's forests, woodlands and wooded savannas is guided by the Cabinet-approved 1992 National Forestry Policy administered by the government through the Directorate of Forestry.

Namibia has 21 proclaimed protected areas totalling over 13% of the country (Huntley 1978, 1989; Huntley *et al*. 1989; MacDonald 1989; Barnard *et al*. 1998). Three large desert parks in the Namib Desert along the coast, together with Etosha National Park, make up over 85% of the total area protected. Diamond mining exclusion laws in the Namib Desert north of Oranjemund protect another 2% of Namibia's land area. A large portion of the Namib Desert falls within protected areas, and it may be the

most comprehensively protected desert in the world. A further 2%-4% of Namibia will shortly fall under conservancy legislation (see Blackie, this volume).

Namibia's protected area network was never planned explicitly to represent or conserve Namibia's biodiversity (Brown 1996; Barnard *et al*. 1998). As with parks in most of Africa, the emphasis was on big game and scenery. Many areas richest in biodiversity have little or no representation in the protected area system. The Namib Desert parks, plus Etosha National Park, make up the vast majority of protected natural areas, leaving less than 1% of the non-desert areas within the protected area network. The three large vegetation types, Dwarf Shrub Savanna, Camelthorn Savanna (Central Kalahari) and Mixed Tree and Shrub Savanna (southern Kalahari), totalling about 30% of the country, are not represented in protected areas (Brown 1992; Barnard *et al*. 1998). About 90% of the country's game populations occur outside the protected area system, already on private commercial farms or communal lands. Wetlands are not well protected in the conservation reserve system. The Mahango Game Reserve and West Caprivi Game Park protect a portion of the Kavango River. However, virtually no part of the Kunene River, or the Cuvelai drainage and oshanas, are included in protected areas. Habitats in urgent need of protection to safeguard unique biological diversity include karst caves, the Kaoko escarpment, the Otavi highlands, ephemeral and saline pans, northern riparian habitats, oceanic lagoons (e.g. Walvis Bay, Sandwich Harbour), Tsumkwe pans and Outjo mopane woodlands (Barnard *et al*. 1998). Thus Namibia's protected area network does not adequately cover or represent the country's biodiversity. Barnard *et al*. (1998) suggests that two important endemism zones (the Kaoko escarpment and coastal plain, and the Sperrgebiet succulent steppe), plus the species-rich Caprivi area, offer three valuable opportunities for regional consolidation of protected areas.

However, it is unlikely that any of the northern or highly populated areas of Namibia will be converted to protected areas. If biodiversity conservation is to occur in these areas, it must occur outside of protected areas (Siegfried 1989). Thus the implementation of the biodiversity convention has focussed on areas outside the formal protected area system. The northern communal areas are the main geographic areas of environmental concern and where there is the most need for biodiversity conservation outside of protected areas. These areas also have the greatest need for sustainable water and rangeland management. An economically-based system of sustainable utilisation of game in protected areas has led to the creation of conservancies demarcated by resident communities, with rights to the benefits from their own wildlife (Richardson 1998). Conservancies already exist in commercial farmlands, and de facto communal land conservancies operate with the help of local NGOs (Owen-Smith 1996). The potential for community-based natural resource management alternatives is both most promising and most advanced in the north, where a wide range of approaches have recently been developed (see Blackie, this volume). The future development of these regions will tend towards increasing contrast between overused settled areas based on pumped water supplies, compared to the proclaimed reserves and dryland CBNRM conservancies.

Traditional systems of land use and production technology among rural Namibians depend on biodiversity, through risk spreading and diversity of resource utilisation (Byers 1997). This can be a tool in helping to conserve regional biodiversity. Tourism based mainly on biological and landscape diversity is a major foreign exchange earner in Namibia. Non-consumptive tourism is especially lucrative, fast growing and can be

compatible with biodiversity conservation (Richardson 1998). The subsistence uses of the most important indigenous food and fibre plants has been documented in the oshanas area (Marsh and Seely 1992). Barnes (1995) has allocated net economic values to the main non-agricultural goods from wild resources in various northern provinces. He calculated net added value per annum to be N$260 per km^2 for Caprivi and N$12 per km^2 for former Bushmanland. The Kunene region generated figures of between N$25 per km^2 and N$35 per km^2 in the same study. These are substantial economic gains, suggesting that further losses of biodiversity will be mirrored by a declining rural economy. Losses of biodiversity will also have implications for equity and the distribution of resources.

The wildlife and tourism industry on commercial farms has grown steadily at about 3% per annum over the last 20 years. The aggregate economic value in 1992 was estimated at N$56 million (Barnes and de Jager 1995). This game farm industry generated over N$30 million in 1991 (Brown 1992). Tourism is now Namibia's third most important foreign exchange earner, estimated to contribute over N$300 million to the country's GDP. Community based tourism projects are restoring the value of wildlife to local people and to Namibia's thriving tourism industry. Holm-Petersen (1996) projected foreign exchange earnings from tourism to top N$ one billion within four years, with the creation of about 20,000 jobs. The potential of this industry is of great significance in linking biodiversity to the country's economy (Byers 1997). For example, the seal colony at Cape Cross is an important tourist attraction with over 10,000 persons visiting the region annually. There is also considerable potential for the development of ecotourism at the seal colonies at Atlas Bay and Wolf Bay, south of Luderitz. The natural beauty of the coastal regions, combined with seals and birds have enabled a significant coastal tourism industry to develop in some areas.

Many indigenous species show excellent genetic potential for use in the world's arid rangelands (e.g. indigenous Namibian cattle breeds, land races of pearl millet, sorghum, groundnut and cowpea), in the pharmaceutical industry and in genetic engineering. The center of diversity of the world's watermelons (genus *Citrullis*) lies in Namibia (Maggs *et al*. 1998). Indigenous Namibian cattle breeds are far superior to imported breeds in resistance to drought, diseases and pests, and production rate. Thus, there is considerable potential value of Namibian biodiversity at a world scale. However, conservation of these indigenous genetic resources will only be effective if the income from their development returns to the people who directly manage them.

4.6   Marine fisheries and resource management

At Namibian independence in 1990, a 200 mile exclusive economic zone was declared within which fishing by foreign trawlers was prohibited except under license to Namibian companies. The Ministry of Fisheries and Marine Resources was created in 1991 to manage and regulate the resource (Amutenya 1995). The government currently maintains limits on catches to allow fish stocks to recover from decades of overexploitation. It is also pursuing a policy of increasing onshore processing capacity, as well as enlarging the Namibian fishing fleet.

Research on the functioning and long-term dynamics of the Benguela ecosystem is needed to predict fish stock abundance and recruitment. Present uncertainties regarding

natural estimates and the effects of environmental changes on fish behaviour, as well as questions on some aspects of survey design and biomass assessment make confident predictions difficult. There is also a general lack of understanding of the inter-relationship between climatic factors and oceanographic processes operating off southern Angola, Namibia and the west coast of South Africa, and its relation to regional climate changes, Pacific El Niños and global warming.

4.7   Research and monitoring

The small size of the Namibian research base and the historical political legacy urges the formation of a national research council to co-ordinate research activity in Namibia. There is also a general need for more applied research to inform sustainable environmental management. Simple and cheap monitoring techniques (Goldsmith 1991) are urgently needed, especially as planning and management responsibilities are devolved at the regional and local level.

Applied multidisciplinary research can provide necessary information and understanding for promoting sustainable natural resources management (Byers 1997). An example is research on traditional uses of natural resources and traditional management practices, which were often quite ecologically sophisticated and sustainable. It is also necessary to understand how and why these traditional practices have changed and broken down as the social and ecological environment changed. This will enable decisions as to whether parts of traditional systems can be maintained, revived or adapted to contemporary circumstances. Natural resources economic studies and surveys, and natural resources accounting can provide useful information for sustainable management. In such studies, the value of natural resources to humans should be broadly conceived to include non-monetizable and an often-unquantifiable value (e.g. socio-cultural, religious, and aesthetic values) not merely monetized market values. Both socio-economic and ecological monitoring is needed for adaptive environmental management in Namibia.

4.8   Regional co-operation

Many of the natural resources that sustain Namibia are shared resources with neighbouring countries, and regional co-operation is required to manage them sustainably. These include water and fish in border rivers and the Cuvelai-oshanas system, transboundary movement of wildlife and livestock, and fisheries of the Benguela Current ecosystem. At present there is only limited co-ordinated research, information exchange and co-operation in fisheries and oceanographic research between countries in the region that would allow understanding of the Benguela Current system as a whole. Such co-operation and joint research planning is essential to sustainably manage and exploit the living marine resources and to address such issues as straddling stocks, high seas fisheries and contingency planning and response in relation to major oil spills or pollution threats on a sustainable basis.

In addition to agreements regarding shared resources, other kinds of international treaties can play important roles in supporting sustainable environment management in Namibia. Livestock marketing agreements can also affect wildlife management. For

example, livestock marketing agreements with South Africa may lead to Namibia having to destroy some wild animals such as buffalo that may spread disease to cattle but that are also are valuable for hunting, tourism and the live animal trade. The downlisting, and eventual delisting, of southern African elephants through the Convention on International Trade in Endangered Species may allow the sustainable utilisation of these populations (Lindeque 1996b, see also Dublin *et al*. 1994).

5 Towards Managing for the Maintenance of Namibian Biodiversity

The constitution of Namibia was drawn up through a consultative process involving the former colonial administration, the United Nations and SWAPO. Current policy and direction is based on the empowerment of the indigenous peoples and reallocation of power to reflect an independent Namibia, aligned to independent African states in a strong expression of post-colonial independence. However, this position is somewhat defined within the discourse and paradigms of the previous colonial bureaucracy.

The current systems of governance throughout the world, including Namibia, were largely developed when short-term economic gain guided development (Field-Juma 1996). During the colonial period, development was driven by political and economic imperatives. While some African countries revised the inherited legal codes following independence, governance systems have generally maintained centrality of state power. Namibia is no exception, for privatisation continues to undermine many traditional resource management systems that relied on common property, particularly in the agro-pastoral areas. This leads to a confusing mix of modern and traditional authority rules and norms. Private property continues to entrench ownership in a landed elite who has monopolised the most productive agricultural land. Denial of access to other agriculturists and pastoralists continues to cause environmental stress in the remaining areas. Any increase in disparity, corruption or cronyism will exacerbate this trend. Loss of access undermines both the economic and ecological viability of pastoral systems. Not only does the shift to exclusive use of the whole quantum of rights severely disrupt traditional land-use systems, it has the effect of limiting the natural resource utilisation strategies of society as a whole (Foucault 1982; Field-Juma 1996; Barraclough and Ghimire 1996). There is growing recognition of the importance of the proximate resource users to sound resource management decision-making. If biodiversity, and hence society is to be maintained in Namibia, governance systems will have to strengthen local-level mechanisms and institutions, while environmental management must increasingly maintain components of traditional management systems (Berkes 1989; Hviding and Baines 1994; Field-Juma 1996; Barraclough and Ghimire 1996).

Management for the maintenance of biodiversity and human society requires that the norms, by which we live, reflect ecological principles. Traditional resource management systems drew from a broad base of knowledge. Hence a more knowledge-intensive society is required to make sound resource use decisions and plan for future needs. Strengthening the institutions that generate knowledge and the links between these institutions, the resource users and policy makers must happen at all levels of society (Evans and Boyte 1992; Field-Juma 1996).

Emphasis on centralised authority and control over natural resources undermines environmental management, partly due to an inhibition of knowledge generation and

flow (Kuhn 1970; Martin 1981). A lack of information and local proprietorship of natural resources at a local level result in a system unable to respond to complex and changing social demands and environmental conditions. Governance systems need to be revised if they are to be responsive to local needs and conditions as well as being able to compete in the global political and economic environment (Field-Juma 1996). Thus, there is a need for a fundamental reorientation towards the ecological systems approach upon which human survival is based. This will require a highly interconnected flow of information, a diversity of approaches, dynamic processes and complexity. The reward will be a fair Namibian society that lives within the constraints and opportunities provided by a healthy and diverse biophysical environment.

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Acknowledgements

WATER RESOURCES OF NAMIBIA

Molly E. Hellmuth

Abstract

This paper describes the water resources of Namibia within the context of the current IIASA PDE project. In the IIASA computer simulation efforts, Namibia's water resources are modelled on two different levels, on a regional scale and on a case-study scale that examines the capital city, Windhoek. At the regional scale level, the country has been disaggregated into three social ecological regions. This paper describes the water resources and the water resource issues within the context of the three regions. The objective of the IIASA work is to provide an assessment of the sustainability of the water resources, and policy measures which may be adopted to ensure its sustainability into the future.

1   Introduction

This paper describes the water resources of Namibia within the context of the current IIASA PDE project. The motivation of the water resources aspect of the project is to gain a better understanding of the sustainability of Namibia's water resources. Located on the south-western coast of Africa, Namibia is the most arid African country south of the Sahara. In addition, Namibia's rainfall is highly variable, and often falls in short, intense storms, where infiltration is frequently low. Namibia receives an average of 300 mm of rainfall per year, compared to an average of 600 mm in Vienna, Austria. Even this comparison can be misleading, as the hot climate and high altitude increase the rate of evaporation of the water resource. Due to the high variability and overall scarcity of Namibian water resources, the management of the water resources is crucial in order to allow future sustainable development to occur.

The IIASA PDE project considers the interaction of population, water resources and economic development on two different levels: on a regional scale and on a case-study scale that examines the capital city, Windhoek. At the regional scale level, the country has been disaggregated into three SERs (see Map 1). These regions were derived based on the existing demographic and hydrologic characteristics of the country. The water resources of each of these three regions are described in detail below.

Map 1. The socio-ecological regions and administrative regions.

SER A encompasses the northern districts Omusati, Oshana, Oshikoto, Ohangwena, Kavango, and Caprivi. SER A covers an approximate area of 148,170 km^2, or about 18% of the total land area of Namibia. However, this region contains 60% of the total population of Namibia. SER B encompasses the Kunene, Otjozondjupa, Omaheke, Erongo, Hardap and Karas administrative districts, covering about 640,570 km^2, or about 78% of the area of Namibia. This macro region contains approximately 29% of the population. Finally, SER C defines the capital city, Windhoek, and its surroundings. This region corresponds exactly to the administrative boundary, Khomas, and covers an approximate area of 37,080 km^2, or about 4% of the total land area of Namibia. Approximately 12% of the population lives in SER C. The water resources of the three SERs are described in detail below.

The main case study of the IIASA PDE project assesses the water resources for the Okavango Delta and the capital city of Windhoek. The conflict between Namibia and Botswana over the development of the water resources of the Kavango River, and the uncertainty of future development of the tributaries to the Kavango River by Angola, present interesting policy questions. Namibia is considering extending the Eastern National Water Carrier to allow withdrawals from the Kavango River. This would augment the water supply for the urban area of Windhoek. Joint Venture Consultants (1993a:S1) summarise that "historical trends and the structure of the Namibian economy suggest that the Central Area will remain the focus of economic growth, with

consequent implications for population growth and service implications." In the IIASA analysis, the question is posed whether the ENWC, in its existing state, will be adequate enough to supply water to Windhoek for the next 20 years.

The IIASA water resource supply and demand model estimates water consumption in relation to its availability for each of the SERs by application of the PDE Model.[1] Thirty-two major hydrologic basins and coastal drainages were delimited for analysis of Namibia's potential and existing water resources.[2] These macro basins were determined based on the river basins, and administrative boundaries, and are shown in Map 2 (FAO 1997; Verheust and Johnson 1998). Note that Namibia's perennial rivers can be found only along the borders; all rivers flowing within the Namibian interior are ephemeral. The amount of available water for each of these basins was determined (depending upon scenario), and then the water was distributed amongst the SERs dependent upon what percentage of the water each basin contributes to water consumption in each SER.
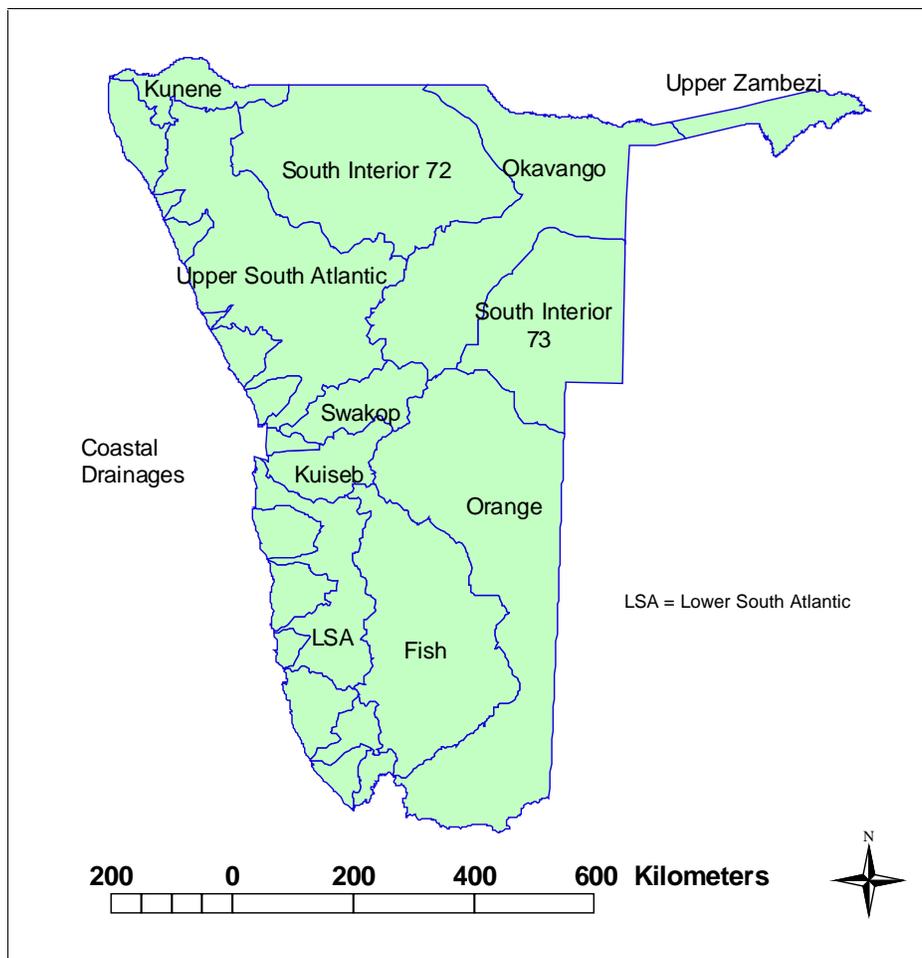

Map 2. Determined macro water basins.

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[1] This model and its results are discussed in a separate paper.
[2] The 32 basins include basins located in Angola, South Africa, Lesotho, Botswana and Zambia.

In addition, the groundwater resources were modelled on a macro-scale, by use of sustainable use rates given from Namibia's Department of Water Affairs (Joint Venture Consultants 1993b). Map 3 shows the main groundwater resources. Approximately 57% of the water consumption in Namibia comes from groundwater, 23% from the northern border rivers, and 20% from local reservoirs. The assured annual yield of the water resource of Namibia is about 500 MCM (Chivell 1992), excluding water in the perennial border rivers. The hydrologic characteristics of each of the SERs are expounded upon in the following paragraphs.
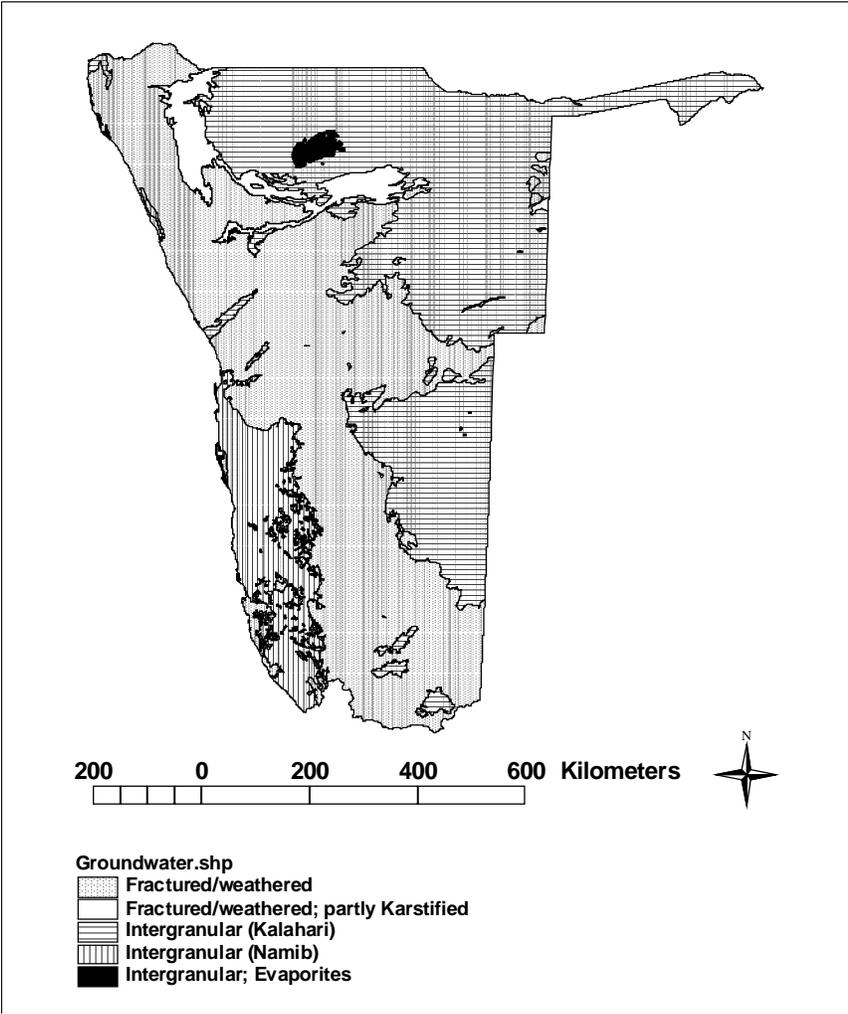
Map 3. Groundwater resource classifications of Namibia. Source: Interconsult.[3]

[3] Interconsult Namibia (Pty) Ltd., Consultants in the Earth Science, P.O. Box 20690, Windhoek, Namibia, GIS data.

2 SER A – Northern Regions

2.1 Climate

The northern region is the wettest region of Namibia, and it is perhaps not by coincidence the most highly populated. Moving across SER A from west to east, the annual average precipitation increases from 350 mm to 650 mm at the extreme end of the Caprivi Strip. The majority of rainfall occurs in the summer months, from October to February. Figure 1 shows the average annual temperature and precipitation by month for SER A.[4] The diagram shows the relative humid season (hatched part of the diagram) and arid season (dotted area) by combining the mean monthly temperature and precipitation curves.[5] The average annual minimum temperatures vary from 13°C in the east to 16.4°C in the western Caprivi strip, and a maximum temperature of 19°C to 26°C.
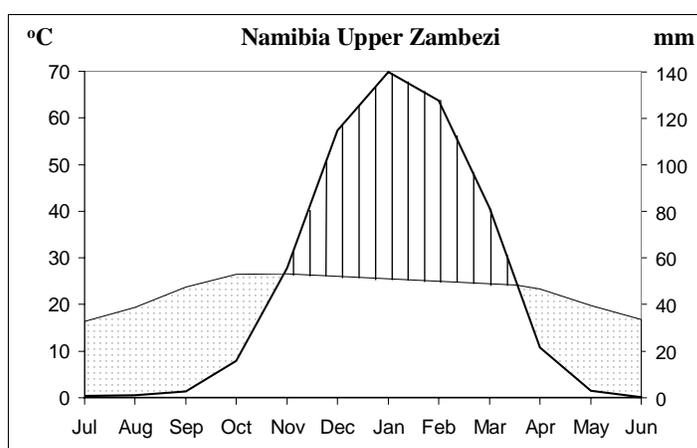
Figure 1. Relative aridity and humidity shown by average annual temperature and precipitation by month for the Upper Zambezi River Basin – SER A.

2.2 Watershed characteristics

The northern region intersects the following watershed basins: Kunene, South Interior, Kavango, and the Upper Zambezi. All of these are international in nature, with the source of the river or drainage system beginning in either Angola or Zambia, before finally reaching Namibia. This has huge implications for Namibia, as future development in Angola or Zambia could significantly decrease the water supply to the northern region. There are two commissions which have been set up in recent years to oversee the management of the Zambezi River Basin (ZACPLAN) and the Okavango River Basin Commission (OKACOM).

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[4] Links Dataset. New *et al*. (1999); for description see Annex A.
[5] Detailed information on the diagrams, see Annex B. The diagrams are based on the drawing rules of the climate diagrams by Walter (1985) and Walter *et al*. (1975).

The Kunene River is perennially flowing, from its headwaters in Angola to its termination into the Atlantic River. The Kunene River presently contains three operational main dams: the Gove and Calueque dams in Angola, and the Ruacana dam on the border of Namibia and Angola. The Calueque dam in Angola provides water for the Oshana region in Namibia through a vast network of pipes and canals.

The south interior basin is also broken into two regions, one in Angola and one in Namibia. This basin contains the Oshanas, a series of drainage lines and pans, which support a wide variety of species and habitat, including over 400,000 Namibians. The Oshana region is the most densely populated region in all of Namibia, and is sensitive to bush encroachment and overgrazing.

The Kavango River forms about 415 km of border between Namibia and Angola before reaching the Okavango Delta in Botswana. The major tributaries to the Kavango River, the Cuito and Cubango, rise in Angola. The Omuramba Omatako River is the most major tributary in Namibia. This river sometimes reverses direction, forming a floodplain in Namibia when the Kavango River is flooding. The Omatako river contains the Omatako dam which is a major supply source for Windhoek. Plans to expand the ENWC would mean that 20 MCM per annum be abstracted from the Cubango tributary in Rundu for interbasin transfer to Windhoek.

The Upper Zambezi basin encompasses the majority of the Caprivi region. The Caprivi is bordered by the Kwando/Linyati rivers to the south and west, and the Zambezi/Chobe Rivers to the east. Eight countries share the Zambezi River Basin, the largest entirely within the SADC region, with a total population of 102.9 million people, of whom 30.8% live in the basin. The basin is estimated to drain a total geographical area of about 1.3 million km^2, covering an area equivalent to an area slightly larger than Angola. The Zambezi River flows over a distance of nearly 3,000 km, dropping in altitude from its source in the Kaleen Hills of north-western Zambia, at 1,585 m above sea level, to its delta in the Indian Ocean, 200 km north of the Mozambican port of Beira. Angola, Botswana, Malawi, Mozambique, Namibia, Tanzania, Zambia and Zimbabwe share the basin. Approximately 3.7% of Namibia's population resides in this basin.[6]

2.3   Groundwater resources

The northern region is mainly comprised of primary alluvial deep aquifers. Primary aquifers occur in loose sediments, such as river sands and gravels. In addition, the northern SER contains the Oshanas, which is a primary perched shallow aquifer, which overlays a deeper, saline aquifer. Approximately 30% of the water supply for the northern "four Os" regions comes from this perched aquifer source. Along the Kavango, 10% of the water supply comes from alluvial aquifers, the rest comes directly from the Kavango River. Along the Zambezi River in the eastern Caprivi, approximately 30% of the water supply comes from alluvial aquifers, with the rest coming from the river (Day 1997).

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[6]   The Zambezi Newsletter provides comprehensive information about the river basin: http://www.sardc.org.zw/imercsa/zambezi/Znewsletter

3   SER B, Namibia Major

3.1   Climate

SER B is the largest of the three regions, covering about 640,570 km^2, or about 78% of the area of Namibia. This region contains approximately 60% of the population, although it is generally spread out, with the exceptions of a few major towns such as Mariental, Lüderitz, Walvis Bay, Karasburg, Keetmanshoop and Maltahohe. The precipitation gradient increases from the south-western corner to the north-eastern corner, rising from a mean annual value of 50 mm to 550 mm. Similarly, the temperature gradient increases from south-west to north-east, exhibiting a mean annual minimum temperature of 13.3°C to 15.5°C in the month of July, and a maximum mean annual temperature of 22.3°C to 25.5°C in the summer. Figure 2 shows the average annual temperature and precipitation by month for SER B.[7]
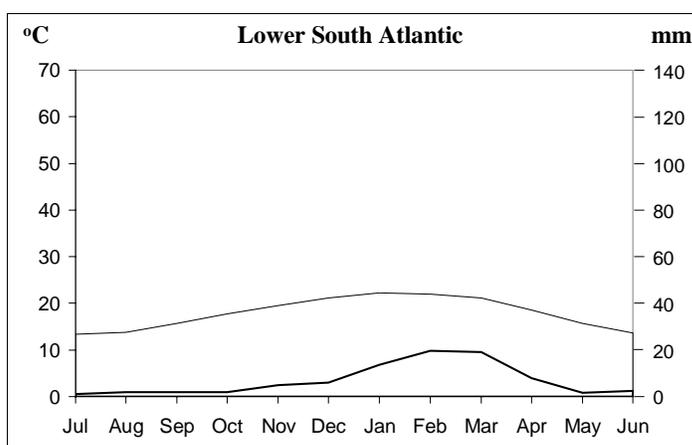

Figure 2. Relative aridity and humidity shown by average annual temperature and precipitation by month for the Lower South Atlantic Basin – SER B.

3.2   Watershed characteristics

SER B is comprised primarily of the following watershed basins: Upper South Atlantic, Lower South Atlantic, Fish, South Interior, and Coastal Drainages. The Upper and Lower South Atlantic basins represent an aggregation of the western flowing ephemeral river basins, with the exception of the Kuiseb and Swakop river basins. The Fish river basin is the most important tributary to the Orange River in Namibia. The south interior basin is dominated by the Kalahari Desert, and contains only ephemeral rivers.

The Fish river basin has four major dams on its river and tributaries: the Nawaspoort, Naute, Merensky and Hardap dams. The largest dam in Namibia, the Hardap dam, lies directly on the Fish River, and was built in 1972. It primarily provides irrigation and

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[7] Links Dataset. New *et al*. (1999); for description see Annex A.

domestic water for the town of Mariental. Namibia currently has access to an agreed 0.5 km^3 of water per annum from the Orange River.

The Upper South Atlantic basins contain the major ephemeral rivers: Hoarusib, Omarur, Ugab and Khan rivers. These rivers flow from the central highlands down the escarpment to the Atlantic Ocean. The Hoarusib's safe yield is approximately 20 MCM per annum. The Omarur's safe yield is approximately 12 MCM per annum and the Ugab's safe yield is 8 MCM.

3.3   Groundwater resources

There are several important aquifers in SER B that supply water for domestic and other purposes. There are three main types of aquifers currently being exploited: alluvial aquifers on the western edge of Namibia, the Grootfontein Karst aquifers, and the Stampriet artesian aquifers in the Orange basin.

The western alluvial aquifers which contain well fields, include the Omdel, the Neis-Neis, and the Omaruru aquifers, all located on various stretches of the Omaruru River. These three aquifers supply Henties Bay, Rossing Mine, Arandis, Swakopmund, Uis Village, Tin Mine, Omaruru and irrigation farmers with water. The Spes-Bona, Khan-Kranzberg, and Khan River aquifers are all located on the Khan river. These aquifers supply Karibib, Usakos, and Rossing Mine with water. The Koichab Pan aquifer provides water to the town of Lüderitz, via a 100 km long pipeline from the north.

The Karstveld, about 2,500 km^2 in extent, contains massive underground water stores. This aquifer is recharged directly from rainfall. Groundwater is abstracted from this aquifer for domestic, irrigation and other purposes for the entire Tsumeb-Otavi-Grootfontein region. There is a canal connecting the Karstveld to the Omatako dam, however it is not presently being used. This water may one day be used as a supplement to water from the ENWC to Windhoek (Joint Venture Consultants 1995).

4   SER C – Khomas

4.1   Introduction

The central region, SER C, is characterised by the Khomas highlands to the west and the Berg Auas mountains in the south. The capital city, Windhoek, originally attracted settlers in the late1800s because of natural springs in the mountains. As the population has grown, however, the water resources required to sustain the city have far outstripped the available local supply. In fact, the existing three dam supply structure (Von Bach, Omatako, Swakop) is not expected to provide enough water for Windhoek as the city grows in the next ten years. One of the main interbasin transfers, the Eastern National Water Carrier, transfers water from the Omatako dam, which lies approximately 165 km to the north of Windhoek, to Von Bach dam.

4.2 Climate

The annual average precipitation for Khomas increases from about 50 mm to 375 mm moving from west to east. The majority of rainfall occurs in the summer months, from December to March. Figure 3 shows the average annual temperature and precipitation by month for SER C.[8] The average annual minimum temperatures vary from 15.5°C in the east to 13.4°C in the west, and a maximum temperature range of 24°C to 25°C.
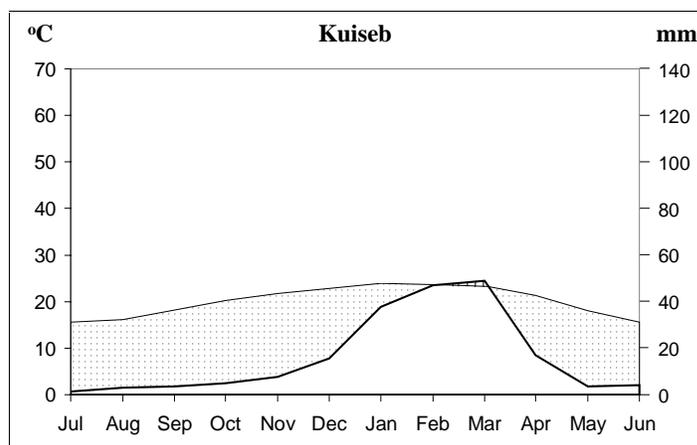

Figure 3. Relative aridity and humidity shown by average annual temperature and precipitation by month for the Kuiseb Basin – SER C.

4.3 Watershed characteristics

The Khomas region is comprised primarily of the following watershed basins: Swakop, Kuiseb, and Orange. As mentioned above, these watersheds do not provide Khomas with all of its water supply, as some of the water is piped from as far away as Omatako dam. The Kuiseb and Swakop basins are characteristic of the ephemeral western flowing river basins that occur all along the coast of Namibia. The Orange basin, as labelled in this analysis, denotes that part of the Orange River basin, outside of the Fish river basin, which lies within Namibian borders.

The Swakop river basin contains three dams, the Swakop, the Von Bach, and the Avis, and the Goreangab reclamation works. The safe yield from the Swakop River is 6 MCM per annum, or approximately 3% of the estimated safe yield from all of the western ephemeral rivers. The assured safe yield is a measure of the long term sustainable quantity of water that can be obtained from the river.

The Kuiseb river contains the Friedenau dam, which is currently not operational. The safe yield of the Kuiseb River is 5 MCM per annum, or slightly less than 3% of the total estimated safe yield of the western flowing rivers. The Kuiseb river is ecologically important as it limits the northward migration of the large sand dunes of the Namib sand sea. It protects the Walvis Bay town and the lagoon.

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[8] Links Dataset. New *et al*. (1999); for description see Annex A.

Finally, the portion of the Orange River Basin lying within SER C contains the Otjivero main and silt dams. Outside of the Khomas boundary, this basin contains the Oanab, Dreihuk, Bondels, Daan Viljoen and Tilda Viljoen dams. The south-eastern flowing Nossob River and its tributaries flow towards the Orange River, but never reach it.

4.4   Groundwater resources

The western flowing rivers are characterised by alluvial aquifers, which often provide groundwater supply to villages when the river is dry. Recharge occurs from intermittent floods in the riverbeds. There are important well fields which currently exploit the Lower Kuiseb and Swakop rivers. The Lower Kuiseb River supplies Walvis Bay, Rossing Mine, Arandis, and Swakopmund with water. The aquifer has been sub-divided into the Rooibank and Swartbank compartments and includes the Kuiseb Delta area known as the Dorop aquifer.

The Osana aquifer is a riverbed alluvial aquifer in the vicinity of the confluences of the Swakop and Okahandja rivers. This well field supplies water to the population of Okahandja, and to irrigation farmers. This water augments supply from the Von Bach dam. The use of water from these well fields is currently considered unsustainable, as the water table is being drawn down. There are plans to complete a desalinization plant by the year 2002, which will augment supply to coastal towns Swakopmund and Walvis Bay, and the Rossing uranium mine. Although the concept of a pipeline from the coast providing desalinated water to Windhoek has been debated, it is at present considered to be impractical due to energy and capital cost considerations.[9]

The Windhoek aquifer used to flow freely at the surface, but has ceased to flow as the aquifer has been taxed by increasing pumping rates from the increased water demands. The aquifer is underlain by schist and quartzite rocks, and receives the bulk of its recharge from precipitation over the Auas mountains. The aquifer is presently a major supply source, providing Windhoek with 2.34 MCM per annum. In time of drought, the production from the boreholes can be increased to augment dwindling surface water supplies.

5   IIASA Regional Level SER Analysis

The IIASA PDE project goal is to get an understanding of the dynamics between the human population and its surrounding environment. Particularly in the case of Namibia, where water resources are scarce, this project is oriented towards policies that might help mitigate future problems with water shortages. A brief description of Namibia's modelled water supply by basin and SER is given below. Also described are the scenarios that were applied in our analysis of the sustainability of Namibia's water resource.

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[9] Personal communication with Martin Harris, NAMWATER, Manager Infrastructure Planning and Design, March 2000.

6   Supply by Macro Basin and SER

The water supply is quantified by first modelling the physical supply, then from this total amount of water, the available supply is modelled. The physical supply is the total amount of surface water and groundwater over a watershed that is theoretically available for human consumption as a result of climate interactions, such as precipitation and evaporation. The available surface supply is the resulting runoff of the total basin runoff that is captured by surface reservoirs and the water that recharges the groundwater reservoirs and is consumed.

Namibia's water resource supply was assessed for each of the SERs by application of the SAINT (Southern African INTegrated) model, [10] which contains two sub-models of a basin-scale water balance and regional scale SER reservoir system. The resultant runoff from the water balance model is "routed" into a single reservoir for each SER, which supplies the demands of each SER. The demands are also supplied by groundwater, which as previously noted, currently supplies up to 57% of Namibia's water. In this model, only the sustainable groundwater yields (Joint Venture Consultants 1993c) are allowed to be abstracted for water supply.

The water balance sub-model is a rainfall-runoff model, which was calibrated to the annual runoff coefficient (ARC) and annual groundwater recharge (R) by basin. The ARC is a measure of the ratio of annual runoff to annual precipitation. Two maps were digitised in order to derive an average unit runoff for each basin: the Unit Runoff Map of Namibia (DWA 1992) and a map of unit runoff of Africa (UNESCO 1978). The links gridded half degree by half degree data set of precipitation was used to derive historical 95 year monthly precipitation series for each basin (New *et al*. 1999). The groundwater recharge information was taken for select groundwater basins discussed in Joint Venture Consultants (1993c). Currently, groundwater abstraction is assumed to occur only where information on its use is available. The modelled basins are shown in Map 4. After the calibration values for the calibration parameters (α, ε, and λ) are determined and tested for each basin, the model may be run to forecast available water supply under variable future climatic conditions.

The calibration of the model to the annual runoff coefficients produces a different monthly hydrograph than calibration of a section of a river basin (within the basin) to monthly-recorded flows. The main difference is the appearance of runoff in winter months where the ephemeral riverbeds are dry. In Figure 4, the calibrated monthly runoff values (inflow depths) to Von Bach dam, which lies within the Swakop river basin, to monthly dam inflows is shown versus simulated monthly dam inflows (Joint Venture Consultants 1993b) for the period of 1924 to 1974. The Swakop river basin monthly runoffs for the calibration to the annual runoff coefficient for the same time period are also shown in Figure 4.

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[10] The SAINT model and calibration procedure are described in detail in a forthcoming IIASA interim report by Molly Hellmuth, Kenneth M. Strzepek and David N. Yates: *Methodological Framework of the Southern African INTegrated (SAINT) Model of Water Supply.*
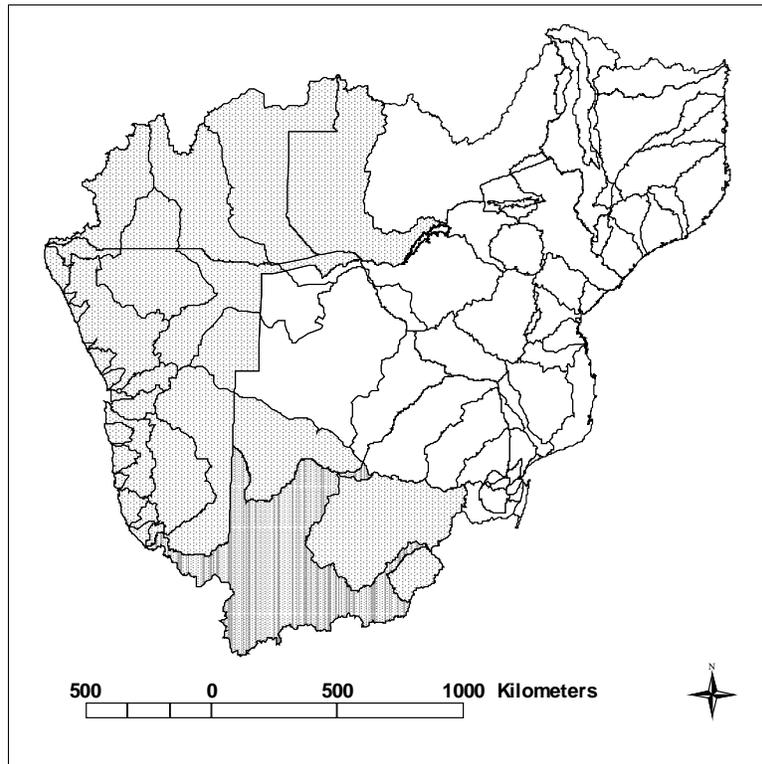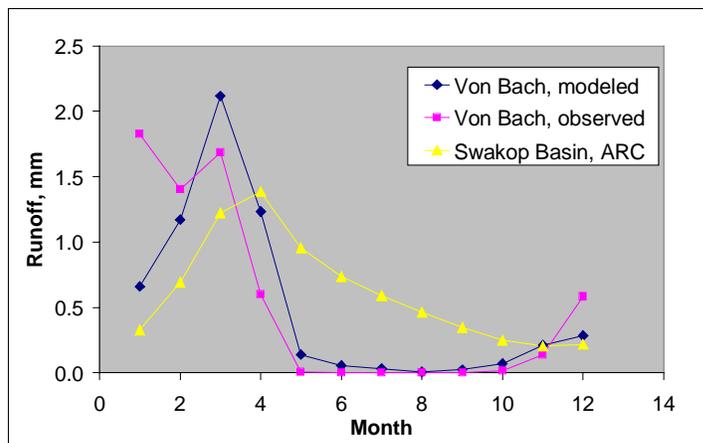
Map 4. Modelled basins (grey area).

Figure 4. Calibration of rainfall to runoff and the annual runoff coefficient.

At the scale of the case study of Windhoek, the existing hydrologic infrastructure is mimicked, and the model is calibrated to existing runoff data for each supply source. This precision is possible because of the existing runoff data; however, the accuracy of predicting supply and demand interactions at the SER level is not sacrificed by using the ARC as a calibration measure. The seasonality is still captured, although the monthly distribution is a less variable. The difference is negligible, however, when considering

the total annual supply and demand at the SER level, because the amount of available water annually is accurate. Additionally, for the majority of the basins in Map 4, monthly runoff data was not available. Note that the total annual amount of runoff (described as a depth, mm) is close, although not equivalent in both cases.[11]

7   Scenario Description

The use of a modelling tool such as the SAINT model can provide powerful insight to decision makers, as different policies are considered. For example, one of Namibia's major goals pertaining to the water sector as outlined in the First National Development Plan for 1995-2000 is to restrict bulk water consumption growth to 3% per annum (Heyns *et al*. 1998). Thus, reasonable bounds of the effective increase in price that will contribute to a stable 3% growth in consumption per annum can be explored within the framework of IIASA's model. Policy goals can be explored within the modelling framework by either being set up as an objective function, where certain variables are optimised to result in a 3% per annum growth in bulk water consumption, or as scenarios.

Several scenarios were considered pertinent to the analysis of the sustainability of Namibian water resources. The project focus is on population, development, environment interactions, and thus it is not surprising that the scenario analysis focuses primarily on modifying these three sectors. In the IIASA analysis, the following scenarios are considered:

(1) Water resource scenarios

  (a) No change in climate.
  (b) Climate change scenario, based on low, medium and high scenario transient predictions of precipitation and temperature changes in 2030, from the Hadley Center's Global Circulation Model.
  (c) Drought scenario, which takes the lowest five-year precipitation series in recorded history, and applies it to the climate series from 2000-2005, 2005-2010, 2010-2015, 2015-2020.[12]
  (d) Changing water price to limit consumption in main urban areas.

(2) Population scenarios[13]

  (a) Low population scenario: HIV/AIDS activity remains at current trends of incidence and prevalence.
  (b) Medium population scenario: A behaviour change occurs in the year 2001.
  (c) High population scenario: An AIDS vaccine is introduced in 2001.

(3) Economic scenarios[13]

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[11] The ARC calibration produces slightly higher runoff depths of 7.4 mm versus 6.2 observed. In some cases, however, this may be reversed, as the micro basin does not necessarily represent the runoff over the whole basin.

[12] These drought series are applied to each of the modelled basins. Cross-correlation is preserved amongst the basins, meaning that some of the basins do not use the lowest five-year historical drought sequence.

[13] The choice of the population and economic scenarios are discussed in more detail in the forthcoming IIASA book with the tentative title: *AIDS, Diamonds and Water: Modeling Population and Sustainable Development in Namibia and Botswana.*

(a) Low growth
(b) Medium growth
(c) High growth

Both the economic and population scenarios affect water demand. The forecast of water demand uses certain drivers; for example, the human population is the main driver for domestic consumption. Domestic consumption can also be increased if income levels are increased, as wealthier households tend to consume more water, and in general have better access to water than poor households. Economic growth can also affect the consumption of water by industry, as an increase in sectoral GDP can effectively cause an increase in water consumption as the sector grows.

8   Conclusions

The water resources of Namibia are considered to be scarce, and highly susceptible to drought. Indeed, the only perennial rivers in Namibia run along the borders. In the past, because it is so much cheaper to do so, the Namibian DWA has expanded the use of domestic water sources rather than build expensive infrastructure to border rivers or build desalination plants (NAPCOD 1996). There are concerns that this is leading to unsustainable off take from certain water tables and ephemeral rivers and giving rise to water quality problems. In addition, activities aimed at conservation of water appear to be having little impact in the absence of proper pricing. Thus, Namibia has some important decisions to make in the near future regarding its water supply.

Embedded within all these concerns and predictions are assumptions about human population development and growth. The growth of the population is slowing, and perhaps may even decrease, due to the AIDS epidemic. Additionally, economic demand management strategies may be applied to reduce the consumption of the water resource. The IIASA PDE project aims to provide a forum for an integrated analysis of the effects that changes in climate, population, and economic structuring might have on the sustainability of the water resource as Namibia moves into the new millennium.

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Appendix A: Description of the Links Dataset

New *et al*. (1999) is being used for climate data for Namibia as well as in all the southern African countries.

The climate time series used for the southern Africa work is a 0.5x0.5 degree lat/long gridded data set of monthly terrestrial surface climate for the period 1901-1996. The data set is comprised of seven climate variables including precipitation, mean temperature, diurnal temperature range, wet-day frequency, vapour pressure, cloud cover and ground-frost frequency. Fields are derived as climate anomalies relative to a 1961 to 1990 base period, which were then interpolated from climate station data to the grid. The anomaly grids were then added back to the 1961-1990 mean monthly climatology to arrive at the monthly climate over the 96-year period.

Precipitation and temperature were interpolated directly from station observations and the resulting time series were compared with other, coarser resolution data sets of similar temporal extent. The remaining, secondary variables were interpolated from merged data sets, comprising station observations and where data were sparse, using synthetic data estimated using predictive relationships derived from the primary variables.

Appendix B: Description of Figures 1–3, after H. Walter

The diagrams used in this report to describe regional climates are taken after Walter (1985) and Walter *et al*. (1975) (see below).

The diagram below provides a basis for interpreting the climate from an ecological perspective. It combines monthly temperature and precipitation curves for a specific region, in order to show periods of relative humidity and aridity. The water balance for a region is more accurately described by use of the potential evaporation and precipitation, which have the same units, and describe the input and output of water into a region. In this case, the temperature is used as a relative measure of the potential evaporation, because the two measures are proportional. However, as the climate becomes more arid, the absolute difference between the temperature and potential evaporation increases. For this reason, the diagram should only be interpreted as a relative comparison of humid and arid periods.

The diagram juxtaposes the temperature and precipitation in a fixed ratio of 10°C to 20 mm precipitation. This ratio has been derived from empirical studies, and can be applied to all regions of the world with the exception of the ecological zone of the Steppe (10°C = 30 mm). The diagram plots values for every month of the year. In the southern hemisphere, the time axis runs from June to July, while for the northern hemisphere it runs from January to December. This ensures that the warmer season be located in the middle of the diagram.

Finally, the magnitude of the vertical spread of the two curves provides a relative measure of the intensity of the humid or drought periods, while the horizontal extent of the shaded areas provides a measure of its duration.
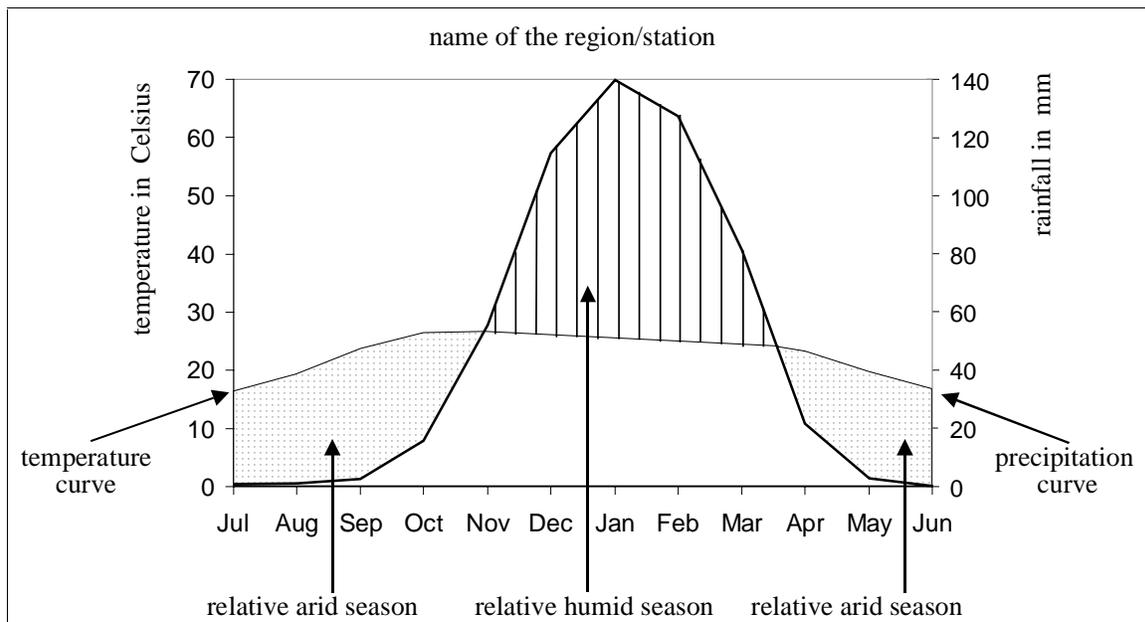
REPORT ON WATER RESOURCES AND WATER RESOURCE MANAGEMENT IN NAMIBIA

Robert K. Davis

Abstract

Namibia has a small population, an attractive climate for tourism, and a preoccupation with water, all of which befit its desert location. The government sector and the private sector have both invested heavily in water supply systems. Policies of heavy subsidisation of water supplies by the central government are being reversed by attempts to recover the full costs of water by the city of Windhoek and by a new parastatal water supply agency whose mission is full cost recovery of the water it supplies. An extensive and complex system supplies the central area from Grootfontein to Windhoek. Extensions to the system have been considered which would include an Eastern National Water Carrier which would tap the remote Kavango River. Water supply in other regions is also being studied. Rural water users in the communal lands will begin taking operation and financial responsibility for their water supplies. Although deserts warp the thinking of water supply planners, Namibia has in recent years shown a more rational psychology toward water development. It may be that Namibia's interest in tapping the Kavango is irrational. Past achievements aside, Namibia still has many difficult issues to resolve concerning its water development strategies.

1   Introduction

Namibia is an arid and semi-arid country with a reasonably sound economy and healthy prospects. It has a small population, an attractive climate for tourism, and a preoccupation with water, all of which befit its desert and near-desert climate. The economy is primarily based upon agriculture, mining and tourism. A growing fishing industry based on the Atlantic continental shelf and fish processing is one of the brighter spots in the economy. The general character of the Namibian economy is covered in reports by Lange (1997a) and UNIDO (1994).

2   Complementary Water Efforts in Namibia to be Noted for the IIASA PDE Project

There are some potentially complementary efforts in Namibia for IIASA to note:

– The USAID funded Natural Resource Accounting project in the Directorate of Environmental Affairs (Lange 1997a, 1997b). Lange's project is natural resource accounting to assess the uses of water. It also has a regional component assessing the use of the Kavango River in Namibia and Botswana and the use of the Orange River

in Namibia and South Africa. The water accounts are disaggregated by use and will be suitable for a Leontief style matrix which is yet to be constructed (as of 1998). The issues addressed in Lange's studies include the economic contribution of water use in each sector and the extent to which the use is subsidised; whether the current patterns of water use and development are the best use of water resources and available capital; and, finally, estimates of the costs of future demands.

− The International Bank of Reconstruction and Development[1] focuses on providing technical assistance to support the government's efforts to reduce poverty, build local capacity, and enhance management of water resources. There are no IBRD loans to Namibia.

− A Global Environmental Fund Study with the Permanent Okavango River Basin Commission of the Kavango basin of Angola, Namibia and Botswana[2]. The GEF study is meant to be a comprehensive look at the resources of the Kavango basin with emphasis on issues related to the water resource and particularly to the catchment area which is almost totally in Angola, and to issues of using the river which are mostly between Namibia and Botswana.

OKACOM was established in 1994 and is an initiative of the three Kavango River Basin states, Namibia, Angola and Botswana. The commission has the function of advising the governments on the sustainable development of the basin. It embodies the principles of equitable and beneficial allocation of water among the basin states while safeguarding the basin ecology. OKACOM will formulate an Integrated Basin Management Plan recognising that there is a need to manage the mounting regional development pressures through a process of open consultation at all levels (agencies, communities, interest groups and government level.

3   Status of Water Resources

The most useful overview and possibly the best available compilation of information on Namibian water resources are found in documents by Lange (1997a, 1997b) and by Ashley *et al*. (1995). Below are extractions of information relevant to the topic.

The government is responsible for the so-called bulk water supplies which are the (treated) supplies provided to certain agricultural, industrial and urban systems. Lange has compiled use of water by source and shows over half the water coming from boreholes with perennial rivers and impoundments (ephemeral rivers) supplying the remainder in about equal portions. It can also be seen that livestock and irrigation are the largest users of groundwater, that irrigation is the largest user of both ephemeral and perennial rivers and that livestock and irrigation together account for well over half (68%) of total water use in 1990. Domestic use accounts for about one-quarter of the total and mining accounts for about 5% (Lange 1997a: Tables 4, 5 and A1). The breakdown of water supplied by government and private entities is not so readily available. Because most private water supplies are boreholes and dams or tanks on farms, they will appear in higher numbers but smaller aggregate quantities than the

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[1] A World Bank Group, information at http://www.worldbank.org/html/extdr/backgrd/ibrd/
[2] Reference Jacob J. Burke – burkej@un.org – and OKACOM web site http://www.iwwn.com.na/ namibianet/okacom/

government supplies. However, Lange estimates that 39% of total use is from own supplies. Rural water supply by government is devolving from central government to communities and is to become self-financing in so far as operation, maintenance and replacement are concerned.

Bulk water supplies are heavily subsidised to municipalities, industry and agriculture by the central government. The subsidy is 71% of total costs (1993). Commercial crops get 96% of total bulk water supply costs as a subsidy; mining, a modest user, receives a 71% subsidy, and urban household use receives a 67% cost subsidy. These three users account for three-quarters of the bulk supplies consumed (Lange 1997a: Table 7), and this in turn has exaggerated the demand for water. Two events mark a reversal of this policy of heavy subsidisation. The largest urban area, Windhoek, has adopted an increasing block rate structure in an attempt to cover the full costs of water supply, and total water use has declined accordingly (Ashley *et al*. 1995). The second event is the creation of a parastatal water supply agency, NAMWATER, whose mission is full cost recovery of the water it supplies (Office of the Prime Minister 1997). The most studied water supply area is the central area, including Windhoek. The most exhaustive study is the most recent study of the so-called emergency water carrier from the Kavango River to the central area. Currently Windhoek is supplied from dams and boreholes. An earlier study, the "Central Area Water Master Plan: Phase 1" of the Namibia Department of Water Affairs (Joint Venture Consultants 1993) provides details of water supplies and demands and a simulation study of the system. The central system is extensive and complex, extending from Grootfontein to Windhoek and potentially including the coast at Walvis Bay. In 1993 it encompassed 12 regional state water schemes, 8 existing storage reservoirs, 12 groundwater aquifers, 3 purification plants, 14 major water demand regions and 35 links which were pipelines and canals. Additional dams, aquifers and links were considered, which involved simulating the system using the Water Resources Yield Model, developed by the contractors for the study, to examine alternative configurations and operating rules. The 1993 study compared the yield of the water system with projected demand. It concluded, or at least supported conclusions by the DWA, that measures would need to be taken to meet projected demands, but not unequivocally. It raised questions which led to the more recent study.

A more recent study of the Eastern National Water Carrier is even more detailed on alternative sources and demand scenarios for the central region. A new systems model, Water Transfer Consultants Model, was developed for the project to allow for changing values of the parameters during the planning period. The design criterion for the system was to meet the shortfall in demand requirements with 100% assured yield in the worst year over the specified fifteen-year period (DWA 1997).

The central northern region is currently the subject of a reconnaissance study of alternative water supplies from the Kavango to a number of towns and a small irrigation scheme. This area currently gets water from the Kunene River. Rural water is also supplied by boreholes in this area of communal land ownership.

The coastal area around Walvis Bay, the only deep-sea port of Namibia, is the subject of a current pilot study of desalting sea water. Desalinization will produce very expensive water to the consumers under a policy of full cost pricing, but Namibia needs to discover how much of their income people are willing to spend on their water supplies. Desalted water could conceivably be provided to Windhoek, but it would

mean a lift of 2000 m, which would be another test of the consumer's willingness to pay under full cost pricing. Outside the communal land areas, water to private farms is supplied privately. The farms are large enough to hire numerous workers whose settlements are supplied with water by the employer so that substantial domestic water supplies can be involved. Quantity and quality standards are enforced by DWA for these supplies. The farms also provide stock water and some irrigation of crops. Namibia grows about two-thirds of its cereals consumption. Beside the DWA, which supplies 42% of the water used, the Department of Agriculture and Rural Development supplies rural and local communities with 19% of the water used. Private supplies account for 39% of the water used.

Some mines are privately supplied, but more generally, industry and irrigated, large-scale agriculture are supplied by the government. The government supplies urban areas, the distinction between urban and non-urban communities being defined by the Ministry of Local and Regional Government and Housing.

Namibia does not have a National Water Master Plan that conveniently provides a repository of statistics for researchers. Supply and demand studies can be found for many of the urban water supply projects. Locating them is a task of searching the DWA library catalogue.[3] NAMWATER is said to be the repository for the "box" files of documents from historic water supply studies in Namibia.[4] The only supply studies of rural, communal water concern the determination of demand for a watering point based on criteria of population and distance from water. When the location for a water point is determined, a borehole is sunk without any preliminary cost or feasibility studies. The design quantities for these boreholes are 25 litres per capita per day. Studies have shown that people in rural communal areas use 10 litres per capita daily with almost no variation from place to place and over time.[5]

Groundwater knowledge is far from comprehensive. Groundwater is studied in connection with water supply plans. DWA has a survey of boreholes by yield and depth which is in a computerised data base accessible from the department's internal network (cited as unpublished in Lange 1997a). Lange (1997a: Table 2) shows the boreholes by region which are experiencing long-term depletion, although the depletion is characterised not as a rate but by whether the users have any readily available alternative supply. Roughly 90% of groundwater use comes from boreholes that have a "very serious depletion problem" as defined by Lange. These are boreholes under DWA management.

Two profound institutional changes will affect the demand for water and the way it is supplied. The first is that a parastatal has been set up to supply water to urban, industrial and bulk water agricultural users.[6] The organisation is called NAMWATER and its mission is full recovery of costs of the water it supplies. As discussed above, Namibian water users are heavily subsidised by the government. Demand will be affected if users are charged the full cost of any new supplies they are provided. This will mean that users must be willing to pay what it costs to provide them with new supplies. Their

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[3] The catalogue is available on the Internet at http://witbooi.natarch.mec.gov.na/namcat.html.
[4] Alexandra Puz, Planning Section DWA (interview Feb. 11, 1998). Contact Hanjorg Drews or Martin Harris <harrism@namwater.com.na>.
[5] I.G. Zijlma interview Feb. 10, 1998.
[6] Act of Parliament No. 12 of 1997: Namibia Water Corporation Act.

demands will be tested and will undoubtedly prove to be less than if their uses are subsidised by charging less than the full incremental cost of supplying the water. The effects on demand would be even greater if full cost recovery instead of subsidisation is pursued on supplies currently provided, but this could prove to be so unpopular that politics would mitigate against it.

The second significant institutional change is that rural water users in the communal lands will begin taking operating and financial responsibility for their water supplies. A new Directorate of Rural Water will administer the changeover, which is to be complete by 2000. The Directorate will retain responsibility for investment in new boreholes and rehabilitation of old boreholes, but the communities will take over responsibility for operation maintenance and replacement of the pump and all above-ground installation. In addition to the nearly 6,000 boreholes in communal lands, another 6,000 are planned by 2004.[7]

4   Strategic Issues Concerning Water Policy and Water Sector Modeling

Although there is much rethinking evident about Namibia's water supply strategy, the documents available are laden with a variety of proclamations about water that are peculiar to living in a semi-desert environment but have little bearing on the real economic issues of water resource allocation, however much they may support the political allocation of water and the rhetoric of urgency about investing in water resource development. Deserts warp the thinking of planners who typically come from humid areas. The following dubious pronouncements are found in the reports cited herein (Lange 1997a:1; Ashley *et al*. 1995):

– water is the scarcest resource;
– water is the single most important constraint in economic development;
– water is the reason Namibia is so sparsely populated.

These are three extreme statements repeatedly found in the rhetoric of arid areas, and usually fall apart on further examination. For example, if water is the scarcest resource, it should also be the highest priced, but it isn't, and if it is not the highest price resource, it is not the most important constraint on development. The point is that water can be provided in almost every situation imaginable at costs which suffice to allow it to be used efficiently for almost any purpose. If development is constrained, it is usually for other reasons. In other words, abundant water in Namibia would not guarantee economic development or a vast population. The UNIDO (1994) review of Namibian industrial development gives the economy a very positive review without once mentioning water as a constraint or even as an important input, but only calling attention to the fact that water is second only to education in commitments of foreign aid to the Namibian government.

As if to refute these statements, Lange (1997a:24) notes that the price of water would not have an impact on business decisions in the manufacturing and service sectors because water costs are a very small share of total costs. These sectors represent the

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[7] I.G. Zijlma (interview Feb.10, 1998) cited the tables from "Regional Strategic Operational Objectives."

high value uses of water that one would expect to grow in a water short economy, if there is such an economy.

One also finds policies and practices in evidence that reflect the desert psychology which afflicts water resource engineers in this environment:

- the practice of giving huge subsidies to the most profligate water users and then decrying their inclination to waste water;
- the failure to price water appropriately;
- the protectiveness shown toward heavy users such as irrigators.

These practices are not rational, if water is as precious as the rhetoric says it is.

Indeed, if water were truly a scarce resource, the nation's economy would pay a great deal more attention to the value added per m^3 of water in the various sectors. One finds that the N\$ added per m^3 varies from 4.7 in commercial agriculture to 538.3 in the service sector. In mining the value is 40 and in manufacturing 132 (Lange 1997a: Table 6). If water were truly a limiting factor and it were priced at its full incremental costs, such extravagant variations in value added would not persist. The low value uses would be squeezed out, and high value uses would expand. It might be argued that water could not be transferred easily from one use to another but it has been pointed out above that Namibia has the plumbing that would allow extensive transfers of water, if users could be compensated for giving up "their" water. This disparity points up the practice of subsidising water use, but also suggests that water may not be as limiting as the mythology claims. Appropriate models could show how water would be used in the Namibian economy if its price were equal to its full incremental cost.

Namibia (and also Botswana) have in recent years shown a more rational psychology toward their desert conditions, as reflected in new attitudes toward demand management and recycling and in the abandonment of schemes like Botswana's Southern Okavango Integrated Water Development Project. That Namibia's interest in (diverting water from) the Kavango may be irrational is suggested by at least one observer. Economist Fred Greiner (1997:1) states that "Phase II of this study should analyse in detail the feasibility of using desalinated water to cover peak water consumption in Windhoek when needed, making use of existing infrastructure (the pipeline from Swakopmund to Arandis and the pipeline from Karibib to Von Bach Dam)." Greiner also observes that Windhoek can tap mines in the Tsumeb area for water supplies.

The outcomes of models simulating and projecting the water sector will be hugely affected by the mindset chosen. The opposite of the desert mindset is the "water is not different" mindset, which treats water the same as any other resource that is to be efficiently developed among competing demands for capital and to be efficiently allocated among competing demands for use. If water is not different, drought losses are not something to be avoided at all costs but are to be approached as a problem in minimising the costs of drought losses (and the nation is not willing to go to any extreme to provide abundant and cheap water supplies at all times). This more positive mindset is reflected in many of the practices Namibia is currently pursuing with respect to water pricing and reuse.

There are at least four possible levels or domains for water resource modelling:

- the economy,

- the river basin,
- the water supply system,
- the nation.

Developing a model of the economy and a sub-model of the water sector could be appropriate.

- The Natural Resource Accounting project in Namibia essentially does this for the natural resource sector and is using the water sector as a case study. Their model would not necessarily be an input-output model, but would contain much of the same information as a simulation study of the water sector. The Natural Resource Accounting project identifies appropriate policy issues and variables for a simulation study of the water sector.

- Namibia is in the rare position of not having any perennial river basins within its borders, and of having a very meagre hydrology in its ephemeral basins, with 2% of rainfall going to runoff and 1% going to inflow. Multiple purpose river basin management may not be an issue because there is not the competition between flood control, navigation, recreation, and water supply to be found in perennial river basins.

However Namibia does have extensive water supply systems that link ephemeral streams, boreholes and water carriers and which might be appropriate subjects for systems modelling. The central and north central systems in particular are extensive and complex and are the focus of consideration for future investment. The feasibility study of the Okavango-Grootfontein link of the national water carrier (Water Transfer Consultants 1997) and the reconnaissance of the north central system underway (DWA 1997) should be rich sources of data for modelling.

- Namibia also possesses the Water Transfer Consultants Model and a Water Resources Yield Model developed for its Northern Water Carrier Study. Each of these models can be rich sources for further modelling (DWA 1997).

Approaching these systems with optimisation in mind, through interconnection and operating strategies, might reveal possibilities for increasing yields merely by changing operating rules or introducing drought emergency routines (as Daniel Shear has done in the Washington, D.C. Metropolitan Water Supply Study, see McGarry 1983). In another case, the California water system is able to move water between the ends of the state merely by altering diversions along the way.

- The supply system model could capture spatial details of a region with urban supply nodes, rural domestic supply points and agricultural-industrial supply nodes. As always, there is a question of how much detail would be cost effective in the ultimate model.

- It may be appropriate to consider modelling water allocations in the international Kavango Basin in view of the Global Environment Facility[8] collaboration with OKACOM to study the basin in Angola, Namibia and Botswana.

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[8] The GEF is a financial mechanism that provides grants to assist developing countries to address environmental problems to transcend international borders in four areas: global climate change, pollution and overexploitation of international waters, destruction of biological diversity, and depletion of the

– If international allocations were to be studied, then the study would necessarily explore the potential for international disagreements and the process for their resolution. This would necessarily consider the elements of water retention and diversion and the vulnerability of water quality and ecosystem integrity to these influences. There would be an opportunity to consider the basin as an integrated resource management unit to be managed for the joint welfare of the people in Angola, Botswana and Namibia. The institutional obstacles to any of this would be formidable, but the prospect cannot be dismissed on the basis of what we know now.[9]

National models offer opportunities to study the variables affecting water demands and uses. By modelling demand as a function of population, industry, GDP/capita, agriculture, urbanisation and efficiency of use (see Ashley *et al*. 1995) it is possible to capture the texture of the water resource policy issues and to begin to manipulate outcomes. Among the issues that could be studied by a simulation of national demand are:

– the feedback loop between demand and supply via pricing;[10]
– reallocation of supplies as a function of system operation with interconnection and changes in pricing/efficient use;
– shifts in the location of population growth through altering the location of investments in infrastructure and relentlessly pursuing marginal cost pricing of all public services;
– introduction of other policy factors such as those affecting desertification (NAPCOD 1996).[11]

A national model might be an appropriate place to compare a strict efficiency mindset against the choice of water politics dominated by desert psychology to the consequences for investment and allocation decisions.

5   Conclusions

Assumptions and objectives are crucial in shaping the outcome of water supply studies. Models perform in response to their assumptions and objectives. This report has reviewed a number of recent developments in water resource policy and planning in Namibia. By taking them into account, in its models IIASA can study the implications of alternative policies on the development of water resources and their environmental consequences.

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ozone layer. The GEF is jointly implemented by the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), and the World Bank (http://www.worldbank. org/html/pic/GEF.html).

[9] Namibia has plans to apply to GEF for funds to conduct an environmental impact assessment of the Okavango basin over a six-year period and which may be a step toward integrated management of the basin. (Interview with Shirley Bethune, DWA, Feb. 11, 1998.).

[10] The Averch-Johnson effect could be explored, in which utilities which fail to marginal cost price are unable to recover costs of expansion and enter a loop of lowering prices to stimulate demand which creates the need for expanding the system.

[11] Namibian Programme to Combat Desertification was established in 1994 and is a joint initiative of the Desert Research Foundation of Namibia, the Ministry of Environment and Tourism, and the Ministry of Agriculture, Water and Rural Development (http://www.dea.met.gov.na/Programmes/Napcod.html).

The critical objectives and assumptions with regard to water development strategies in Namibia may be stated as the following questions:

– Will water resources be developed according to the principles of economic efficiency, or will desert psychology and "water is different" prevail?[12]
– Will the greatest portion of water supplies be priced to users according to full cost recovery principles now adopted by Namibia?
– Will the potential gains from recycling of water supplies be fully exploited?
– Will the potential be exploited for increasing yields of the integrated water supply systems through optimal configuration and optimal operating rules, including drought emergency planning and the gains from optimal conjunctive use of the surface and groundwater supplies?
– What is the role of international agreement in shaping Namibia's water joint futures on the Kavango River or, potentially, other international rivers?

The consequences of the answers to these questions can be vast in terms of the investment Namibia makes in water resources in the next 50 years, and in terms of the consequences for the shared freshwater resources of the southern African region.

– If Namibia were to act under the influence of a desert psychology, it would spend immensely more resources on water development and have a far greater impact on its freshwater resources than may be rational.
– If water is not priced to users according to full cost recovery rules, greater amounts of water supplies will be demanded and the desert psychology will be in full force, leading to ever greater schemes for water development.
– If waste water is not reused up to the point where marginal benefits equal marginal costs, more freshwater supplies will need to be developed because of inefficient use of wastewater.
– If the optimal potential for system integration and operation is not realised, additional freshwater supplies will be demanded. Irrational drought planning will have the same consequence.
– An international agreement between Angola, Botswana and Namibia over the management of the Kavango River system might deal with the allocation and management of the river to the benefit of all parties. Without it there may be strife, particularly if Namibia's interest in the Kavango waters for its central water supply system compels Namibia to unilateral development of the Kavango supply.

There is a prospect in Namibia that water policies are moving in the direction of greater efficiency. Evidence supporting this observation is presented in preceding sections of this report. Looking at the consequences of alternative policies 50 years into the future, as IIASA can do, has the distinct possibility of influencing the trend of water resource policies in these countries.

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[12] The principles of economic efficiency would lead to maximisation of the net benefits of water resource development or to minimising the costs of a particular water resource objective such as the costs of drought avoidance.

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LAND REFORM IN NAMIBIA

Lazarus Hangula

Abstract

In a furtive glance, Namibia may appear to be a country with limitless land resources. Such a view is, however, misleading. Despite the existence of large and uninhabited tracks of land, especially in central and southern parts of the country, Namibia is faced with problems of destitution, squatters, land shortage, overcrowding and land degradation.

By introducing the system of private holding on land, the projection of European history onto the socio-economic life of Namibia has created a dual system of land tenure in the country, that is, communal and freehold land tenure systems. Encouraged by colonial laws and racist policies, European settlers developed an uncontrolled appetite for native land. This led to unprecedented land grabbing and dispossession, especially during the period of South African colonial administration. Many Africans were pushed away from their ancestral lands and relegated to reserves or home areas *(Bantustans)* in the periphery. This state of affairs alienated the black population, inspired rebellion, nurtured nationalist ideas and lastly, led to the liberation struggle as well as abdication of the old regime and independence. Namibia's liberation struggle was as much for independence as for the "stolen land."

After ten years of political independence, Namibia still seems to be far away from the dismantlement of the colonial scaffolding as far as land is concerned. The commercial holding is as stable as it was before because of its title deed, which is protected by the country's constitution and the exorbitant prices of its land markets. Lands formerly falling under *Bantustan* areas are now called communal areas and are legally government land. The majority of the black population (over 70%), whose livelihood largely depends on land, live here. Due to ecological constraints, some individuals have resorted to fencing off what is generally communal land for themselves. This results in a multitude of conflicts over land in the communities across Namibia. In this connection Pankhurst's (1996) book, *Resolvable Conflict? The Politics of Land in Namibia,* retains its actuality.

1   INTRODUCTION

With a total land size of 824,269 km^2 (the surface area of the land covered by the uninhabited off-shore islands and the country's territorial sea waters excluded), a total population of 1.4 million and an average statistical density of 1.6 inhabitants per km^2 (according to the 1991 census; GRN/NPC 1994), Namibia would appear to be an idyllic eldorado in a world that increasingly faces serious problems of land shortage and overcrowding. The low mathematical density, however, is delusive and becomes

apparent when it is considered in the light of the country's geomorphology and the climatic conditions that, to a great extent, determine the settlement patterns of the population in the country.

Namibia has varied types of climates that range from barren and arid in the south, desertic at the coast (i.e. Namib Desert) and in the south-east (i.e. Kalahari Desert), to subtropical in the northern and north-eastern parts of the country. Due to their average temperatures, these types of climates impact differently on the average annual precipitation in the country. The precipitation in Namibia varies from 400 mm-500 mm in the north and north-east (i.e. Caprivi, Kavango and former Owamboland as well as the Otavi-Grootfontein-Tsumeb triangle), 250 mm - 400 mm in the central highlands, to almost 0 mm annually in the Namib Desert (Leser 1970:199-200; Siiskonen 1996:293). In non-desertic areas the abundance and exuberance of flora and grazing as well as the availability of water are, to a great extent, influenced by the local conditions of precipitation. However, the "appearance and conditions of the desert are determined by the quantity and distribution of water, whether from local rainfall or the periodic flow of the rivers entering the region... [M]ost water in the Central Namib [desert] rivers derives from rainfall in the Namibian highlands" (Kinahan 1991:5).

Coupled with the local geomorphology, these climatic and pluviometrical conditions determine the ecology and create an enabling environment for human living and economic space or *Lebensraum* as Leser (1970:199) called it. They also influence the types of quality and quantity of products that can be produced in an area (Carter 1968).

For historical, political, economical and legal reasons, land in Namibia is unevenly distributed between descendants of the white settler community and those of the (mostly black) indigenous communities. While the white community, which makes up only 11% of the country's total population (GRN/NPC 1997), occupies about 60% of the total useful land (Adam and Werner 1990; Republic of Namibia 1991), the black community occupies only 30% thereof. Moreover, the emerging high and middle classes among the black community are also shifting their economic and land tenure grounds. Because of its economic and emotional value, land in Namibia was the cause of decimating colonial wars between the Germans and the indigenous communities of the Namas, Hereros and others in the pre-colonial period (1888-1906), and later led to disparity in land holding. Later on, this tenure disparity between the natives and the settler community led to a protracted war of independence which lasted from 1968 to 1989.

Although the war has ended and, with the implementation of the United Nations Resolution 435, the country attained political independence on 21 March 1991, and the policy of national reconciliation was enshrined in the preamble of the country's constitution, the scaffolding of discriminatory colonial policies regarding access to land and other economic means still remain intact to the dismay of the majority of the people in the country, including the powerful umbrella of the National Union of Namibian Workers and part of the parliamentary official opposition. Adding to this state of affairs are some post-independence socio-economic phenomena and trends such as the illegal fencing of communal lands (Tapscott and Hangula 1994) and the eviction of farm residents. Similarly worth noting are the claim of ancestral land by desperate landless and minority indigenous groups (Hangula 1997) and the promising conservancy programme, which is part of a new attempt to re-introduce wildlife in the communal areas for cultural and economic reasons, that is, as a means to enable the communities to

benefit from their natural resources. These trends also contribute to the reduction of the volume of the arable and residential lands as well as that of the commons and rangelands, thus making the sharing of and competition for the related finite resources difficult.

At least 65% of Namibia's population lives in the rural areas where the dependency on land to make a living is still very high. In this regard it is certain that in the long run, for a non-proletarianised and rural-based majority, destitution of land may create socio-economic problems. This is alarming as it may cause the policy of national reconciliation to dwindle at best, or collapse at worse, if the matter is not addressed with the care and urgency it deserves (Pankhurst 1996).

Land reform is, thus, a *sine qua non* if the country is to leave the ghost of the past injustices behind, reconcile and enter the path of socio-economic development as it faces the challenges of the new millennium. In order to be successful land reform in Namibia needs to be genuine and far reaching. That means, it has to redress the imbalance of the past by not only (1) facilitating access to land for those whose livelihood depend on it, (2) guaranteeing a secure tenure for the country's poor both in rural and urban areas,[1] but also (3) by addressing the issue of land administration and management, including taxation and the protection of the environment and biodiversity.[2] Moreover, in such an "extremely arid and drought-prone" country like Namibia (Devereux *et al*. 1995:5), a complete land reform can only be achieved if an attempt is made to establish a reform linkage between different forms of land use, the resettlement policy and productivity through a broader and well designed land use plan for the country.

2   History, Politics and the Law

The present debate and analyses of land reform in Namibia and beyond are better understood when considered in the context of the country's natural as well as social, political and economic history, both old and contemporary. Differences in climate, the disparity in precipitation and ecological chains have traditionally conditioned the human settlement, thus considerably impacting on natural population distribution patterns throughout the country.

The earliest inhabitants of Namibia are believed to be the Khoisan speakers, a large group of hunters/gatherers who settled and led a nomadic life on the edges of the Kalahari and Namib deserts some thousands of years ago. Later, this nomadic group was followed by a group of pastoralists who occupied the central parts of what is now the Namib Desert (Kinahan 1986, 1991). They were subsequently followed by a group of agropastoralists who settled in the northern parts of the country which (because of the pearl millet staple food that is produced there) is today known as the *Omahangu Corridor* and which extends along the northern border from the Zambezi in the Caprivi to the Kunene River in the western end of former Owamboland. Although very elastic in the early period due to the demands of an economy that was predominantly based on the movement and erratic nature of the relevant natural resources (Hangula 1997), the area where these groups, or rather their descendants, settled formed the home area of

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[1] The planned, new flexible land tenure in Namibia may offer a solution to this problem.
[2] Article 95(l) of Namibia's Constitution.

specific indigenous communities (Leser 1982:17-18). Before the European intrusion, land use by all Namibian communities was (and is still) predominantly based on a communal land tenure system (Gotthardt 1927; van Warmelo 1962; Siiskonen 1996).

2.1   The European intrusion and the dynamics of its land tenure

The European intrusion into south-western Africa in the period of preclusive imperialism was mainly geared towards acquiring land for the colonial establishment. This is elucidated by the fact that the very first acts ever concluded between native communities and colonial settlers throughout Africa were almost exclusively concerned with land (Hesse 1905, 1906). The existence of vast uninhabited tracks of land, combined with a humanitarian and very liberal system of land allocation and a comparatively weak technological system of defence on the part of the native communities encouraged the intruders to grab more and more land from the indigenous peoples, thus lastly leading to insurgence, wars and effective colonial occupation (Gründer 1985). In most cases the implementation of the colonial policy of the effective occupation went hand in hand with the transformation of native lands into state land or *crown lands,* which were earmarked for allocation to those settlers who helped the colonial state break the resistance of the natives or for use by the state. Historically this state of affairs also applies to Namibia and contributed to the emergence of a dual type of land tenure system in the country.

2.2   Land tenure systems in Namibia

John Bruce (1993:1) defines land tenure as "the terms on which land is held: the rights and obligations of the holders of the land. It is a legal term and means the right to hold land." The ways through which persons can hold land may, however, differ from country to country, or even within the same country, as a result of socio-historical processes.

As tenure issues determine the (rights) relationship between the holder, user and the property, they are also *eo ipso* legal issues. Tenure issues do not refer to the volume or quality of land *per se,* but due to their intrinsic relationship with productivity and the livelihood, the issue of quantity and quality of land also plays an important role in the land question. Hence, the issue of land value may differ from one economic regime to another, and from one land tenure type to another.

There are three prevalent types of land tenure in Namibia today: communal land tenure, freehold and leasehold. While communal land tenure and commercial land tenure are antithetical to each other, the leasehold reflects a certain portion of synthesis between them. These tenure types reflect the property (rights) relationship to land both as property and as resource to a holder, or user.

2.2.1 Communal land tenure

The customary tenure (also known as traditional or communal tenure) is a type of holding in which land is considered to be the property resource of members of an entire community. Communal land use is, thus, a form of utilisation of land and/or usufruct of

land-related natural resources that is accrued to an individual by virtue of his or her belonging to a community which is the customary legal owner of such land. In this form of tenure, whoever is a member of the community is *mutatis mutandis* entitled to the use of such land. For members of this community, land is a *res communes* (Bromley 1992:458).

This fact notwithstanding, however, *communal* land tenure is also a property regime which involves substantial control, access, use and management of land by the community through community institutions (Bruce 1993:8).

In general, communal land use is indicative of the predominance of a nature-based system of economy and utilisation of land for different forms of primary economic activities, such as the collection and gathering of nature products through the hunting of wildlife, grazing of livestock, cultivation of crops, community mining or dwelling. Land use in pre-colonial Namibia was also predominantly communal with most communities being involved in hunting, pastoralism, subsistence agriculture, etc. Up to the period of European colonial intrusion in south-western Africa in the mid-1880s, the prevailing land tenure was communal in Namibia, including Rehoboth and the episodic Republic Upingtonia (1884-1885).[3] Subsequent to the European intrusion and the establishment of colonial settlements in the territory, a new property concept and regime regarding land law was introduced in Namibia.

An important characteristic of the communal land tenure system is its nuance of primeval humanitarianism, which considers land as an open access resource to which everyone is naturally entitled to have access to be able to make a living. However, as elucidated by the theorists of the "tragedy of the common" (Hardin 1968), the policies of this primeval humanitarianistic land tenure system may fall prone to vulnerability when confronted with a divergent, individuocentric and more speculative land tenure system as is the case with commercial land tenure. That is what happened after the (European) freeholding or commercial land tenure system was introduced in Namibia.

Conceptually and formally, homelands disappeared when the legislation concerning the third tier authority and the 1968 Bantu Nations Act was repelled by the Namibian Constitution (Schedule 8) at independence. However, some scaffolding of colonial strategic planning still remains intact with former homelands now posing as communal areas, despite the creation of new administrative regions which abhor ethnic geographic entities. In addition, "police-zone" restrictions of the old regime are being perpetuated by the so-called veterinary fence, which prevents the export of meat and plants from communal areas into the commercial area, but not vice-versa, although communal areas have also become commercial areas of some kind. This state of affairs still prevents 60% of the country's population in the communal areas from having access to better agricultural market prices in the commercial area.

In terms of their philosophy *Bantustans* or homelands were designed to control the natives and to serve as labour reservoirs for the supply of manpower to the farms as well as the public and private sectors of the colonial establishment. Despite this fact,

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[3] This was a temporary settler hunter 'republic' established by the Thurstland Trekker Boers who, while fleeing the British jingoism trekked in a long march from areas in the territory of today's South Africa to an area in today's south-western Angola known as Humpata. The Republic Upingtonia enclosed the area today occupied by the towns of Grootfontein, Tsumeb and Otavi.

however, in terms of land policy, they guarantee access to land for multifarious purposes for the majority of the country's population.

2.2.2 Freehold and colonial exacerbation of land acquisition

John Bruce (1993:10) defines freehold tenure or private ownership of land as "a tenure under which land is held free of any obligations to the monarchy or state, other than payment of taxes and observance of land use controls, imposed in the public interest." The holding of land under this tenure system can be individual or collective.

The projection of European history into Namibia, as in other parts of the African continent, happened at the peak of the Industrial Revolution, when Europe's industrialisation required new products, productive units and markets. For that reason land became the focal point of the colonial enterprise. In terms of the 1815 historic Vienna Congress and the politics of the concert of Europe (Holbraad 1970; Baumgart 1974), however, land in Europe could no longer be acquired through the classic means of conquest and occupation, hence, the option of European powers to bid for colonies in other continents, especially in Africa, thus inaugurating the onset of the age of preclusive imperialism (1870-1914). The bid for land is also highlighted by the fact that all over the African continent the creation of colonial territories was preceded by the establishment of settler colonies and (private: individual or company) estates or land holdings. But owners of such land holdings were not always on the spot. For instance, A.C. Lüderitz, who was the first German ever to acquire land – Lüderitzland or Angra Pequena – in Namibia, and who laid the foundation for the establishment of the first German "colony" in Africa (Lüderitz 1946; Holst 1941), does not seem to have ever set foot on Namibian soil.

The encounter of an indigenous land tenure system that is humanitarianistic and not based on a system of property registration with a land-hungry, freehold-oriented and militarily highly equipped settler community soon made the incoming white settlers "voracious for land" in Namibia (Fuller 1992:10). This also caused the land of the native communities to be successively grabbed. As a result, a "common theme of Namibia's colonial history has been the loss of land by indigenous peoples to white settler colonists" (Fuller 1992:17). This trend began with the Germans in the early 1880s and reached a critical point at the outbreak of the German-Nama and German-Herero wars and in the German dispossession policies in the aftermath of these colonial wars (DKGG 1890-1910).[4] Following the introduction of the system of *reserves* for natives (Adams and Werner 1990:4-14) and the creation of *crown lands* by the German administration in the aftermath of the colonial wars, white areas started emerging in Namibia.

The changing of flag and government in Windhoek in 1915 as a consequence of an overturn in the balance of force at the beginning of World War I in southern Africa and the onset in 1920 of the mandate arrangement of the Versailles Conference regarding colonial territories of Germany did not alter the trends of colonial land policies in Namibia. To the contrary, South African expansionistic, annexationistic and racialistic

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[4] Deutsche Kolonialgesetzgebung, a series of volumes containing legislation applicable to German colonies.

politics exacerbated and, lastly, polarised the land question up to the date of Namibia's independence.

Indeed, South Africa considered its mandatory power over the then South West Africa on behalf of the British government a welcome move to enable it to solve some of its social problems at home through a massive resettlement programme (Fuller 1992:33-39). This so-called Land Settlement Programme of the South African government was introduced as early as 1920 in Namibia and was designed to benefit the poor segments of the white population in South Africa. Similarly, the Land Board was also established "with the dual purpose of managing the Land Settlement Programme and of overseeing the use of open government grounds" (Fuller 1992:36). Moreover, the Land Settlement Programme not only provided for the resettlement of whites from south of the Orange River into Namibia, it also slowly and systematically managed to push a considerable number of Namibia's black population off their land. Table 1 shows an exponential increase in the number of white people and an arithmetical ownership shifting of land from the hands of the Africans into the hands of the European settlers in the territory, from a customary community land tenure to a private and commercial type of land holding.

Table 1. Growth of white farms in Namibia, 1913-1962. Source: Fuller (1992:37).

Year	White population	Number of farms	Area in hectares
1913	14,830	1,138	11,490,000
1935	31,800	3,255	25,467,628
1946	37,858	3,722	27,413,858
1955	49,930	5,050	37,868,124
1962	72,000	5,500	39,812,000

At the time of independence, the areas with customary tenure became known as communal areas while those with prevalence of private holding became known as commercial areas.

3   Communal Areas

Despite the traditional concept of land as a communal property resource prevailing among the indigenous communities, freehold, a new legal concept of land holding, making land the property of an individual or family in perpetuity, was introduced in Namibia. Henceforth there are two types of land tenure coexisting in the country: communal and commercial land tenures.

Today, customary or traditional land tenure is prevalent in those areas that were reserved for use by members of the country's indigenous communities. For historical reasons, areas of traditional land tenure in Namibia partly coincided with the home areas of the indigenous communities and with the Bantu homelands of the apartheid period

(Hangula 1994:9), as they have been successively defined and readjusted by the administration since the early days of the colonial administration.

The reallocation of land, which was carried out during the colonial period, attained its apex with the Odendaal Plan of 1962 and its implementation through the *Development of Self-Government for Native Nations in South West Africa Act of 1968* that formally established Bantu homelands in Namibia. The end-product of this Act was the creation of twelve autonomous ethnic entities in Namibia that had the white governments in Pretoria and Windhoek moving the strings of power in the homelands of Owamboland, Kavangoland, Eastern Caprivi and Caprivi Region, Hereroland East and Hereroland West, Tswanaland, Namaland, Rehoboth Gebied, Damaraland, Kaokoland, and Bushmanland, which were formally established later on (see Appendix Map).

3.1   Owamboland

With an area of some 5,607.2 km^2 or 5,607,200 ha, the Owambo homeland of the Odendaal Plan hosted one half of Namibia's population. The endemic water situation in the area during the dry season was partially solved through the construction of the Owamboland Water Canal and the Ruacana Water Pipeline. The latter channels water from the Kunene River at Kaluheke in Angola and Ruacana to the more arid areas of central Owamboland. Although poor in minerals (with the exception of salt), the area is naturally fertile due to its geographical location in the centre of the Kuvelai Delta.

The main economic activities of the people in the area revolve around crop production (mainly pearl millet or *omahangu*, sorghum, melon, watermelon, pumpkin, beans, groundnuts, etc.) and livestock production (mainly cattle, goats and donkeys). Although the area produced enough food for the sustenance of the local population in the past, today, due to migration of the potential labour force from rural to urban areas, the yield from traditional agriculture is insufficient to cover the food needs of the local population. Additionally, because of population growth, the amount of arable land has decreased considerably, thus rendering it unsuitable for extensive agriculture. As a consequence, the majority of the population can no longer produce enough for themselves. They need some remittances from relatives who are in formal or informal employment, pension, etc., to supplement the food harvest from the fields and enable them to make a living (Devereux *et al.* 1995:83-84). The former Owamboland is currently going through an important phase of economic transition and social transformation, from traditional subsistence agriculture to an entrepreneur-based economy. Subsequent to post-independent regional delimitation, the former Owamboland was divided into four administrative regions: Ohangwena, Omushati, Oshana and Oshikoto regions.

3.2   Kavangoland

With a size nearly as big as the former Owamboland (i.e. 4,170.5 km^2 or 4,170,500 ha) the former Kavango Homeland hosts only 6% of the country's total population. The region owes its life to the life-spending waters of the (Cubango) Kavango River, which also forms the boundary between Namibia and Angola and greatly influences the settlement patterns of the population of the region. As a result the majority of the

population of Kavango lives in the perimeter of the Kavango River. The interior is, to a great extent, uninhabited or is sparsely populated (Adams and Werner 1990). The region is one of Namibia's rare greenbelts. The soil is good for crop production (e.g. pearl millet, maize, groundnuts, melon, watermelon, cotton, etc.) and for livestock rearing (mostly cattle and goats) (Odendaal Commission 1964; Leser 1982). The river also provides some fish. The region is a target of extensive government agricultural development programme projects, on the one side, and of community forestry projects, on the other. Because of its abundance in wildlife and handcrafts, the region also has the potential for conservancies and tourism.

3.3   Eastern Caprivi and the Caprivi Region

Situated between the Zambezi River in the east, the Mashi/Linyanti River in the west, and Lake Liambezi and the Chobe River in the south, Eastern Caprivi is Namibia's best served region as far as water resources are concerned. Together with the Kavango Region, Eastern Caprivi is one of the country's rare greenbelts. After independence the former Eastern Caprivi was administratively fusioned with former Western Caprivi, thus forming the Caprivi Region. The region has an area of 19,532 km^2 and its population makes up 6% of the country's total population.

Because of its interpotamic geographical situation between perennial rivers (including the Kavango River), the Caprivi Region is a very fertile area where maize, pearl millet, melons, pumpkins, groundnuts, etc., can grow abundantly (Curzon 1947). In fact, agriculture is the main economic activity in this region. But since time immemorial, people living along the rivers are involved in two forms of agricultural activity, namely rain-fed cropping and winter gardening. The rain-fed agriculture concerns all local farmers and is practised on the higher grounds. The winter gardening is practised in river beds by those villagers who are close to rivers. Fresh water fishery has also been an important economic activity (Tvedten *et al.* 1994). The region also has the potential for forestry, tourism and commercial agriculture.

3.4   Hereroland East and West

The drama of colonial land expropriation affected the Herero and the Nama communities in a singular way, as 75-80% of the total land of these communities were confiscated. The Herero community was not only subjected to decimating colonial wars at the turn of the 19th century, but also saw a considerable number of its members heading into a long colonial diaspora which lasted nearly one hundred years. The survivors of those wars were confined to reserves while their land and cattle were confiscated or were turned into crown property at the beginning of the colonisation.

The Hereroland of the Odendaal Commission consists of different pockets of land sparsed across eastern, central and western Namibia (i.e., Aminuis, Hereroland East, Hereroland West, Omatjete, Ovitoto, Otjimbingwe and Otjombinde or Rietfontein Block). Together, these pockets of land form what is today known as the Herero communal area. While Hereroland East and Hereroland West are bigger tracks of land covering hundreds of square kilometres, Omatjete, Otjimbingwe, Ovitoto, Aminuis (Omongwa), and Otjombinde are small portions of land surrounded by commercial

farms. Livestock, mainly cattle, goats and related industry, is the basis of the traditional economy of the Otjiherero-speaking community. In an area with such an economic basis and where the aridity of the climate, the paucity of the rain and the porosity of the soil are relatively accentuated, wide, open land is an important and welcome resource. The Odendaal Commission's Hereroland had an area of about 5,899.68 km^2 or 5,899,680 ha.

3.5   Tswanaland

As regards the Tswana-speaking community, the Odendaal Commission recommended:

> That the area known as the Corridor, approximately 155,400 hectares in extent and situated between the eastern boundary of Aminuis and the western boundary of Bechuanaland be assigned to the Tswana group as a homeland to be known as Tswanaland. (Odendaal Commission 1964:380)

Notwithstanding the above provision, the Commission's recommendation also contained restrictions according to which no self-governing authority should be given to the community and that: "until such time as their numbers and development justify the assumption of greater responsibility, the magistrate of Gobabis should exercise judicial authority." In fact, until Namibia's independence, the Corridor had not evolved to a self-governing homeland. Quite to the contrary, today it is serving both as a grazing area for some big communal farmers and partly as a resettlement area for a community of destitute Namibians who were ejected from the surrounding commercial farms (Hangula/GRN 1992).

3.6   Namaland

In pre-colonial times, as well as today, Namaland is not a unitary socio-political and geographic entity, but rather an anthropological linguistic concept denoting unity of language and culture for different communities (Berseba, Bethanien, Gibeon, Hoachanas, Vaalgras, etc.) in southern Namibia. The total size of the area allocated to the Nama-speaking communities of southern Namibia by the Odendaal Commission is 2,167,707 km^2 for a population estimated as being 34,806 persons or 6.62% of the total population. Due to general land scarcity in areas such as Amperbo, Hoachanas and others, and because of the extremely arid conditions of the area, the economic activity of the communities in the southern communal areas is predominantly based on farming with the more frugal and drought-resistant small stock (i.e. goats and sheep) although some cattle can be found in areas such as Vaalgras. Although after independence the government purchased a few farms (e.g. Voigtsgrund, Mara, etc.) in the area to resettle landless people, the total size of the communal lands in that part of the country today still reflect the policy scaffolding of the Odendaal Commission.

3.7   Rehoboth Gebied

The Odendaal Commission proposed an area of 1,136,028 ha to form the homeland of the then 11,257 Rehoboth Basters and Kleuringe who made up 4.56% of the total population. The core of economic activities in urban Rehoboth today lies in professional skills such as carpentry, building, welding and other small industries, as well as

technical services. Because of the arid climate the economic activities of rural Rehoboth is also dominated by small stock farming, as is the case in most communal areas of the territory of the Great Namaqualand of the pre-colonial period.

3.8   Damaraland

Damaraland was allocated an area of 4,799,021 km^2 as a homeland for the then 44,353 native speakers of the Damara language, who made up 8.43% of the total population of Namibia at that time (Odendaal Commission 1964:29-37). Because of its arid climate and geographic situation on the edges of the Namib Desert, the economic basis of the communal area Damaraland consists of small stock farming, mainly goats. The area also has big touristic and mining potential. The valleys and plains of the Hoanib and Ugab rivers also show some potential for agriculture.

3.9   Kaokoland (or Kaokoveld)

An area of 5,702,219 km^2 was earmarked by the Odendaal Commission as a homeland for the then 9,234 Himba, Tjimba and Hereros of Kaokoland, who made up 1.75% of the total population of Namibia. The economy of this hilly area is based almost exclusively on livestock rearing, especially cattle and goats. Because of its primeval beauties (e.g. river landscape, waterfalls and local culture) the area also has the potential to become a centre of touristic attraction in the country. It also has the potential to host the hydroelectric power of the country.

3.10   Bushmanland

For the then 11,762 San population who made up 2.24% of the total population, the Odendaal Commission set aside an area of some 2,392,671 km^2. Today, half of this territory is set aside for the resettlement of the (Herero) returnee community of the long colonial diaspora in Botswana. The economy of what has become known as Bushmanland is based on wildlife and veldfoods. But today, aided by national and international NGOs, the area is experimenting with agriculture and conservancies. The area is also a potential tourist destination.

4   White Farming Area

In the apex of the implementation of the Odendaal Plan, the territory in the *police zone* was set aside for the white population, who at the time made up 13.97% of the total population of Namibia. At the attainment of independence the area under the *administration for whites* became officially known as the commercial farming area.

    Because of the constitutional rights of freedom of movement and settlement (Article 21 of the 1990 Namibia Constitution), people may now easily move from one communal area into the commercial area and vice-versa, and establish residence wherever they want. In spite of these "paper" rights, discrepancies still exist between communal and commercial areas in terms of employment and housing facilities as well as municipal services. But, unlike in the past where race was the main limiting factor in

the access to land in the commercial area, today it is the purchasing capacity of a person that keeps the scaffolding of these two economic areas intact.

5   Leasehold and PTO[5]

Because of the nature of today's global (and multi-national) economy, which is constantly on the lookout for greener pastures, it may be befitting that for non-national institutions, land is leased for a number of years rather than bought and held in private holding in perpetuity. Such an arrangement may be more recommendable for the lands under communal tenure.

6   Land Reform

The preceding sections have tried to expose facts and explain the processes that led to the land problems of today's Namibia. These facts ought to serve as a point of departure or, at least, as preambular considerations for a genuine process of land reform. Article 23(2) of the Namibian constitution provides the framework for the nation to "redress social, economic or educational imbalances in the Namibian society arising out of past discriminatory laws or practices." One such imbalance that affects Namibia's social fabric is the land question, which dominates the daily headlines of the local media. One possible step to overcome the imbalance is an effective land reform. The creation in 1990 of the Ministry of Lands, Resettlement and Rehabilitation, responsible for land issues and the resettlement of the destitute at independence, was a decisive but certainly only exordial step in the right direction. In an initially racially-polarised society like the Namibian society at independence, one ought to inquire: On which areas of land use should the envisaged reform focus?

Because of certain socio-economic intricacies of Namibia's land question, land reform ought to be as comprehensive as possible. It should include issues such as access to land, types of tenure, tenure security, resettlement of needy landless citizens, land administration and management, protection of environment, ecosystems and biodiversity as well as land dispute resolution mechanisms. Judging by the draft land policy document (GRN 1997), the government seems to have identified the most crucial areas that need to be addressed. There are, however, some latent but burning issues, such as the maximum permissible size of a landed property per individual or household, land accumulation, land markets and so forth, that also need to be addressed.

6.1   The issue of restitution or compensation

Contrary to the steps taken by South Africa, where there is some form of restitution for land expropriated from the indigenous communities during the colonial period, Namibia has ruled out any form of compensation or restitution, opting instead only for a resettlement programme. By doing so, Namibia is trying to avoid legal intricacies

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[5] Permission to occupy was/is the type of leasehold in use in unproclaimed settlements in communal areas. Currently, it includes the lease of communal land, which is used for business (i.e. gain) purposes. Leasehold is in use in proclaimed settlements (e.g. towns) and areas under the freehold system. In the Namibian context, PTO is comparable to leasehold. While leasehold is for commercial areas, PTO is for the communal areas.

inherent in conflict of rights, which might arise from multiple land claims. The only great difficulties and irony of Namibia's approach is that most government resettlement activities are carried out on the already overcrowded communal areas. For example, the community of (Herero) returnees from the long colonial diaspora (in Botswana) had to be resettled on communal lands at Gam.

6.2   The aporia of Namibia's land reform

The land tenure regime which prevailed before Namibia's independence is well known. So is the projection of the racial relation in the landed property. Land, as the most basic resource and more so for a country whose national economy depends on natural resources (e.g. agriculture, fisheries, minerals, tourism, and hydropower),[6] is a catalytic agent of development. Since land was also the main cause of the country's liberation struggle (Republic of Namibia 1991), any meaningful socio-economic reform should also be geared towards redressing the imbalance in the land need, distribution and use (Republic of Namibia 1991).

Namibia's land reform, like any other socio-economic reform in the country, is subject to the imperatives of the policy of *national reconciliation* that is enshrined in the constitution (Preamble) through which former enemies, or adversaries, are encouraged to live together and work for the building of a new, prosperous and peaceful nation. However, this noble intention of the national reconciliation policy cannot dispel the difficulties and hurdles inherent in the social, economic and political reform Namibia has to go through to build a new society based on equal opportunity (Article 95). Furthermore, there are some socio-economic variables, such as the landed property rights of the formerly advantaged, that the fathers and mothers of the Namibian constitution deemed necessary to be maintained, probably for the sake of national reconciliation as well as the country's political and economic stability. Thus, the policy of national reconciliation and the constitutional right to property (Article 16) seem to have been conceived as practical measures to create confidence in a polarised post-war society. Indigenous communities and trade unionists see this approach as being not only one-sided but also appeasing in regard to the prevailing *status quo* in the land question.

On the other hand, to be effective, land reform in Namibia needs to be carried out within the context of law. But there are not only grievances on the part of the progeny of the dispossessed, but also resistance on the part of the new landlords. Furthermore, the supreme law of the land only allows "expropriation of property[7] in the public interest, subject to the payment of just compensation" (Article 16).

As things now stand, land reform in Namibia is presently based on three important but shaky pillars, namely (1) the availability of marketable land; (2) the availability of funds to acquire such land; and (3) the quality as well as quantity of the land offered. Consequently, by subscribing to the market principle of *willing seller, willing buyer* the land reform becomes a reactive exercise, submissive to the drives of the market

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[6] Namibia's State President S. Nujoma's opening address at the National Land Conference, which was held in Windhoek, 26 June - 1 July 1991.
[7] See 20. and 21. of the Agricultural (Commercial) Land Reform Act 'on compulsory acquisition of agricultural land' (GRN 1995).

principles.[8] Together with the fencing off and degradation of lands in communal areas as well as the increasing scarcity of the resource land in the communal areas, where the majority of the population lives, this fact creates social tensions in the community, casts some doubts and raises impatience about the ability of the government to bring about land reform under the present constitutional and legal framework. This doubt is also variously expressed by the Namibian Trade Unions. This state of mind is certainly not conducive to the main political aim of the social reform in the country, that is, national reconciliation.

Another land reform anomaly lies in the different exordial approaches adopted by the government in its handling of the commercial and communal lands. Commercial lands appear to be mythicised as untouchable, while communal lands were declared state lands. Based on Schedule 5, Article 100 of the Namibian constitution vested the ownership and control of the communal lands, which were perceived to be "Representative [i.e. third tier] Authority's property," by the Namibian government at independence. These two constitutional clauses (i.e. Schedule 5 and Article 100) also nationalised all other lands of public interest that are not privately owned, such as, for instance, nature conservation areas, game parks, water reserves, national roads, etc.

Although noble in intention, the inclusion of the communal lands in the package of the "sovereign ownership of natural resources" may, however, pose some problems regarding property rights. First, this *de facto* nationalisation of communal lands was done in total oblivion and exclusion of other lands which are under a different property regime. Secondly, it focuses on the minor portion of the country's land. Thirdly, this move means that *de jure* indigenous communities of Namibia do not possess land in the land of their ancestors, while the progeny of settlers has recognised title rights to land in the country by virtue of historical legacies and colonial laws and rights. Fourthly, the vesting of communal lands in the Namibian State also cause some problems of a practical nature related to security of tenure for the indigenous people. In the absence of any protective legislation, the state may feel at liberty to make use of its powers of "eminent domain – the power of the state to take land with or without the consent of owners or holder" (Mathuba 1995:3) – to acquire any portion of communal land as it may wish.

Through the mystification of the commercial lands, exclusion of any kind of restitution, and its subscription to the *willing seller, willing buyer* principle, the government may seriously manoeuvre itself into an aporia or legal labyrinth in land reform from where it may find difficulty to get out so easily.

7   Conclusion

Land in colonial Namibia was characterised by many historical, political and socio-economical imbalances. Post-independent Namibia's land legislation has many issues to address. These include access to land for all, and more so for the poor and the disadvantaged. These constitutional issues of equity, affirmative action (Articles 10 and 23) and security of tenure in all tenure regimes in the country ought to be addressed. For

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[8] See 14(1) of the Agricultural (Commercial) Land Reform Act: "Subject to subsection (2), the Minister may, out of moneys appropriated by Parliament for the purpose, acquire [...] (2) (a)-(d) any agricultural land [...]" (GRN 1995).

that to happen, a conducive atmosphere needs to be created. Goodwill and co-operation by everyone are an essential element for such an atmosphere. But for now the land question in Namibia is characterised more by the absence than by any clear and significant act of land reform. In the light of the interest and the emotions attached to the resource land, much more could have been done to hasten the reform process. The Communal Land Reform Bill currently under discussion in the parliament is certainly an important legal step, which will contribute towards the land reform process in the country.

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Appendix

Map of Namibia, according to the Odendaal Plan of 1962.
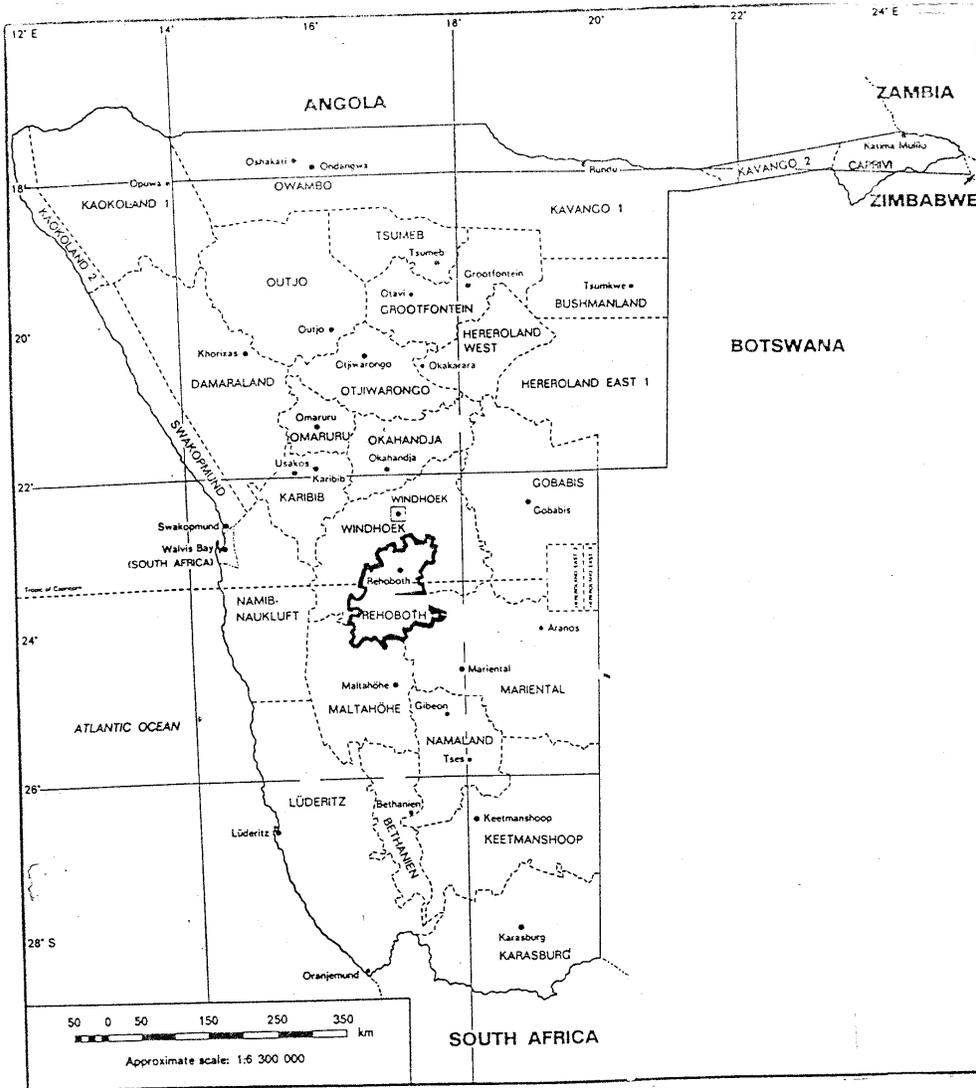
A FREEDOM UNCOMMON: THE DEVELOPMENT AND CONSEQUENCES OF NAMIBIAN CLAIM TO ITS EXCLUSIVE ECONOMIC ZONE

Lauren E. Hale

Abstract

The rapid development of the marine fisheries industry has large implications for the coastal management, employment, migration, and health conditions in Namibia. For hundreds of years, due to an ambiguous definition of territorial rights off the coast of Namibia, foreign fleets heavily fished its waters, rich with hake, horse mackerel, pilchard, and anchovy. Since independence in 1990, Namibia, a recognised sovereign state, has claimed and identified its valuable marine resource and has worked diligently to enforce its marine territorial rights. Employment prospects, job security, and migration patterns are all affected by the changed management practices of the industry, with highly increased migration to Walvis Bay. Among employees in the fishing industry, there is a high prevalence of HIV/AIDS and other poor health outcomes, potentially resulting from inadequate living quarters and limited opportunity for human empowerment. The government of Namibia and the Ministry of Fisheries and Marine Resources must consider the social and health outcomes associated with the development of the Namibian marine fisheries industry.

1 Introduction

For hundreds of years, due to an ambiguous definition of territorial rights off the coast of Namibia, foreign fleets heavily fished its waters, rich with hake, horse mackerel, pilchard, and anchovy. Since independence in 1990, Namibia, a recognised sovereign state, has claimed and identified its valuable marine resource and has worked diligently to enforce its marine territorial rights. The rapid development of the marine fisheries industry has large implications for the future of coastal management, employment, migration, and health conditions in Namibia. The purpose of this paper is to discuss the history of the fishery, its recent development post-independence, and some of the social and health issues facing the people involved in the fishing industry of Namibia. Section 2 describes the history of the marine fishing industry preceding and following Namibia's independence. Section 3 describes various employment patterns and prospects for the development of the Namibian marine fishing industry.[1]

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[1] In a country where 10% of the population earns 65% of the national income, and where most of the people in rural areas live in severe poverty without access to basic services, Namibia ranks as one of the most unequal societies in the world (UNDP/UNAIDS 1997). With such gross inequities, aggregated data

2　Total Immersion: A History of Fishing off the Namibian Coast

Off the southernmost tip of Africa, two of the world's great ocean currents meet: the warm, swift-flowing Agulhas Stream, which has washed the eastern shores of the continent on its way south, and the intensely cold, green waters of the Benguela Current, which have swept north-eastwards from the Antarctic. After mingling briefly with the warmer, faster water, the Benguela is deflected by the land mass, and flows sluggishly up the west coast. On its way north, and before it swings westwards to complete its counter-clockwise circulation, the current is constantly harassed by the strong offshore winds that shift the surface water and induce an upwelling from the cold depths.

The sediment of ages is brought towards the surface … phosphates and nitrates discharged by prehistoric rivers, nutrients from dead and decaying matter, trace elements and minerals … all are brought within the galvanising touch of the sun's rays.

Countless billions of minute marine organisms graze in these fertile waters, forming the first link in a food chain that sustains rich resources of pelagic and demersal fish. The south-east Atlantic is now recognised among the richest ocean pastures known to man, one that has attracted long-range exploitation by a dozen fishing nations and that has nourished a meteoric growth rate in the fishing industry of South and South West Africa. (Lees 1969)[2]

When Lees wrote this illustrative passage as the first three paragraphs of her book on the development of the South African and South West African fishing industry, she surely could not have known the details of the international political negotiations in store for this plentiful sea. Yet, she accurately portrayed the oceanic region as a hub of mercantile activity and political desire.

The coastal waters of Namibia, immediately north and west of South Africa, are blessed with the cold, nutrient-rich Benguela current coming from the south (see Figure 1). This ocean current enriches the south-east Atlantic waters with nutrients, resulting in one of the most bountiful fishing grounds in the world, and supporting several very distinct fisheries. Offshore, hake (*Merluccius capensis* and *M. paradoxus*), horse mackerel (*Trachurus capensis*), and orange roughy (*Hoplostethus atlanticus*) flourish, while closer to shore, the pilchard (*Sardinops ocellata*) and anchovy (*Engraulis encrsicholus*) stocks are naturally profuse.

Portuguese merchants record the first discovery of these bountiful biological resources in their search for new trade routes. The site on the northern coast where Diego Cao erected a cross in 1484 is now known as Cape Cross and visited by tourists for its abundance of fur seals (Lees 1969). South of this plentiful site, the Portuguese sailors identified the present-day site of Walvis Bay. And even further down the coastline, in 1487, Bartholomeu Dias found a "most desolate place with no sign of human life," now one of Namibia's prime fishing harbours, known as Lüderitz (Lees 1969). Today, the coastline of Namibia is marked by two proper harbour towns – Walvis Bay and Lüderitz (MFMR 1995) (see Figure 1).

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may overlook the most informative statistics regarding basic characteristics of human development in Namibia. Bearing this in mind, certainly a sector-wise approach is appropriate.

[2] Lees (1969) provides an important history of the Namibian fishery. The account based on extensive research is accurate, where verifiable, yet may include industry bias, since Robin Lees is the daughter of a top executive in a Namibian fishing company (Eriksen 1989).
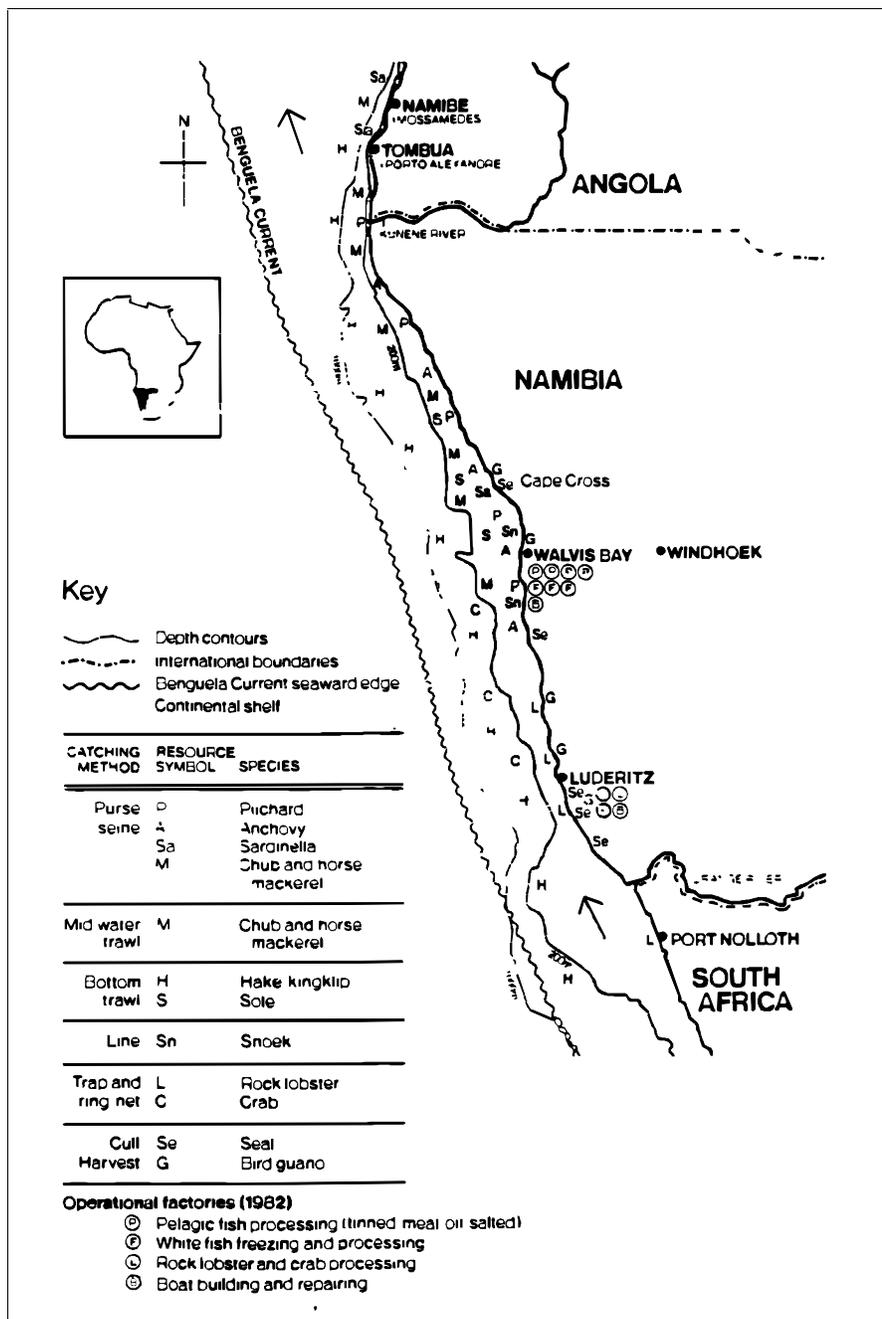
Figure 1. The Namibia fishery: Resources and capacity. Source: Moorsom (1984).

As the years passed, the waters became well-known to foreign mariners who marvelled at the ease with which the great numbers of fish could fill their nets. In 1613, the Englishman Thomas Koridge recorded the following: "The aboundance of water, cattell, fowle, and fishe, and every other good thinge for refreshinge hath given us hope it may be ynhabyted by our people [sic]" (Koridge 1613, from Lees 1969).

By 1652, Europeans flocked to the Namibian coastline, fulfilling Koridge's expectations of foreign settlements there. Dutch ships had established Walvis Bay as a

"refreshment station" for the benefit of passing Dutch ships (Lees 1969). So many fish were available the people actually complained about the plenty: "It is often the case here that we catch more fish than we require. It is to be wished that cattle, sheep and other livestock were obtainable in equal abundance" (*Journal of Walvis Bay* 1655, from Lees 1969).

In the 18th century, a large number of English and American boats were hunting whales and fur seals off the arid desert coastline. Colonists in South Africa exhibited competitive concern:

> The fact that the English and American whaling companies considered it worth their while to send large numbers of ships across thousands of miles of sea… is to our minds sufficient proof that there is honey in the flower, as they say; and that this honey can be gathered with far greater profit and less danger by inhabitants of the Cape itself than by these foreign adventurers, who have the additional disadvantage of having to melt down the blubber on board their ships. But even this obstacle does not deter them…. (Quoting the Chartered Company of South Africa from Lees 1969)

Similarly, the British believed that they maintained a right to the waters over other foreign fishermen. In 1795, Captain Alexander sent up the British flag all along the coast of Namibia to warn foreign whalers and sealers of the "British prerogative" (Lees 1969). With continued intensive whaling and sealing efforts, by the 1830s, the whales had "been largely wiped out and the island seal colonies severely depleted" (Moorsom 1984).

In 1884, Germany declared the land of Namibia its territory, and as the years progressed, a German-influenced fishery developed. Despite German political control of the land, the German interest in fishing was short-lived, perhaps because Germany never had a strong fishing fleet. In the early 1900s, a group of Italians from Sicily began to take prominence in the Cape in South Africa. Lees offers one potential explanation, "The easy-going Coloured[3] fishermen were no match for the hard-working skillful Italians." The Sicilians spread from the Cape northward into Walvis Bay, but most of their names had been changed and absorbed into their Afrikaner communities (Lees 1969).

The intensity of foreign fishing decreased during World War I, but this diminution did not last long. After the war, European fishermen returned from the trenches to find the Namibian harbours filled with trawlers, whalers, and motor boats. Fishermen from all over the world were laying claims on the bountiful waters (Lees 1969).

In 1922, South Africa issued Proclamation No. 18 for "better protection of fish and seals in territorial waters." The legislation provided closed seasons for some species and minimum size limits for others. Proclamation No. 18 remained active for 27 years, although it was little enforced (Lees 1969). The Fishing Industry Development Act of 1950 empowered the South African Fisheries Development Corporation to pursue fisheries management objectives in the territory now known as Namibia. Yet, even with these attempted management regimes, nothing slowed the rapid growth.

In the early 1950s, six large factories developed along the Walvis Bay waterfront. The pilchard catch soared from around 1,000-1,200 tons (Moorsom 1984; Lees 1969,

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[3] 'Coloured' is a term used to describe people of mixed racial descent. It is commonly used within southern Africa with no inherent derogatory meaning.

respectively) in 1949 to around 262,000-289,080 tons (Moorsom 1984; Lees 1969, respectively) in 1953. At this point, factory employment was recorded at approximately 2,500 people with a fleet of over 80 boats (Moorsom 1984; Lees 1969). In the 1970s and then again in the 1980s, there were major collapses of the pilchard industry (see Figure 2). Prior to Namibian independence in 1990, proper management of this fishing region was apparently lacking.

The offshore stock was equally mismanaged. Even when regulations were established, they were so lenient as to be considered virtually non-existent. By the mid-1960s, as many as 100 foreign vessels, flying under 15 or more national flags – notably the USSR, Poland, and Spain – could be found in the waters of Namibia.

In 1969, the FAO-commissioned convention in Rome officially established the International Commission on South East Atlantic Fisheries. ICSEAF was modelled on other regional fishing conventions – especially the International Commission for North Atlantic Fisheries. The primary functions of both ICNAF and ICSEAF were to provide a "forum for the governments involved to pool scientific research and agree to regulatory measures and organise back-up administrative, monitoring, and information services" (Moorsom 1984). Unlike ICNAF and other regional conventions, however, ICSEAF was not actually concerned with regional fisheries management. Rather, it was specifically interested in the Namibian off-shore industry, particularly hake. That is, although the ICSEAF reference area included the ocean off the coasts of Angola and South Africa, ICSEAF only concentrated on the Namibian Sea. Another major difference between ICSEAF and other fisheries conventions was that most other fisheries conventions involved the co-operation of the coastal states being served. Yet, in this instance, Namibia[4] had no participation, even though its waters were the focus of the convention.

As a purely voluntary association, usually meeting once a year and based in Spain, 10,000 km away from its Namibian focus, ICSEAF was "an unlikely vehicle for rapid and effective action" (Moorsom 1984). Nonetheless, fishery management was its self-proclaimed purpose. The convention developed procedures and a committee structure proving only "moderately effective for discussion and decision making" (Moorsom 1984). A range of restrictive measures were adopted over the years: catch quotas, minimum mesh sizes, limits on by-catch with other species, and a closed 25 km coastal zone to protect the pilchard stock and hake breeding grounds. In actuality, however, the regulations and its mutual enforcement system had "little scope" (UNIN 1988). Quotas were so high that they were not even reached by the avaricious fishermen of the 17 ICSEAF-member countries[5] (Tordesillas 1993). Additionally, despite the minimum mesh size standard, many of the trawlers fitted their nets with pantyhose to prevent fish from escaping (Stuttaford 1994).

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[4] Neither Namibia nor the UN Council for Namibia were represented in the ICSEAF 17 countries. In the early 1970s, a motion was made to include Namibia, but it was lost.

[5] The countries that were officially fishing from these waters include: Belgium, Bulgaria, East Germany, France, Japan, Ghana, Holland, Israel, Italy, Japan, Poland, Russia, Spain, South Africa, South Korea, Taiwan, West Germany.
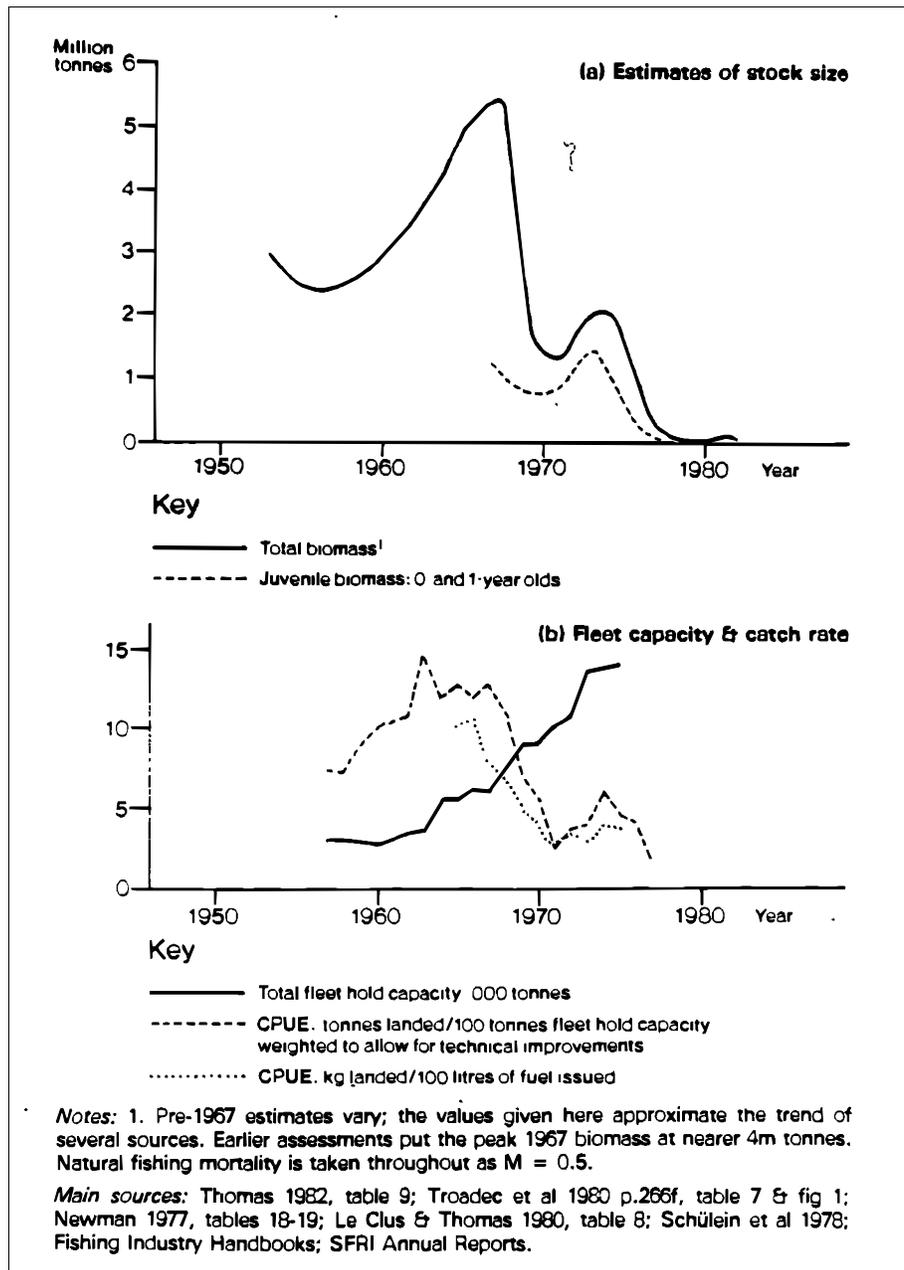
Figure 2. The collapse of the pilchards stock. Source: Moorsom (1984).

As shown in Figure 3, the real measure of the ICSEAF management regime is evident in the time series data of the hake harvested at each year, but unfortunately even these self-reported numbers are not reliable (UNIN 1988). By the late 1970s, the catch of hake consistently exceeded one million metric tons annually, and there was general evidence of over-fishing (UNIN 1988). Hake catch peaked in 1978 at 1.5 million tons, before its sharper decline between the years of 1976 and 1980 when the hake population had more than halved. Furthermore, within those years, the catch per unit effort (CPUE) of fisherman had dropped 60% indicating that less fish were available in the waters (Moorsom 1984).
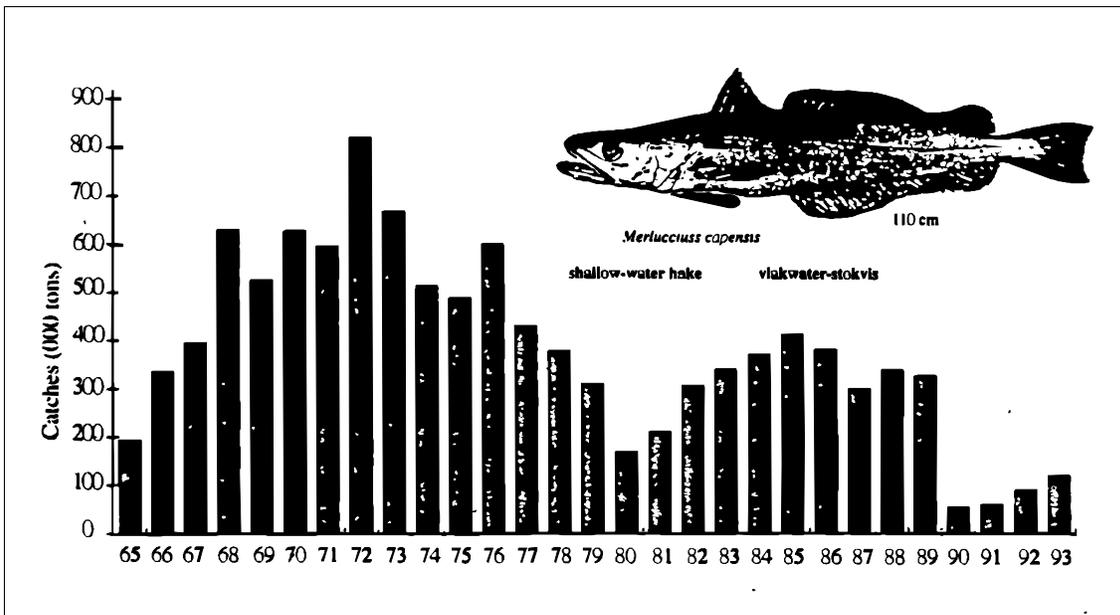
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Figure 3. Catches of hake in Namibia waters. Source: Hamukuaya (1994:73).

The 1980s brought similar patterns of heavy over-fishing from the ICSEAF fleets, although stocks were much lower during this period. For example, in the three-year period between 1986 and 1988, the various countries caught over 1.3 million tons of hake annually (Hamukuaya 1994).

The United Nations Conference on the Law of the Sea was equally unsuccessful in protecting these waters. In an effort to prevent inequitable exploitation possibly resulting in a "tragedy of the commons" scenario, this international agreement was designed to limit access to marine resources to the adjacent coastal state. The signatories of UNCLOS agreed to create EEZs for commercial fishing reaching 200 nautical miles[6] off the coast of every participating sovereign state. During this time, however, Namibia was under the illegal jurisdiction of South Africa and was not considered a sovereign state – this despite the fact that the UN Council for Namibia was the fifth party to ratify the convention[7] (UNDP/FAO 1989).

Prior to the 1990 Act of Independence, Namibia remained under South African rule, but the Madrid-based ICSEAF refused to recognise a Pretoria-declared 200-mile offshore zone under the 1972 Law of the Sea Convention (Jacobs 1989). As stated, this decision of ICSEAF not to recognise the zone was based "on the UN denunciation of South Africa's administration of the territory as illegal" (Jacobs 1989). Other reasons, including potential benefit from fishing in the region, were surely also influential.

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[6] The international nautical mile is 1,852 metres.
[7] The UN Council for Namibia ratified UNCLOS III on April 18, 1983. The UN Council for the Cook Islands and the UN Council on Namibia were the only two of the 119 signatories of UNCLOS that were not considered sovereign states.

Ultimately, no EEZ was recognised for the 200 miles off the coast of Namibia, as it had been for the 117 other signatories of the agreement.

The result made these waters "one of the few fishing grounds in the world where there [was] no internationally recognised coastal state management authority" (UNDP/FAO 1989). This non-existent enforcement scheme made the coastal waters of Namibia a new feeding ground for displaced foreign fishing vessels looking for an open access area. Quickly identified as the only plentiful fishing grounds without an internationally recognised state ownership, this was an open invitation to foreign fishermen to fish heavily. This marine exploitation occurred consistently, despite the understanding of customary international law and other international proclamations opposing such exploitation[8] (Moorsom 1990).

By independence in 1990, Namibia's estimated off-shore stocks were reduced to a mere 20% of its UNCLOS III levels. The newly formed Namibian government moved swiftly and effectively in claiming its fishing territory. Immediately after Namibia became established as its own internationally recognised sovereign state, the Constitution explicitly identified an EEZ in Article 3. Despite numerous requests for access agreements and even a three-year negotiations process with the European Community (Morris 1992; Tordesillas 1993; MFMR 1991; GRN 1994), Namibia in 1994 unilaterally banned all fishing agreements with other countries (MFMR 1994). Instead, fisheries relations with foreign interests would be based on mutually beneficial commercial joint ventures. By adopting this approach, Namibia thus excluded grants to foreign fishing fleets for access. "Namibia seeks to move away from the standard form of fishing access agreement in which developed nations secure access for their vessels to the waters of developing countries" (MFMR 1994). In this autonomous move, unusual for a developing country, Namibia took control of its natural resource security and would no longer tolerate foreign exploitation. Since independence, a strong and well-managed fishery has emerged, resulting in perhaps the "most well-managed fishery in Africa, if not the world" (Amutenya 1995). The fishery is continuing to grow, with very real consequences for the Namibian people.

3 Historical Employment Conditions for the Namibian Fishing Industry

"Walvis Bay ... is not at all a suitable place for a residential site," observed Major Thomas in 1920. (Quoted in Lees 1969)

Historian Lees describes Walvis Bay in the early part of this century as a dismal place: "There were no proper streets and the two policemen rode around on camels" (1969). The rough sea, harsh winds, and unattractive living conditions may explain why the native Namibian population was little involved in the marine fishing industry for hundreds of years.

After World War II, however, when the pilchard fishery was thriving, the Walvis Bay area experienced waves of growth, nearly as dynamic as the stocks of fish in the

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[8] Various proclamations were issued against this foreign fishing. Among them are: Decree No. 1. For the Protection of the Natural Resources of Namibia by the UN General Assembly in 1974, The Algiers Declaration by the UN Council for Namibia in 1980, and the Paris Declaration by and International Conference in Support for the Struggle of the Namibian People in 1985 (UNDPI 1986).

sea. For example, between 1951 and 1958, the white population quadrupled from 936 to 4,000, and due to migrant contract workers from northern Namibia, the black population swelled to 7,000 at times (Moorsom 1984). During this period, a contracted labourer system, in which workers from northern Namibia migrate with the demand for employment, became and remains a standard mechanism for maintaining a large and seasonal labour force (Moorsom 1995; Pendleton and Frayne in this volume).

For the Namibian workers in the industry, the conditions were less than desirable. The fishing villages were communities filled with "illiteracy, poverty, drunkenness, malnutrition and disease" (Lees 1969). One estimate counted, "There was a coloured population of 1,000 and 900 bottles of wine were sold in a day, while one out of every 9 men, women, and children was convicted each year on charges connected with liquor" (Lees 1969).

When the municipality banned temporary housing structures, the fishing companies raced to build houses for their employees and compounds for labour conscripted from northern Namibia, Ovamboland. In 1951, the Fishery Development Corporation, with a loan from the South West African administration, began to assist in the financing of housing schemes for fishermen.

The fishing companies were expected to provide housing for the fishermen and factory workers, accepting responsibility for destitute communities. Yet their responsibilities grew increasingly complex as the industry expanded (Lees 1969). Moorsom describes the substandard social and living conditions of those involved in the industry. Within the housing compound, there were 8,000 cramped quarters with 16 persons to a room and a regular policy of harassment. Identity documents were required to pass a single checkpoint, and visitors were strictly controlled. "Under such conditions and laws the compound has all the appearances and many of the functions of a prison labour camp" (Moorsom 1984).

Additionally, factory conditions were hard. As in many industries, the overriding concern of the management was to process fish in peak condition; the pace was relentless. Supervisors were harsh and sometimes violent. Safety and occupational health often meant little more than first aid coverage. Workers, required to stand for long periods of time, commonly suffered from swollen legs. Injuries from moving machinery and from handling raw fish on the canning and lobster packing lines were commonplace; subsequent infection from these wounds was frequent (Moorsom 1984).

Additionally, Moorsom points to differential treatment by race.

The contrast between white and black experiences in the factories is extreme. White employees expected and obtained the full privileges of apartheid society: permanent, rewarding jobs, career prospects, good salaries, subsidised housing and valuable fringe benefits such as life and health insurance, school fees, and leave allowances. Most held positions of responsibility. (Moorsom 1984)

Black workers were "treated as expendable units of labour-power as cogs in an industrial machine." At the end of season, they would have no guarantee of future employment. In practice, the companies gave preference to workers with previous experience and built up a stable labour force – half the workers at a cannery in 1974 had 10 years experience behind them, 20% had 20 years or more. But thousands of workers lost their jobs with the collapse of pilchard canning (see Figure 2) (Moorsom 1984).

The workers were tied to production lines for long irregular shifts of 12 hours or more for six to seven days a week. At times, the working season was shortened to five to six months in reduction plants, three to four months in lobster plants, and two to three months in pilchard canneries. There were no unemployment benefits and neither the companies nor the state provided paid sick leave. There was no social welfare program and but little chance of disability benefits, lump-sum payment upon retirement, or company pensions to supplement the tiny state pension to which some might be entitled (Moorsom 1984).

With this dynamic and often unpleasant history, the currently developing fishing industry carries with it a burden to improve the conditions for the fishermen and factory workers. The remainder of this paper addresses some of the future challenges regarding an increased fishing industry.

3.1   Current employment trends and prospects

The complex details regarding the foreign fishing of this coast prior to independence contribute to the discontinuity that the marine fishing industry experienced in 1990. With the 1990 establishment of the Ministry of Fisheries and Marine Resources, the priorities and policies of the fishing industry could be re-evaluated. The human population sector has been of primary importance to the Namibian government; David Evans at the Windhoek-based MFMR declares, "Employment is not an important priority, it is the only priority" (Evans, personal communication).

One of the goals of the Sea Fisheries Act, which was passed and implemented in late 1992, was to assure involvement by Namibian nationals at all levels of the fishing industry. A reduced quota fee offered to Namibian interests created a financial incentive for their participation (International Monetary Fund 1995). The allocation of fishing rights was influenced by governmental efforts towards Namibianization, an intentional plan to promote participation in the fishing industry by Namibians who had been socially, economically, and educationally disadvantaged by discriminatory laws or practices which were enacted or practised prior to independence (Amutenya 1995; Ndjaba 1995). Each applicant for access was assessed using criteria relevant to the development of a domestic industry that would best benefit the Namibian people.

Before 1991, according to a UNIDO Report on the Development Programme of Fisheries Industrial System in Namibia, the highly profitable off-shore hake sector employed less than 200 Namibians (Isaaksen *et al*. 1992). Currently, the hake fishery alone employs more than 5,000 Namibians (Amutenya 1995).

Similarly, at independence, the fishing sector produced 1.5% of the GDP. By 1996, it had increased to 4% and is expected to grow at increasing rates. The government optimistically expects that in the year 2000, over 15,000 jobs will be created in the fisheries sector (Barnes 1993; Iyambo 1997). Of these jobs, around 4,000 will contribute to building the fleet and approximately 11,000 will belong to shore establishments involved in processing (Isaaksen *et al*. 1992). The employment in this sector is expected to surpass the number of jobs provided by the mining industry within the next year (Cohen 1999).

If the MFMR continues to increase the total allowable catch of the hake stock, the industry will continue to grow (see Figure 4). There are, of course, limitations to the

extent that the industry can grow before the fish stocks are threatened. A cautionary management plan is crucial. The number of people employed in the industry is limited by the supply of Namibia's resource; over-fishing by the domestic industry would be as damaging as over-fishing by foreign fleets (Pronk *et al*. 1994). An MFMR economist suggests that the maximum number of employees who could be employed directly by the fisheries sector is 20,000. There are, however, additional jobs that will be created indirectly as a result of the growing industry through increased processing opportunities (Hamunyela, personal communication).
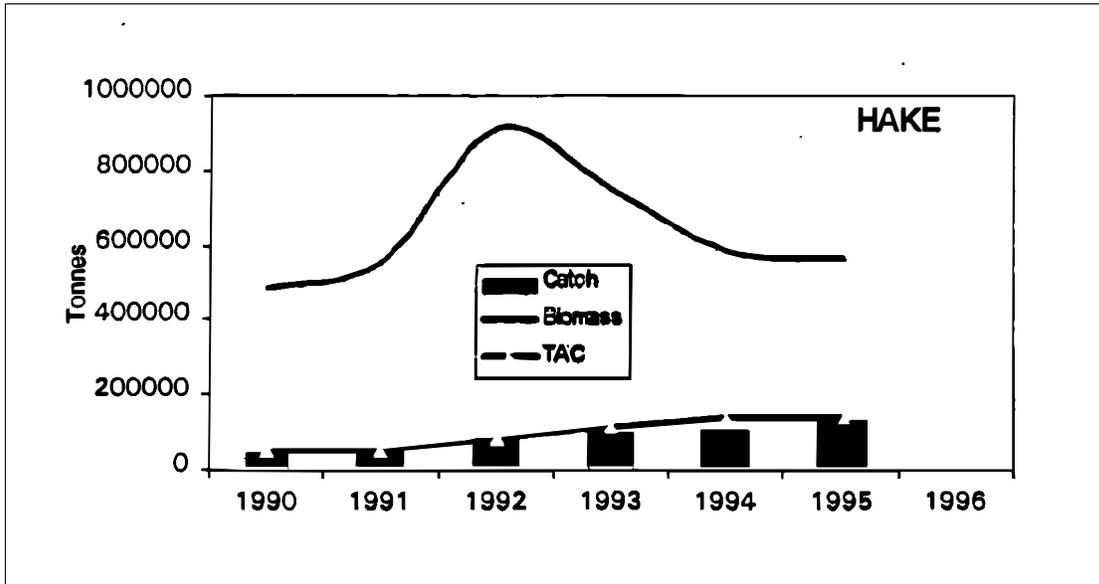

Figure 4. Hake catch, biomass, and total allowable catch. Source: MFMR (1995).

Looking purely at the numbers, the recent and projected massive growth of Namibians employed in the fisheries sector is quite an achievement. The MFMR made valiant efforts to develop the industry such that it could give preference to a Namibian-based industry. The rapid increase of Namibian involvement in the marine fishing industry has brought about many important changes in the nation's economy, migration patterns, and health conditions.

3.2 Migration to the coast

As previously discussed, the large increase in Namibian involvement in the fishing industry resulted from a long-overdue recognition of the EEZ and from the government's specific efforts to Namibianize the fleet. Many people, not already living near the ocean, relocated permanently while others were seasonal migrants. This produced a dramatic migration of individuals around the country. Of the two primary fishing harbours in Namibia – Walvis Bay and Lüderitz – Walvis Bay has experienced the greatest population increases (see Figure 5). The majority of the migration has come from the regions of Oshana, Oshikoto, Ohangwena, and Omusati to Walvis Bay

(Tvedten and Mupotola 1995). In particular, Walvis Bay had a 1991[9] population of 30,452; that number is expected to increase due primarily to migration to over 53,600 by the year 2000 (GRN/NPC 1994).

Figure 5. Migration trends. Source: Tvedten and Mupotola (1995:16). Note: the regions have been scaled in accordance with the population, to further illustrate the trend. Map: Social Sciences Division/Erik Holtar.

The population numbers in the above paragraph do not reflect the many seasonally conscripted workers from the north who are not counted as permanent residents of Walvis Bay. For migrant workers, the development of the fishing industry is particularly meaningful. The workers leave their families in the villages in the north, with little financial support, for extended periods of time (Moorsom 1995). Ultimately, this changing family structure is expected to affect Namibian household consumption and

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[9] The 1991 census estimates for Walvis Bay are questionable, however, since it did not become part of Namibia until 1994.

fertility patterns. Increased migration may also contribute to patterns of promiscuity and prostitution among the migrant workers, increasing the risk of various sexually transmitted diseases, including HIV/AIDS (Figaji, personal communication).

3.3   HIV/AIDS and other diseases

The fishing industry itself seems to be particularly threatened by poor health. Estimates suggest that over 50% of those involved in the fishing industry are already HIV positive (Fuller, personal communication). The high incidence of HIV/AIDS and poor health outcomes is a function of two interrelated forces: substandard living conditions and limited human empowerment.

The housing compounds remain cramped, unsanitary; they are often unsafe. The 1997 Housing Report describes the conditions:

> The municipal compound, used primarily to house male season contract workers for the large fishing companies is a closed prison-like structure with a control gate. The rooms have either 16 or 28 sleeping bunks and very little else, with virtually no private or communal social facilities inside the compound. (Municipality of Walvis Bay 1997)

Both unsanitary and cramped living conditions lead to a general reduction in personal sense of control and quality of life, which has its own adverse effect on health outcomes (Wilkinson 1998). In addition, the opportunity for the physical spread of disease is high. Further, since educational programs in the facilities are limited, informed decision-making regarding sexual behaviour and hygiene is infrequent, while unprotected promiscuous sex is frequent (Figaji, personal communication).

The fishing industry management and government are particularly interested in preventing the spread of contagious diseases, with an emphasis on HIV/AIDS. Certainly, increased mortality among workers has immediate effects on the productivity of the factories. Beyond the losses through death, productivity is hampered by absenteeism taken by HIV-positive individuals for their own sick days, family responsibilities, and funeral visits (Cloete, personal communication). Further, the HIV/AIDS epidemic will adversely affect the productivity level of the industry as the number of orphaned children increases and the dependency ratio of the country as a whole rises (UNDP/UNAIDS 1997).

Since many problems from the epidemic are not specific to HIV/AIDS, policy and program responses must address the root causes and consequences of the wider challenges of reducing vulnerability through community development and education programs (Mann and Tarantola 1996; Topouzis 1998). Leaders in the community and the fishing industry must work to improve the living and working conditions of all employees, reducing the multifaceted consequences of high morbidity and mortality (Figaji, personal communication).

4   Conclusions

There is doubtless a significant relationship between employment in the fishing industry, migration, and health patterns in Namibia. With the extensive changes in the fishing industry since independence, much of the needed policy changes have come from the MFMR. Clearly, the recent development of the industry can be very beneficial

to the population, but such benefit does not come without a cost to the health of the nation. To begin, the housing situation must be improved. Educational campaigns and programs must be established and widespread, targeting vulnerable populations. Further, the MFMR must consider the undesirable social implications caused by abrupt policy changes. For example, short, labour-intensive fishing seasons swell the numbers of conscripted migrant workers, thus dramatically increasing the spread of disease. The MFMR must also review the fact that an intensive fishing season may be harmful to the fish stock.

MFMR efforts alone are not sufficient, however. Other organisations must consider policy options regarding the fishing industry. The government should co-operate with private, public, and non-governmental organisations in creating policies and programs to improve the current substandard employment and living conditions. The fishing corporations themselves should take more responsibility for their employees. The government needs to improve current education and public health programs both in the fishing industry and the nation as a whole (UNDP/UNAIDS 1997).

Solutions to public health problems generated by Namibian fisheries growth require analysis, priority setting, and planning from all sectors. Programs and policy must address issues related to poverty, environmental degradation, and urban growth particularly present in Walvis Bay. Additionally, programs should consider gender and economic inequality, migration patterns, and environmental sustainability. These issues are critical as both determinants and consequences of the spread of HIV/AIDS (UNDP 1999).

The social consequences witnessed in the rapidly developing fishing industry in Namibia highlight many of the important linkages between population, development, and environmental management. The challenge remains to find and implement effective and beneficial policies so that the development of the fishing industry can contribute positively to the human resources of the nation.

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INLAND FISHERIES DEVELOPMENT IN NAMIBIA: EVALUATING ALTERNATIVE PATHS FOR SUSTAINABLE DEVELOPMENT

Daniel O. Okeyo

Abstract

Inland fisheries are an alternative path for sustainable development. An updated checklist of inland fishes of Namibia as well as their distribution is recorded. Nearly all of the fish species are contained in the floodplain wetlands of four perennial river systems: Kunene (SER B – at least 62 species), Kavango (SER A – at least 80 species), Zambezi (SER A – at least 75 species), and Orange (SER B - at least 14 species) catchments. Khomas (SER C), permanent water bodies of which constitute mainly state reservoirs, contains only more or less introduced fish species. One may conclude that there are more inland fish species found in SER A than in SERs B and C in that order of importance. In addition to the above systems, more of the artisanal, angling and commercial fisheries activities also centre on the seasonal Oshanas of the Cuvelai and the man-made reservoirs. There are new potentials of further inland fisheries activities in the form of aquaculture and recreation. The latter links readily with revenues from tourism. Keen attention must be paid towards post-harvest losses associated with marketing practices of artisanal inland fisheries. Preservation through sun drying, salting, frying and smoking occurs in inland Namibia. The best fishers (harvesters, traders) of inland fish and fish products in Namibia are women and children. Several gears used by the women in fish harvesting are mentioned in the text. Management policies, regulations and recommendations, which will bring about sustenance of food security, are discussed.

1   Introduction

This paper is concerned with the inland fisheries development in Namibia. Section 2 contains an overview of some historic, current and future trends of the development. Section 3 provides the scientific and common names of fish, the names of localities of distribution as per different water bodies within the borders of Namibia, as well as an inter-state and statistical presentation of numbers of inland fish families. Centres for the concentration of artisanal fisheries, be it in the perennial and ephemeral rivers (riverine), natural and man-made lakes (lacustrine), or in pans and vleis (palustrine) are discussed in Section 4. Often the existence of such centres correlates with trends in human population growth and migration. Captive (aquaculture) and sports (angling) fishing activities, which may sometimes be considered artisanal, are presented in Sections 5 and 6, respectively. Marketing and trade (Section 7) covers gear and vessel crudeness and availability to local fishers (males, females, children), and post-harvest activities of

indigenous as well as a modern means of healthy preservation, storage for harvesting and marketing. Section 8 elaborates on women's direct involvement in the development of inland water fisheries (e.g. vessel and gear making, harvesting and post-harvesting operations). Section 9 presents silent or lacking management policies and regulations governing the capture and sales of natural and captive inland water fisheries, followed by recommendations in the utilisation and implementation of analysed basic data (Section 10).

For purposes of convenience, reference is made throughout the chapter to three so-called Socio-Ecological Regions of Namibia, namely:

SER A: Caprivi, Ohangwena, Kavango, Omusati, Oshana, and Oshikoto
SER B: Erongo, Hardap, Karas, Kunene, Omaheke, and Otjozondjupa
SER C: Khomas.

2 Overview

There has been a trend in the development of the fisheries in Namibian waters. Pre-independent development was mostly marine, administered and conducted from Cape Town, South Africa (Morcos *et al*. 1993). Small research stations operating from Lüderitz and Walvis Bay (SER B) were occupied with near shore resources such as rock lobster, seals and the shore-based angling fishery. A Fresh Water Research Centre also existed at Hardap (SER B). With independence, fishery management and research were allocated to the Ministry of Agriculture, Fisheries, Water and Rural Development, Department of Fisheries and Water. In February 1991 a Ministry of Fisheries and Marine Resources was created, and this also took over the responsibility for the fresh water resources from the Ministry of Wildlife, Conservation and Tourism. The staff at the Fresh Water Research Centre at Hardap were integrated into the staff of the Ministry. In 1995, a White Paper on "The Responsible Management of Inland Fisheries in Namibia" was published (MFMR 1995), and in 1996, it was put into legislation, with the expressed interest to protect the floodplain fisheries, in particular the establishment of some form of ownership and protection of the oshana (Balarin and New 1996). At the same time, Namibia recognised that sustainable inland fisheries development (e.g. artisanal fisheries, aquaculture) had a role to play in food security and improvement of socio-economics for future generations. To that end, a draft aquaculture policy white paper (New 1996) and the draft aquaculture act was formulated. Further detailed consultation is currently underway to verify the statuses of artisanal fisheries as well as aquaculture (New 1997).

3 Fish Names

An updated checklist of inland fishes of Namibia, including scientific, common and authority names and from which water bodies they have been recorded (see Appendix Table A1), is essential for inland fisheries development. Successful management depends on the knowledge of what fish are available. In order to update the classification, all taxonomic revisions made on fishes of Namibia since recent times (Dr. Clint Hay, personal communication; Bethune and Roberts 1991; Day 1997; Holtzhausen 1991; Skelton 1993; Tvedten *et al*. 1994; van der Waal 1991a, 1991b; van Zyl and Hay 1994) were incorporated, using some data base of the National Museums of Namibia.

Eschmeyer (1990) was widely followed with some modifications and exceptions. For example, Citharinidae is considered as a family of its own, following Eschmeyer 1990, separate from the recognised family Distichodontidae according to Skelton (1993). Aplocheilichthyidae is considered as a family of its own, following Sethi (1960) and Meyer and Lydeard (1993), separate from the recognised families Poeciliidae (Eschmeyer 1990) and Cyprinodontidae (Skelton 1993), respectively. Aplocheilidae is represented in Namibian waters by a single unnamed species. Mastacembelidae is recognised as a family under the order Synbranchiformes other than the order Perciformes in accordance to Gosline (1983) and Travers (1984a, 1984b). All spellings of fish names followed the original authorised descriptions.

3.1   Distribution

It is generally agreed that the northern perennial rivers of Namibia, and particularly their flood plains, are the richest in inland fish species, probably by an order of magnitude (Barnard 1998; Curtis *et al*. 1998). Almost all of the 107 fish species (Appendix Table A1; or 103 fish species, according to van Zyl and Hay 1994) are associated with the four floodplain wetlands: i) Kunene (SER B), ii) Kavango (SER A), iii) Zambezi (SER A; Day 1997), and iii) Orange (SER B) catchments (Figure 1). Namibia also has some unusual and interesting natural and artificial water bodies, particularly in the arid Namib Desert (SER B) and Karstveld system, as well as in the East Caprivi system (SER A). These systems support numerous endemic (Day 1997; Holtzhausen 1991) and rare (Curtis *et al*. 1998; Skelton 1993) fish life. For example, three interior water bodies, Aigamas Cave near Otavi, Lake Guinas near Otjikoto and Caprivi pans (all in SER A) support fish species which are categorised as endangered and/or endemic only to these interior waters (Appendix Table A1). Namibian inland waters suffer from the effects of numerous alien fish species. For example, six water bodies, state dams (Omatako – SER A and Swakop – SER C), Omatako drainage, the Kuriman Eye, Lake Otjikoto (SER A), and lower Orange (SER B) support fish species which are alien (Appendix Table A1; Brown *et al*. 1985; de Moor and Bruton 1988). Finally, the coastal lakes ranging from and including the Orange River estuary to Lüderitz also support fish species categorised as 'of marine origin.' Fishers and managers may use this information in making a decision on which inland waters to develop. Commercial fishers with crude gear may also learn which water body supports fish life.
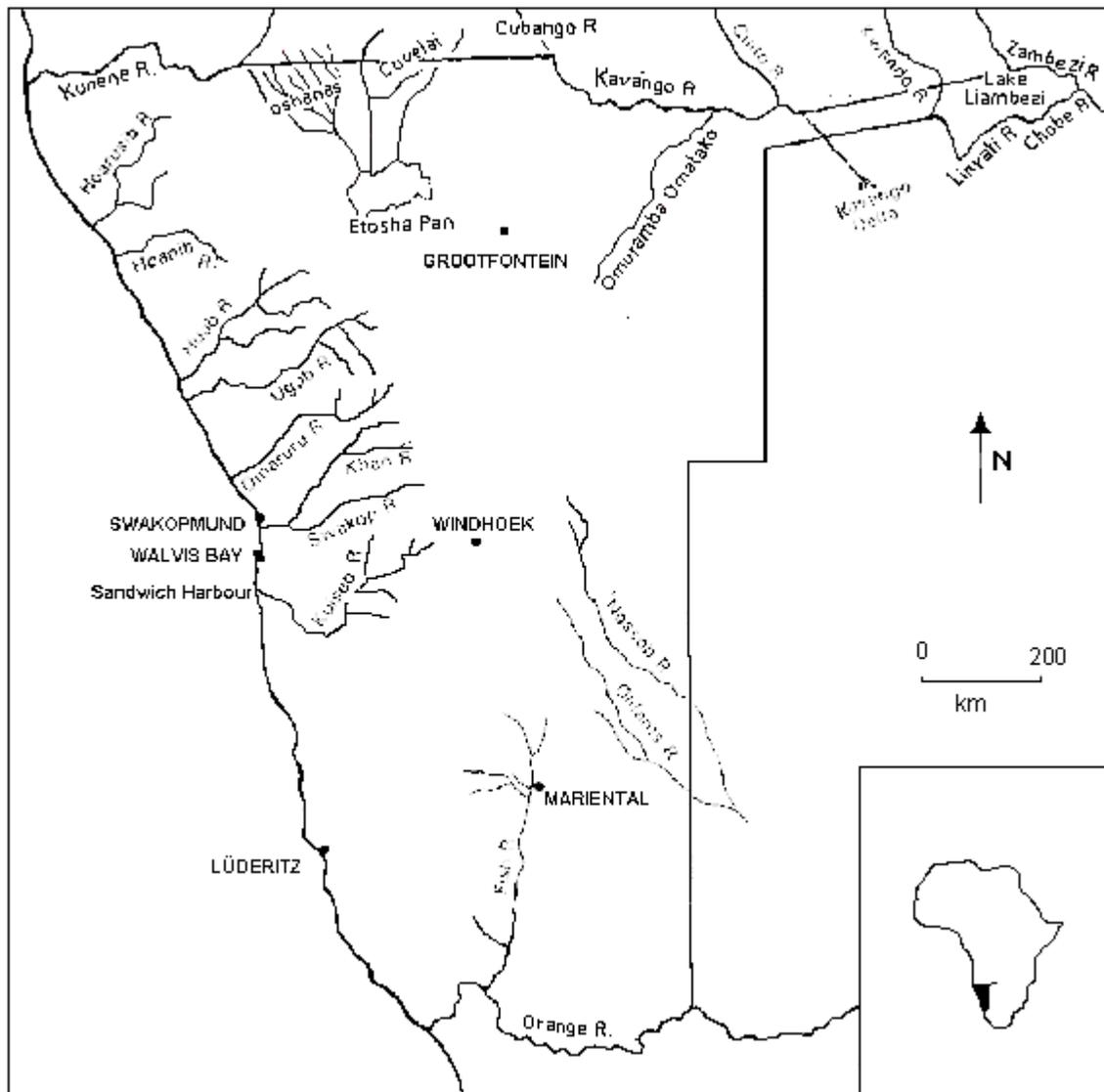
Figure 1. Major wetland ecosystems of Namibia.

3.2   Statistics

The updated total number of fish species of Namibia is at least 107, belonging to 47 genera and 21 families (Appendix Table A1, Figure 2). Other recently recorded total numbers exist in the literature (Dr. Clint Hay, personal communication; Bethune and Roberts 1991; Day 1997; Holtzhausen 1991; Skelton 1993; Tvedten *et al*. 1994; van der Waal 1991a, 1991b; van Zyl and Hay 1994). Of the 21 fish families (107 species = 100%), only five families, Cyprinidae (26.67% of the total 107 species), Cichlidae (21.67%), Mochokidae (7.50%), Clariidae (5.83%) and Mormyridae (5.00%) and Kneridae (5.00%), were abundant in that ranking order (Figure 2). Seven fish families (Poecilidae, Anabantidae, Aplocheilidae, Citharinidae, Characidae, Atherinidae and Mugilidae) are represented by a species number ranging between 1.67% and 4.17%, while seven other fish families (Centrarchidae, Mastacembelidae, Aplocheilidae, Hepsetidae, Claroteidae and Schilbeidae) are represented by the lowest species number

of only 0.83%. This information may be useful to fishers and managers in determining which fish species to develop in terms of mass production. Fish families with more species can be the best to begin with.
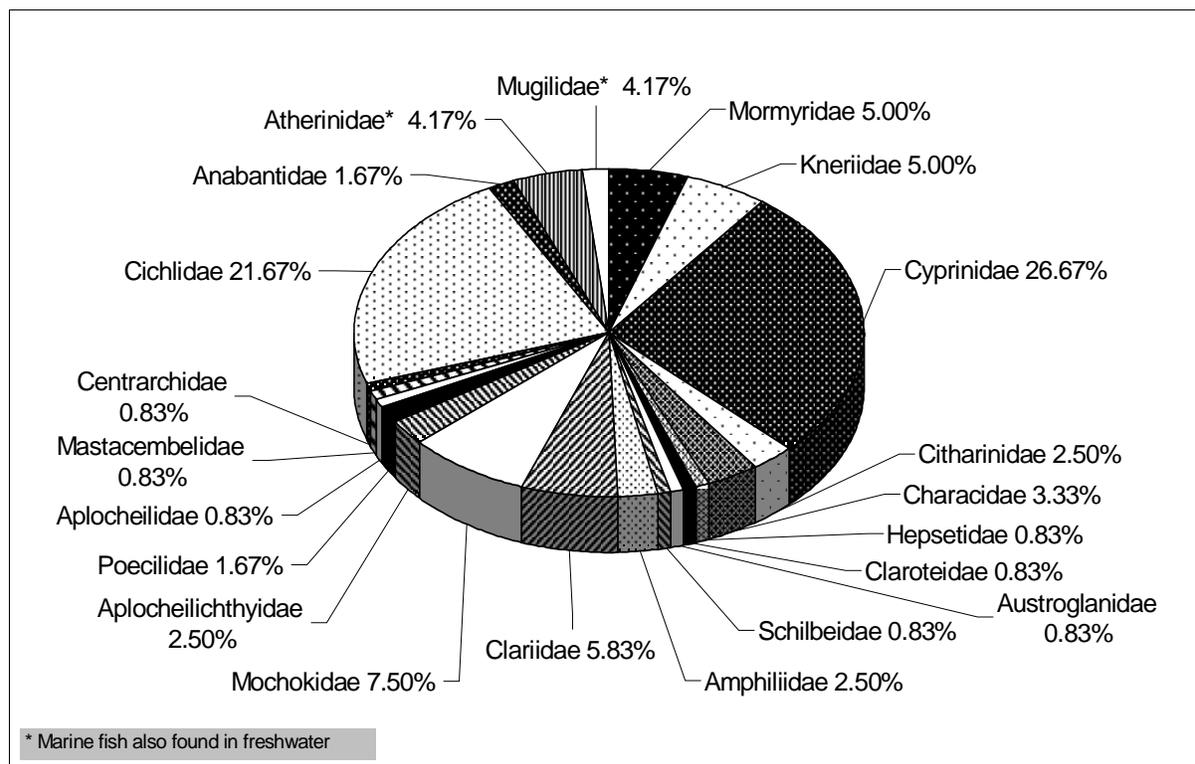

Figure 2. The number (in percentage) of fish species recorded from freshwater bodies of Namibia.

4   Centres of Artisanal, Angling and Commercial Fisheries

The artisanal and commercial inland water fisheries centre mainly around the perennial Kunene River (SER B) and the seasonal oshana of the Cuvelai system, the perennial Kavango River drainage, the perennial Zambezi River and the perennial cum seasonal Chobe-Linyanti-Kwando-Lake Liambezi (East Caprivi) system (SER A), and the perennial Orange River and estuary system (SER B; Figure 2). Man-made reservoir systems, resorts cum fishing lodges and aquaculture practices also support minimal fisheries activities (aquaculture is discussed in Section 5). There are at least 62 updated total number of fish species in the perennial Kunene River (SER B) and the seasonal oshana of the Cuvelai system (Appendix Table A1). Holtzhausen (1991) reported 68 fish species from the Kunene River. Personal observations made during a two-year environmental impact assessment of the lower Kunene River as well as at and below the Ruakana Reservoir concluded that people of the Kunene Region are not fishmongers. Most parts of the river, which form the border between Namibia and Angola, are steep-banked and run through a thinly populated area. The Himbas in the area do not use fish. During floods, however, the seasonal oshanas form in the Cuvelai River system in

Angola (Marsh and Seely 1992). Fish move southwards from their normal habitats in the perennial rivers of Angola (Day 1997), and are harvested with a variety of methods in Namibia (Sandlund and Tvedten 1992; Tvedten *et al*. 1994). Only a small number of people fish from the oshanas. Personal observations showed that people who live around many oshanas and Lakes Olusandja (Lake Perera) and Oponono prefer eating freshwater to marine fish. Catches can be very high. For parts of the oshana area, during maximum peaks of floods, individual fishermen may catch up to 150 kilograms per day (Tvedten *et al*. 1994); outputs over 60 days during the same time was estimated by van der Waal (1991a) at 250 metric tons. The most important fish caught in the oshanas are barbel (*Clarias* spp.), the straightfin barb (*Barbus paludinosus*) and the three-spot tilapia (*Oreochromis andersonii*) (Marsh and Seely 1992). All fish species transported into the oshanas will die during the dry season. Management plans, therefore, should aim at maximising the output in socio-economic terms without any consideration to the effects of fish stocks.

There are at least 80 updated total number of fish species in the Kavango River drainage (SER A; Appendix Table A1). The same total was recorded recently (van Zyl and Hay 1994). The Kavango River drainage has a relatively higher fish species number than any others. The river is under greater pressure because only a small potion passes through one of the most thickly populated regions of Namibia, Kavango and western Liambezi. According to Tvedten *et al*. (1994), about 160,000 people live in the Kavango Region, about 80% of them within 5 km of the river itself. The growth rate of the human population was >3% per year. The fish stock is quite heavily exploited and overfishing may occur (Hay 1995). Fishing is performed with a variety of traditional and modern methods (Appendix Table A2). Personal observations at markets in Rundu and in the vicinities of homes along the river, indicate that fish is an important source of protein for both the urban and rural human population in the area. Hay (1995) recorded a steadily rising quantity of 1,000 tons of fish caught per year from the Kavango River, which may exceed or come close to exceeding the maximum sustainable yield of the system (van der Waal 1991b). In order to maintain the fishing rate to sustainable levels, Hay (1995) recommends management measures, such as: i) restriction on the use of "non-traditional gear"; ii) specification of the allowable sizes and control over number and length of gill and seine nets; iii) ban of fish poisons, explosives, drag nets and any other gear that span more than half the width of the river; vi) reduction of fishing efforts during periods of low flow, but, increased intensity in peak flood season, when there is plenty of fish in the form of juveniles; v) proclamation of closed areas; and vi) the control of livestock grazing on the river banks. These measures may only be fruitful if carried both on the Namibian and Angolan sides, coupled by education of the local communities.

There are at least 75 updated total number of fish species in the perennial Zambezi River and seasonal cum perennial Chobe-Linyanti-Kwando-Lake Liambezi (East Caprivi) system (SER A; Appendix Table A1). Holtzhausen (1991) recorded a total of 76 fish species. Like in the Kavango drainage system, the fishery in East Caprivi is also under considerable pressure due to human population growth as well as environmental changes (Tvedten *et al*. 1994). According to the GRN/NPC (1994), the region has a human population of 90,400, in an area with a total surface of approximately 19,532 km^2. This gives a population density of 4.62 persons, which is considerably higher than the national average of 1.69 persons per square km^2. Several years of inadequate floods

have altered the ecosystem by leaving large parts of the region, which are normally under water during flooding seasons, completely dry. Fish occupy a central place in people's culture and daily life; it is the dominant commodity at the central market place in the regional capital Katima Mulilo in Caprivi Region. There is clear evidence of overfishing in parts of the system, stemming from a combination of ecological changes and increased fishing pressure due to changes towards modern gear and disintegration of traditional fishery management practices. Incipient commercialisation has rendered traditional management practices less effective. At the same time, no government management has replaced the old systems.

The Orange River (SER B) and estuary support at least 14 updated total number of fish species. Tvedten *et al*. (1994) also recorded the same number of fish species from the system, while Day (1997) recorded 17 fish species from the stretch that forms the common border between South Africa and Namibia. Few subsistent communities live along the Orange River. Possible fish yield and the ecology of the fish in the lower part of the river have not been thoroughly investigated. The utilisation of fish in the river is low, mainly due to the low population density in the area. There is, however, concern that increasing utilisation of the water resource in the upper part of the river by South Africa, may be detrimental to the Orange River estuary and mouth, which is a RAMSAR[1] site for the protection of waterfowl.

5   Aquaculture

The feasibility potentiality of aquaculture in Namibia has been recently reviewed (Balarin and New 1996; New 1996, 1997). This section emphasises freshwater aquaculture. With the restricted water resources available, the free-lance (unmanaged) fishing practice in inland waters, and the market restrictions caused by low priced marine fish, aquaculture may not appear to have any large potential in Namibia yet. There are three types of freshwater aquaculture: (1) 'Hatchery' for the production of fish fry or fingerlings to be introduced to natural waters for enhancement of dwindling natural fish stocks or to be set out in ponds or cages for production of market size fish. (2) 'Extensive,' where fingerlings are introduced in ponds to grow on natural foods for harvest. (3) 'Intensive' fish culture, where fingerlings are introduced in ponds or cages and intensively fed with artificial food until harvest. In Namibia these types of fish culture practices have been classified into two categories: "rural culture-based inland fisheries" and "commercial inland aquaculture" (New 1997).

The rural culture-based inland fisheries include the government-supported Freshwater Fisheries Institute in Hardap (SER B), the Rural Development Centre in Ongwediva, the Mahenene Fingerling Production Ponds in Mahenene, and government private ponds (Sinerge, Lake Olusandja in SER A). At present there is no aquaculture going on at FFI; the ponds are about to be privatised (C. Hay, personal communication). Previously, fingerlings of tilapia (e.g. *Oreochromis mossambicus*) and catfish (e.g. *Clarias gariepinus*) were produced at Hardap for experimental purposes or sold to

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[1] The Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an intergovernmental treaty which provides the framework for national action and international co-operation for the conservation and wise use of wetlands and their resources. There are presently 119 Contracting Parties to the Convention, with 1021 wetland sites, totalling 74.8 million hectares, designated for inclusion in the Ramsar List of Wetlands of International Importance.

commercial farmers with private dams. FFI is under the Ministry of Fisheries and Marine Resources. RDC and MFPP are also involved in a combination of 'tilapia and catfish' and 'tilapia alone' fry and fingerling production, respectively (Appendix Table A2). Five fish species, namely: redbreast tilapia (*Tilapia rendalli*), greenheaded tilapia (*Oreochromis macrochir*), threespot tilapia (*Oreochromis andersonii*), blunttooth catfish (*Clarias ngamensis*), and sharptooth catfish (*Clarias gariepinus*) are raised at RDC and MFPP. Both RDC and MFPP are currently under the Ministry of Agriculture, Water and Rural Development. In addition to FFI and RDC ponds are the oshanas, consisting of large number of pans and depressions that are seasonally flooded with water and stocked with fish species (see potential areas, Appendix Table A2). Some of these oshanas form private farms and are made deeper to hold water for long periods of time. Other private ponds were excavated in 1997 near Lake Olusandja by an Italian NGO, Sinerge. The ponds will soon be transferred to the government of Namibia and a local NGO.

Almost no commercial inland aquaculture exists in Namibia. There are, however, a number of small-scale ventures as well as potentials (personal observation in 1998; Balarin and New 1996; New 1997; Appendix Table A2). For example, the Zambezi Fish Farm, Katima Mulilo (SER A), an operational farm on a pilot scale, is specialised in raising tilapias (*Oreochromis andersonii*, *Oreochromis macrochir* and *Tilapia rendalli*). The farm is expanding in order to produce more tilapias as well as catfish, *Clarias gariepinus* (Day 1997). As mentioned earlier, FFI in Hardap (SER B) is proposed to go private, under the name of The Catfish Company of Namibia (see Appendix Table A2). The company is to establish catfish (*Clarias gariepinus)* farming in cages in Hardap Reservoir. Broodstock from the reservoir would be induced to spawn and fingerlings reared in FFI nursery ponds. Juveniles would be stocked in cages suspended in coves of the reservoir. There is another proposed polyculture research project included within a "Zero Emission Research Initiative" at the Namibia Sorghum Brewery, Tsumeb (SER A; personal involvement). The newly excavated ponds (4,000 m^2 by a depth of 3 m) are still maturing and not yet stocked with fish. Researchers from the University of Namibia and personnel from FFI have been requested to collect and stock seven or eight fish species of different trophic levels, such as herbivore *Tilapia rendalli*, algivore *Oreochromis macrochir*, ditritivore/diatomivore/zooplantivore *Oreochromis andersonii*, benthivore/molluscivore *Sargochromis giardi* and *Sargochromis carlottae*, omnivore *Schilbe intermedius*, bottom feeder cum scavenger *Synodontis nigromaculatus*, and a pelagic fish species *Brycinus lateralis* (Appendix Table A2). Fish may also be stocked in various farm dams within commercial lands of Namibia and even in tanks. Apart from the fin-fish culture mentioned above, there is potential for freshwater cray fish *Charax* spp. (New 1997; Appendix Table A2), freshwater clam and frog farming (personal observation).

6   Sports Fisheries

Sports fisheries in inland waters mainly occur in the perennial rivers Kavango, Zambezi/Chobe/Linyanti/Kwando and Orange, and in the oshanas (SER A) and state reservoirs. The most valuable representatives of sports fishery species belong to the families Characidae (e.g. the tigerfish, *Hydrocynus vittatus*) and Cichlidae (e.g. several breams) (Tvedten *et al*. 1994) in the perennial rivers, the families Cyprinidae (e.g. the straightfin barb, *Barbus paludinosus*) and Clariidae (e.g. the sharptooth catfish, *Clarias*

gariepinus) in oshanas (Balarin and New 1996; Appendix Table A2), and the families Centrarchidae (e.g. the largemouth bass, *Micropterus salmoides*) and again Cyprinidae (e.g. the common carp, *Cyprinus carpio*) in the state reservoirs (Bethune and Roberts 1991; Appendix Table A2). The two latter groups of fishes are alien; they are native to the Nearctic realm (e.g. North America) and the Oriental realm (e.g. Asia). Four state reservoirs with great sports fisheries (see Appendix Table A2) are Naute, Hardap (SER B), von Bach (SER C) and Omatako (SER A) (van Zyl and Hay 1994). The authors suggest that the fisheries in these reservoirs are under-utilised. The concessions to exploit reservoir fishery commercially, however, seem not to have been successful. The oshanas (SER A) represent an ecosystem where a major fish species invasion (Appendix Table A2) has taken place as a result of interbasin water transfers, to cope with the human population increase experienced in northern Namibia. There are good signs towards the development of the sports fisheries in perennial rivers, in terms of the establishment of fishing lodges, which provide accommodation and opportunities for angling (Day 1997) and other tourism activities (Tvedten *et al*. 1994). These are coupled with license fees for boats, fishing permits and any other payment.

7   Marketing and Trade

Artisanal fisheries technology is the most important source of inland fish supply in the Namibian diet. Fishers, who consist of women, children and men, in that ranking order of importance, use canoes (boats) and gears produced locally. They use technology requiring low capital investment with adequate yield, which has been developed in their respective regions (Appendix Table A3).

The most commonly used vessel in harvesting inland water fishes of Namibia is the "dugout canoe" called *Wato* in the Kavango or *Mikolo* in the Caprivi region (SER A, Appendix Table A3). The canoe has been a traditional fishing craft in Africa since ancient times. The canoe is designed symmetrically, such that the stern is identical to the bow. A canoe may vary by regions, in size, material and construction method. Generally, a dugout is made by chopping out the middle of log of respective size, forming a depression that accommodates the number of fishers and gear. Canoes are mostly operated in shallow water near land, propelled by paddles or poles. When big logs are unavailable, canoes are made by adding planks. In fact there are also big canoes made completely by planks. Otherwise, floating tied logs or rafts may be found in rivers and swamps with calm wave action. Like elsewhere in Africa, it can be predicted that the development of inland water fisheries may be coupled with the evolution of vessels made from large wood planks to those made from plywood, fiberglass-reinforced plastic and from aluminium, and from those propelled by paddles or poles to those powered by out-board motor engines (personal observation).

Artisanal fishing gears that have developed over the years are mostly passive. The gears are stationary. Good examples are the "scoop basket," named *Tambi* in the Kavango or *Lishino* in the East Caprivi region (Tvedten *et al*. 1994; Appendix Table A3). Catch is recovered by simply removing the gear from the water or collecting the catch in the gear after a period of time. Traps are constructed from locally available material by local craftspeople, who may be knowledgeable of the behaviour of the fish in relation to environmental conditions. The traps are easily repaired when damaged. Fishing activities are usually limited by the bulkiness of the traps and the number of

trips to be carried in the artisanal vessels. The question of using locally available material to develop collapsible traps needs to be addressed. Apart from being bulky, other disadvantages of using traps are high losses of gear due to current, storm damage, degradation of material and inability of locating the gear by fishers. Fish are also caught by small baited hook tied to a reed or pole, *Erowo* (in Kavango region and Caprivi; Appendix Table A3; Tvedten *et al*. 1994). Hooks and line are the simplest fishing method. It may range from one fisher with one hook to several fishers with complex multihooks or long lines of several kilometres. Operation is easy and inexpensive. Any vessel or shoreline can be used to catch fish by hooks. Many women and children are engaged in fishing with baited hooks; the bait attracts the fish, which swallows it and gets hooked. Fish spear, designated as *Musho* in the Kavango or *Muwayao* in the Caprivi region (Tvedten *et al*. 1994; Appendix Table A3) is also used in harvesting. A fish spear may be a crude gear, but due to refraction it takes considerable experience to calculate the exact position of the victim. Entangled and gillnets are recent gear technology developments acquired from developed countries. Beach or bank active fishing and seine nets are becoming very popular in the fishing communities.

Post-harvest handling of fish catch (FAO 1992a) starts immediately, when hauled onboard or onshore. Catch from traps, handline and hook or seine nets are taken live or very fresh. Fish from overnight laid entangled and gillnets are of two qualities. Those caught in late night are fresh, while those caught in early night are in a semi-spoiled form. The fresh fish are sold at fish markets (e.g. Oshakati, Rundu, and Katima Mulilo, SER A). As for fresh marine fisheries, where this practice is mostly used, the icing of an inland water fish species can be developed. Spoiled fish are dissected, opened and dried in the sun. The traditional methods currently applied in preserving and storing fish carcass are drying, smoking, salting (fermentation; FAO 1992b) and frying. Most small sized fish species and small cuts from large fish are preserved by sun drying. Although simple, this method is weather dependent. Another problem is that in some areas, sun-drying is practised unhygienically. Fish are spread directly on the sand, small stones or on rocks. These products are sandy and not appealing to the eye. Because there are high market demands, fisheries managers have failed to enforce high hygienic standards. The best sun-dried products are from raised drying racks or mats. This reduces contamination from wind, insects and other animals, and the products look more attractive. Smoking is the most common traditional preservation technique. Depending on the source of wood used, smoke contains substances that kill bacteria, colour the products and impart special flavour. Smoking kilns, which can be easily constructed by local craftspeople using local available material, are required. Salting alone is not very common in communal areas of Namibia. But salting while frying is a common phenomena and is the most popular processing method for women in urban or trade centres. The women prefer frying small-sized fish species to large ones. The small fish are cheaper, use less oil, easy to prepare and have higher economical returns. Fried fish is an important source of protein in large towns, where fish eating is a habit.

Inland fisheries development relies on techniques of handling, storage and distribution. The greatest part of fish losses in this region occurs at these stages. Fresh fish consumption is restricted mainly to areas lying within a short distance from a landing site. Lack of good transport and refrigeration facilities reduce the radius of the distribution of Namibian freshwater fish species. Fresh fish are normally transported on bicycles or open vehicles. A commercial transport system is too expensive to run where

there are marginal profits. Use of insulated containers from developed countries is also beyond the scope of many fish traders. All of the packaging materials used for processed products is simple and made from locally available low-cost materials. Some of the packaging is strong enough to protect the packaged products from damage. For example, sun-dried small fish species products are packaged in sisal bags or poly sacks for storage and distribution. Sun-dried smoked and salted products are also wrapped using dry, long banana leaves, remains of maize stems, mats or reeds. The wrapping material around the fish is tied tightly by sisal ropes, banana pseudostem sheath, special stem sticks or back strips from special tropical plants. Re-usable packing material, such as baskets, old cardboard boxes, different designed local containers, are most common in transporting small quantities of processed products to wholesale or retail urban markets. Since the packages cannot be cleaned easily, it is possible to contaminate new products, thus promoting more post-harvest losses.

Inland fisheries play a big role in community development. The most important is on health and nutrition. Humans cannot provide all 20 amino acids required for building proteins in the body. Some of these are acquired from eating fish. For example, fish protein is rich in essential amino acids, especially lysine, and is a good source of fat-soluble vitamins A, D and E. Fish liver and roe contain B-vitamins. Fish therefore contributes to household food security and nutrition, helping to build a strong healthy nation. During times of drought, when staple crops such as millet (*mohangu)*, maize and beans fail, fish acts as a buffer. Inland water fisheries also play a role in the sustenance of the social and cultural fabric of the community. They create employment for many people. They are a source of some income, in terms of cash and gifts. Money earned from the trade may help in paying school fees for young people and in buying necessary household commodities. Fishers, especially women and young girls, while spending several hours fishing, also exchange ideas and news for future community development.

8   Women in Fisheries in Namibia

The literature (Tvedten *et al*. 1994; Balarin and New 1996; IUCN 1993) and many years of personal experience support the fact that women play a crucial role in the exploitation and conservation of African fisheries. Namibia is no exception. In Namibia, women use traditional methods to catch fish from the rivers and floodplains. The most common method used during floods is the fish kraal, locally known as *sintunga* in Kavango region or *sibanga (*or *njamba)* in Caprivi (Appendix Table A3; Tvedten *et al*. 1994). About 87% of all households reported that this is one of the three most common traditional methods used in fishing in the Kavango region, and women are the main users. Women usually construct the fish kraal themselves, by tying reeds and sedges together to form a one meter long, one meter high mat. The ends are folded inwards, with a small opening to trap the fish. The kraals can be set up and checked in the early morning and late afternoon, when women go to the river for water or washing. The kraal requires little attention. Therefore, they allow women to attend to other priority tasks such as planting and weeding. The dry season finds the fish stocks most concentrated in the receding floodplains and in pools in the diminishing rivers and streams. The most popular method used in fishing during this time is the stem-twig funnel *(sikuku* in Kavango region or *singunde* in Caprivi) (Appendix Table A3). This is a funnel of stems and twigs tied with strands of palm leaves. At least 90% of households use a stem-twig funnel in the Kavango region (Yaron *et al*. 1992). With one approach,

women and young girls wade into the water, where fish are rustled out of the grasses and chased into the funnel. Another method primarily used by women during the dry season (especially in Kavango region) is the conical trap (Appendix Table A3) (Yaron *et al*. 1992). The basket is thrust over fish in ankle to knee-deep water, and the fish is taken out through a hole in the side. Women also use small baited hooks tied to reed or poles (*erowo*, Appendix Table A3), to catch fish from riverbanks and shoreline.

These traditional methods of fishing have played a role in fish conservation, where overfishing has not been a problem for many years. Unfortunately, women are now subsidising traditional gear with modern gear. For example, women are the main users of mosquito nets *(mashiri makwe* in Kavango region or *moskito* in Caprivi). The net is used in a similar manner as the *sikuku*, with one or more women chasing the fish into a net held by two women, who close the net around the fish. Several people criticise this method of fishing. The nets work similarly to the *sikuku,* when used as a drag net. According to Tvedten *et al*. (1994), a 50-year-old woman urged that *sikuku* should be redesigned to allow small fishes to pass through.

Women typically handle the preparation, processing and storage of fish. In addition to cooking, fish may also be pounded and added to soup. The fish, which is dried and stored in huts, may be damaged by insects or may rot in the hot summer months. The reason for drying fish is to buffer the drought seasons. But women complain that people in the household will just eat up the dried fish, saving none for times when there is no meat or fish. As principal caretakers, women use the food or income from fishing for the whole household. On the average, it is the woman's fish that feeds the family. As a result, women are often eager to learn new skills or to obtain mosquito nets. They recognise that fishing is a way to upgrade living standards and to boost household food security.

9   Management Policies and Regulations

The Ministry of Fisheries and Marine Resources currently handles matters of freshwater fisheries. The Freshwater Fish Institute, situated at Hardap on the Fish River (SER B), is responsible for monitoring and evaluating the fishery, as well as for management activities. The institute, which is located over 500 km away from the perennial rivers Kunene (SER B), Kavango and Zambezi/Chobe/Kwando/Linyanti (SER A), presently employs only one fisheries biologist. Due to expenses and logistics, the station conducts only two or three investigations a year in the Kavango region and in Caprivi (Tvedten *et al*. 1994). There is already a trend reflecting a shift in priorities from state dams and aquaculture, to the natural river systems. The institute, however, has no permanent employee in the northern regions.

Fisheries policies, laws and regulations mostly concern issues such as the types of gear that may or may not be used, open and closed seasons, and bag limits for fishers. Natural resource management in Namibia fluctuates between two polar tendencies. Typically, the central government is vested with authority and decision-making, and the regional offices of sectoral ministries simply implement and enforce policies and legislation. Article 100 of the Constitution makes the government responsible for all water resources in Namibia. Therefore it is the state which will set up the terms of how the river systems and other water bodies are to be used. The MFMR has the mandate to manage the inland fish resources, to set up the overall management objectives, as well

as the strategies to achieve them. A further description of management policies and regulations of inland water fisheries are found in the literature (Balarin and New 1996; Day 1997; New 1997; Sandlund and Tvedten 1992; Tvedten *et al*. 1994).

There is a New Draft Inland Fisheries Act (Day 1997:35). Significant components of the policies contained in the draft are:

a) To promote the sustainable use of the freshwater fisheries of Namibia;
b) To protect and to conserve the ecosystems and habitats on which freshwater fish depend;
c) To ensure that the benefits deriving from freshwater fisheries are justly and equitably distributed, in particular that traditional and subsistence fisher-people are not deprived from the resource on which they have historically depended;
d) To enter into co-operative agreements with neighbouring states whose freshwater catchments are shared with Namibia.

A White Paper on "The Responsible Management of the Inland Fisheries of Namibia" by the Section Inland Fish, Directorate Resource Management of the MFMR (1995) was released in December 1995. Communities with vested interest in naturally occurring inland fisheries participated by supplying information towards putting up the white paper. Thus, the proposed new legislation discourages commercialisation of the fisheries resources in unfair competition with traditional fishers. In summary, the white paper aims at (explicitly, a) to c)):

a) allowing sustainable use but to protect biodiversity, i.e. by having closed seasons and closed areas (or breeding sanctuaries), by banning certain fishing methods, by developing an appropriate licensing system, and by bag limits and size restrictions;
b) controlling fishing by gear restrictions, giving preference to "passive" rather than "active" gear, and to traditional rather than modern gear;
c) policing fishing activities using police officers and Ministry officials;
d) developing different management approaches for different systems;
e) protecting the interests of subsistence households;
f) allowing local communities to share the income generation from fish;
g) supporting research where needed;
h) developing regional co-operation where needed.

Fish in the Kavango region and Caprivi are an essential part of food security. The intention is therefore to follow a policy of optimal, not maximal, yields in order to maintain fish stocks. The management of shared rivers is complicated and needs continual address.

A White Paper and Aquaculture Act on "Government Policy for the Responsible Aquaculture Development" are currently underway (Cacaud 1997:7-23; New 1997). A draft summary of its contents was already available in July 1997. Among other important aquacultural policies, the following items have been discussed in the documents:

a) establishment and function of national advisory committee for aquaculture;
b) establishment and conducting of aquaculture within designated aquaculture zones;
c) conducting aquaculture only with a license;

d) ownership of aquaculture products;
e) regulations;
f) enforcement by aquaculture inspectors;
g) offences and policies;
h) miscellaneous provisions and short title (e.g. time to seek license; exemptions, etc.).

10   Recommendations

The bulk of the Namibian human population live near perennial water bodies (especially in SERs A and B) and the ocean. Apart from water for domestic and industrial use, the water bodies also provide fish for food. The ocean produces relatively cheap fish for export and local consumption. Fish prices, however, tend to increase, depending on the methods used in preserving and transporting the fish from the ocean to the people of Namibia. Like elsewhere in Africa, the Namibian human population is bound to increase with time. Therefore more fish will be required to feed additional mouths. In order to be able to meet such pressing food demands, the following is recommended:

1. Continued development and research of inland water fisheries, especially in SERs A and B.
2. Management and protection of floodplain fisheries.
3. More research centres developed within the vicinity of inland water bodies (i.e. SERs A and B).
4. Development of artisanal fisheries and aquaculture to play a major role in food security and to improve socio-economics in the future.
5. Emphasis of aquaculture practices in communal areas, in order to bring fish closer to the majority of the people of Namibia.
6. Implementation of draft policies and regulations.
7. Involvement of women and children in the conservation of inland water fisheries.
8. Monitoring of health hazards linked to harvest and post-harvest fish handling.
9. Public education using fisheries extension officers.
10. Law and regulation enforcement by fisheries scouts.

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Appendix

Table A1. Checklist and distribution of inland fish species of Namibia.

K=Kunene; OK=Kavango; Z=Zambezi; OR=Orange

Group/Family	Authority*	Common name	Water body and drainage
MORMYRIDAE		Snout fishes	
Mormyrus lacerda	Castelnau, 1861	Western bottlenose	K; OK; Z
Hippopotamyrus anasorgii	Boulenger, 1905	Slender stone basher	K; OK; Z
Hippopotamyrus discorhynchus	Peters, 1852	Zambezi parrotfish	K; OK; Z
Marcusenius macrolepidotus	Peters, 1852	Bulldog	K; OK; Z
Petrocephalus catostoma	Günther, 1866	Churchill	K; OK; Z
Pollimyrus castelnaui	Boulenger, 1911	Dwarf stone basher	K; OK; Z
KNERIIDAE		Knerias	
Kneria maydelli	Ladiges &Voelker, 1961	Kunene kneria	K
CYPRINIDAE		Barb; Yellowfishes; Labeos	
Mesobola brevianalis	Boulenger, 1908	River sardine	K; OK; Z; OR
Opsaridium zambezense	Peters, 1852	Barred minnow	OK; Z
Barbus breviceps	Trewavas, 1936	Shorthead barb	K; OK
Barbus barotseensis	Pellegrin, 1920	Barotse barb	K; OK; Z
Barbus unitaeniatus	Günther, 1866	Longbeard barb	K; OK; Z
Barbus bifrenatus	Fowler, 1935	Hyphen barb	K; OK; Z
Barbus thamakanesis	Fowler, 1935	Thamalakane barb	OK; Z
Barbus barnardi	Jubb, 1965	Blackback barb	K; OK; Z
Barbus fasciolatus	Günther, 1868	Red barb	K; OK; Z
Barbus radiatus	Peters, 1853	Beira barb	K; OK; Z
Barbus haasianus	David, 1936	Sickle-fin barb	OK; Z
Copstomabarbus wittei	David & Poll, 1937	Upjaw barb	OK; Z
Barbus trimaculatus	Peters, 1952	Threespot barb	K; OR
Barbus poechii	Steindachner, 1911	Dashtail barb	K; OK; Z
Barbus eutaenia	Boulenger, 1904	Orangefin barb	K; OK; Z
Barbus miolepis	Boulenger, 1902	Zigzag barb	OK; Z
Barbus multilineatus	Worthington, 1933	Copperstripe barb	K; OK; Z
Barbus afrovernayi	Nichols & Boulton, 1927	Spottail barb	K; OK; Z
Barbus hospes	Barnard, 1938	Namaqua barb	OR
Barbus argenteus	Günther, 1868	Rosefin barb	K
Barbus paludinosus	Peters, 1852	Straightfin barb	K; OK; Z; OR
Barbus mattozi	Guimanaes, 1884	Papermouth	K
Barbus kerstenii	Peters, 1868	Redspot barb	K; OK
Barbus kimberleyensis	Gilchrist & Thompson, 1913	Largemouth yellowfish	OK
Barbus aeneus	Burchell, 1822	Smallmouth yellowfish	OR, state dams
Barbus cordringtonii	Boulenger, 1908	Upper Zambezi yellowfish	OK
Labeo umbratus	A. Smith, 1841	Moggel	OR
Laboe capensis	A. Smith, 1841	Orange River mudfish	OR
Labeo ruddi	Boulenger, 1907	Silver labeo	K
Labeo cylindricus	Peters, 1852	Redeye labeo	OK; Z
Labeo lunatus	Jubb, 1963	Upper Zambezi labeo	OK; Z
Labeo ansorgii	Boulenger, 1907	Kunene labeo	K and Guanza River
Cyprinus carpio	Linnaeus, 1758	Carp (common!)	Introduced throughout, e.g.

			in state dams; in Omatako drainage and may eventually enter Kavango River drainage
CITHARINIDAE (considered as separate from Distichodontidae		Citharines	
Hemigrammocharax machadoi	Poll, 1967	Dwarf citharine	K; OK; Z
Hemigrammocharax multifaciatus	Boulenger, 1923	Multibar citharine	K; OK; Z
Nannocharax macropterus	Pellegrin, 1925	Broadbar citharine	OK; Z
CHARACIDAE		Characines	
Brycinus lateralis	Boulenger, 1900	Striped robber	K; OK; Z
Micralestes acutidens	Peters, 1852	Silver robber	K; OK; Z
Rhabdalestes maunensis	Fowler, 1935	Slender robber	K; OK; Z
Hydrocynus vittatus	Castelnau, 1861	Tigerfish	OK; Z
HEPSETIDAE		African Pike	
Hepsetus odoe	Block, 1794	African pike	K; OK; Z
CLAROTEIDAE		Claroteid Catfishes	
Parauchenoglanis ngamensis	Boulenger, 1911	Zambezi grunter	OK; Z
AUSTROGLANIDIDAE		Rock Catfishes	
Austroglanis sclateri	Boulenger, 1901	Rock catfish	OR
SCHILBEIDAE		Butter Catfishes	
Schilbe intermedius	Rüppell, 1832	Silver/butter catfish	K; OK; Z
AMPHILIIDAE		Mountain Catfishes	
Leptoglannis rotundiceps	Hilgerndorf, 1905	Spotted sand catlet	K; OK; Z
Leptoglannis cf dorae	non Poll, 1967	Chobe sand catlet	OK; Z
Amphilius uranoscopus	Pfeffer, 1889	Common/stargazer mountain catfish	OK; Z
CLARIIDAE		Air-breathing Catfishes	
Clarias gariepinus	Burchell, 1822	Sharptooth catfish	K; OK; Z; OR
Clarias ngamensis	Castelnau, 1861	Blunttooth catfish	K; OK; Z
Clarias stappersii	Boulenger, 1915	Blotched catfish	K; OK; Z
Clarias liocephalus	Boulenger, 1898	Smoothhead catfish	K; OK
Clarias theodore	Weber, 1897	Snake catfish	K; OK; Z
Clarias cavernicola	Trewavas, 1936	Cave catfish	Aigamas cave, near Otavi
Clariallabes platyprosopos	Jubb, 1964	Broadhead catfish	OK; Z
MOCHOKIDAE		Squeakers, Suckermouth Catlets	
Chiloglanis fasciatus	Pellegrin, 1936	Okavango sucker mouth (Okavango rock catlet)	OK, Kwando Systems
Chiloglanis neummanni	Boulenger, 1911	Neumann's sucker mouth/rock catlet	K
Synodontis nigromaculatus	Boulenger, 1905	Spotted squeaker	OK; Z
Synodontis woosnami	Boulenger, 1911	Upper Zambezi squeaker	K; OK; Z
Synodontis macrostigma	Boulenger, 1911	Largespot squeaker	K; OK; Z
Synodontis macrostoma	Skelton & White, 1990	Largemouth squeaker	K; OK; Z
Synodontis leopardinus	Pellegrin, 1914	Leopard squeaker	K; OK; Z
Synodontis thamalakenensis	Fowler, 1935	Bubblebarb squeaker	OK; Z
Synodontis vanderwaali	Skelton & White, 1990	Finetooth squeaker	K; OK; Z

APLOCHEILICHTHYIDAE (considered as separate from Cyprinodontidae)		Topminnows and Lampeyes	
Aplocheilichthys johnstoni	Günther, 1893	Johnston's topminnow	K; OK; Z
Aplocheilichthys hutereaui	Boulenger, 1913	Meshscaled topminnow	OK; Z
Aplocheilichthys katangae	Boulenger, 1912	Striped topminnow	K; OK; Z
POECILIIDAE		Live-bearers	
Poecilia reticulata	Peters, 1859	Guppy	Introduced into the Kuraman Eye and Lake Otjikoto
Xyphophorus helleri	Heckel, 1848	Swordtail	Lake Otjokoto
APLOCHEILIDAE		Nothobranchius	
Nothobranchuis sp.		Caprivi killifish	Caprivi pans
MASTACEMBELIDAE		Spiny Eels	
Aethiomastacembelus frenatus	Boulenger, 1901	Longtail spiny eel	OK; Z
CENTRARCHIDAE		Basses & Sunfishes	
Micropterus salmoides	Lacepéde, 1802	Largemouth bass	Introduced into dams, i.e Swakop and Omatako and waters of central Namibia
CICHLIDAE		Cichlids	
Hemichromis elongatus	Guichenot, 1859	Banded jewelfish	OK; Z
Orthochromis machadoi	Poll, 1967	Kunene dwarf happy	K
Pseudocrenilabrus philander	Weber, 1897	Southern mouthbrooder	K; OK; Z; OR
Chetia welwitschi	Boulenger, 1898	Angola happy	K
Pharyngochromis acuticeps	Steindachner, 1866	Zambezi happy	OK; Z
Thoracochromis albolabris	Trewavas & Thys van de Audenaerde, 1969	Thicklipped happy	K
Thoracochromis buysi	Penrinth, 1970	Namib happy	K
Sargochromis carlottae	Boulenger, 1905	Rainbow happy	OK; Z
Sargochromis codringtonii	Boulenger, 1908	Green happy	OK; Z
Sargochromis giardi	Pellegrin, 1903	Pink happy	K; OK; Z
Sargochromis greenwoodi	Bell-Cross, 1975	Greenwood's happy	Z
Sargochromis coulteri	Bell-Cross, 1975	Kunene happy	K
Sargochromis gracilis	Greenwood, 1984	Slender happy	K and Cutato trib
Serranochromis altus	Winemiller & Kelso-Winemiller, 1990	Humpback largemouth	OK; Z
Serranochromis angusticeps	Boulenger, 1907	Thinface largemouth	K; OK; Z
Serranochromis longimanus	Boulenger, 1911	Longfin largemouth	Z
Serranochromis macrocephalus	Boulenger, 1899	Purpleface largemouth	OK; Z
Serranochromis robustus	Günther, 1864	Nembwe/Tsungwa	OK; Z
Serranochromis thumbergi	Castelnau, 1861	Brownspot largemouth	K; OK; Z
Tilapia sparrmanii	A. Smith, 1840	Banded tilapia	K; OK; Z; OR and central
Tilapia guinasana	Trewavas, 1936	Otjikoto tilapia	Lake Guinas; translocated to Lake Otjikoto and many reservoirs

Tilapia ruweti	Poll & Thys van den Audenaerde, 1965	Okavango tilapia	Z
Tilapia rendalli	Boulenger, 1896	Redbreast tilapia	K; OK; Z
Oreochromis mossambicus	Peters, 1852	Mozambique tilapia	Introduced to inland regions, e.g. Lake Otjikoto, and coastal river drainages including lower Orange
Oreochromis andersonii	Castelnau, 1861	Threespot tilapia	K; OK; Z
Oreochromis macrochir	Boulenger, 1912	Greenhead tilapia	K; OK; Z
ANABANTIDAE		Labyrinth Fishes	
Ctenopoma intermedium	Pellegrin, 1920	Blackspot climbing perch	OK; Z
Ctenopoma multispine	Peters, 1844	Many spined climbing perch	OK; Z
ATHERINIDAE		Silversides	
Atherina breviceps	Valennciennes, 1835	Cape silverside	Estuaries and coastal lakes from Orange River to Lüderitz
MUGILIDAE		Mullets	
Mugil cephalus	Linnaeus, 1758	Flathead mullet	OR estuary

* Name of the person identifying the species, and the year of identification. The placement of the comma follows the *International Code of Zoological Nomenclature* (1985).

Table A2. Inland fish in culture and other potential species.

Centre for culture/ water body	Species	Authority*	Common name
CURRENT ACTIVITIES			
Zambezi Fishfarm, Katima Mulilo	*Clarias gariepinus*	Burchell, 1822	Sharptooth catfish
	Oreochromis andersonii	Castelnau, 1861	Threespot tilapia
	Oreochromis macrochir	Boulenger, 1912	Greenhead tilapia
	Tilapia rendalli	Boulenger, 1896	Redbreast tilapia
Rural Development Centre, Ongwediva	*Clarias gariepinus*	Burchell, 1822	Sharptooth catfish
	Clarias ngamensis	Castelnau, 1861	Blunttooth catfish
	Oreochromis andersonii	Castelnau, 1861	Threespot tilapia
	Oreochromis macrochir	Boulenger, 1912	Greenhead tilapia
	Tilapia rendalli	Boulenger, 1896	Redbreast tilapia
Mahenene Fingerling Production Ponds, Mahenene			"Catfish" "Tilapia"
Communal Farms, oshanas			"Catfish" "Tilapia"
Klein Hamakarn Farm Tanks, Otjiwarongo			"Catfish" "Tilapia"
Varius Farm Dams	*Oreochromis mossambicus*	Peters, 1852	Mozambique tilapia
Namibia Brewery, Tsumeb (proposed)	*Brycinus lateralis*	Boulenger, 1900	Stripped robber
	Oreochromis macrochir	Boulenger, 1912	Greenhead tilapia
	Sargochromis carlottae	Boulenger, 1905	Rainbow happy
	Sargochromis giardi	Pellegrin, 1903	Pink happy
	Schilbe intermedius	Rüppell, 1832	Silver catfish (butter catfish)
	Tilapia rendalli	Boulenger, 1896	Rebreast tilapia
	Oreochromis andersonii	Castelnau, 1861	Threespot tilapia
	Synodontis nigromaculatus	Boulenger, 1905	Spotted squeaker
The catfish Company of Namibia, Hardap Dam (proposed)	*Clarias gariepinus*	Burchell, 1822	Sharptooth catfish
Proposed Activities Adjacent to Kavango River			"Tilapia"
Potential Freshwater Crayfish Farm, Swakopmund (proposed)	*Charax* spp.		
Olifants Fontein Farm, Grootfontein (abandoned)			"Crayfish"
Miske Farm (interested)			"Crayfish"
Proposed Activities, Caprivi			Freshwater prawn
POTENTIAL AREAS			
Oshanas (e.g. Sinerge, Lake Olusandja	*Clarias gariepinus*	Burchell, 1822	Sharptooth catfish
	Clarias ngamensis	Castelnau, 1861	Blunttooth catfish
	Oreochromis andersonii	Castelnau, 1861	Threespot tilapia
	Oreochromis macrochir	Boulenger, 1912	Greenhead tilapia
	Tilapia rendalli	Boulenger, 1896	Redbreast tilapia
Reservoirs	*Barbus aeneus*	Burchell, 1822	Smallmouth yellowfish
	Barbus kimberleyensis	Gilchrist & Thompson, 1913	Largemouth yellowfish
	Clarias gariepinus	Burchell, 1822	Sharptooth catfish

	Barbus paludinosus	Peters, 1852	Rosefin barb
	Cyprinus carpio	Linnaeus, 1758	Carp (common!)
	Labeo capensis	A. Smith, 1841	Orange River mudfish
	Labeo umbratus	A. Smith, 1841	Mogge
	Mesobola brevianalis	Boulenger, 1908	River sardine
	Micropterus salmoides	Lacepéde, 1902	Largemouth bass
	Oreochromis macrochir	Boulenger, 1912	Greenhead tilapia
	Oreochromis mossambicus	Peters, 1852	Mozambique tilapia
	Tilapia rendalli	Boulenger, 1896	Redbreast tilapia
	Tilapia sparrmanii	A. Smith, 1840	Banded tilapia

* Name of the person identifying the species, and the year of identification. The placement of the comma follows the *International Code of Zoological Nomenclature* (1985).

Table A3. Indigenous names of vessels and gear used in artisanal fisheries.

Local name	Common name	Description
KAVANGO		
Wato	dugout canoe	a log of respective size, chopped in the middle to form a depression that accommodates fishers and gear
Sikuku	stem-twig funnel	a funnel of stems and twigs tied with strands of palm leaves
Sintunga	fish kraal	tying of reeds and sedge together to form a metre long, metre high mat, which are manipulated into all sorts of shapes and sizes
Muduwa	valve traps	reed compartments of fish kraals or traps
Masasa	type of fish fence/trap	reed mats with "compartments" of valves (muduwa)
Runkinda	type of fishing basket	tapered basket woven from stems or roots which has large hand-size opening
Tambi	scoop basket	oval-shaped basket with handle across the mouth
Sididi	conical trap	a metre-long trap woven of stems which has a hole on the side through which fish is removed
Erowo	drop angling hook	small baited hook tied to a reed and twine and dropped into the water from shoreline
Egondo	drop angling hook	large baited hook tied to a reed/pole and twine and dropped into the water from a canoe
Makoka	fishing line	wrapped around the middle of a butter-fly shaped piece of wood with hooks tied to the end and plugged up to quite some distance from a canoe
Musho	fish spear	long, light reeds with a metal shaft or barbed tip
Rushungu	shrub paraliser	pounded and dried roots of a shrub, spread over the water to paralyse fish
EAST CAPRIVI (ZAMBEZI, CHOBE, LINYANTI, KWANDO)		
Mikolo	dugout canoe	see Wato
Siyandi	fish fence	see Masasa
Sibanga	small fish kraal	see Sintunga
Njamba	large fish kraal	built across deep (up to 1 metre) flowing drainage channel
Lukuko	valve traps	see Muduwa
Lifula	long open funnel	see Sikuku
Lishino	scoop/draw basket	see Tambi
Singunde	push basket	see Tambi and Sikuku; mommon in muddy pools
Mundo	buds	narrow walls of 30 m long by 60 cm high erected across flooded valleys when floods recede with sods, clay and grass
Erowo	hook & line	see Erowo
Muwayao	multi barbed fish spear	see Musho
Cambeti	shrub paraliser	pounded, dried pods carried in canoe in bucket containers and applied where a lot of fish are spotted

PART II: DEVELOPMENT

GOVERNMENT POLICIES ON SUSTAINABLE DEVELOPMENT IN NAMIBIA[1]

Rob Blackie

Abstract

This paper examines the evolution of key government policies on sustainable development in Namibia since 1990. Namibia's approach has been generally home grown, responding to issues that are of concern to the Namibian public and policy-makers. The most successful policies have been those that have either been based on strong community-level institutions such as conservancies, or on high-quality scientific analysis, such as management of fisheries or environmental assessments of large projects. Both examples have involved strong stakeholder participation in the formulation of policies and legislation. Inter-ministerial co-operation has been variable depending on the issue dealt with. Some issues, such as EAs, have proved cheap relative to overall project costs and are not perceived as a threat by the ministries concerned. Other issues, such as those relating to land and local governance of natural resources, have required co-operation from up to four government ministries to resolve conflicts. Government institutions that allow public participation and co-operation within government, as well as with stakeholders are examined and compared. Lastly, conclusions are drawn as to what direction should be taken by government in future to ensure that development is sustainable.

1   Introduction

Upon gaining independence in 1990 the Namibian government faced an unenviable task. In virtually all spheres, the government it inherited was oriented away from the developmental needs of the country. Government was exceptionally centralised and policy setting was undemocratic. In the environmental sphere this was as true as in other sectors: policy-making was oriented towards urban and freehold farming areas, and there was a lack of the appropriate skilled personnel. More importantly, there was a lack of experience in democratic methods. A series of initiatives appeared from the then Ministry of Wildlife, Conservation and Tourism (now Ministry of Environment and Tourism) to try to reorient environmental planning. Unusually this did not involve a formal National Environmental Action Plan which prescribes a wide range of actions to be taken (as used in other African

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[1] This paper was originally written in 1997 by Rob Blackie. In 1998 an updated version was written under the title "Government policies on sustainable development in Namibia" in collaboration with Peter Tarr (Acting Head of the Directorate of Environmental Affairs) as Research Discussion Paper No. 28, which included details of the form of the Sustainable Development Commission which were not decided at the time of the original paper. This paper is substantially based on the 1998 paper.

countries), but the published plan (Brown 1992) instead concentrated mainly on problems, institutions and processes rather than specific goals in themselves. This gradually led to a series of cross sectoral programmes, housed within the MET but controlled by steering groups of stakeholders. In parallel with MET's programmes there have been a range of ministries developing their own programmes with major environmental implications, such as policies on water, land and fisheries. These programmes have had many similarities with the MET's programmes since they have faced similar constraints in terms of available data and personnel and developing policies and legislation for entirely new objectives.

2   Key Resources for Namibian Development

A few key resources are focused on in the rest of the chapter. These are either important for future growth of the economy (water, fisheries and wildlife) or crucial to the livelihoods of the majority of the rural population (water, woodlands and grazing land). Those essential to future growth are (with the exception of wildlife) mainly based in urban areas, or are large-scale operations and operate in the formal sector. The problems and opportunities in these sectors often involve some degree of state regulation and involvement. Those sectors which are crucial to livelihoods tend to be rural, small scale and informal. Hence, an appropriate state role is in providing a legal framework and technical advice, such as through extension officers. Attempts to control activities in many parts of rural Namibia are doomed to failure in any case due to the exorbitant cost of monitoring in a country with such low population densities. In any case most environmental issues at local levels can be most effectively solved by making those who must make investments in environmental issues the same people who benefit from them.

3   Local Environmental Problems:
Natural Resources Policy in Rural Areas

This section deals mainly with communal land tenure areas which constitute about 41% of the country's total land area (based on Werner *et al*. 1990). Most of the Namibian population still lives in rural communal areas, overwhelmingly in the north. Local level environmental problems in these areas not only affect about 65% of the Namibian population (GRN/NPC 1994), but also those who are the poorest. Freehold farming areas occupy the bulk of central and southern Namibia, but are not examined in depth since they are not expected to show much growth in the medium term. The number of people living on freehold farms is only about 9% of the Namibian population, and may be falling. In contrast to the freehold farming areas, the communal area's contribution to marketed output is rising rapidly (CSO 1998).

3.1   Forestry and wildlife

In common with most countries, past policy has been highly technocratic in forestry and wildlife, based around preservation in protected areas and highly restricted (and generally unsuccessful) rules on resource use outside protected areas. Namibia's current policy on wildlife and forestry is less restrictive and more enabling on resource use (Jones 1997).

Within protected areas and on freehold farms, wildlife numbers have generally been increasing in recent years. In protected areas, numbers of animals have risen significantly since 1990. In freehold farming areas the conditional use rights given to farmers in the 1960s and 1970s have led to increases in wildlife numbers as farmers have switched to mixed game and livestock farming, or pure game farming operations (Barnes 1996). Approximately 450 out of a total of 6000 freehold farms are registered as hunting farms (Morsbach, personal communication). In addition 150-200 are registered as guest farms, lodges, hotels and camps which do not have hunting (author's calculations from MET lists of guest farms, hotels, etc., contained in the yearly accommodation guide for tourists).

Following the successful example of freehold farms the government in 1996 amended nature conservation legislation to allow groups of people to register as 'communal area conservancies' with similar rights as private farmers. The benefits that communities will get are expected to lead to them investing more time and resources into managing and improving their natural resource base. Communities which wish to register must elect a representative committee, negotiate and agree boundaries with neighbouring communities and draw up a constitution and management plan. Wildlife numbers in Kunene and Caprivi, where these initiatives are most advanced, have been recovering from decades of poaching (on Caprivi see Rodwell *et al*. 1995; on Kunene, Jon Barnes, personal communication), so that communities are in a position to benefit substantially from wildlife. As of early 1999 four conservancies had been registered, and fifteen to twenty communities are in the process of applying.

The government is currently formulating policies and contemplating legislative reform to deal with people who live in parks (mainly the Caprivi Game Reserve and the Namib-Naukluft park) and to build relations with communities living next to protected areas (Jones 1997). This will explicitly recognise that land in and around protected areas is subject to a variety of legitimate uses, and that balancing these must be done by the government in partnership with the communities.

Forestry has had a much lower profile in Namibia than wildlife. Although commercially exploitable forest comprises only about 2.5% of the land area (Kojwang undated), and there is only one state forest, the value of forests to the nation is high for a variety of reasons. The most important of these are as inputs to agricultural systems: for instance, browsing for livestock, and as food sources during droughts.

The extent of forest resources and the rate of change outside local studies are still unknown in Namibia. At present there are two projects underway to document forest resources, the National Forest Inventory and the Forest Cover Mapping Project. The National Forest Inventory should be completed by 2001. Based on existing evidence the system of requiring permits for wood cutting is ineffective, and deforestation has occurred in some communal areas. Law enforcement by the Directorate of Forestry of the MET is reasonably successful in the circumstances. In contrast to communal areas, freehold areas effectively suffer the opposite problem, namely bush encroachment[2] (too much woody vegetation).

In a similar move to the wildlife conservancies, forestry policy aims to promote local protection of forest resources thorough conditional use rights. For some areas with

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[2] See NAPCOD (1996) and Lange (1997) for discussions.

abundant resources this will mean the establishment of 'community forest reserves' with similar conditions to wildlife conservancies. Primarily, though, forestry intends to introduce extension programmes that will promote tree planting, nurturing and protection of trees on farms and communal grazing land. However, the missing link at present is a clear communal land policy that will encourage investment in communal land.

3.2   Communal land

The legal status of communal land[3] (as a whole rather than specific resources that lie on or under it like water or wildlife), which covers about 41% of Namibia, is exceptionally confusing,[4] despite the recent passage of the Communal Land Act through Parliament. The applicable law is a combination of laws and precedents from before 1990 that originated in South Africa, Namibia and the 'homelands,' as well as the guiding principles of the Constitution, customary law and post-1990 sectoral legislation. The relationship of post-1990 sectoral legislation to the Communal Land Act is unclear. This causes problems for residents of these areas since they are not sure that they will have continued access to their land. This, in turn, discourages investments that can generate wealth, such as in planting fruit trees, improving grazing or building improved housing. Tenure security tends to be strongest in the homesteads and fields of a household, and weakest on the communal grazing land. Although the legal situation is vague, security of tenure is usually best for men and their access to cropland. Similarly it is usually weakest for women.

At present the legal vacuum, which will continue until the Communal Land Act is brought into effect, is causing several serious problems. While many of the provisions of the Act should reduce some of these problems, it may be several years until the institutions such as the Regional Land Boards are working. First, the allocation of land is made by traditional leaders who are aware that their *de facto* right to do this may be curtailed in the near future. The Communal Land Act implies that in the future their ability to allocate land will be restricted to 'customary grants' which will probably be smaller areas than at present. In addition, paying a traditional leader for land has been declared illegal. Hence, allocation of grazing land is rapid at present so as to reap the benefits of payment while it is still possible. In the northern and eastern regions of Namibia this has resulted in vast, though unquantified, amounts of land being fenced off into large ranches over the last ten years.[5] Recent estimates of fencing in the densely populated Oshikoto region of northern Namibia indicate that around 25-50% of the communal land has been fenced off into large private ranches (in parts of some regions enclosure of land is now effectively complete). In addition subsistence farmers occupying arable land with associated small grazing enclosures occupy another 20% of

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[3] Which is technically state owned.
[4] For instance see various chapters on the relationship between traditional authorities and land administration in d'Engelbronner-Kolff *et al.* (1998).
[5] The forthcoming Environmental Profile of the "four Os" regions (formerly Ovamboland, now the administrative regions of Oshikoto, Ohangwena, Oshana and Omusati) will contain detailed information on this trend in one of the areas most effected. See Namibia National Farmers Union (1998) for the view taken by the umbrella union for communal farmers.

the area.[6] Hence the remaining open grazing land is only about 30-55% of the region. This has impoverished neighbouring inhabitants of these areas and is causing considerable social tensions occasionally erupting into violence (Cox *et al.* 1998).

The legal situation also means that communities are often unable to improve resource management in their areas. This is because any system is constrained by the inability of communities to exclude outsiders from using their resources. The overlap between different sectoral legislation and policies means that there are problems developing rapidly in some areas. In Kunene there are several conservancies that are experiencing problems in their relationships with tour operators because of this. Several of these conservancies have allocated exclusive rights to commercial wildlife viewing, but are unable to prevent the wildlife (or tourists) from being disturbed by livestock. A right to exclusive use of wildlife resources loses most of its value when there are no rights excluding outsiders from using other resources. Systems of common property resource management are very varied by area, so that traditional systems in some areas are strong and still work effectively.[7]

Women's land rights are also a major issue. In practice women are the primary resource managers in areas where migrant labour is important,[8] which is much of the country. However, inheritance systems mean that they are often deprived of their land and homes when their husband dies, hence incentives for long-term investments are reduced. Informal pressure on traditional authorities appears to have reduced this problem in recent years. The Communal Land Act should give enforceable legal rights to widows.

3.3   Freehold farming land

Incentives to sustainably manage natural resources on freehold farming land are good, due to strong individualised ownership of land. However, some commentators have suggested that closed (i.e. fenced-off) grazing systems are ecologically undesirable in Namibia's climate (Brown 1993; Robertson forthcoming). In support of this theory is the widespread problem of bush encroachment in the freehold farming areas, which in 1994 was estimated to cost the economy about N$100m a year (Quan *et al*. 1994). This figure is disputable though due to the difficulty of establishing whether land productivity has actually fallen. One recent study concludes that total output has actually risen, and that there is little evidence in terms of actual output to support a claim of severe land degradation (Lange *et al*. 1997). This problem has also been observed in fenced off communal areas such as the Mangetti (DRFN 1998). The country's variability of rainfall means that in practice many freehold farmers mimic pastoralist strategies through movement of cattle to other farms rented, purchased or borrowed from relatives.[9] In addition, some game farmers who have adjacent properties

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[6] The preceding figures are from Fuller *et al.* (1996) for Oshikoto, excluding the area studied more recently by Cox *et al.* (1998).
[7] Interviews with Ben Fuller based on his fieldwork in southern and western Namibia and informal observations of agricultural extension officers in northern Namibia. Also see Fuller and Turner (1995).
[8] Author's observations in northern Namibia.
[9] This tendency has been noted for the 1960s by Sullivan (1996) and for the 1920s by Sylvester (1998). The author has interviewed freehold farmers in the Tsumeb and Maltahohe farming districts who confirm the existence of a rental market for grazing within freehold farming areas. This is also an explanation for

have unified their operations to form larger units, called 'commercial area conservancies.' Declining subsidies for freehold agriculture have meant that farms have diversified into non-traditional activities such as game farming. Around 450 (out of 6000) farms are registered as hunting farms, and in addition significant numbers are guest farms. However, despite the strong incentives for sustainable resource use, bush encroachment is a major problem in the freehold farming areas of the country.

The government now has two pieces of legislation regarding farm size. The Subdivision of Agricultural Land Act of 1970 forbids subdivision of freehold land for agricultural purposes. The Agricultural Land Reform Act of 1995 makes provision for the government to expropriate land where the owner has multiple holdings or 'excessive' amounts of land, under-utilised or abandoned land, or where land is required for resettlement. Hence, farmers cannot buy multiple properties to gain the advantages of mobility which are crucial in such a variable environment. Similarly, communal area residents in areas adjacent to freehold farms will be unable to buy a piece of freehold farm to extend their land due to the subdivision law. Paradoxically, the wide variation in farm sizes, and the lack of a definition of excessive land holdings, means that a farmer with two farms of 5000 hectares is more likely to have land expropriated than a neighbour who has one farm of 20,000 hectares.

In line with a policy to encourage the sale of farmland for resettlement and to discourage under-utilisation, the Agricultural Land Reform Act also made provision for a Land Tax, which will be introduced in the near future. This will be based on the unimproved value of the land, so as to encourage investments in agricultural land, and is expected to trigger sales of large quantities of agricultural land.

3.4   Inland fisheries

About 100,000 people in Namibia are estimated to derive direct or indirect benefits from inland fisheries (Jay 1997) mainly in the north and northeast. The White Paper on inland fisheries favours management by 'subsistence households' at a local level (Van Zyl *et al*. 1998), with oversight by the government to ensure sustainable use. Accompanying legislation is at present being drafted and aims to resolve two local conflicts. First, subsistence fishers will be favoured over large-scale commercial harvesters, allowing more equitable access to the resource. Second, closed seasons will be allowed so that water quality is maintained in seasonal pools for use by livestock.

4   Formal Sector Large-Scale Activities

Namibia's economy as a whole is disproportionately dependent on a small number of large-scale formal activities, which directly and indirectly provide government revenue and lead the rest of the economy. In 1995, minerals, food products and tourism contributed over 90% of export earnings (CSO 1998). These sectors are considered below, with the exception of agriculture which was discussed in Section 3. Formal sector supply of water and land are considered due to their key role in tourism and formal sector economic activity in general, as well as their scale of operation which is non-local.

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the common strategy of owning multiple farms, as shown by ownership figures in Werner *et al*. (1990).

4.1   Mining

In the past mining was the centrepiece of the Namibian economy, producing 41% of GDP in 1980. Due to growth in other sectors this has declined to below 20% during the 1990s (CSO 1998). The main mining areas of the country are in the south and west, where diamonds and uranium are the major contributors. These areas have very low population densities being either arid or hyper-arid or under-the-sea. Hence, the main concern of the government is to maximise government revenues subject to acceptable environmental standards (e.g. EAs). A recent study concluded that on the available evidence the government is being reasonably successful at maximising this revenue (Lange and Motinga 1997). Similarly the use of environmental impact assessments (and follow up activities) generally means that the environmental impacts are acceptable. A recent survey indicated that the cost of environmental assessments in relation to large-scale mining was rarely more than 1% of the project cost.

Small scale miners obviously cannot afford to undertake EAs, hence an alternative system of environmental contracts has been devised. These set down standard conditions designed to protect the environment while still allowing mining to be economically viable. Miners themselves propose the conditions, which set out their plans for implementation. This has meant that miners are able to design a system that satisfies their needs, hence leading to a high degree of compliance (Tarr, personal communication).

4.2   Fishing and marine resources

Fishing and fish processing have risen dramatically in importance since 1990, with the rigorous application of controls on fishing to ensure a sustainable harvesting of fish stocks. The sustainable 'total allowable catch' levels have increased since 1990 in response to this policy, with variations due to climatic conditions. Fish landings increased from 400,000 tonnes in 1990 to 800,000 in 1993, followed by falls during 1994-1996 (due to adverse climatic conditions).[10] The exploitation of fish species such as Orange Roughy and Alfonsino, as well as the processing of fish from outside Namibia meant that the fall in tonnage of around 35% over the period was accompanied by stable earnings from fish products. Contribution of fishing and fish processing to GDP has risen from 3.9% in 1990 to 8.1% in 1995. The fishing industry is labour intensive and provided an estimated 11,000 jobs in 1995, equivalent to about 5% of formal sector employment. Indications in early 1998 were that the long-awaited recovery of fish stocks is underway.

The government has recognised the crucial role of sustainable management from 1990, in the words of former Fisheries Minister Hifikepunye Pohamba, "setting total allowable catches is not so much a matter of balancing conservation against jobs, but rather of balancing jobs now against jobs in the future." The key message of the 1991 White Paper 'Towards Responsible Management of the Fisheries Sector" was that conservative quotas would have to be set in the short term to allow substantial growth in the medium to long term (MFMR 1991). To ensure that decision-making can be effective, the government has invested heavily in marine surveillance and supporting

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[10] This paragraph is based on MFMR (1998).

institutions such as the National Marine Information and Research Centre which researches the population dynamics of commercially important species of fish. The controls on the fishing industry are amongst the most comprehensive in the world (O'Toole 1997). Technical staff of the Ministry makes recommendations to the Fisheries Advisory Council which consists of representatives of government ministries, industry and unions. The FAC then makes a final recommendation to the Minister. The institutional arrangements are further discussed in Section 5.

The present system has one overriding strength, which is that it is oriented to setting catch levels which allow recovery of fish stocks. However, there are several opportunities for improving the system. Most importantly, over-capacity in the industry provides a powerful lobby for interpreting scientific data over-favourably. This has arguably led to catch levels which have inhibited recovery of the pilchard stock. Opening the Sea Fisheries Advisory Council proceedings to public debate would make these differences of opinion much clearer and encourage public debate on how to trade off short-term retention of existing jobs against more jobs in the longer term.

4.3   Water

The policy and legislative framework for the water sector has not changed significantly since the Water Act of 1956, except for the recent commercialisation of bulk water supply. Virtually the only legislation making reference to sustainable water use at present is the Namibian Water Corporation Act of 1997 which requires that water is used sustainably, with exceptions requiring specific Ministerial approval and publication in the Government Gazette. NAMWATER, a government parastatal (responsible for bulk water supply) which began operating in March 1998, aims to put water supply on a commercial footing, and requires that the Corporation does so in a sustainable way. NAMWATER is aiming for full historic cost recovery (both as a policy and within the powers given to it by the Act) within 5 years. It will also have to be financially viable in such a way as to be able to raise money for future investments in water infrastructure. In the past there has been a strong supply orientation which has been reinforced by extensive subsidies. To complicate the switch to a more sustainable system the cost of new water supply options is in the region of N$4-7 per cubic metre (about double the existing costs). Hence, what prices are required for full-cost recovery will depend on the success of demand management. In near future the entire policy framework will change substantially with the instituting of a 'water sector management review' over 18 months from 1998.[11]

Increasing the supply of water in the centre of the country is extremely difficult since most of the existing groundwater sources are close to fully exploited, or in some cases overexploited leading to falls in groundwater levels. The crucial issue concerning overexploitation of groundwater is to what extent this is irreversible. The overexploitation of some aquifers may lead to permanent damage to their storage capacity. At present some aquifers which are being overexploited are substantially subsidised if one takes into account the long-run cost of supply. For instance, Kamanjab residents pay only 23% of the cost of provision of water, which is clearly inappropriate

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[11] For a review of the key issues see Boois (1999).

for an aquifer exhibiting serious groundwater depletion problems. Desalination has not been considered as an economically viable technology outside the coastal region (MAWRD 1993). In addition, the large number of small farm and large-scale dams mean that the potential for capturing water from the ephemeral rivers is limited (Jacobsen *et al*. 1995). Increasing supply often risks ecological damage downstream and will certainly deprive downstream users. Hence, the major supply option considered at present for the central region is the Kavango river (comparisons of the Kavango option to alternatives are discussed in depth in MET 1999a). This will require major investments, which will be paid for through increased cost recovery. However, it is not expected for them to be punitive to any water users except those who are using water for low value irrigated crops. Only two sectors are major users of water: agriculture and households, which make up 75-95% of total water use (author's calculations based on Lange 1997). Within the household sector, the only consumers likely to be able to restrain demand substantially and quickly are high-income consumers, who consume in the range of 5-10% of total water use. At present in Windhoek and several other towns there are 'stepped' water prices which show some recognition that efficiency and equity concerns need to be balanced. Low income urban consumers will probably continue to be protected by a policy of cheap water for a 'lifeline supply' followed by progressive increases as water use increases. Rising water prices and public education have led to static or falling water demand per capita in recent years, only outweighed by the high rate of urban growth.

Water demand is growing due to population growth, urbanisation, and income growth. It is not clear, though, whether the development of the economy will be more or less water intensive than at present. Figures from the Department of Water Affairs show that high income residents use vastly more water than low income residents (MAWRD 1993).

Namibia's northern communal areas which supported almost 60% of the population in 1991 (GRN/NPC 1994) have much more accessible water sources. At present large numbers of people in Caprivi and the Oshanas area have access to low-cost water from water pipelines with communal or private taps, particularly when compared to alternative sources such as boreholes (FG Consult and NEPRU 1997). Although urban centres in northern Namibia are at present small (containing 5% of the total Namibian population compared to 12% in Windhoek alone), decentralisation and a possible second national city, as envisaged in the National Land Policy (MLRR 1998) would ease demands on water in the central region significantly. Peace in Angola, and economic development in Botswana, South Africa, Zambia and Zimbabwe may accelerate urban and industrial growth.

Outside the 'bulk water' supply and use discussed above, most water use is through small installations, mainly for livestock watering. Freehold tenure area livestock farmers overwhelmingly use ephemeral dams and groundwater on their farms, and, hence, pay the full operational cost of water supply. However, they benefit from enormous pre-Independence subsidies that gave substantial (often 100%) subsidies for the development of water supply on freehold farms, which have up to 100,000 boreholes on them (Lange 1997 quotes this from a Department of Water Affairs database, although it is unlikely that more than 40,000 are in use).

Box 1. Communal area water supply.

> Communal area residents benefit from highly-subsidised water supply, again mainly from groundwater. Government policy is now to hand over management of waterpoints to elected committees who will be expected to pay 100% of water supply costs within 10 years. The process of consulting stakeholders on this policy took 16 months and ensured that all stakeholders had significant input. Comments from the regional workshops (MAWRD 1997) indicate that although the policy generally has a high degree of support there are some significant points of dissent. Most obviously these were the connections to the land issue, the time scale for implementation, and the role of traditional leaders in management structures. The implication for water use in the future seems clear though. The policy makes provision for disincentive tariffs to ensure the sustainable use of water and for the monitoring of water use. This policy is still in the first year of operation which is concentrating initially on the establishment and training of committees. The long-run success of this policy is very much dependent on the ability of communities to pay for their water. A study conducted for the Ministry of Agriculture, Water and Rural Development (FG Consult and NEPRU 1997) concluded that (except the communities on pipelines) most communities would not be able to pay on a per-household basis, but would be able to on a livestock-related basis (which is a good proxy for total use since livestock use most of the water provided in rural areas). A key unanswered question at present is whether the livestock-rich members of communities will be willing to pay these charges.

4.4   State land

Land in Namibia actively managed by the state is mainly national parks and game reserves. About 15% of the land area of Namibia is mainly used for tourism. Biodiversity conservation, the most obvious justification for national parks, is rather poorly served by the parks as the Biodiversity Country Study recently showed (Barnard *et al*. 1998), since the hotspots of endemism generally occur in the western escarpments of the country which are almost completely unprotected. Tourism, however, is well promoted by the parks, and management of the accommodation in the parks has recently been handed over to a parastatal, Namibia Wildlife Resorts. This, in turn, will pay rental to the government for the use of the parks. Recent proposals, still at the stage of consultations, have been to entirely revise the framework for protection of land. This will mean that there are a variety of protected areas from 'People's parks' which will give residents of communal areas rights to charge admission fees and other strong land use rights to more traditional protected areas. Even with the more traditional protected areas, neighbouring communities will get more benefits through consultation and allocation of concessions within protected areas.

5   Legislation, Co-ordinating Institutions and Policy

Most issues that government deals with are cross-sectoral, and sustainable development is a particularly clear example. Government has had to deal with several dilemmas in this regard. First, the need to democratise government has frequently conflicted with the views of technocrats in government. As the discussion below reveals, the institutions which promote sustainable development in Namibia vary in how they balance democratic

representation and technical expertise. Second, there has been some debate on how to combine decentralisation and co-ordination. Some government initiatives have decentralised to community or household level, others to regional level, while many are still run from central government. As discussed above this has led to some contradictory initiatives. However, it has also allowed experimentation with different approaches to development. The discussion below tries to consolidate the key issues that need to be addressed.

Most government policies acknowledge that development in a sector usually involves a range of stakeholders, from the private sector and NGOs to the public sector. Hence many institutions have consultative mechanisms to try to incorporate stakeholders in the policy process as well as in the day to day decisions of government. At the national level these institutions are mainly appointed by a Minister from nominations by interest groups. At the lower levels there is a mixture from wholly elected institutions to wholly appointed bodies. In addition, an important feature is the legal framework and the support given to an institution. Institutions which work at the local level are elected and self-financing, are those most likely to be accountable to the communities they serve, but are also limited by lack of resources and technical expertise. These institutions, most obviously Conservancies and Waterpoint Committees, tend to require substantial government and NGO support for training.

5.1   National institutions

There are a number of important bodies for co-ordination and consultation at the national level (Table 1). Although this list is not comprehensive it includes the most important bodies in existence at present.

Table 1. National bodies for co-ordination and sustainable development.

Institution	Central Govern-ment	NGO and Farmer's Unions	Private sector/ parastatal	Other members	Functions
Namibian Planning Advisory Board	6		1	1	Advise Cabinet and local authorities on town planning
Standing Committee for Mining and Mineral Rights	4				Recommendations on mining and prospecting
Sea Fisheries Advisory Council	7	0		9	Advice to Minister of MFMR
Sustainable Development Commission	9	3	2	4	See above
Council of traditional leaders				All	Advice to the President on control and use of communal land
Land Reform Advisory Commission	5	2		5	Advice to the Minister of MLRR
Forestry Council	5	3		5	Advice to the Minister of MET

The public accessibility of these bodies varies. The Land Reform Advisory Commission was established under the 1995 Commercial Land Reform Act, which includes a presumption against public access to information on its proceedings. The Sea Fisheries Advisory Council and the Council of Traditional Leaders have neither a presumption for or against public access in the legislation. By contrast the envisaged Sustainable Development Commission is required to make its proceedings and decisions accessible to the public.

The procedure for appointment is similarly variable: some give discretion to the relevant Minister as to which organisations to approach for nominations (e.g. for the Forestry Council), while others prescribe that the particular organisation nominate its representatives (e.g. for the Sustainable Development Commission).

5.1.1 The sustainable development commission

The most wide-ranging institution is the Sustainable Development Commission as proposed in the forthcoming Environmental Management Act. The SDC will consist of nine government representatives from various government ministries, two private sector representatives, one trade-union representative, one town or regional planner, three NGO representatives, and two members on the basis of expertise. As with many other stakeholder-based institutions, the purpose of the SDC is to promote integration of different government policies and objectives and evaluate proposals at the strategic and project level (see Table 2). The wide range of stakeholders is expected to promote 'buy-in' of the principles of sustainable development.

Table 2. Selected functions of the Sustainable Development Commission. Source: MET (1999b).

• Promoting co-ordination amongst stakeholders
• Reviewing sustainable development strategies
• Reviewing environmental assessment reports
• Investigating complaints regarding Namibia's environment and making referrals to appropriate agencies such as the Ombudsman or Prosecutor General
• Reviewing policies, programmes and legislation of the government

At the policy level, the SDC will review government policy formation to ensure that it incorporates principles of sustainable development. These include public participation in policy processes, inter-generational equity, sustainable use of natural resources and public access to information. Since a wide range of stakeholders will be represented on the SDC it is hoped that it will be effective through encouraging a culture of participation in government. In addition, the publication of its recommendations, combined with the principles of environmental management which are enshrined in the Act, mean that non-governmental organisations will be able to challenge policy-making in the courts. The role

of the SDC in these processes will be to oversee, and should enable more efficient policy-making by incorporating concerns of sustainable development early in the policy formulation process. Due to a lack of enforcement powers on its recommendations, a series of checks and balances are proposed. In addition to the 'Strategic Environmental Assessment' route there will also be a more traditional way of dealing with project environmental issues. This will involve EAs for projects, which will have significant impacts.

5.1.2 The sea fisheries advisory council

The Sea Fisheries Advisory Council provides recommendations to the Minister of Fisheries and Marine Resources on a variety of issues. The most important of these is setting 'total allowable catch' levels for various species. The Council includes government officials and independent outsiders, as well as representatives of the employees of the fishing industry. This enables it to try to balance short-term concerns of preserving existing jobs with longer-term concerns of rebuilding fish stocks to their previous levels. There has been some controversy in recent years over whether the decisions taken over fishing levels (especially of the pilchard stocks) have been overoptimistic (Namibian Evolutionary Ecology Group 1996; Manning 1998) and short term. In 1995 and 1996, the assessment of MFMR scientists was more conservative than the assessment of scientists hired by the industry. The middle way was taken by allocating a TAC that lay between the two recommendations. There has been a consistent effort by the MFMR to increase dialogue with industry, so as to improve the quality of decision-making and promote ownership of fishing policies by the industry (Van Zyl *et al*. 1998). Public debate on decisions is at present limited due to limited access to information, including recommendations of MFMR scientists and the Sea Fisheries Advisory Council.

5.1.3 Council of traditional leaders

There is some disagreement over how the present powers of traditional leaders compare with their 'traditional' powers – although the leaders themselves stress how they are weak compared with their previous powers. Other commentators though have stressed that they may be stronger now than in the past (Werner 1997). Traditional leaders have a vital role in providing an institution which operates from the national level through the Council of Traditional Leaders down to the village level. At the national level they have a constitutionally-defined role to advise the President on the 'control and utilisation of communal land.' The Council was legislated for in 1997, and its membership is based on traditional authorities which are recognised by the Ministry of Regional and Local Government and Housing. The first meeting was only held in 1998 so its role in practice is not yet clear. Two issues are important in terms of the Council. First, the Council has a right to comment on draft legislation relating to communal land. Second, it provides another route by which information can be communicated from government to the population of the communal areas. Informal agreements with traditional leaders since 1990 have already made some progress in reducing discriminatory practices against women in communal areas. For instance, the Uukwambi traditional authority has had a specific programme to involve women in traditional courts and other traditional authority structures (Becker 1998). However, while this is not dealt with by law progress will remain very dependent on particular traditional leaders who vigorously promote change.

5.1.4 The forestry commission

The Forestry Commission will advise the Minister of Environment and Tourism on forest policy generally and on the National Forestry Policy in particular. The Minister will have to make yearly reports on the progress in implementing the National Forest Policy, which will have as its main aim the protection of soil and water resources, the maintenance of biological diversity and maximising the sustainable off-take from forests.

5.1.5 Land reform advisory commission

The Land Reform Advisory Commission was established by the Agricultural Commercial Land Reform Act of 1995. Its functions are to advise the Minister of Lands, Resettlement and Rehabilitation on land reform-related issues, and to conduct investigations on issues relating to land reform. The advice it must give includes how to define under-utilised land, excessive prices for land, the rights of farm workers and their families on expropriated land, recommending the future uses of land that is purchased by the government, and making recommendations on who can be resettled on such land and what they can do. Proceedings and recommendations can only be made public with the specific permission of the Minister, and, hence, very little is actually known about how the LRAC operates.

5.2   Regional and local institutions

As noted in Section 3 many environmental issues occur primarily at a local level, and are most appropriately dealt with at that level. Regional-level institutions operate in three distinct ways. Some are entirely dealt with through the Regional Council or municipalities, hence they have a strong representation from the affected communities. Others have the Governor chairing a largely technical committee. Finally, some operate at a regional level, and are entirely staffed by non-elected people with the Regional Officer (the top civil servant in a Regional Council) of the Regional Council attending to allow for some co-ordination.

As can be seen in Table 3 there are wide ranges of approaches to management at the local and regional level. In many cases this does not matter too much since the same people are represented on many of these committees and so will informally co-ordinate activities. In areas where communities have conflicting opinions on these issues there could be more serious problems where different institutions are controlled by different groups. For example, a Central Water Committee could plan for extra waterpoints in an area that a land use plan drawn up by a Land Use and Environmental Board had decided should stay free of waterpoints. One possible way of overcoming these problems has been the Forum for Integrated Resource Management, which has a pilot project in the Khoadi Hôas conservancy in Kunene. There the Grootberg Farmer's Association has used its strong community base to form a conservancy. The Ministry of Environment and Tourism and the Ministry of Agriculture, Water and Rural Development have agreed to ensure that their staff operates to the requirements of the conservancy. This is unusual because staff of line ministries usually report to either the head office in Windhoek or to Regional Councils.

The shortcomings due to duplication and uncoordinated activities are balanced by some advantages. The individual approaches are providing alternative models for resource

management in communal areas, and are stimulating discussion on which approaches are most appropriate. When an institution works well it will naturally expand into other areas. The Sustainable Animal and Range Development Programme of the MAWRD has found that farmers' unions, once they gain experience and legitimacy, naturally become the contact point for development in an area.

Table 3. Regional and local institutions for resource management.

Institution	Level of responsibility	Membership	Powers
RLBs	Regional	Appointees	Land allocation
Wildlife Councils	Regional	Governor and appointees	Wildlife and tourism management
Inland fisheries advisory board	Regional	Governor and appointees	Inland fisheries management
Regional Land Use and Environmental Boards	Regional	To be finalised	Land use planning and natural resource management
Regional Councils	Regional	Elected	General planning in rural areas
Community forest management body	Smaller than a region	A body representative of the community	Management of natural resources in a forest
Conservancies	Community	Elected	Wildlife and tourism management
Waterpoint committees	Community	Elected	Waterpoint management
Central Water Committee	Region	As on local committees plus traditional leaders	Representing the region on water issues
Community forest reserves	Community	Elected	Forest management
Traditional authorities	Varies	Customary law and elections ratified by Minister of Regional and Local Government and Housing	'Customary grant' land allocation, and advisory powers

6   Conclusions

Namibia's progress in integrating development and the environment has been impressive given the circumstances encountered in 1990. Most of the necessary institutions for sustainable development are now in place. The Sustainable Development

Commission will provide general oversight, and sectoral institutions (such as the Sea Fisheries Advisory Council) bring together stakeholders at a more sectoral level. Democratisation of natural resources has proceeded well, with some obvious exceptions. The major challenges that remain are to improve the ability of these institutions to support development in Namibia, and clarity on Namibia's vision for sustainable development. Within this context it is also necessary to identify the indicators of sustainable human development. In some circumstances this will mean encouraging more public debate and providing information to the public. There is also a need for improved policy analysis for public debate. At present there is a rapidly developing debate of 'traditional' economic policies, led by institutions such as NEPRU, the Namibia Economic Working Group, the Committee on Economics of the National Assembly, UNDP and the University of Namibia. Widening this debate to a broader range of issues must be pursued by those working in the field of sustainable development. Improving co-operation between institutions is vital since many development and policy issues can only be initiated by government departments.

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EDUCATION IN NAMIBIA

Riikka Shemeikka

Abstract

During the colonial period, an unequal system of education was established in Namibia. The majority of the Namibians suffered for lack of qualified teachers, learning materials and school buildings. In addition, there were differences in curriculum between the population sections. Weaknesses in the education system resulted in high drop-out and repetition rates, and a relatively high proportion of the population had no formal schooling. Since independence, the number of schools, pupils, teachers, and the proportion of professionally qualified teachers have increased. The share of public expenditure on education from government spending has increased, as well as education expenditure per capita. Progress has been made in the educational levels of the population and the quality of education. There are, however, still large regional differences in education. These problems are largely a legacy of the long colonial period, and are not quickly or easily rectified.

1   Introduction

Educational services in Namibia were started by missionaries in the southern part of the country in 1805. The London and Wesleyan Missionary Societies began their work with the Nama, Damara and Herero people; the Rhenish Mission followed. In the northern part of the country, the Finnish Missionary Society built up the basis of the educational system during the 1920s and 1930s for the Ovambo-speaking groups. During the first three decades of the last century, Catholic and Adventist Missions started their work in the Kavango, Caprivi and Kaokoveld regions.

During the colonial period, an unequal system of education was introduced in Namibia. During German colonial time (1884-1915) some educational services were organised by government authorities, but they were only for the white settlers' children. Education of the majority of Namibians was left to the missionaries. South African rule started in 1915, and during the 1920s all educational services were placed under the control of the state. Mission schools, however, continued to be the major providers for educational services among the majority of Namibians. Until 1960, all of the schools in the populous northern areas were run by missions; in 1962 over half of the schools there were still mission schools. The South African government had a policy of segregated education, working along the lines of apartheid. The population was divided into three groups: "natives," "coloureds and basters," and "whites." The curriculum and educational system for the majority, classified as "natives," were different from those

meant for the other two groups (Notkola and Siiskonen 2000; Odendaal Commission 1964).

During colonial times, public spending on education varied greatly between regions and population sections. This resulted in differences in learning and teaching materials, school buildings, the proportion of qualified teachers and the amount of pupils per teacher. The weaknesses in the education system resulted in high drop-out and repetition rates. In addition, the proportion of the population without any formal schooling was relatively high.

At independence, free primary education was established in the Constitution. Education is now compulsory until completion of primary school or reaching the age of 16. The education system consists of seven years of primary school, three years of junior secondary school, and two years of senior secondary school. Technical and vocational training possibilities are also available, as well as teacher education colleges, the Polytechnic of Namibia and colleges of agriculture. University-level education is provided by the University of Namibia. Adult and continuing education facilities are also available, including, e.g., literacy courses. (GRN/NPC 1995.)

Public expenditure for education was 31% of the government spending in 1998. The number of pupils, teachers, and schools has increased since independence. One important goal of the education policy is universal access to primary education and a high completion rate of primary schooling. In addition to increasing the enrolment rates, emphasis has been put on increasing the quality and efficiency of education. There are, however, still regional inequalities in the educational system, largely as a legacy of apartheid policy in colonial times (UNDP 1999; GRN/NPC 1995).

2   Level of Education

The most detailed information on educational levels of the population is available in the *1991 Population and Housing Census* (GRN/NPC 1994a). This gives the state of education in Namibia shortly after independence. More recent data will be available when the results of 1996 Demographic Sample Survey (GRN/NPC 2000) are published. The government also annually publishes up-to-date information on the number of pupils, teachers, schools, and government spending on education.

Information on literacy in 1991 is based on the census question "can you read and write in any language with understanding" without proof that the respondent has any real skills. This tends to produce overly high literacy rates, which should be taken into account while using the census data. According to the 1991 census, 76% of the population aged 15 and above was literate; the literacy rate was 90% among urban and 71% among rural population (GRN/NPC 1994a). Another means of estimating literacy is to use the proportion of population who has completed grade 4 in primary school. Measured this way, the literacy rate would have been 62% in 1991. Five years later, in 1996, the adult literacy rate was reported to be 81% (UNDP 1999).

The proportion of population who have never attended school was 23% for the population aged 6 and over, and 26% for those aged 15 and above in 1991(GRN/NPC 1994a). There were remarkable differences between rural and urban areas: 27% of the rural and 11% of the urban population had never attended school. For those aged 6 and over, 37% were attending school in 1991 (19% for ages 15 and above); 40% of those

aged 6 and over had left school (55% for ages 15 years and above). In 1996, the proportion of population who never attended school was below 20% of those aged 6 and above (UNDP 1999).

The differences between age groups are, naturally, significant in the educational categories "no schooling," "currently attending school" and "left school." In 1991, the proportion of those who never attended school was the smallest among the 10-14 year olds, i.e., 9%, and increased fast among the adult population, 66% for those aged 65 and older. The proportion currently attending school was high for 6-19 year olds in 1991. It was the largest, i.e., 91% among the 10-14 year olds. School attendance is still relatively common among people in their early 20s; 25% of those aged 20-24 were attending school in 1991 (GRN/NPC 1994a).

By 1991 55% of the population aged 15 and above had ended their schooling. 20% had left school with some primary education (less than completed), 7% had completed primary school (i.e. completed grade 6), 21% left school with some secondary education (less than completed), 4% after completing secondary school (i.e. grade 12), and 3% left school with tertiary education (GRN/NPC 1994a).

Public expenditure on education increased from 26.7% to 30.8% of government spending between 1991 and 1998. In the same time period, education expenditure per capita increased from N$ 417 to N$ 470 (in 1990 Namibian dollars) (UNDP 1999).

Between 1989 and 1998, the number of teachers increased by 29% and the majority of new teachers were professionally qualified. The proportion of qualified teachers increased from 66.5% in 1992 to 79.3% in 1998. The teacher/pupil ratio has stayed about the same, however, 1:28.9 in 1990 and 1:29.1 in 1998. The number of schools has increased by 23.4% since independence. In 1998, it was 1,489 (UNDP 1999).

The number of pupils in primary school increased by 23% and those in secondary school by 77.7% between 1990 and 1998. Altogether there were about 500,000 pupils in primary and secondary schools in 1998. Between 1994 and 1998, net primary school enrolment increased slightly, from 92.6% to 93.4%; the net secondary enrolment increased from 31.9% to 37.8%. The promotion from junior secondary to senior secondary school increased from 40.3% to 46.8% between 1991 and 1997. Tertiary education increased quickly during the first years after independence, more current information is unfortunately missing. University enrolment increased by 1,000 students between 1991 and 1994, as did non-university tertiary education (UNDP 1999; GRN/NPC 1995).

Figure 1 presents the population of Namibia by age, sex and educational attainment in 1991. The population is divided into four educational groups. "Pre-school or attending school" consists of those who are currently attending school, including all levels of education, i.e., primary, secondary and tertiary education. It also includes all 0-5 year old children (pre-school). "No schooling" presents those with no formal education; children too young to go to school (ages 0-5 years) are included in the category "pre-school or attending school" as mentioned above. "Left school with primary education" presents all who have ended their schooling with primary education. It includes both those who have completed primary school and those who have left before finishing primary school. "Left school with secondary or higher education" presents those who have left school with secondary or higher education, including those with only partly completed secondary school.
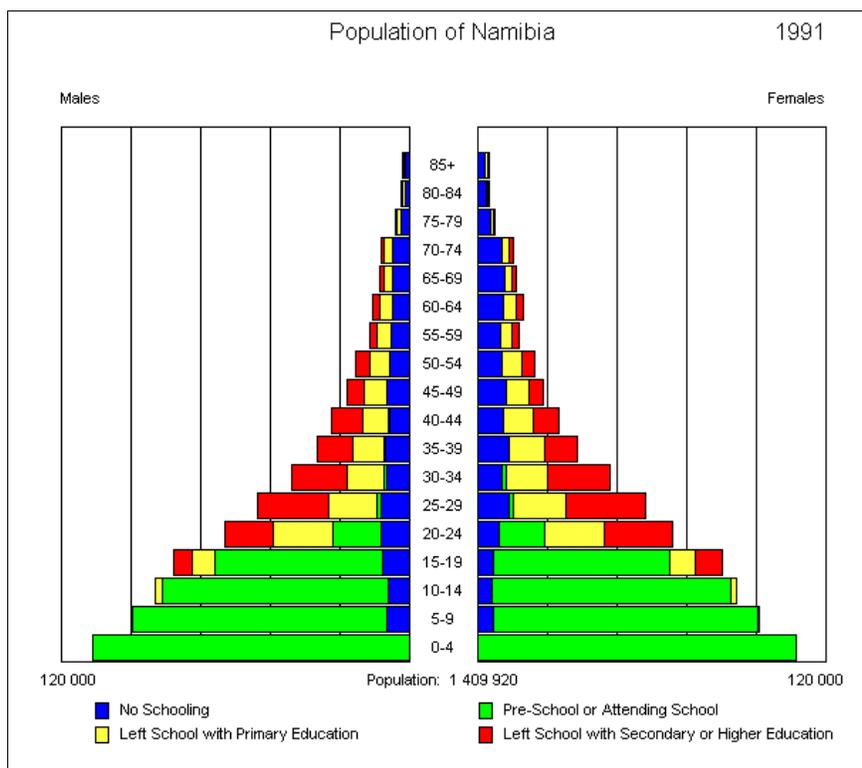
Figure 1. Population of Namibia by education in 1991. Source: GRN/NPC (1994b).

3   Gender Differences in Education

Gender differences in education are relatively small in Namibia. By 1991, 23% of females and 22% of males had never attended school. In urban areas, the proportion was slightly higher among females than males; in rural areas it was just the opposite (GRN/NPC 1994a). In 1996, the proportion of those without any formal education was below 20% among both males and females (UNDP 1999).

Comparison of the age groups in 1991 shows that in the young age groups, females had a smaller proportion with no formal education and a higher proportion currently at school than males. The proportion with no schooling was larger among males than females until ages 25-34. Among the population over 35, males more often had at least some formal education than females. Compared by single years of age, the proportion currently in school was the highest at age 11 for both girls and boys, 94% and 90%, respectively. Females had higher current school attendance until 18 years of age, and males thereafter (GRN/NPC 1994a).

Among the population aged 15 and older who left school, gender differences were relatively small by 1991: 28% of males and 27% of females left school with some primary education; 24% of males and 25% of females left school with some secondary education. The proportion with tertiary education was slightly higher for males than females: 3.5% and 2.7%, respectively. University education was more common among males than females: 1.3% and 0.8%, respectively (GRN/NPC 1994a).

The literacy rate for males was 78% and for females 76% by 1991. The literacy rate for females was higher than for males until age group 25-29; thereafter males have a higher literacy rate than females. The difference between genders increased with age. The lowest literacy rate was among rural females aged 65 and above, 25%. Women are active in adult literacy training; almost 80% of 30,000 pupils in the National Literacy Programme in 1993 were females (GRN/NPC 1994a, 1995).

Since independence, the proportion of males and females in primary and secondary school has become more equal. In 1990, 52% of the pupils in primary school and 56% in secondary school were females. In 1998, the proportion of females in primary school was 50.1% and 52.7% in secondary school. Women are active in adult education and in education meant for out-of-school youth. Of those completing secondary education in the Namibian College of Open Learning in 1994, 72% were women (UNDP 1999; GRN/NPC 1995).

4 Educational Differences Between Language Groups

Educational attainment varies between the language groups. Language was determined in the *1991 Population and Housing Census* by asking which language was spoken at home. Especially the San-speaking population had a very large proportion with no education: 79% of those aged 15-24. The national average among this age group was 11%. Above the national average were also the Otjiherero, Nama/Damara and Rukavango, but the proportion with no schooling was well below 20% among the 15-24 year olds in these language groups. Below the national average was the proportion of 15-24 year olds with no formal education among the Tswana, Oshiwambo and Caprivi speaking population. Among those speaking English, German and Afrikaans it was almost negligible (GRN/NPC 1994a).

Among the San-speaking population aged 15 and above, almost 90% of those who left school had only primary education, while almost all of the English or German speakers had secondary or tertiary education. Proportions among other language groups varies; e.g., among Oshiwambo speakers who left school, over 60% had only primary education. An interesting detail is the concentration of tertiary education in some language groups: e.g., 64% of all who finished tertiary education belonged to the English, German and Afrikaans speaking population, while their share of the total population was only 13% (GRN/NPC 1994a).

5 Regional Differences in Education

There are major educational differences between regions and language groups in Namibia. A large part of this is due to the colonial history of the country. During the South African colonial period, until the year 1960, educational services of the so-called "northern sector" of the country relied on mission schools. These were gradually converted into community schools, starting in 1960. In 1962, 48% of the schools of the northern sector were still mission schools, while the rest were government or community schools. Along the lines of apartheid, the population was divided into three groups: "natives," "coloureds and basters," and "whites." In the southern sector, 78% of the schools for "natives" were mission schools. Altogether, 57% of the schools for "natives" were mission schools and under the control of church authorities and

missionary societies. Mission schools were run by, e.g., Rhenish Missionary Society, Finnish Missionary Society, Roman Catholic Mission, and Anglican Church Mission. Of the schools for "coloureds and basters," 89% were mission schools, while the rest were government schools in 1962 (Odendaal Commission 1964).

For "whites," state educational services were established by 1920, with a provision for private schools. The establishment of primary, secondary and high school education, and the introduction of compulsory school attendance for "whites" happened in 1921. The report of the Odendaal Commission states:

> In the case of Whites, Basters and Coloureds who have a well-developed educational tradition and who have moreover grown up in a reasonably developed environment, the level of education can be expected to be higher. In the case of the indigenous language groups, amongst whom a tradition of education has only recently begun to develop, an attempt must be made to promote literacy and general knowledge amongst the broad masses" (Odendaal Commission 1964:para. 969).

This approach resulted in a dual educational system. The curricula and syllabi in schools for "coloureds and basters" were the same as for "whites." Schools for the indigenous language groups should follow the curriculum of schools in South Africa, and pupils made examinations for the Department of Bantu Education in South Africa (Odendaal Commission 1964).

Differences in resource allocation between the regions and population sections resulted in differences in the teacher/pupil ratio: in 1962 for "whites" it was around 1:24, for "coloureds" 1:31, and for "natives" in the northern parts of the country 1:40 (Odendaal Commission 1964). In present day Namibia, there are still regional differences in education. The teacher/pupil ratio is between 1:30 and 1:40 in most of the northern regions, and a little over 1:20 in most of the other regions. The highest ratio is in Ohangwena, 1:45, and the lowest of 1:21 in both Karas and Hardap (Friedrich Ebert Stiftung 1997).

In addition, there are regional differences in teacher qualification. In 1993, 67% of the teachers were qualified on average. The lowest proportion of qualified teachers was in the Rundu region in northern Namibia, 44%. Above the national average were the proportions in the Windhoek educational region, 84%, and in the Katima Mulilo educational region in northern Namibia, 70% (GRN/NPC 1995).

The unit cost of pupils varies between regions. For instance, in 1993 a pupil in primary school in Windhoek cost 2.5 times as much per year as in Ondangwa in northern Namibia. Some reasons for the differences are the smaller teacher/pupil ratio, the larger proportion of qualified teachers with higher salaries, and a higher rate of hostel accommodation in southern regions (GRN/NPC 1995).

Educational levels differ as well between regions. In 1991, the proportion of those who never attended school among the population aged 15 and above was the highest in Kunene and Omaheke regions, i.e., 49% and 46%, respectively. It was the lowest in the Karas and Khomas regions, i.e., 12% and 13%, respectively. In other regions it varied from 17% to 35%. In 1996, the proportion of those with no education was still the highest in the same regions. It was above 30% in Omaheke and below 30% in Kunene and Otjozondjupa regions. It was the lowest in Khomas, Oshana, Karas and Erongo, around 10% (UNDP 1999; GRN/NPC 1994a) (see Figure 2).
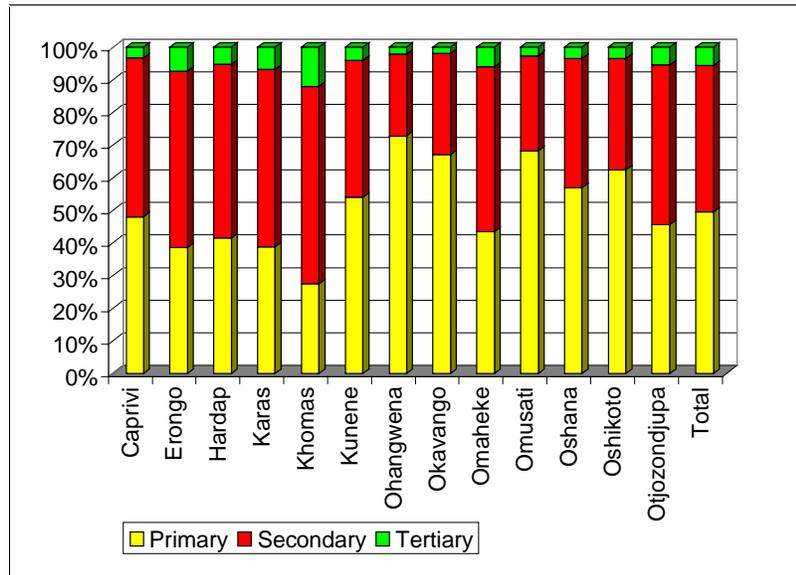
Figure 2. Proportion of population with no education among ages 6 and above in 1991, in %. Source: GRN/NPC (1994a).

Among the population aged 15 and above who left school, the proportion of those with secondary education in 1991 was the highest in the Khomas and Karas regions, 46% and 43%, respectively. The lowest proportion of those with secondary education was in the Ohangwena and Omusati regions, 10% and 13%, respectively. The proportion of those who left school with tertiary education was the highest in the Khomas, Karas and Erongo regions, 9.0%, 5.3% and 5.2%, respectively (see Figure 3).

Figure 3. Population aged 15 and above, who left school by 1991 by highest educational attainment and by region, in %. Source: GRN/NPC (1994a).

The literacy rate varied from 91% in the Khomas region to 51% in the Kunene region in 1991. In Erongo, Karas and Oshana regions, it was above 80%, and almost 80% in Hardap, Omusati and Oshikoto regions. The second lowest was in Omaheke region, 57% (see Figure 4).
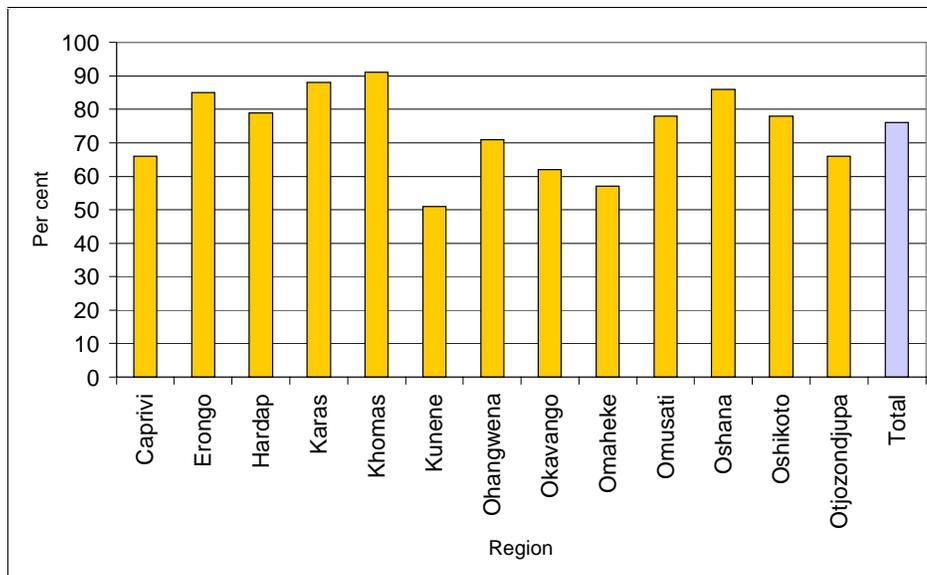

Figure 4. Literate population aged 15 and above by region in 1991, in %. Source: GRN/NPC (1994a).

For the purpose of the IIASA research project "Evaluating the alternative paths for sustainable development in Botswana, Namibia and Mozambique," these three countries were each divided into socio-economic regions. Divisions were made by expert groups consisting of researchers and other experts in the fields of population, economy and environment in these three countries. Namibia was divided into three regions. SER A consists of densely populated northern regions, i.e., administrative regions of Caprivi, Kavango, Ohangwena, Omusati, Oshana and Oshikoto. Most of the other administrative regions are found in SER B. The administrative region of Khomas forms SER C. Figure 5 shows the populations of these three SERs divided by age, sex and educational groups.
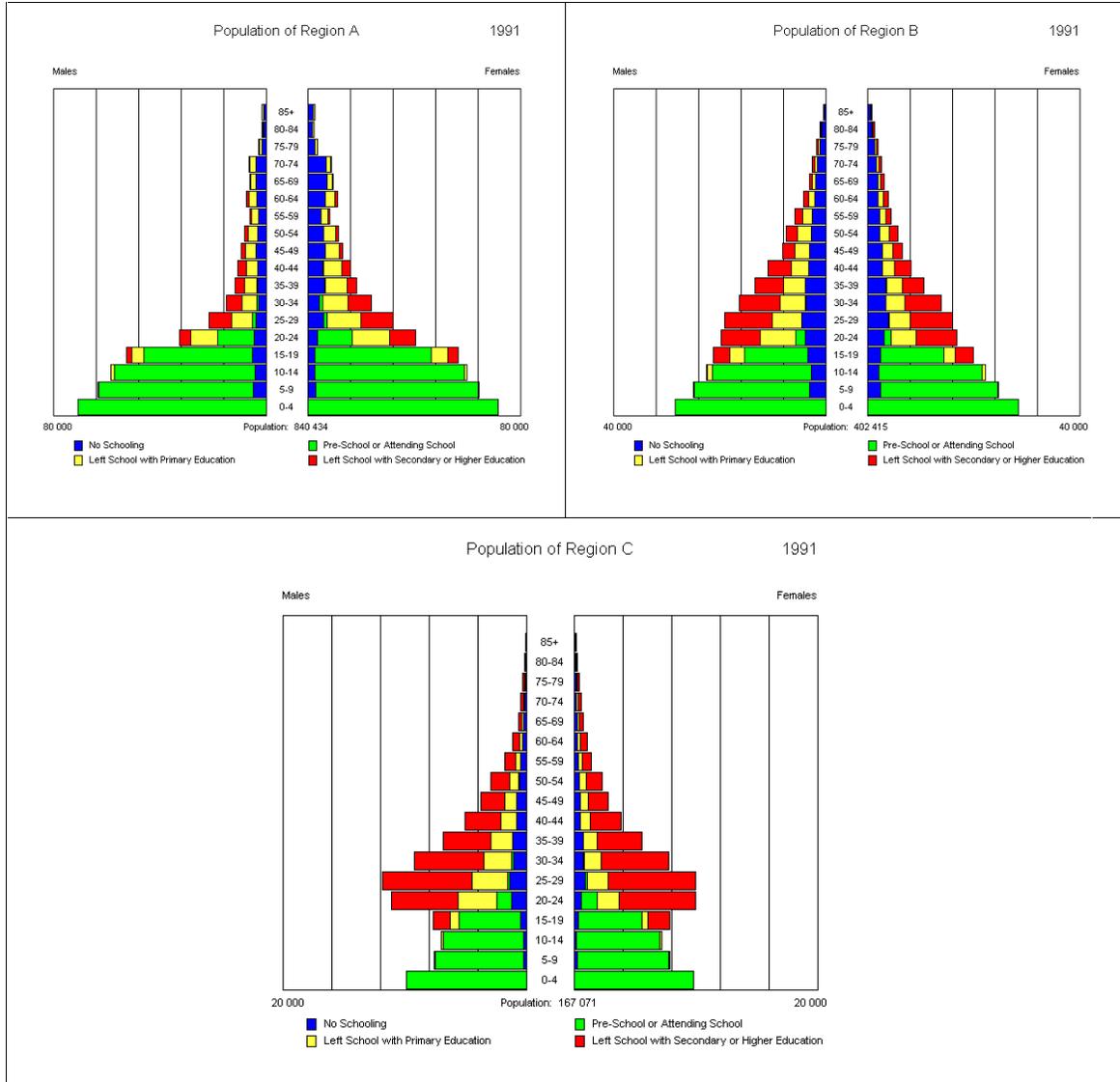

Figure 5. Population of the three socio-economic regions of Namibia by age, sex and education in 1991. Source: GRN/NPC (1994b). Please note that the pyramids are presented in different scales, due to the large differences in population sizes.

6   Conclusions

There are many challenges in developing the educational sector in Namibia. After the colonial period, the new government inherited an educational system with major inequalities in resource allocation between population sections. Due to the lack of resources in schools that were meant for the majority of the population, the colonial educational system had a relatively high proportion of unqualified teachers, high teacher/pupil ratio, absence of teaching and learning materials, and unsatisfactory physical facilities. This resulted in a relatively high proportion of the population with no formal education, high repetition levels and a high level of school drop-outs. At the time of independence, there were large regional differences in education. These problems were attacked by the national development policy.

In the First National Development Plan for the years 1995-2000 (GRN/NPC 1995), the initial goal of the educational policy is to provide universal primary education. Later, this goal will be extended to junior secondary education. Adult and continuing education services are available for those not in school. The five major goals of educational development are: (i) equitable access; (ii) improvement of internal efficiency; (iii) quality; (iv) life-long education; and (v) demographic participation (GRN/NPC 1995).

In order to provide equitable access to schooling and its benefits, affirmative action is needed to reduce the inequalities of the past. Improving internal efficiency includes actions for reducing grade repetition rates, reducing teacher/pupil ratio where it is high, and raising the quality of education outcomes. Improving the quality means ensuring that teachers are well prepared, taking a pupil-centred approach, developing better textbooks and instructional materials, and improving physical facilities. Life-long learning fulfils the needs of those who lack appropriate education. Democratic participation is also important: in order to teach about democracy, teachers and the whole educational system have to practice democracy (GRN/NPC 1995).

NDP1 sets some numerical target outcomes for the education and training sector. They include increasing the adult literacy rate to 80%, increasing the net enrolment of 6-15 year olds to 94%, and increasing secondary enrolment by 40%. They also include increasing tertiary enrolment to at least 11,000, increasing the number of students in vocational training institutions by 60%, increasing the progression rates between primary and secondary school to 75%, and at least maintaining progression rates between junior and senior secondary school at 45%. All of these target outcomes should be reached by the year 2000 (GRN/NPC 1995). Taking into account the progress made during the 1990s, there seems to be a good chance that the majority of these numerical target outcomes will be achieved during the first planning period.

Physical targets of the sector include building schools and educational centres in different regions. Institutional and policy targets include reducing disparities in the primary level teacher/pupil ratio so that the ratio in the worst region is no more than 50% greater than the ratio in the best region; delineating institutional responsibilities between educational authorities and ministries; and establishing a teacher service commission. Financial targets are to reduce the inequalities in primary educational expenditure per capita across the country and to consider options for cost recovery by 1997. The legislative target is to introduce a new Education Bill early in the plan period (GRN/NPC 1995).

Undoing the colonial legacy by reducing the large regional differences in education is one of the major challenges of the government. Progress has been made since independence, e.g., the number of pupils has substantially increased in every level of education, likewise the number of schools and qualified teachers. Developing the educational system is, however, a difficult and costly task, and despite the progress already achieved, much is still to be done.

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ALTERNATIVE PATHS OF ECONOMIC DEVELOPMENT IN NAMIBIA

Dirk Hansohm

Abstract

Namibia has a rich resource endowment and a high per capita income. However, poverty and inequality are top world wide. This presents a formidable challenge to policy-makers. The Namibian government addresses them through its First National Development Plan (GRN/NPC 1995). While its priorities – growth, employment, overcoming of poverty and inequality – are adequate, they do not address fully the real choices, and there is a lively and controversial discussion within Namibia on these.

This paper gives an overview of economic development in Namibia since independence. The situation in 1990 is compared with the present state. On this basis three central choices for development are discussed: the degree of international integration versus higher emphasis on 'self-sufficiency,' the role of the public versus private sectors, and the scope for rural versus urban development. Each section sets out the theoretical discussion on these choices, recaps the Namibian situation and discussion, and provides conclusions for a Namibian balance between the choices. The conclusion draws together the results of the three sections and comes up with arguments concerning the three issues relevant for a strategy of sustainable development in Namibia.

1   Introduction: Options of Economic Development in Namibia

Namibia is a country with a rich resource endowment and a high per capita income, but also very high poverty and inequality. The central challenge of policy-makers is to transform the country from a state both of poverty/inequality and of dependence on exports of raw materials, to one of higher widespread welfare and a diversified economy.

The Namibian government has set itself four central development objectives:

- reviving and sustaining economic growth;
- creating employment;
- reducing inequalities;
- eradicating poverty.

It is recognised that achieving growth is a central (though not sufficient) condition to achieve the other three objectives. The current First National Development Plan (GRN/NPC 1995) aims at achieving an average growth rate of GDP of 5% per year.

While many observers have criticised this objective as being too ambitious and unrealistic, it can be argued that such a growth rate is both necessary in order to attain significant progress on the other objectives and also possible – in light of the low economic base Namibia starts off with – on the condition that appropriate policies are implemented.

Which are the strategic choices to be made to achieve the development objectives? In the process of developing an energy policy for Namibia, a group of around 40 key Namibian decision-makers representing the spectrum of the Namibian society were brought together in a series of workshops to think about Namibia's future. Because investments in energy have a long-term character, the range of possible developments over the next decades has to be known. The exercise came up with four scenarios of Namibia's development over the next 30 years (see Figure 1). These scenarios present what is believed to be reasonably possible (rather than what the decision-makers would like the future to look like), without attaching any degree of probability on any of the scenarios. Neither are changes in developments over time discussed. This is a useful abstraction in order to highlight features of the choices. However, in reality, at least some of the scenarios do not seem to be sustainable over a longer period.
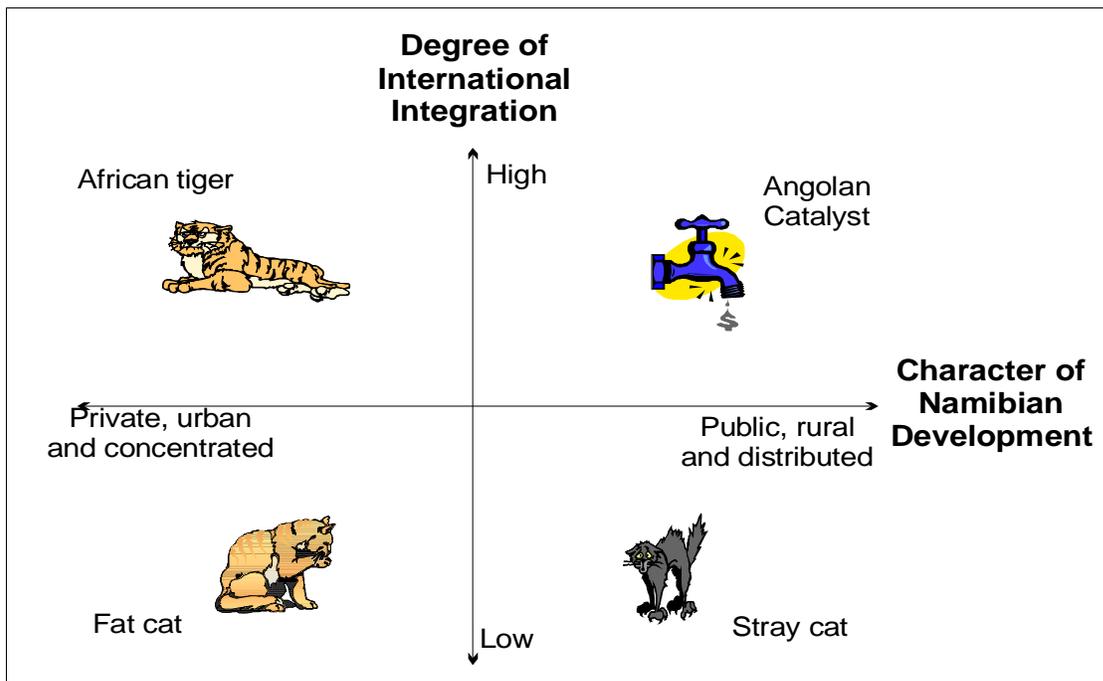

Figure 1. Scenarios of Namibian development.

The key differences between the scenarios are in three dimensions:

- whether they are primarily driven by the private or the public sector;
- developments implying concentration on urban areas as well as in terms of income versus developments, giving more attention to the rural areas and more equal income distribution;
- their degree of international and regional integration.

The first two dimensions move in parallel, i.e. those scenarios implying higher concentration were private driven and vice versa. Thus, these can be shown in one dimension (horizontal), while the third dimension is shown in the vertical axis.

The three dimensions reflect crucial choices discussed in the Namibian society. This paper does not go into the discussion of the political economy of the four scenarios. Rather, these serve to illustrate the point that Namibia's future is quite open. The process of scenario-thinking also showed a high degree of uncertainty among policy-makers about the cost and benefits as well as sustainability of different paths.

This paper aims to contribute some thoughts based on international experiences to inform this discussion. Before discussing the three choices, the next section provides an overview of Namibian development since independence.

2 The Record of Economic Development of Independent Namibia

At independence, Namibia started off with incomes much higher than the average sub-Saharan African country (four times as high in 1994), but with an entrenched extreme inequality and poverty. Further important characteristics were the dependence on resource exports (minerals, beef, fish), and an extreme high economic integration with South Africa.

What has been achieved since independence in 1990? As Figure 2 shows, compared both to its past (the pre-independence decade) and the SSA average, Namibia's record is impressive. However, in terms of per capita growth (which is the variable we have to look at), we see that what has been achieved in economic growth has been cancelled out by population growth of the same rate (see Figure 3). In other words, there has been no improvement of welfare in real terms.
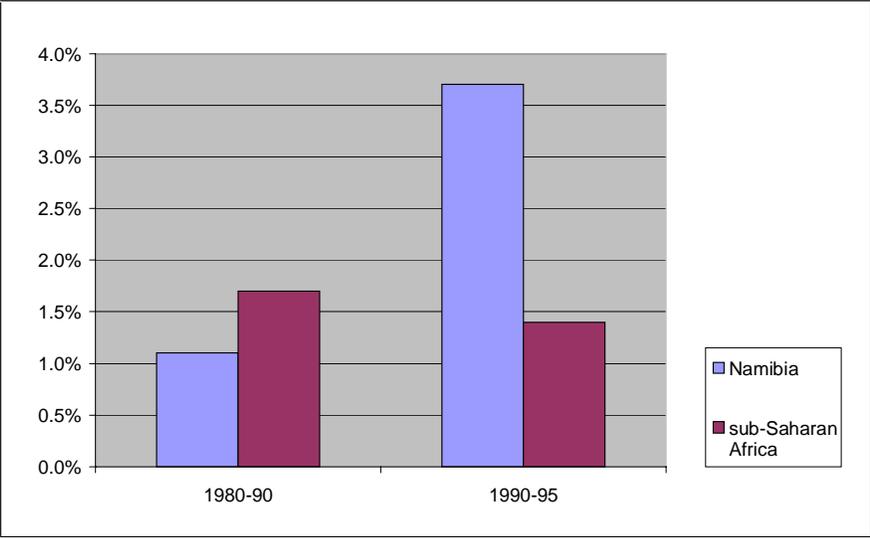

Figure 2. Average annual growth rates in Namibia and sub-Saharan Africa, 1980-1990 and 1990-1995. Source: World Bank (1997).
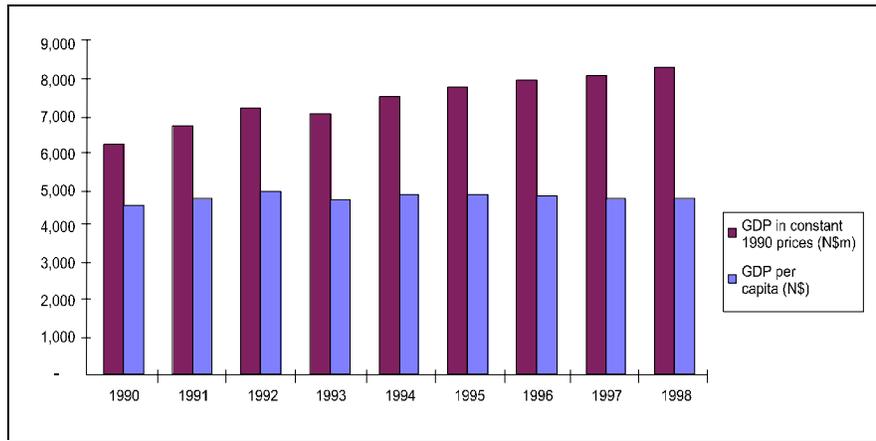
Figure 3. GDP development, 1990-1998. Source: NEPRU (1998:5).

At present, there is little evidence to indicate how the distribution of welfare has changed, how inequality and poverty have developed since independence (Hansohm and Presland 1998; Schade *et al.* 1997). However, as Figure 3 shows, the scope for improvements has been too limited to achieve substantial progress. Development history shows that sustainable improvements of poverty and inequality can only be achieved in the context of growth.

Figure 4 shows the structural changes the Namibian economy has undergone since the beginning of the 1980s. The figure shows clearly that both the agricultural and the mineral sector faced a secular decline (based on stagnating gross output). Unfortunately there are no comparable figures on the development of employment, but Figure 5 shows that in 1993 still half of the population worked in agriculture. This constant relationship between output and employment in agriculture reflects the fragile character and low growth potential of this sector, due to a large degree to the aridity and low quality of soils. The mineral sector is in its mature stage – resources exploited are increasingly marginal and high cost.
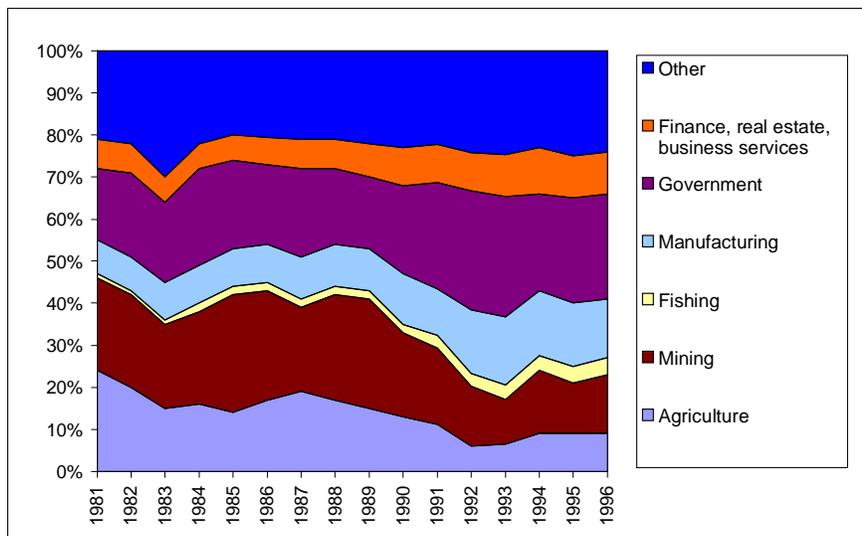

Figure 4. Change of GDP composition by sector, 1981-1996. Source: CSO (1997).
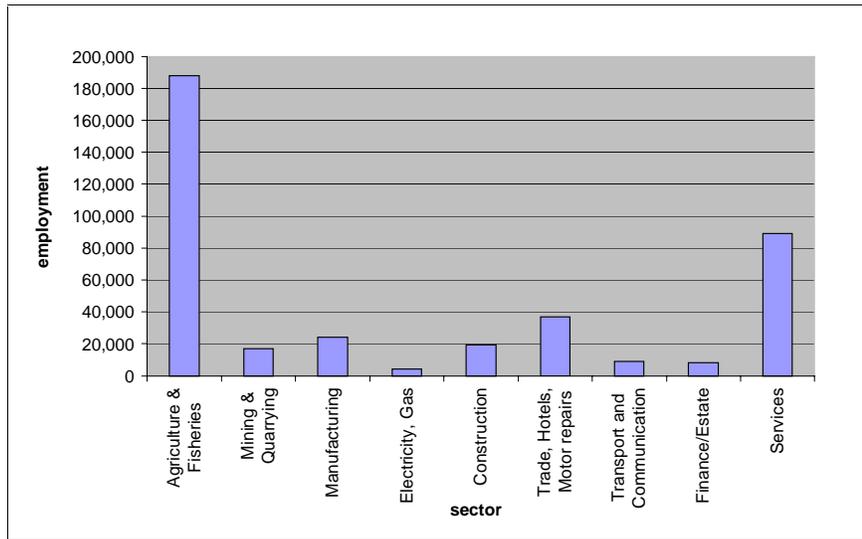
Figure 5. Sectoral distribution of employment in Namibia (1993/94). Source: MLHRD (1994).

Growing sectors are fishing, manufacturing, finance, and, largest of all, government. The manufacturing sector is growing and slowly diversifying, but is presently largely based on meat and fish processing. The expanding financial sector is important to underpin the economic diversification. The expansion of government, however, which is financed by an increasing tax burden as well as by rising debt, is not sustainable.

3 Three Central Choices for Strategies of Sustainable Development

The scenarios for Namibia's future (Figure 1) indicate three central choices for development, which are in the following discussed in turn.

3.1 International and regional integration versus economic self-sufficiency

Today there is wide agreement that market-oriented, liberalised approaches to development are superior to inward-looking, import-substituting approaches. However, there is some uncertainty about the distributional impacts of trade liberalisation, and especially the impacts on the poor (e.g. Woodward 1996). Furthermore, the present economic crisis in East Asia is interpreted by some as an indication for the necessity to question the received wisdom of outward-oriented development strategy, which is largely empirically based on the so far successful East Asian model. In Africa, there are voices which question the appropriateness of the outward-oriented model to Africa because of the different situation on the world market and the less favourable starting position of Africa. It is feared that a rapid liberalisation might lead to de-industrialisation. Most observers estimate that the overall welfare impacts of the Uruguay Round leading to the establishment of the World Trade Organisation for Africa as a whole will be negative (e.g. Goldin and van der Mensbrugghe 1995), due to the comparative disadvantages of SSA (low educational standards, poor infrastructure,

weak industrial structures, unintegrated markets and weak supply responses). However, this assessment is not universal (e.g. Francois *et al.* 1995).

How is the Namibian situation? As Figure 6 shows, the development after independence does not show increasing openness (measured as percentage of foreign trade of GDP) – if anything, the contrary.
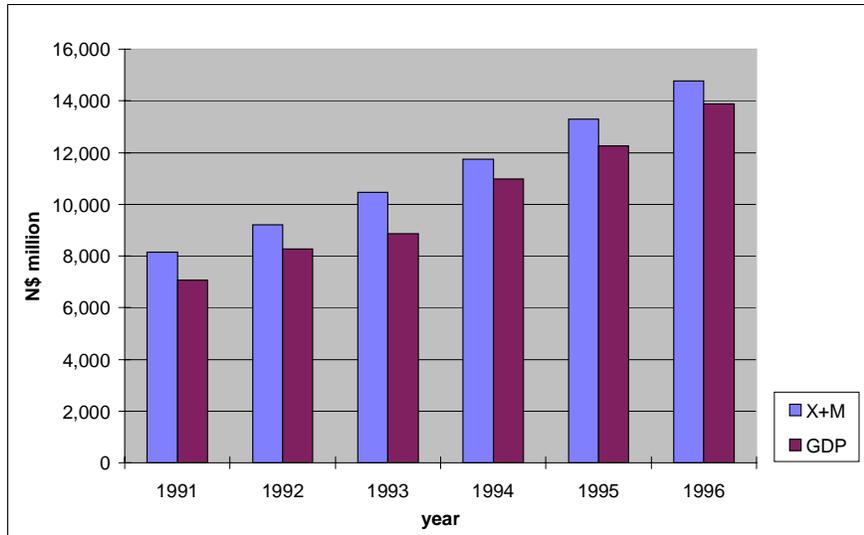
Figure 6. Namibia's foreign trade (exports [X] and imports [M]) and GDP (N$ million, current prices, 1991-1996). Sources: Bank of Namibia (1996), and unpublished data from the Bank of Namibia.

The export structure has also not changed to any substantial degree (Figure 7). The traditional resource exports (diamonds and other minerals, fish, beef, fruit) dominate. Manufactured exports, while increasing over some years, returned to the initial low level later.

Figure 7. Namibia's export structure (% of major groups, 1990-1996). Source: WTO (1998:10).

The high country concentration remained as well (Table 1). Trade is concentrated in SACU, but that within the whole Southern African sub-region (SADC) remains unimportant (on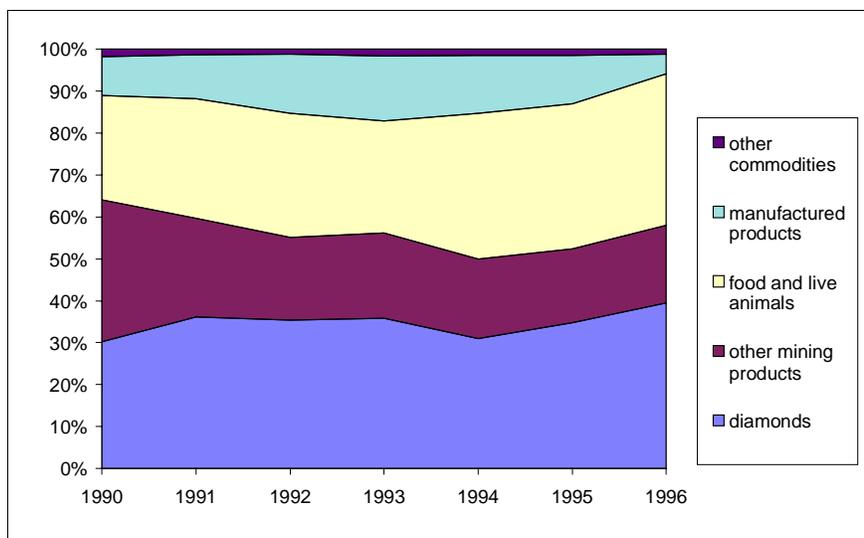ly 12% of SADC's trade is intra-regional). This is partly due to a great number of remaining trade barriers within the region, but mainly to the similar resource endowment and limited production structure of all countries (with the exception of South Africa).

Table 1. Direction of trade, 1993 (N$ million, % of total). Source: Bank of Namibia, quoted by Donovan (1996:20).

Country	Imports	%	Exports	%
South Africa	3383	87.1	1153	27.4
European Union	194	5.0	2167	51.4
United Kingdom	20	0.5	1450	34.4
Spain	32	0.8	258	6.1
Germany	100	2.6	140	3.3
Belgium	2	0.1	232	5.5
France	40	1.0	87	2.0
Japan	3	0.1	411	9.7
Ivory Coast	129	3.3	70	1.7
United States	46	1.2	51	1.2
Switzerland	7	0.2	74	1.8
Other	121	3.1	287	6.8

Namibia is highly economically integrated with South Africa and Botswana, Lesotho, and Swaziland through the Southern African Customs Union and the Common Monetary Area (without Botswana). Further, Namibia is a member of the Southern African Development Community and the Common Market of Eastern and Southern Africa. It is also part of the Cross-Border Initiative. Furthermore, there are a number of bilateral trade agreements planned. In existence presently is a scheme with Zimbabwe. Parallel to these regional initiatives Namibia is also committed generally to an open and outward-oriented economic strategy. It is one of the founding members of the WTO and as such committed itself to a process of comprehensive trade liberalisation.

However, these agreements are not only overlapping and partly undermining each other, their value is also disputed in public discussion and their future is regarded uncertain (see Figure 1). The old integration schemes of SACU and CMA are highly suspicious because of their colonial origin. While the impact of SACU is in fact double-sided, the benefits of CMA are overwhelming. SADC is seen more positively, although it has still a long way to go to become an integrated economic region. International integration is seen by many as a threat, rather than as an opportunity. Economic welfare in the future is by many equated with independence – from South Africa – rather than with further integration. In this mood, notions of self-sufficiency are popular (see Box 1 and Box 2).

Box 1. Self-sufficiency in food for Namibia? Source: MAWRD (1997).

The terms 'food self-sufficiency' and 'food security' are often misunderstood. The state of *food security* is attained when all members of a nation's population are sufficiently well fed for them to be able to lead a healthy and active life. *Self-sufficiency* in food is reached when a nation produces enough for its population and does not need import. Normally, food self-sufficiency refers to self-sufficiency in the area of staple food grains, rather than complete self-sufficiency – no country is self-sufficient in all foods.

Namibia is far from being self-sufficient of food: between 50% and 80% of its grain requirement are imported every year. However, it is not advisable to strive for food self-sufficiency in grains for two reasons. First, due to Namibia's ready access to the world grain market and its neighbourhood to South Africa, one of the world's largest maize producers, there is no danger that Namibia will be unable to import food. Second, production costs of grain are significantly higher in Namibia. The investment necessary would be in excess of N$ 1.3 billion. Experience also has shown that irrigation schemes producing cereal crops have so far been unable to meet even their operating costs. This means that achieving self-sufficiency in grain would imply lower income for Namibia than if grain would be imported.

However, food security of households does not depend directly on the nation's income. People are food insecure when they have insufficient income, and the principal way to overcome poverty is the creation of employment opportunities. Furthermore, cheap food prices are essential for poverty reduction. In sum, for the case of Namibia we can conclude that self-sufficiency in grain would not have a direct positive impact on the attainment of food security. On the contrary, it appears to make this more difficult.

Box 2. Energy security or energy self-sufficiency for Namibia?

Namibia's economy and its energy sector are integrated into the Southern African region and with global trade. The country imports all of its oil products and about two-thirds of its electricity. The future pattern of foreign trade in energy depends on availability and price of different energy supply sources as well as investment decisions on potential new hydro-electric schemes (Epupa) and gas fields (Kudu).

Among the country's energy policy goals are security of supply, social upliftment, investment and growth, sustainability, and economic competitiveness and efficiency. The crucial challenge for Namibia's energy policy is how the country can best achieve its policy goal of energy security and how it could maximise the potential gains from participating in regional co-operation and the global market.

In the presence of a global oil market security in oil and coal supply is easily achieved through diversity of supply and import options, eliminating the need for self-sufficiency. Electricity, however, is not easily or cheaply stored and reliable supply is dependent on secure generation sources and local or bi-national integrated grid networks. The regional electricity market is still very undeveloped.

On this background, a choice has to be made about the appropriate level of local supply versus imports. In the electricity sector this means local development of electricity generation where it is cost competitive and an assessment of the risks in importing competitively priced electricity from neighbouring countries.

The impacts of liberalisation as stipulated by the WTO agreements are uncertain because they depend crucially on the ability of governments to make the most of new opportunities and to enable threatened economic sectors to adjust, and to the same degree on the capacity of the private sector to respond to new opportunities. Further, it is important to note that the results of the Uruguay Round are not equal to total liberalisation. Important limits to market access in industrial countries remain, most importantly higher rates of tariffs for manufactured goods (tariff escalation).

Unfortunately, the discussion on trade liberalisation is dominated by fears about the future, largely due to the influence of organised producer interests, who naturally focus on the threats to their presently sheltered position, which allows them to gain rents. As everywhere, consumer interests are not organised and vocal, not to speak of the future interests of emerging production lines. Table 2 summarises relevant issues to consider when assessing the impacts of global liberalisation.

Table 2. International economic integration (impacts of Uruguay Round). Source: Hansohm (1997).

Benefits/Opportunities	Costs/Threats
Impacts on Producers	
Lower barriers for exports = new market opportunities	Tariff escalation (disincentive for industrialisation [= lack of liberalisation])
Greater security and predictability of market access	Minimal immediate gains due to composition and present direction
Preferential schemes are heavily hedged, non-contractual	Erosion of preferential access to SACU and EU
Time to adjust	
Higher efficiency due to competitive pressure	
Constraint on rent-seeking activities because of constraints on discretionary action	
Incentive for food producers	
Cheaper inputs for producers	
Impacts on Consumers	
Manufactured goods cheaper	Food imports more expensive
Impact on Government Revenues	
Taxes on trade are inferior	Loss in SACU income
	Capacity to address Uruguay Round issues/commitments
	Commitments of a developing country (as SACU member)

The table shows that while the impacts on government revenues are negative in the short term (from a development point of view, even these are rather positive), the impacts on consumers are mixed. On the producer level, at least in the longer term, the positive impacts are more numerous and significant than the negative ones.

Important for an overall assessment for the choices on international integration are the following points:

1. Although historically understandable, strategies focusing on economic independence (from South Africa) are costly and lead to less welfare, rather than more. Concepts of 'self-sufficiency' do not appear to be sustainable.

2. Regional integration is important to enlarge markets, but mainly to create and sustain an environment of competition and a system of clear and transparent rules, independent from the day-to-day concerns of individual governments.

3. Although they are of 'colonial' origin, the existing effective schemes of regional integration (SACU, CMA) should be retained as building blocks for a larger SADC. Experiences in the region and elsewhere have shown how long and difficult a process it is to build economic unions. This suggests that it is not wise to destroy existing bodies in order to start anew.

4. At the same time, for small countries with a specialised resource base, international integration is essential. The WTO establishes a legal system of international trade, which is an important step forward for the small countries, beyond the era of limited, privileged, but uncertain market access. It is not wise to halt or even reverse Namibia's degree of openness in order first to go for regional integration.

The inward-looking scenarios *fat cat* and *stray cat* are not favourable from a development point of view.

3.2   The roles of the private and public sectors

The discussion on the role of the private versus public sectors in development continues to be one of the central controversies in the debate about the recipe for growth and sustainable development. Until the 1970s development theories agreed on the necessity of a central role for the state, based on the experiences of market failures in industrial countries. In the case of developing countries, the case for state intervention seemed to be even stronger because of the challenge of rapid development (e.g. Hirschman 1958; Lewis 1954). In the 1980s the pendulum swung to the other extreme. Strengthened by the disillusioning failures of development, especially in SSA, the paradigms of state failure, market-led, liberalised strategies, if not a radical retreat of the state, became dominant (e.g. Krueger 1974; Lal 1983). In the 1990s the radical position of free marketeers gave way to a more balanced view, regarding the efficiency of state intervention as more important than the reduction of its size (see Killick 1989).

The following figures provide some indication of the size of the public sector in Namibia. Figure 8 shows that after some boom of government spending after independence, the share of percentage returned to the 1990 level.
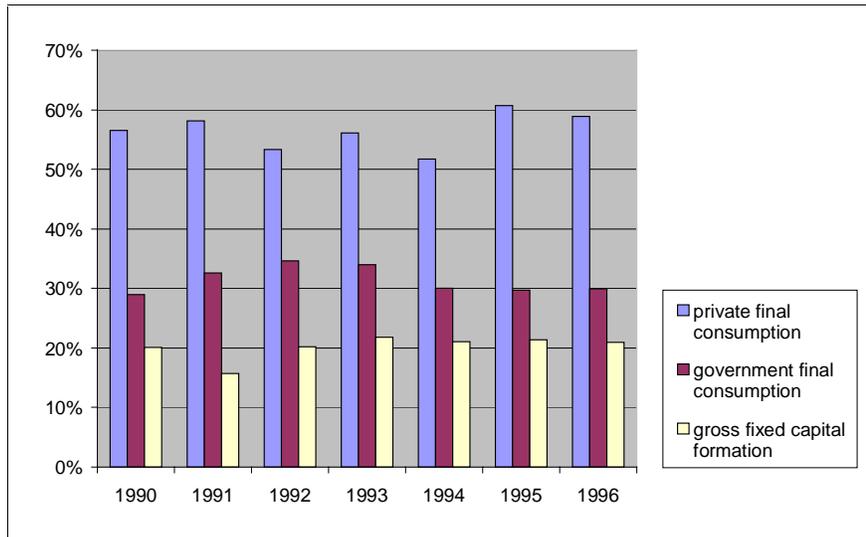
Figure 8. Private and public spending as % of GDP (1990-1996). Source: CSO (1997).

Figure 9 shows that after some uncertainty at independence, private investment picked up and is now much more important than public spending.
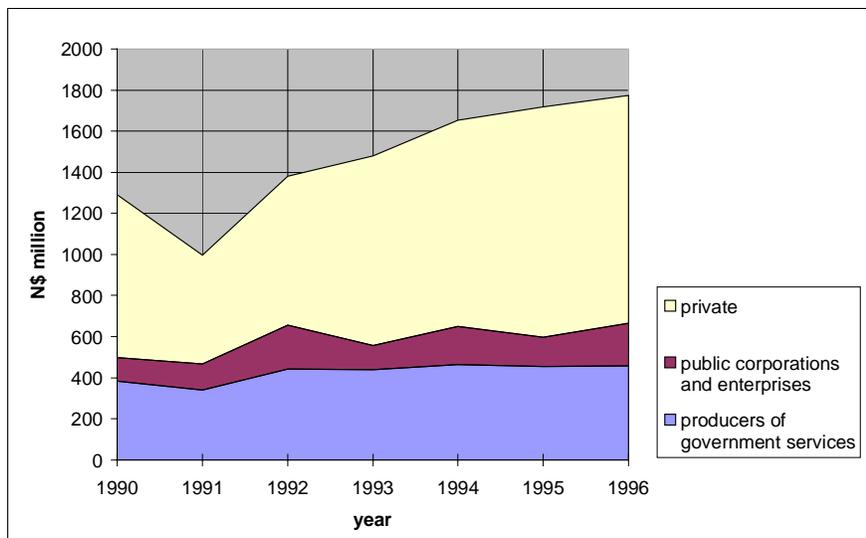
Figure 9. Gross fixed capital formation by ownership (constant 1990 prices, N$ million). Source: CSO (1997:31).

The international comparison (see Figure 10), however, shows that government spending in the mid-1990s is almost double as high as in 1980, and to the same degree out of line with comparative country groups on a geographical (SSA) or income basis (low- and middle income countries). This reflects the high increase in public activity: public employment grew from 46,000 at independence to almost 77,000 in 1997. The share of personnel costs has increased from 55.6% of tax revenue to almost 60% in 1996/97. This contrasts with an aim of a reduction to less than 40%.

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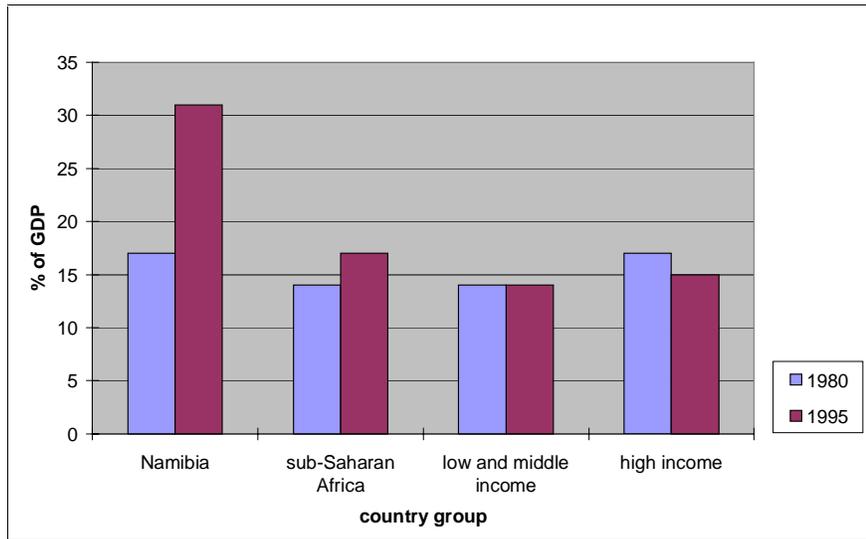
Figure 10. Namibia's government consumption as percentage of GDP in international comparison (1980 and 1995). Source: World Bank (1997).

The size of government is not, however, a cause for concern by itself. Decisive parameters are the ability to finance spending by revenue (size of deficit, level of debt), and the appropriateness of and efficiency with which government resources are spent. Figure 11 shows a varying, but increasing level of deficit.
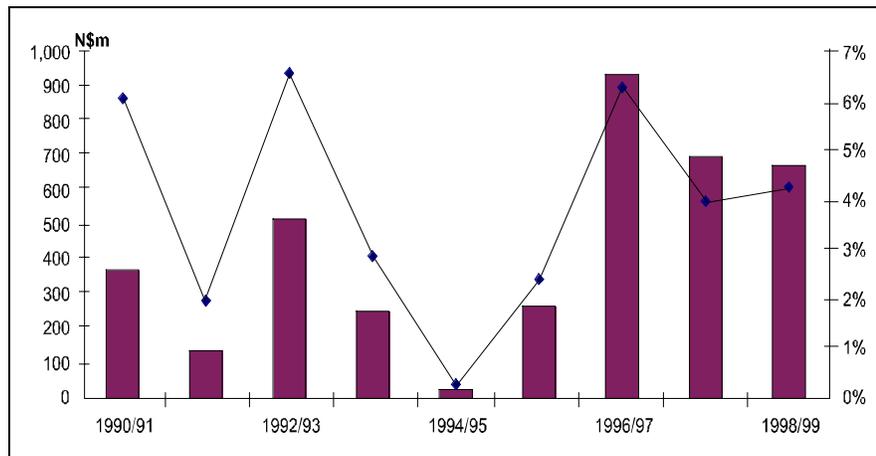
Figure 11. Budget deficit in N$ million and % of GDP (1990/91 to 1998/99). Source: NEPRU (1998:39).

Accordingly, the level of public debt has been increasing in an unsustainable way (see Figure 12). However, the level of Namibia's debt and the level of debt service going along with that is still far from the 'debt trap' situation other countries face (see Figure 13).
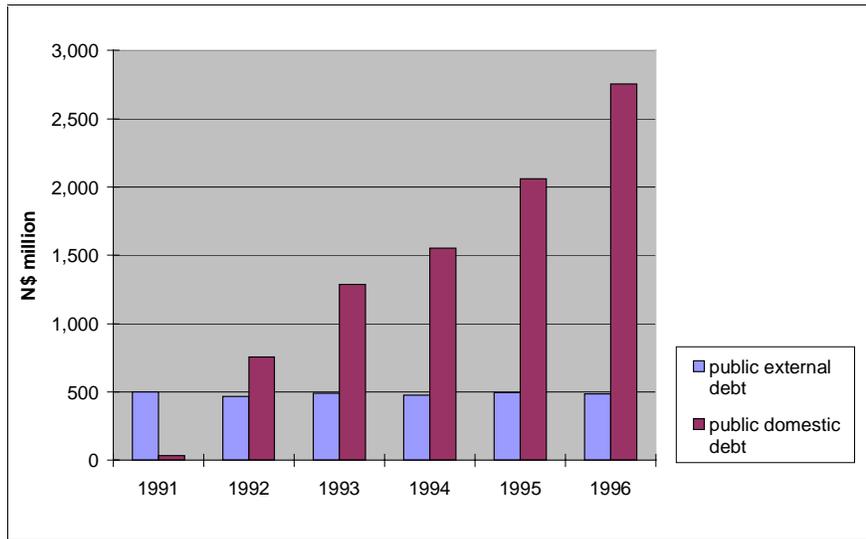
Figure 12. Total government debt (1991-1996, N$ million). Source: Bank of Namibia (1996).
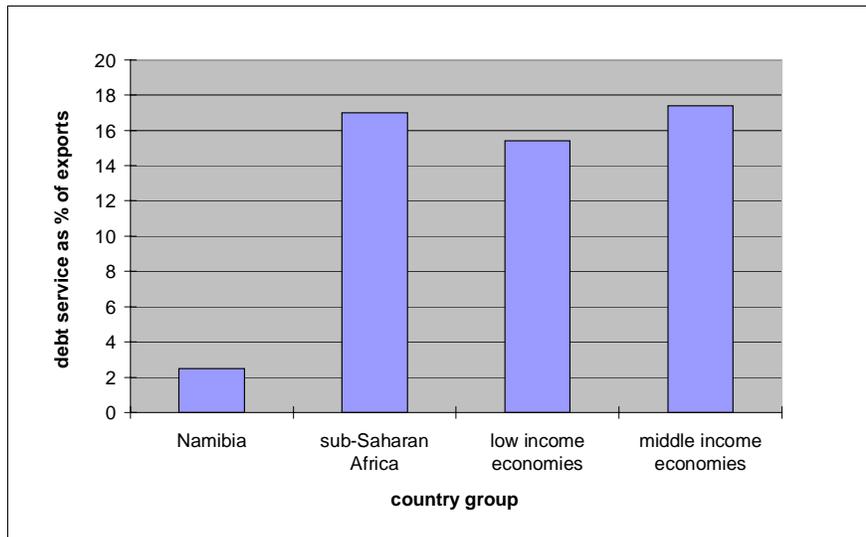
Figure 13. Debt service ratios in comparison (1995). Sources: World Bank (1997); Bank of Namibia (1997).

What can we say about the appropriateness and efficiency of government spending? In general terms, the spending pattern with an exceptionally high emphasis on education, health and infrastructure is well geared to the achievement of Namibia's development objectives by creating an enabling environment for investment. However, the intra-sectoral spending leaves room for improvement. In the area of education, for example, there seems to be too little attention to the needs of the labour market, as indicated by the high need of import of qualified labour on the one hand, and high unemployment on the other. Higher emphasis on vocational training is necessary.

Another area of concern is the increasing importance of current spending, especially on personnel, to the detriment of capital investment. Unfortunately the

recommendations of the Wages and Salaries Commission to increase public salaries, but at the same time also to relate them to performance and to slim down the public sector, has only been implemented partially (i.e. wages have been increased), due to the pressure trade unions can bring on its ally government.

The experiences with Namibia's parastatal sector has been typical for SSA (see Abdel Rahim 1996). Public enterprises had been established originally on the grounds of lack of private enterprise. While this was a valid argument at the time, today one can see a circular relationship. The highly-subsidised parastatal sector is undermining private engagement at least in some areas (NEPRU 1995). A recent internal evaluation revealed 'disastrous performance.' In 1997/98 29 parastatals were allocated more than N$ 300 million and did not contribute to revenue. Government recognises urgency to formulate a clear-cut policy on privatisation.

The financial crisis in 1997, necessitating an austerity budget, has shown the end of Namibia's first post-independence phase with seemingly unlimited government resources.

These observations point to the lesson taken elsewhere that while measures should be taken to make the public sector more efficient, there are many activities which are better performed by private entities.

3.3   Rural versus urban centred development

It is widely agreed that one of the central failures of traditional development policy in SSA and elsewhere was its *urban bias* (Lipton 1977), which not only led to rural poverty, but also to growth losses because of inefficiencies. In Africa, during the economic crises of the 1980s, necessary adjustment has led to drastic income falls, mainly of urban wage earners, and at least relative gains by rural agricultural producers, so that this gap has been reduced (Jamal and Weeks 1988). It has been widely agreed that development strategies must look beyond mere export orientation, but has to relate strongly to agricultural development (e.g. Adelman 1984).

How far do this evidence and this recommendation hold for Namibia?

According to the 1993/94 Namibian Household Income and Expenditure Survey (CSO 1996), almost exactly one-third of all households are urban (33.8%). In the past 15 years, Namibia's urbanisation has grown stronger than other regions, and far outpaced that of SSA (Figure 14).
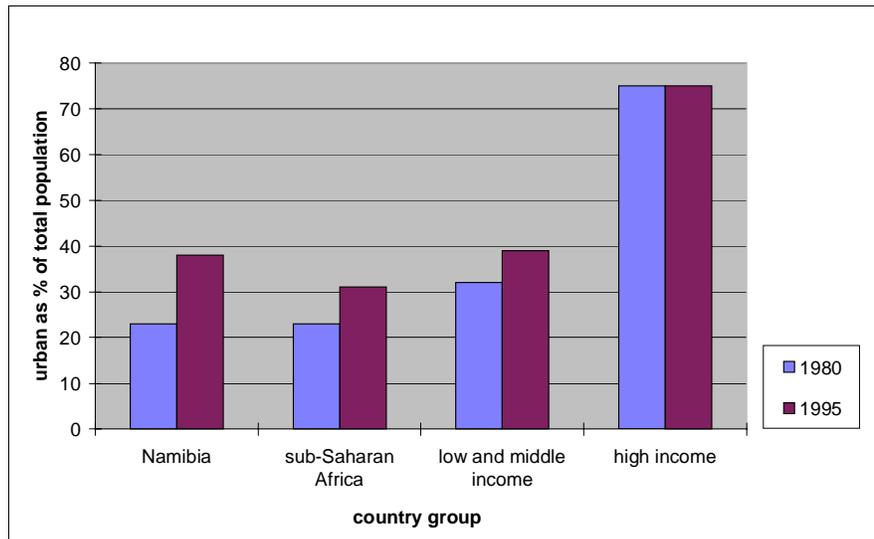
Figure 14. Namibia's degree of urbanisation in international comparison (1980 and 1995). Source: World Bank (1997).

Average household incomes are highly differing among regions, the urban areas having incomes more than three times as high as rural areas (see Figure 15). Does this reflect an 'urban bias' as it did to a large degree in SSA countries, which Namibia can still maintain because of its favourable fiscal position?
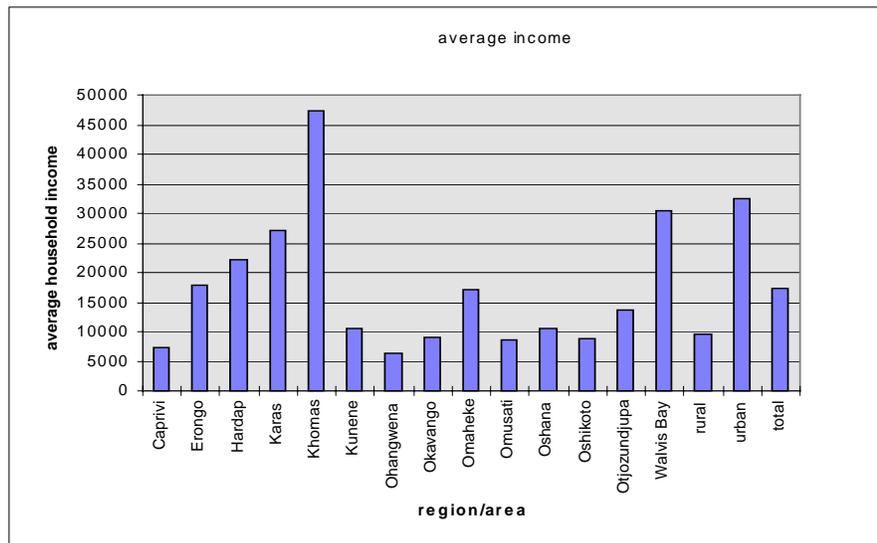
Figure 15. Average household income by region (1993/94).

Namibia's land use pattern suggests rather a situation untypical for SSA (see Figure 16). The area of cropland, which is the basis for intensive agriculture, has remained minimal (1% of the total area). Because of limited and highly variable rainfall, assessments of future possibilities for agricultural intensification are conservative (World Bank 1997). Today, the natural resource base shows clear signs of being mismanaged, notably with regard to water, energy, soils, and grazing land (Auty 1996).

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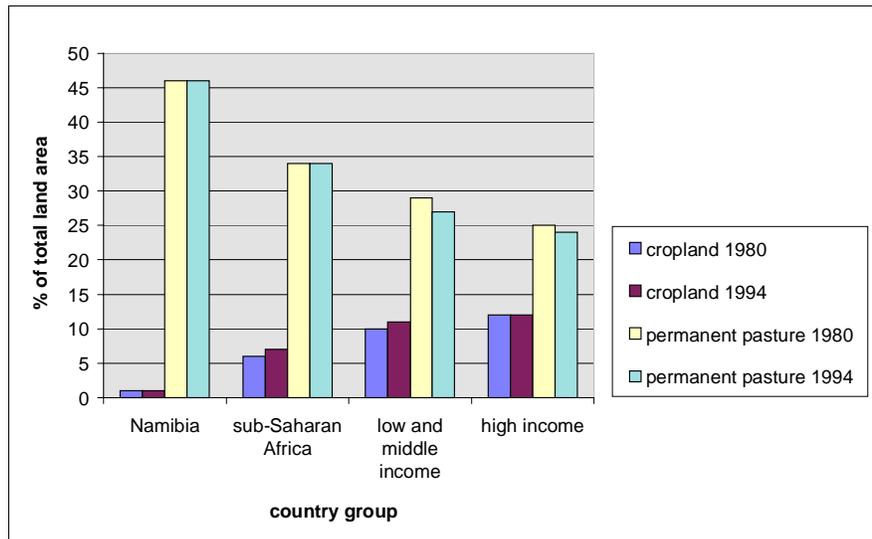
Figure 16. Namibia's land use pattern in international comparison (1980 and 1994). Source: World Bank (1997).

The low population density, even in the North Central regions where most of the population lives, reflects the fragile character of agriculture and sets narrow limits on rural development. Lessons from other countries, where agricultural growth has been driving rural development through supply of agricultural outputs for further processing and demand for inputs to agriculture and for simple consumer goods, are only applicable to a very limited extent.

On this basis, further urbanisation is inevitable, and programmes of rural development must be evaluated carefully. For example, incentives for manufacturing companies to locate in specific areas should only be given on a temporary basis and if it can be expected that inherent advantages of the selected locations will lead to a sustainable settlement in the long term.

4   Conclusion: Towards a Strategy of Sustainable Development

A strategy for economic development in Namibia has to start from the acknowledgement of two necessities:

- Transition to an economy with less poverty and a higher degree of equality.
- Transition from the present economy, mainly based on exports of minerals and agricultural resources, to an economy whose growth is based on skills.

In this context, sustainable development necessitates rapid change, rather than the maintenance of the status quo.

Namibia is lucky as a latecomer (becoming independent around thirty years later than most other countries of SSA) and can gain from the experiences of others. In fact, several instances show that Namibia has realised these gains. For example, Namibia is pursuing a policy of economic openness without going through the painful and costly

experience of import substitution. And government is democratically elected and accountable without going through a phase of autocratic rule.

In other respects, however, there are untypical features of Namibia which limit the ability to copy successful models. The most important of these features are the small and thinly spread population, and the neighbourhood to a large economy, South Africa. Unfortunately, the colonial legacy overshadows an objective assessment.

From the point of view of sustainable development, optimal choices concerning these choices discussed above appear to be:

- A careful balance between regional and international integration, based on the concept of comparative advantage;
- A private-sector-led growth strategy, assisted by a lean and efficient public sector, creating and maintaining human skills and infrastructure;
- Growth led by urban centres (especially Windhoek, Walvis Bay/Swakopmund, the North Central region), based on some manufacturing, but especially on service provision.

Looking back at the four scenarios of Namibia's future (Figure 1), the two inward-looking scenarios *fat cat* and *stray cat* are unfavourable. From a development point of view the clear favourite would be the outward-oriented, private led and urban concentrated scenario *African tiger*. The fourth scenario *Angolan catalyst* has some appeal (assuming peace in Angola) both in having a regional dimension and in being rurally based. However, there are clear limits both to rural development (due to low population density) and to regional development (due to low incomes and little complementarity of the production structures).

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Acknowledgements

EMERGY EVALUATION OF WATER SUPPLY ALTERNATIVES FOR WINDHOEK, NAMIBIA

Andrés A. Buenfil

Abstract

Emergy is all the energy of one kind previously required to produce something. By evaluating complex systems using emergy methods, the major inputs from the human economy and those coming "free" from nature can be integrated to analyse social and environmental problems holistically. Emergy analysis is a tool that can complement traditional cost-benefit analysis to make more integrated resource management decisions. In this study, emergy analysis was used to compare alternative ways of supplying water to Windhoek, the capital of Namibia, to select the most appropriate option.

The study evaluated the following three out of ten water supply alternatives: 1) taking water from the Kavango River; 2) desalinating seawater from the coast, near Walvis Bay; and 3) pumping groundwater from the Tsumeb aquifer. It was concluded that the best alternative, among these three options, is to use groundwater from the Tsumeb aquifer system, but without exceeding maximum sustainable pumping yields. This alternative consists of pumping no more than 20 million m^3 of groundwater per year from the Tsumeb aquifer and connecting this water with the Eastern National Water Carrier near Grootfontein. However, if the Kudu natural gas reserves along Namibia's continental shelf can be used to co-generate electricity and distillate water, the desalination option might provide the greatest benefit for the local, national, and regional economy, despite having the highest capital cost. The worst alternative evaluated was the Kavango River option, in spite of being the least expensive system proposed. This alternative may not be sustainable in the long run and have large negative effects to the environment. Before any new water supply system is implemented, efforts should be concentrated in reducing water demand (e.g. by using economic incentives) and increasing efficiency (e.g. by reducing water losses from leaking pipes and evaporation).

1　Introduction

1.1　Water and population dynamics in Namibia

Namibia is one of the most arid countries in the world (Day 1997; Ashley *et al*. 1995) and the driest country in sub-Saharan Africa with approximately 80% of its territory consisting of desert, arid, and semi-arid land (Lange 1997). Local people have adapted to this arid environment (e.g. the Koikoi in the Kalahari Desert), but the majority of Namibians have historically lived near

perennial sources of surface water, such as the Kunene and the Kavango Rivers in the north. However, things have changed in the last two decades due to rapid population growth and economic development.

After Namibian independence in 1990, Windhoek, the capital, began to expand rapidly. Some estimates indicate that the city is currently growing at approximately 5% a year, and water use is expected to quadruple from current levels of about 18 million m^3/year by the year 2020 (Water Transfer Consultants 1997). Despite the lack of sufficient water sources, the population, industry, government and commerce continue to become centralised in Windhoek, in the central region of Khomas. This has forced the Department of Water Affairs to search for water sources further away from Khomas to meet increasing water demands. As part of the water master plan, the DWA would like to finish the last phase of the Eastern National Water Carrier. The ENWC consists of a network of about 550 km of pipes and 200 km of open canals to transport water to the water-scarce region in central Namibia (Day 1997). Initial planning and construction of the ENWC started in the early 1970s with the goal of eventually connecting the Kavango River with the city of Windhoek over a distance of approximately 720 km (Water Transfer Consultants 1997). By 1990, a 203 km open-canal section of the ENWC (from Omatako to Grootfontein) was completed. Besides losing large volumes of water due to evaporation, this canal has also been a lethal trap to many animals trying to move through the region in their seasonal migrations (Jones 1987).

Particularly poor runoff seasons in 1994/95 and 1995/96 resulted in very little inflow to the major dams supplying Windhoek with fresh water. As a result, the DWA proposed to build an emergency 260 km-long pipeline from Rundu to Grootfontein to extract about 17.5 million m^3/year from the Kavango River, finally linking the ENWC with the Kavango River. A good rainy season in 1996/97 postponed this emergency plan, but the government is still determined to build the pipeline to secure water for meeting growing demand.

The Kavango pipeline is quite controversial because it could impact the Okavango Delta in Botswana. This wetland ecosystem depends on the in-flowing waters from the Kavango River because evaporation rates in this region are about three to five times greater than precipitation rates (Scudder *et al*. 1993). This extraordinary inner-delta ecosystem provides food, refuge and habitat for many plant and animal species. The wetland acts as a sponge absorbing water during the rainy season and slowly releasing water during the dry season of the delta. In addition to its intrinsic value and to the biophysical functions of the delta, approximately 70,000 people live in its floodplain and depend on the ecosystem for survival (Ramberg 1997). Many conservation and environmental groups have opposed the pipeline project to protect the social and environmental characteristics of the Kavango region.

In addition to the Kavango pipeline, several other alternatives have been proposed to meet Windhoek's growing water demand. Each alternative proposed has some associated economic, social, and environmental costs. Decisions for selecting the best option are mainly based on cost-benefit analyses, often ignoring impacts on environment and socio-economic conditions. The objective of this research was to evaluate different ways of supplying water to Windhoek from an integrative and holistic perspective. Thus, this study can complement traditional economic analyses for selecting the most appropriate water supply option. The quantitative tool used for evaluating the alternative water supply systems was emergy analysis. Emergy (spelled with an "m") is all the available energy required to make a product or provide a service.

1.2 Emergy analysis

Accounting for work done by the environment is commonly underestimated by standard economic calculations. This is because money is only paid to humans for their services required in obtaining an environmental resource and not for the actual materials being bought (Odum 1996). For example, several days of meteorological work acting over thousands of km^2 are required to concentrate fresh water from the oceans and for delivering this water to upland regions of Southern Africa in the form of rain. Humans paid nothing for this work. To capture a portion of the energy embodied in the rain, humans may construct a hydroelectric power plant to transform the elevated potential energy of the water into electricity for use by society. Whereas traditional market analysis would give little if any value to the precipitation, emergy analysis places value on the precipitation based on how much energy is required directly and indirectly to create the rain and transport it to the elevated landscape. Thus, emergy can account for work done by all types of biogeospheric processes (e.g. sun, wind, rain, tide, geologic cycle, soil formation, ecosystem services, etc.) as well as human services, putting all on a common basis for a meaningful comparison. Emergy does this by expressing energies of different forms as energy of one kind (commonly solar emergy), measuring all energy used directly and indirectly to generate a product or provide a service.

Different forms of energy are compared using their transformities, which are ratios of emergy to available energy. Transformity is easily understood with an example. For a tree to produce one joule of wood it requires around 30,000 joules of sunlight directly and indirectly (e.g. wind, rain, etc.). Thus, the wood produced has a transformity of 30,000 solar emjoules per joule of available energy, or sej/J. The complete explanation about emergy analysis and the methodology for conducting emergy analyses, such as the ones presented in this paper, can be found in Odum (1996).

1.3 Water supply alternatives for Windhoek

The principal characteristics of the water supply alternatives that were considered in this study are listed in Appendix Table A1. The values shown in this table were obtained from Joint Venture Consultants (1993) and Water Transfer Consultants (1997). Due to the limited time to conduct this research and the difficulty to obtain the necessary data, emergy evaluations were only conducted for the first 3 alternatives: i) Kavango pipeline; ii) desalination of seawater; and iii) groundwater extractions from the Tsumeb aquifers. The principal area affected by the development of each water supply system is shown in Figure 1. Although these 3 alternatives were considered most urgent for analysis using emergy techniques, the others are no less important. Thus, to be confident which water supply alternative is the most appropriate, the remaining 7 alternatives need to be evaluated.
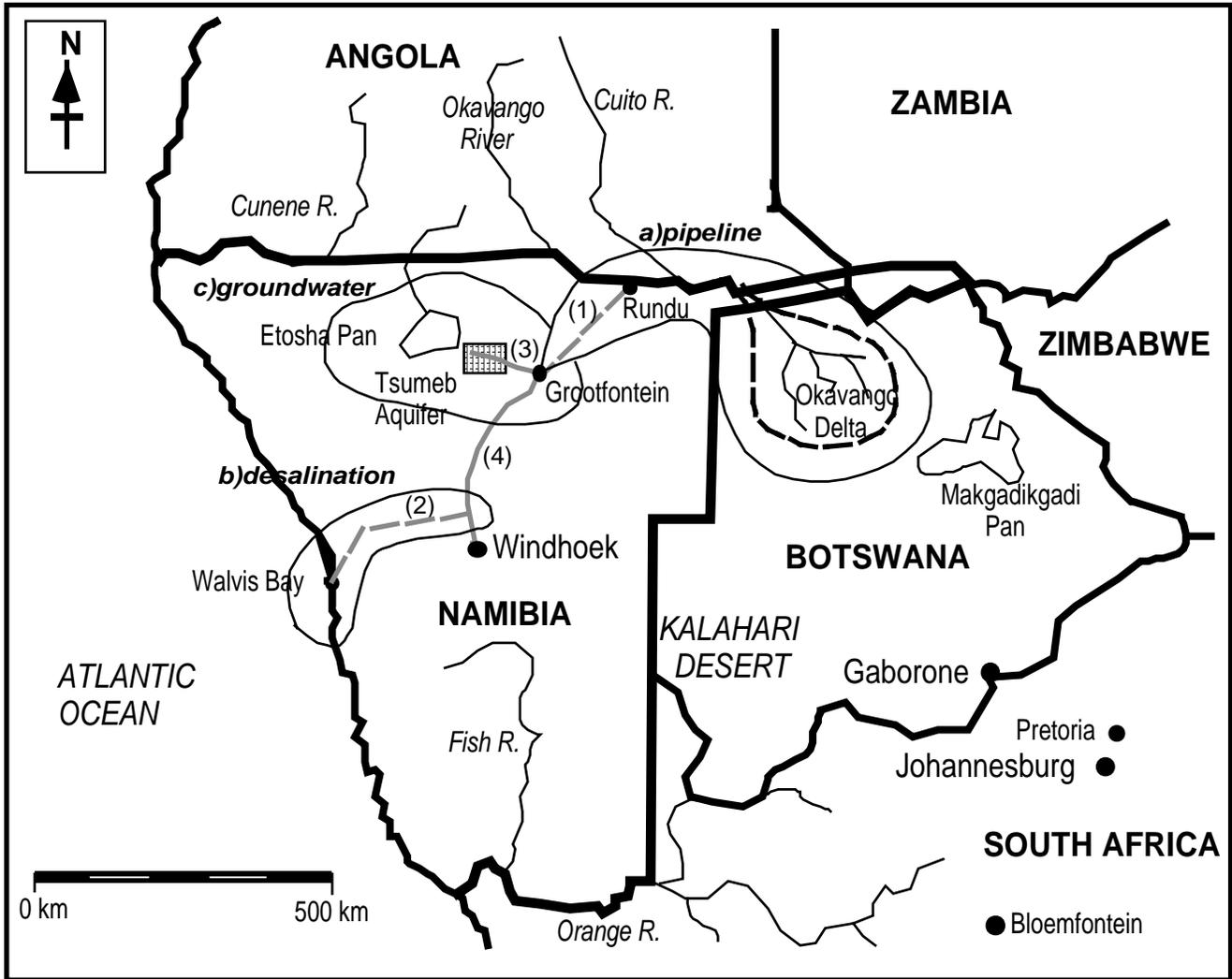
Figure 1. Map showing the 3 water supply alternatives for Windhoek that were evaluated with emergy analysis: (1) Kavango River pipeline; (2) pipe for transporting desalinated water; (3) groundwater pipeline; (4) existing canal; (━ ━) approximate boundary of the Okavango Delta; (⬯) relative and approximate influence area for each water supply system.

2   Results

Figure 2 shows the aggregated systems diagram for the Kavango River pipeline. This diagram is a conceptual model that characterises the transport of water from Rundu to Grootfontein along a 260 km-long pipe. Appendix Table A2 presents the results of the emergy evaluation of the Kavango pipeline and of the other two water supply alternatives. Appendix Table A3 documents the reference data and shows the complete calculations for the emergy evaluation of the Kavango pipeline system. Due to limited space, the systems diagrams as well as the documentation for the emergy analyses of the groundwater and desalination tables are not included in this report. Appendix Table A4 illustrates some of the negative impacts predicted for each water supply option. Appendix Table A5 compares several emergy indices among the three water supply alternatives evaluated.

3   Discussion

The systems diagram for the Kavango pipeline (Figure 2) illustrates what could happen if this project is developed. Components of higher transformity or energy quality are arranged from left to right in the diagram. For example, water from the Kavango ecosystem would increase the infrastructure (e.g. assets) and urban population in Windhoek. The heat sink depicted in the diagram represents the second law of thermodynamics where much available energy is "lost" as it is transformed and upgraded from left to right. The figure shows where the water would come from, how it would be transported, how the economy would benefit, and how the environment may be affected. Since the diagram includes the environment and the economy, it is a conceptual impact statement. The flows of water, money, energy, and materials crossing the boundary of the ENWC box are the inputs evaluated in the emergy table (i.e. part a) of Appendix Table A2). The emergy tables for the water alternatives analysed (Appendix Table A2) show the solar emergy and emdollar values for each input. The solar emergy is obtained by multiplying the energy/material inputs by their corresponding transformity. The emdollar values, which are obtained by dividing the emergy of each input by the sej/$ ratio of Namibia, represent the macroeconomic value of a product, resource, or service. The emdollar value provides an approximate idea of the direct and indirect value of the resource or service in question. The emdollar value per m^3 of water (shown in the last column of Appendix Table A2) can be used to compare the alternatives under the same basis. The water supply system with the lowest emdollar value per m^3 is the most efficient.

Appendix Table A4 illustrates some of the principal negative impacts that could result from the development of each water supply alternative. Although several assumptions were made to generate these values (see Appendix Table A3), this table attempts to quantify some of the potential environmental consequences of developing each water supply system. For example, if the pipeline project is carried out, the impacts on the Rundu-Kavango region may total 8.42 million emdollars per year. This means that the local region may lose 8.42 million dollars per year of services that the Okavango Delta provides, both directly and indirectly.

International Market

services & information

minerals, fuels, elect. machines, & goods

Wildlife

Rain

Sunlight

$

pop
assets
Windhoek

pop
$
water
A
ENWC

local pop

wild

water
B
Kavango Basin

Heat sink (2nd law of thermodynamics)

Legend:

heat sink

money flow

energy/material flow

water flow

system boundary

exchange

process

energy source

storage

interaction

producer

ENWC=Eastern National Water Carrier; pop=people;
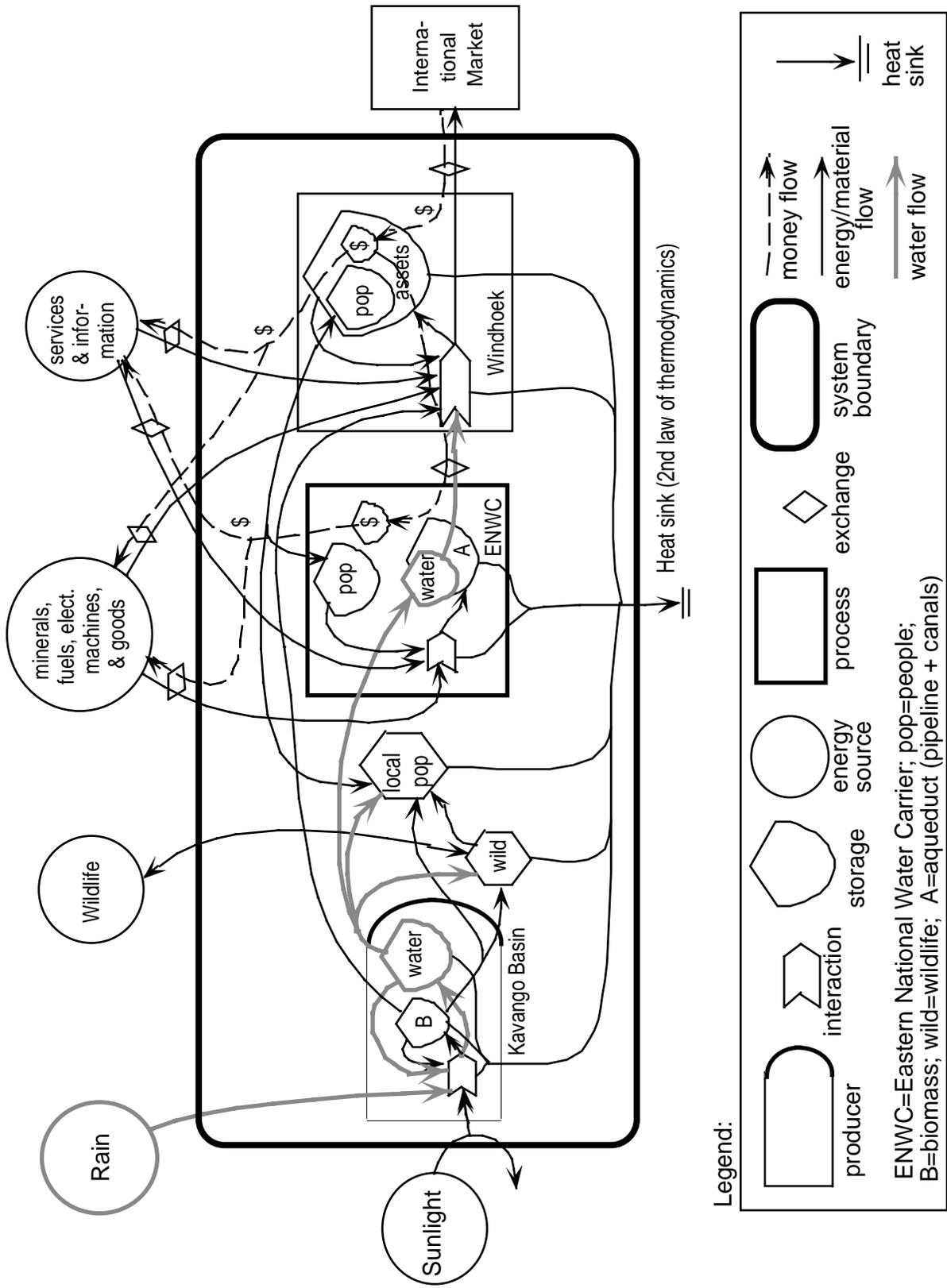B=biomass; wild=wildlife; A=aqueduct (pipeline + canals)

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Figure 2. Systems diagram of the Kavango River pipeline (from Rundu to Grootfontein).

The emergy indices (Appendix Table A5) were used for analysing and comparing the feasibility and sustainability of the alternatives in question. The transformity (see Section 1.2) of water supplied to the ENWC indicates the efficiency of delivering this water. For any commodity or resource (in this case fresh water), the lower the transformity, the greater the efficiency of the production process. The Emergy Investment Ratio represents the purchased emergy from the economy (e.g. services) divided by the free emergy inputs from the environment. This ratio measures the intensity of the proposed project. If the EIR of the proposed development is greater than the regional EIR, the project may negatively affect the environment. The Emergy Yield Ratio of a process is the emergy of the output (yield) divided by the emergy of all inputs coming from the human economy. This ratio indicates if the process can be economically competitive, and measures the net contribution of the product to the economy beyond its own generation. The Environmental Loading Ratio is the sum of the local non-renewable resources and the purchased services divided by the free renewable resources. This ratio is an indicator of how much the environment is being stressed by the development project. A high ELR suggests more pressure on the environment, whereas a low ELR indicates a more appropriate level of development. The Emergy Sustainability Index is calculated by dividing the EYR by the ELR and is intended to reflect how sustainable a certain process may be in the long run. The more sustainable projects have higher ESI since they maximise their economic yield with minimal environmental loading. The Emergy Benefit to the Purchaser represents the emergy in the product divided by the buying power of the money paid for such product (in terms of emergy). Since the environment is not paid with money for its services to the human economy, the emergy of environmental resources contributes more real wealth than what is paid for. Thus, this ratio indicates how much more emergy is delivered in a product to the purchaser relative to the buying power of the payment. As Appendix Table A5 illustrates, all of the emergy indices computed favour the groundwater option.

Economically, the two most feasible water supply options are the Kavango pipeline and the Tsumeb groundwater projects (Water Transfer Consultants 1997). The desalination proposal (desalinating water from the coast and pumping it uphill to the ENWC) is very energy intensive and expensive. From an economic standpoint, desalination is not a viable technology outside the coastal region (Blackie and Tarr 1998). Similarly, the results of the emergy evaluation suggest that desalinating water from the coast and pumping it to the capital is the least sustainable option, especially in the event of an energy shortage. The economic cost for maintaining and operating the desalination plant would increase if the non-renewable fuels required to generate the electricity become scarce. However, Namibia's Kudu natural gas reserves are estimated to be 147 E9 m^3 (MBendi 2000). Already several foreign energy companies, such as Chevron, Shell, Amoco, Mobil, and Norsk Hydro, have acquired the rights to extract some of this natural gas (MBendi 2000). If most of this natural gas is used within Namibia instead of being sold to developed countries, there is greater potential for improving the quality of life of the Namibian people. One way of doing this is by using the natural gas to generate electricity and fresh water. Co-generation of electricity and drinking water by a power/distillation facility may be more efficient than first generating the electricity and then using this to desalinate seawater by reverse osmosis. An emergy analysis can be used to check this hypothesis. In addition, desalination may be an effective way of solving some of the water scarcity problems along the major

coastal towns, such as Walvis Bay and Swakopmund. Fresh water would certainly raise standards of living and attract more tourism along the coast. Furthermore, the water produced from the desalination process is already drinkable and does not require any additional treatment.

The transformity, a measure of energy quality, for desalinated water (5.8 E6 sej/J) is approximately equal to that of gasoline (6.6 E6 sej/J) (Odum 1996). We would consider flushing toilets or washing cars with gasoline to be a foolish luxury. Therefore, to use this desalinated water for anything but direct human consumption, or in industrial applications such as pharmaceutical production, would be a gross waste.

The two other alternatives, the Kavango pipeline and the groundwater scheme, are only marginally better than the desalination option. Both have a very low percent renewable index, a low EYR, a low ESI, and high transformities. In addition, the EIR for both alternatives is more than 50 times greater than what it should be to effectively match such development with the surrounding environment (Buenfil 1999). Based on emergy theory, for a product to effectively compete in the market for the long term it has to have an EIR similar to that of its surrounding region.

However, if one of these three alternatives has to be selected, the emergy analyses would indicate the groundwater alternative as the most appropriate for the following reasons:

1) Most of the emergy indices for the groundwater option are slightly more favourable than those for the pipeline or the desalination projects (see Appendix Table A5).
2) The total water capacity of the groundwater systems would be 20 million m^3 per year versus 17.3 million m^3 per year for the Kavango pipeline.
3) Assuming that the maximum sustainable pumping yield used in the analysis (20 million m^3 per year) is indeed sustainable (i.e. groundwater extraction is less than the natural recharge rate), then this option has provably a lower impact on the local region relative to the pipeline (see Appendix Table A4).
4) The water quality of groundwater is typically much higher than that of surface water. Thus, the Tsumeb groundwater may only require some simple treatment (e.g. hardness removal). The water coming out of the Kavango pipeline, on the other hand, will require more sophisticated and expensive treatment to remove the turbidity and purify the water to make it potable.
5) Although the estimated capital cost for developing the pipeline is lower than the groundwater project, this difference is minimal, i.e. 139 million dollars for the pipeline vs. 150 million dollars for the groundwater scheme (Water Transfer Consultants 1997). Furthermore, if the treatment cost for purifying the water would be included, the groundwater alternative would provably be more cost-effective than the pipeline option.
6) Once Windhoek is connected to the Kavango River, the city will probably become dependant on this water to sustain its population and economic growth. This could be catastrophic, not only because of the potential loss of a significant portion of the delta, but also because it could trigger political, and even military, disputes with Botswana and Angola.

Nevertheless, these advantages do not mean that the groundwater option is the best alternative and should be implemented. Nor does it mean that supplying Windhoek with groundwater from the Tsumeb aquifer system will solve the water scarcity problems of

the city. It is imperative that the rest of the water supply alternatives are evaluated with emergy to make a solid and secure decision.

Ultimately the real problem of Windhoek is not of engineering new designs for supplying water to meet projected demands; it is of maximising water use efficiency and reducing the rapid growth of the population. Windhoek, which accounts for about 50% of Namibia's urban population with close to 200,000 people, is the principal migration destination in Namibia with approximately 40% of all migration (see Pendleton and Frayne, this volume). Although this high migration rate will continue to increase the population of the city, unfortunately the HIV/AIDS epidemic could halt growth and even lower the population in the near future. The prevalence rate of the HIV/AIDS infection in Windhoek, based on women who sought prenatal care in 1996, was 16% (US Bureau of the Census 1998). Furthermore, by the end of 1997 approximately 20% of the adult population (ages 15-49) in Namibia was estimated to be infected with HIV/AIDS (UNAIDS/WHO 1998). Despite the high present rate of migration and its possible increase in the future due to the increase of rural HIV/AIDS morbidity and mortality, this epidemic may reduce Windhoek's projected water demand for decades to come. Consequently, more precaution should be taken before spending millions of dollars for developing new water supply networks, such as the Kavango pipeline, which could degrade the regional environment.

4   Policy Recommendations

There are still many things the government of Namibia can do to alleviate the water scarcity problems of the city. Some of these measures are:

1) Promote the decentralization of the government, commerce and industry: "Although urban centres in northern Namibia are at present small, containing 5% of the total Namibian population compared to 12% in Windhoek alone, decentralization and a possible second capital city (as envisaged in the National Land Policy) would ease demands on water in the central region significantly" (Blackie and Tarr 1998).
2) Continue to implement measures to reduce the very high rate of women's fertility to lower the rate of population growth.
3) Develop new and better water conservation programs. For example, reducing the growth of water demand by 3% per year would allow current supplies to last to the year 2003 (Day 1997).
4) Invest in repairing pipes from the water distribution system to reduce water leaks.
5) Invest in covering the open canal section of the ENWC from Omatako to Grootfontein to minimise evaporation.
6) Since no major health problems have been observed from reusing treated wastewater to augment the potable water supply system (Isaacson and Sayed 1988), continue this practice.
7) Stop subsidising the water sold to the public and let the market determine the actual economic value of this precious resource. In 1997, the cost of water in Windhoek was about 1.2 N\$ per m^3; however, a more realistic cost should be about four times as much (Day 1997). The appropriate price of water should also be based on socio-economic studies.
8) Charge more money to excessive consumers: "High income residents use vastly more water than low income residents. For instance in Windhoek residents of high

income areas use 615 litres of water per day on average compared to 70 litres per day by low income area residents" (Blackie and Tarr 1998).

5   Conclusion and Recommendations

The main objective of this research was to use emergy analysis to recommend the most appropriate way of supplying fresh water to Windhoek. Emergy is the energy required to make something. Emergy evaluations are based on a donor system of value where all the fundamental forms of energy are included which are driving a system and put into the common units of solar emergy for a meaningful comparison. In emergy evaluations, the "free" work of nature (such as sunlight, rain, and soil generation) is taken into account and added to the work produced by humans and their machines in complex social/natural systems.

The most effective way of supplying water to Windhoek from the three water supply systems evaluated was determined to be the groundwater option. This alternative consists of pumping 20 million m^3 per annum of groundwater from the Tsumeb aquifer system, comprised of the Unconfined Kalahari (11.5 million m^3/annum) and the Carbonate (8.5 million m^3/annum) aquifers, and piping the water to the Eastern National Water Carrier near Grootfontein. Compared to the other two supply alternatives (the Kavango pipeline and the desalination project) the groundwater option appears to be a better choice for maximising the overall welfare of nature and society in the long term. However, prior to pumping groundwater from the Tsumeb aquifer, it is recommended to conduct emergy evaluations of the other possible water supply alternatives mentioned in this study (see Appendix Table A1).

This report only shows the benefits to Windhoek and some possible losses to the local regions. A complete analysis would need to investigate the net changes in emergy at the local (e.g. Rundu/Okavango Delta), national (e.g. Namibia), and regional (e.g. Southern Africa) levels to be certain of selecting the most appropriate and sustainable alternative. For example, it is possible that the best option might be to desalinate water since, regardless of its high economic and emergetic costs, the net change of emergy (i.e. emergy gain minus emergy lost) might bring the greatest benefit for both man and nature at all levels. Consequently, the net change in emergy at the local, national, and regional economies have to be analysed before deciding which water supply alternative to develop.

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Acknowledgements

Appendix

Table A1. Principal water supply alternatives for Windhoek, Namibia.

Water supply alternative	Characteristics
1. Kavango Pipeline (from Rundu to Grootfontein)	Pipeline diameter (type): 800 mm (GRP) Pipeline length: 260 km Pumps: 4 booster pump stations Flowrate: 17.3 E6 m^3/year (note: 1 E6 = 1 x 10^6) Total estimated capital cost: 603 million N\$ Estimated time to develop: 1.5 years
2. Desalination of seawater (from Paaltjies to the Von Bach Dam Treatment Works near Okahandja)	Pipeline diameter (type): Assumed 800 mm (GRP) Pipeline length: 350 km (estimated) Pumps: Assumed 12 booster pump stations Static head: 1,330 m Flowrate: Assumed 17.3 E6 m^3/year Total estimated capital cost: 1,895 million N\$ Estimated time to develop: 4 years

3. Tsumeb Aquifers
(to be connected to the ENWC near Grootfontein):
 	
   a) Unconfined Kalahari Aquifer
 	
   b) Carbonate Aquifer
	a) Unconfined Kalahari Aquifer
	Collector pipes diameter (length): from 160 mm to 500 mm (354 km)
	Delivery pipe diameter (length): 700 mm (35 km)
	Wells: 120 production boreholes with sustainable yields of 264 m^3/day
	Long term sustainable yield: 11.5 E6 m^3/year
	Total estimated capital cost: 320 million N\$
	Estimated time to develop: 6 years
	b) Carbonate Aquifer
	Collector pipes diameter (length): from 160 mm to 400 mm (290 km)
	Delivery pipe diameter (length): 800 mm (60 km)
	Wells: 80 production boreholes with sustainable yields of 290 m^3/day
	Long term sustainable yield: 8.5 E6 m^3/year
	Total estimated capital cost: 326 million N\$
	Estimated time to develop: 6 years
	Total estimated capital cost (a + b): 646 million N\$

4. Platveld aquifer (to be connected to the ENWC)	Collector pipes diameter (length): from 160 mm to 400 mm (204 km) Delivery pipe diameter (length): 500 mm (60 km) Wells: 70 production boreholes with sustainable yields of 196 m^3/day Long term sustainable yield: 5.0 E6 m^3/year Total estimated capital cost: 277 million N\$ Estimated time to develop: 6 years.
5. Kunene River pipeline (from Oshakati to Grootfontein)	Pipeline diameter (type): 800 mm (GRP) Pipeline length: 346 km. Flowrate: 17.3 E6 m^3/year Total estimated capital cost: 875 million N\$ Estimated time to develop: 2.5 years
6. Orange River pipeline (from Noordoewer to the Von Bach Dam Treatment Works near Kahandja, 80 km north of Windhoek)	Pipeline diameter (type): Assumed 800 mm (GRP) Pipeline length: 850 km. Pumps: 15 booster pump stations Flowrate: Assumed 17.3 E6 m^3/year Total estimated capital cost: 2,418 million N\$ Estimated time to develop: 8 years
7. Treated wastewater reuse (Goreangab Municipal Reclamation Works)	Capacity: 2.4 E6 m^3/year (being increased to 7.7 E6 m^3/year) Approximate unit cost of reclaimed water: 1994 US\$ 0.7 per m^3

8. Dams on ephemeral rivers:
  a) Donkersan Dam
  b) Friedenau Dam
	No data available

9. Other pipelines:
  a) Congo (~ 1000 km)
  b) Zambezi (~ 800 km)
	No data available

10. Water conservation programs	No data available

Table A2. Emergy evaluation tables for each water supply alternative.

a) Emergy evaluation of the Rundu – Grootfontain pipeline (17.3 x 10^{6} m[3]/year)

Note and Item	Energy Data (unit/yr)	Unit	Solar Transformity (sej/unit)	Solar Emergy (xE18 sej/yr)	EmDollars[a] 1996 (x1000 US$/yr)	EmDollars[a] 1996 per m[3]
RENEWABLE (FREE) RESOURCES						
1. Kavango River water[b]	8.19E+13	J	4.8E+04	4.0	233.6	0.01
PURCHASED AND OPERATIONAL INPUTS						
2. GRP pipe[b]	3.16E+13	J	6.6E+04	2.1	122.5	0.01
3. Concrete[b]	1.40E+06	kg	1.0E+12	1.4	82.4	0.005
4. Fuels[b]	7.49E+12	J	6.6E+04	0.5	29.1	0.002
5. Electricity[b]	2.29E+14	J	1.6E+05	36.6	2151.9	0.12
6. Machinery & equipment[b]	7.32E+04	kg	6.7E+12	0.5	28.9	0.002
7. Labour, services & capital costs	3.97E+06	$	1.7E+13	67.4	3966.2	0.23
8. Operating costs	9.81E+05	$	1.7E+13	16.7	981.4	0.06
9. Maintenance costs	9.63E+05	$	1.7E+13	16.4	962.8	0.06
TOTAL				145.5	8558.7	0.49

b) Emergy evaluation of desalinating water from the coast and piping it to the Von Bach Dam near Okahanja (17.3 x 10^{6} m[3]/year)

Note and Item	Energy Data (unit/yr)	Unit	Solar Transformity (sej/unit)	Solar Emergy (xE18 sej/yr)	EmDollars[a] 1996 (x1000 US$/yr)	EmDollars[a] 1996 per m[3]
RENEWABLE (FREE) RESOURCES						
Sea or brackish water[b]	2.51E+14	J	7.40E+03	1.9	109.4	0.01
PURCHASED AND OPERATIONAL INPUTS						
GRP Pipeline[b]	4.25E+13	J	6.60E+04	2.8	164.9	0.01
Concrete[b]	1.71E+06	kg	1.00E+12	1.7	100.8	0.01
Electricity[b]	1.02E+15	J	1.60E+05	163.7	9629.2	0.56
Labour, services & capital costs	1.26E+07	$	1.70E+13	214.1	12591.4	0.73
Operating costs	4.31E+06	$	1.70E+13	73.3	4311.9	0.25
Maintenance costs	8.81E+05	$	1.70E+13	15.0	881.4	0.05
TOTAL				472.4	27789.0	1.61

c) Emergy evaluation of linking the Tsumeb aquifer with the ENWC (20.0 x 10^{6} m[3]/yr)

Note and Item	Energy Data (unit/yr)	Unit	Solar Transformity (sej/unit)	Solar Emergy (xE18 sej/yr)	EmDollars[a] 1996 (x1000 US$/yr)	EmDollars[a] 1996 per m[3]
RENEWABLE (FREE) RESOURCES						
Groundwater[b]	9.4E+13	J	1.7E+05	16.4	962.1	0.048
PURCHASED AND OPERATIONAL INPUTS						
Collector pipes (steel)[b]	7.3E+05	kg	1.8E+12	1.3	76.4	0.004
Delivery pipeline (GRP)[b]	1.1E+13	J	6.6E+04	0.7	42.7	0.002
Concrete[b]	1.1E+06	kg	1.0E+12	1.1	62.4	0.003
Electricity[b]	2.1E+14	J	1.6E+05	33.6	1976.5	0.099
Pumps and machinery[b]	6.1E+04	kg	6.7E+12	0.4	24.0	0.001
Labour, services & capital costs	4.3E+06	$	1.7E+13	73.1	4300.0	0.215
Operating costs	7.9E+05	$	1.7E+13	13.4	790.0	0.040
Maintenance costs	3.0E+05	$	1.7E+13	5.1	300.0	0.015
TOTAL				145.1	8534.1	0.43

[a] Solar emergy divided by 1.7 E13 sej/1996 US$ (emergy per dollar ratio for Namibia in 1996).
[b] These emergy values are for the material and/or energy content only, independent of the $ paid to humans.

Table A3. Footnotes for the emergy analysis, local impacts, and emergy indices for the Kavango pipeline system.

RENEWABLE (FREE) RESOURCES	
1. Kavango River water	
Volumetric flowrate: 1.73 E7 m³/year	(Water Transfer Consultants, 1997)
Total dissolved solids (TDS): 50 ppm	(Day, 1997)
Average temperature: 288 K	Estimated
Gibbs Free Energy (G)=[(8.33 J/mole/K)(K)/(18 g/mole)]*ln(1000,000-TDS in ppm/965,000 ppm)	
G: 4.74 J/g	
Density of water: 1.0 g/ml	Estimated
Energy = (volume)(G)(density)(1.0 E6 ml/m³)	
Energy: 8.19 E13 J/yr	
Transformity: 4.85 E4 sej/J	(Odum, 1996)
PURCHASED AND OPERATIONAL INPUTS	
2. Glass reinforced pipe (GRP): filament winding process; composed of glass-fiber reinforced polyester resin	
Expected lifetime of the pipeline: 35 years	(Water Transfer Consultants, 1997)
Diameter of pipeline (inner): 0.8 m	(Water Transfer Consultants, 1997)
Diameter of pipeline (outer): 0.85 m	Estimated
Area of GRP material: 0.065 m²	(Area outer – Area inner)
Length of GRP pipeline: 260 km	(Water Transfer Consultants, 1997)
Volume of pipeline: 16846.8 m³	(Area outer – Area inner)*(length)
Density of GRP material: 1.9 MT/m³	(T3 Tank Manufacturers)
Mass of GRP material: 32,009.0 MT	(vol. * density)
Total GRP material required: 36,810.3 MT	(Assume 15% defects, breakage, rubber joints, etc.)
Energy (J/yr) = 3.16 E13 J/yr	(36810.3 MT / 35 years)*(1000 kg/MT)*(30.0 E6 J/kg)
Transformity: 6.60 E4 sej/J	(Brown, 1994) for plastic and rubber
3. Concrete	
Concrete use for the pipeline layout: 150.0 kg/m	Estimated
Total concrete for layout: 1.11 E6 kg/yr	(150 kg/m)*(260,000 m) / 35 years
Concrete for pup stations, etc.: 2.86 E5 kg/yr	Estimated: (10,000 MT*1000 kg/MT) / 35 years
Total concrete required: 1.40 E6 kg/yr	
Emergy per mass: 1.0 E12 sej/kg	(Brown, 1994) assume same as for $CaCO_3$
4. Fuels	
Fuel use (oil, gasoline): 30.0 L/m	Estimated
Total energy use: 7.49 E12 J/yr	(30 L/m)*(260,000 m)*(0.96 kg/L)*(3.5 E7 J/L gasoline)/35 years
Transformity: 6.60 E4 sej/J	(Odum, 1996)
5. Electricity	
Electric power required per year: 7250 kW	(Water Transfer Consultants, 1997, p. 70)
Energy: 2.29 E14 J/yr	(7.25 E6 W)*(1 J/W-sec)*(3600 sec/hr)*(24 hr/day)*(365 day/yr)
Transformity: 1.60 E5 sej/J	(Odum, 1996)
6. Machinery & transport equipment	
a) Trucks & transport equipment: 6.67 E4 kg/yr	Assume 100 trucks with an avg. weight of 10 MT / 15 year lifetime
b) Pumps, steel pipes, etc.: 3.67 E3 kg/yr	Assume: 4 pump stations @ 10 MT + 1 base pump station @ 15 MT = 55 MT/15 years
c) Shovels, tools, etc.: 4.00 E2 kg/yr	Assume 1000 shovel, tools, etc. @ 2 kg = 2000 kg / 5 year lifetime
d) GRP machinery: 2.50 E3 kg/yr	Assume: 50 MT / 20 year lifetime
Total: 7.32 E4 kg/yr	(a + b + c + d)
Emergy per mass: 6.70 E12 sej/kg	(Brown, 1994)

7. Labour, services & capital costs	
Services & capital expenditure: 3.97 E6 US$ (1996)/year	discounted capital expenditure = (596.92 MN$) / (4.3 N$/US$) / 35 years (Water Transfer Consultants, 1997).
Emergy per dollar ratio: 1.70 E13 sej/US$ 1996	(Buenfil, 1999) (assuming 3% growth of GDP per year)
8. Operating costs	
Operating fixed costs: 5.35 E5 US$ (1996)/yr	(2.3 MN$/yr) / (4.3 N$/US$) (Water Transfer Consultants, 1997)
Pumping (electricity) costs: 4.47 E5 US$ (1996)/yr	(1.92 MN$/yr) / (4.3 N$/US$) (Water Transfer Consultants, 1997)
Total: 9.81 E5 US$ 1996	
Emergy per dollar ratio: 1.70 E13 sej/US$ 1996	(Buenfil, 1999) (assuming 3% growth of GDP per year)
9. Maintenance costs	
Direct maintenance costs: 9.63 E5 US$ (1996)/yr	(4.14 MN$/yr) / (4.3 N$/US$) (Water Transfer Consultants, 1997)
Emergy per dollar ratio: 1.70 E13 sej/US$ 1996	(Buenfil, 1999) (assuming 3% growth of GDP per year)

ENVIRONMENTAL AND SOCIAL IMPACTS

10. Loss of water to the Kavango Delta (this is the water removed from the Kavango river)	
Volumetric flowrate: 1.73 E7 m³/yr	(Water Transfer Consultants, 1997)
Gibbs Free Energy (G): 4.74 J/g	See note 1
Density of water: 1.0 g/ml	Assumed
Energy: 8.19 E13 J/yr	(volume)(G)(density)(1.0 E6 ml/m³)
Transformity: 4.85 E4 sej/J	(Odum, 1996)

11. Loss of net primary productivity of the delta (net primary productivity is a common ecological indicator of all the organic matter generated by plants during a given time)	
Net primary production of the delta: 2.093 E17 J/yr	(100 E11 g of organic matter / yr.)*(5 kcal/g)*(4186 J/kcal) (Scudder *et al.*, 1993)
Avg. flow of runoff to the delta: 1.0 E10 m³/yr	(Scudder *et al.*, 1993)
% of rate abstraction by pipeline: 0.17%	(1.73 E7 / 1.0 E10)*100%
Loss of productivity in the delta: 1.07 E15 J/yr	Assume 1% reduction in water flow reduces productivity by 3%: (0.17 * 3.0)/100 * 2.09 E17 J/yr
Transformity: 9.0 E3 sej/J	(Odum, 1996) assumed to be the same as estuarine net production

12. Loss of regional wildlife	
Diverging 17.3 E6 m³/yr of river water to Windhoek will result in an average decrease of approximately 0.2% of the river's current flow (Water Transfer Consultants, 1997). However, this percentage will be much greater during the dry season since there is less flow and the same amount of extraction. I assumed that during the dry season 1% of the river will be "missing." This higher value will be used to calculate the wildlife loss since water for wildlife survival is limited during the dry season. From a simple computer simulation model (Buenfil, 1999), a 1% decrease in the river flow might reduce total wildlife biomass of the delta from 110.0 E6 kg/yr to 108.5 E6 kg/yr. This results in a net loss of 1.5 E9 g/yr. The model was calibrated using data from Scudder *et al.* (1993). Thus, assuming a 1.5 E9 g/yr decrease in the average wildlife biomass:	
Wildlife biomass loss in J = 3.14 E13 J/yr	(5 kcal/g of wildlife)(4186 J/kcal)(1.5 E9 g/yr)
Transformity: 4.0 E6 sej/J	(Odum, 1996) assuming average wildlife transformity is similar to the transformity of veal

13. Loss of ecotourism	
Tourist $ attracted by the Kavango basin: 165 E6 US$/1996	(Parry & Murray-Hudson, 1997, p. 59)
Tourist $ "lost" because of the pipeline: 3.3 E6 US$/1996	Assuming a 2% reduction in tourism to the region because of the pipeline
Emergy per dollar ratio: 1.20 E12 sej/$	(Odum, 1996) avg. sej/$ ratio for the developed world

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EMERGY RATIOS AND INDICES	
14. Transformity of Kavango River water at Grootfontein	
Total emergy (yield): 145.5 E18 sej/yr	total emergy (sum of items 1 to 9 in Table A2-a)
Energy: 8.19 E13 J/yr	same as note 1 above, (assuming negligible losses)
Transformity: 1.78 E6 sej/L	(total emergy/energy) = (145.5 E18 sej/yr)/(8.19 E13 J/yr)
15. % Renewable	
Renewable emergy (R): 4.0 E18 sej/yr	emergy of water (item 1 in Table A2-a)
Non renewable emergy: 1.4 E20 sej/yr	(emergy of items 2 to 9 in Table A2-a)
% Renewable: 2.8	(renewable / non-renewable) * 100%
16. Emergy Investment Ratio	
Free emergy: 5.4 E18 sej/yr	(items 1 and 3 in Table A2-a)
Purchased / imported services & materials (F): 1.4 E20 sej/yr	(items 2,4,5,6,7,8 and 9 in Table A2-a)
EIR = purchased / free emergy: 26.1	
17. Emergy Yield Ratio	
Total emergy (yield): 145.5 E18 sej/yr	total emergy (sum of items 1 to 9 in Table A2-a)
Emergy of feedbacks: 140.1 E18 sej/yr	(items 2,4,5,6,7,8 and 9 in Table A2-a)
EYR = yield / feedbacks: 1.04	
18. Environmental Loading Ratio	
Renewable emergy: 3.97 E18 sej/yr	emergy of water (item 1 in Table A2-a)
F + local non-renewable: 1.4 E20 sej/yr	(items 2 to 9 in Table A2-a)
ELR = [(F + local non-R) / R]: 35.6	
19. Emergy Sustainability Index	
ESI: 0.03	ESI = EYR / ELR
20. Emergy Benefit to the Purchaser	
Price to be paid for the piped water: 5.9 E6 US$ (1996)/yr	yearly price of water to recover all monetary costs = sum of dollar flow of items 7 to 9 in Table A2-a
Emergy of money paid: 1.0 E20 sej/yr	(5.9 E6 US$/yr * 1.7 E13 sej/US$)
Emergy value of the piped water: 1.45 E20 sej/yr	total emergy of product water per year
EBP: 1.45	(emergy of water / emergy of money paid)
21. EmDollar value per m^3 of water delivered to Grootfontein	
Total solar emergy: 145.5 E18 sej/yr	(sum of items 1 to 9 in Table A2-a)
Emergy per money ratio: 1.7 E13 sej/1996 US$	(Buenfil, 1999)
Annual flowrate: 17.3 E6 m^3/yr	(Water Transfer Consultants, 1997)
Emdollars per m^3: 0.49 emdollar/m^3	(Solar emergy/yr)/(emergy per money ratio)/(annual flowrate)

Table A4. Expected negative impacts from each water supply system.

Note and Item	Energy Data (unit/yr)	Unit	Solar Transformity (sej/unit)	Solar Emergy (xE18 sej/yr)	EmDollars[a] 1996 (x1000 US$/yr)	EmDollar[a] 1996 per m³
a) Possible negative effects of the pipeline project on the Okavango Delta						
10. Loss of water	8.19E+13	J	48460	3.97	233.6	0.014
11. Loss of net primary productivity	1.047E+15	J	9000	9.63	566.5	0.033
12. Loss of regional wildlife	3.144E+13	J	4.0E+06	125.60	7388.2	0.427
13. Loss of tourism	3.340E+06	$	1.2E+12	3.96	232.9	0.013
TOTAL				143.20	8421.2	0.487
b) Possible negative effects of the desalination project on the coastal region near Walvis Bay						
Loss of seawater	4.10E+14	J	7435	3.05	179.3	0.010
Rain required to dilute the brine	2.40E+14	J	7435	1.78	105.0	0.006
Loss of shelf net primary productivity	2.40E+14	J	9.00E+03	2.16	127.1	0.007
TOTAL				6.99	411.3	0.024
c) Possible negative effects of pumping Tsumeb groundwater on the Stumeb and Etosha Pan regions						
Loss of water storage	9.4E+13	J	1.74E+05	16.36	962.1	0.048
Loss of regional wildlife	6.0E+12	J	4.0E+06	24.00	1411.8	0.071
Loss of tourism	3.9E+05	$	1.20E+12	0.47	27.5	0.001
TOTAL				40.82	2401.4	0.120

[a] Solar emergy divided by 1.7 E13 sej/1996 US$ (emergy per dollar ratio for Namibia in 1996).

Table A5. Comparison of emergy indices among the three water supply systems evaluated (bolded numbers are the preferred among the 3 alternatives).

Note[a] and Emergy Index	Best when index:	a) Pipeline	b) Desalination	c) Groundwater
14. Transformity of transported water (sej/J)	↓	1.78 E6	5.76 E6	**1.53 E6**
15. % Renewable	↑	2.81	0.40	**12.71**
16. Emergy Investment Ratio	↓	26.09	131.15	**7.81**
17. Emergy Yield Ratio	↑	1.04	1.01	**1.14**
18. Environmental Loading Ratio	↓	35.64	252.92	**7.87**
19. Emergy Sustainability Index	↑	0.03	0.004	**0.14**
20. Emergy Benefit to the Purchaser	↑	1.45	1.56	**1.58**
21. EmDollar value per m³ of water delivered	↓	0.49	1.61	**0.43**

[a] These numbers refer to the corresponding notes in Table A3, which explain how each emergy index for the pipeline project was calculated.

A STRATEGY FOR APPROPRIATE TECHNOLOGY FOR DEVELOPMENT IN NAMIBIA – RECENT UNIVERSITY OF NAMIBIA INITIATIVES: SELECTED EXAMPLES AND CALL FOR COLLABORATION

A.T. Critchley, F.J. Molloy, J.D. van Harmelen, and K.E. Mshigeni

Abstract

The University of Namibia's Mission Statement gives the core functions of the institution as: teaching, research and community outreach. In the context of a developing African country, the university also has a heavy social responsibility. It is believed that the responsible application of appropriate science and technology can address a number of development issues. Sustainable utilisation of natural resources, and knowledge-based value addition (valorisation) of new products and services forms a cornerstone of this strategy. In this regard, UNAM has made much progress and has become a regional centre for research in ZERI-related activities.

Under-pinning elements of research and development by an academic institution are partnership and support from the private and public sectors. UNAM has made great strides in this field and is responsible for a number of innovations, particularly in the implementation of a unique private/public partnership for addressing the utilisation of waste in Windhoek.

The technology which Namibia needs in order to make use of its many biological and physical assets exists around the world. There needs to be a transfer of this technology to enable the creation of employment and to improve living standards in Namibia. These initiatives provide job creation and training opportunities contributing to the wider Namibian community in terms of poverty alleviation and quality of the environment. This paper not only calls for collaboration with colleagues around the world, but indicates where Namibia has developed expertise which can be of benefit to both developing and developed countries. The transfer of technology can be a two-way process!

1   Introduction

Namibia has a single university based in the capital city of Windhoek. The university has a responsibility to the wider regions of the country and has a number of satellite centres based in the major towns.

Basic and applied research activities are required to improve employment opportunities and the standard of living of the Namibian population. Advances in, and applications of, science and technology and knowledge-based value added production

and entrepreneurship (Angula 2000) will allow Namibia to progress from a consumer society to a regional producer, with goods of high export potential. In this context it will be essential for the university to forge alliances with both public and private sector organisations both within Namibia and internationally. These alliances can be organised in a variety of ways, ranging from full commercial partnerships to strategic alliances or service/consultancy contracts. Development of capacity building programmes which have job creation as one of their primary goals should be given priority.

Namibia has a number of regional assets, including natural and human resources. The potential for development and advancement of the country is high. It has a number of competitive advantages in the form of sunshine, pristine land, low population density, wide open spaces and wilderness. It probably has the cleanest marine environment in the world! These are competitive marketing "tools/advantages" which should be promoted when Namibian goods are exported.

Namibia is the driest country in sub-Saharan Africa. A major factor limiting the development of agriculture and industry is access to sufficient water supplies. Given the large land area, the population is widely dispersed.

Since the educational responsibilities of the University of Namibia are geographically dispersed, with its various satellite centres, it is important that electronic delivery of information to off-campus students is implemented. High quality teaching materials need to be produced, taking into account all of the advantages and disadvantages of electronic delivery and self-paced learning. The production of such teaching materials requires skills in instructional design and preparation, presentation and delivery of electronic information.

This paper highlights selected efforts of the University of Namibia in the area of sustainable and responsible utilisation of natural resources. The use of organic wastes and wastewater as valuable resources for value-addition activities is outlined. Much of the progress made by UNAM has been through strategic partnerships with private companies (e.g., Namibia Breweries, the meat processing companies Hartlief and Meatco, and the seaweed producer Taurus Products) and this is discussed throughout the paper. In addition, we are calling for even wider participation and collaboration with the international scientific and development community.

2 Support for Research Capacity and Development Enhancing Training, Research and Information Technology

This section highlights successful areas of research at UNAM and identifies further agenda for development and calls for co-operation from the international community. A considerable amount of basic technology already exists, both locally and internationally. We do not need to reinvent the wheel, but rather look at importing (licensing) technology from partners, and then promote the diffusion of information and implementation of appropriate technology for development in Namibia.

Namibia should be involved with site testing and modifications for local conditions (e.g., solar energy applications, desalination, etc.). Improvements to design and applications would be forthcoming from such research. Namibia should then look to manufacture components and assembly of parts locally to reduce import costs and to

create local employment and knowledge, i.e. centre(s) of expertise would be established.

Namibia currently imports over 90% of its consumer products; the value of imported fresh produce alone is estimated at N$1.5 billion! Recently the Multidisciplinary Research and Consultancy Centre at the University of Namibia established a Technology Transfer Office which is currently involved in a project with the University of Stuttgart, Germany. The object is to locally produce batteries for the storage of solar-generated power. The TTO should become a centre of expertise for the examination and assessment of alternative solutions and applications of science and technology for the benefit of Namibia. Such a centre of expertise would also have a significant impact regionally.

The TTO requires support to investigate other pressing applications of technology, for example:

- It is surprising how little use is made of the abundantly available solar energy in Namibia. The TTO should be involved in developing wider applications and investigating cost reductions.

- Desalination technology linked to solar energy exists; its application in Namibia should be pursued.

- Clustering of industries requiring hot water and steam around a solar generator or biodigester should be investigated. Steam can be used, for instance, for pasteurisation of substrates for mushroom production. This is already a well-developed technology in Namibia. Hot water can be used for industrial extraction processes, for example, for gel extraction from plant biomass. Hot water streams can then be used for soap production, where the remaining heat as well as the clustering of waste streams are used for the recovery of glycerol. This is but one example where waste streams can be clustered to provide resources and inputs to other industries, following the zero emissions principles. The TTO should look at such principles for clustering.

- The novel application of solar and wind technology for reduction of dependency on high cost electricity (particularly in integrated systems such as integrated mariculture). Agitation, aeration and water pumping can be achieved with alternate sources of energy.

- The marketing of goods for exports needs to focus on Namibia's pristine environment and add value to the abundant natural resources. However, access to certain markets (particularly the EU) requires that total quality management standards of quality control and assurance are achieved and maintained. Indeed such quality centres need certification. The TTO office should be involved with ensuring that these quality standards can be met. One example is that Namibia is producing very high-quality white fish which is exported to the EU. But the necessary certification has to be obtained through South Africa. The testing and certification agency should be in Namibia. The TTO needs to assist in establishing and having such facilities accepted by the EU. The costs involved in going it alone can never be justified or sustained. This can only be achieved in a partnership arrangement with an international certification agency!

- Import replacement of fresh goods, many of which can be produced locally. The TTO needs to investigate and promote those commodities which can be cost

effectively produced in Namibia. Market gardening and the use of recovered water and waste recycling principles should be a central focus.

3   Zero Emissions Research and Initiatives

The Zero Emissions Research and Initiatives programme is an international initiative. The underlying principles of this initiative are essentially to ensure zero waste and zero emission. In the instance of the former, waste is generally considered to be a resource in the form of an input in some downstream activity.

Although the total arena of waste and emissions is considered, most of the work in Namibia to date has been undertaken in the field of organic waste. It constitutes about 80% of problem waste in most developing countries. Organic wastes are a valuable source of nutrients, but if they are not treated or processed in an appropriate manner, they are a severe cause of pollution and a health hazard.

Another key objective of the ZERI concept is based on the philosophy of becoming less dependent on the idea of expecting the earth to produce more, but concentrating rather on doing more with what the earth produces. Some examples of this are to be found in agriculture where, in the case of cereals, we generally only utilise 8%-10% of the total biomass in an economical manner. In forestry we generally utilise only around 30% of the total tree. In the sisal industry they only utilise the fibres which comprise less than 2% of the total biomass. One could go on mentioning any number of examples.

UNAM has taken the issues of waste utilisation further and established itself as a provider of appropriate technology, entering into partnerships with the producers of organic wastes, to use certain waste streams for value addition activities, resulting in the creation of new products, services and job creation. In this regard UNAM has been working closely with Namibia Breweries (Pty) Ltd., and the meat processors Hartlief and Meatco. These corporate linkages are outlined in the following sections.

4   Case Study: Tunweni Brewery

The case study of Tunweni Brewery is an excellent example of the efforts to promote private sector co-operation with the University of Namibia. Tunweni Brewery is a wholly owned subsidiary of Namibia Breweries Ltd. and is situated on the farm Ludwigshafen, 13 km to the north of Tsumeb, which in turn is some 450 km north of Namibia's capital, Windhoek.

At Tunweni Brewery they brew a traditional (sub-Saharan Africa) beer which has as its main ingredients malted sorghum and maize meal. It is an unfiltered and very nutritious beer with an alcohol content ranging from 3.5% to 6% depending on the number of days since manufacture. This variation is a direct result of the brewing process in which the product is only partially fermented in the factory. The fermentation process is being completed in the wax board (non-Tetrapak) carton, in which the product is packaged for marketing. As a result, this product has a shelf life of only 5 to 7 days, after which it is returned to the factory for disposal. During the brewing process the following waste streams are generated:

- Solid waste: spent grains with a moisture content of 60% consisting of carbohydrates 74.3%, protein 17.4%, fibre 6.6%, and ash 0.8%; and cartons from returned beer. Solid wastes form important substrates for value addition in the process of mushroom farming, pig production and earthworm cultivation (vermi-culture) (discussed later).

- Liquid effluents: Plant washdown water – up to 20% solids (spent grains) approximately 1% caustic soda and less than 0.5% formaldehyde; boiler blowdown water – high sodium chloride content; sewage from staff ablution facilities – grey water; returned beer 5%-7% alcohol – low pH. The liquid effluents are first treated through a biodigester for the production of methane biogas and then pass the algae basins for nutrient recovery before being available for irrigation purposes.

4.1   ZERI Namibia Project at Tunweni

Our challenge in this project was to develop an integrated biosystem facility (modified from an original concept design from China) which will treat all of the above-mentioned waste streams in terms of the ZERI concept of zero waste and zero pollution. All of the organic outputs and wastewater from the brewery can be reused to produce products of higher value (e.g., biogas, mushrooms, pigs, etc.). The collaborative partner, the Tunweni Brewery, is a useful research and development ground for the integrated system since the varied produced wastes are "clustered" and then treated sequentially. In line with the demands for treatment of wastes and value addition to the components, we have constructed the following functioning facilities.

4.1.1   Settling tank and filtration unit

Although not originally included in the plan it was necessary to construct this unit in order to remove the high level of solids in the effluents from the factory (excluding sewage). It was found that the term "spent" is not an accurate description of the spent grains from this brewing process and as a result fermentation continues in any place where there is an accumulation of these solids. This factor resulted in a sharp reduction in the pH of the water which in turn interfered with the water chemistry throughout the system. In order to overcome this problem it is essential that almost all of these solids are removed. We have achieved solids removal via a gravity fed system which includes a settling tank as well as a series of filter beds consisting of a system of filter materials varying from large, hand sized stone down to fine crusher dust.

An added, unforeseen benefit of this system is that we are able to remove a considerable portion of the formaldehyde by air stripping (evaporation) in these beds.

At present the solids removed via this process can only be successfully used as an additive to the growing medium for mushroom cultivation (see this section). Other attempts for utilisation, for instance, as a substrate for earthworm farming and composting, have to date not proved to be satisfactory, due to the fact that this material starts fermenting as soon as it is reconstituted with water. In the case of mushroom farming the pasteurised fermentation of the substrate is minimised and does not interfere with mushroom growth.

4.1.2 Pig farming operations

Spent grains are mixed with commercial feed at present, primarily to provide the proteins lacking in the spent grain, but in time this protein requirement will be supplemented by a combination of residual substrate from mushroom cultivation and earthworms.

The filtered effluent, after the process as described above, is used to flush the urine and faeces from the pigpens twice a day. The reason for this is that we require the wet faeces (prior to evaporation of the ammonia) to be washed into our biodigester for maximum benefit during the anaerobic digestion process.

An added advantageous side effect of this system is that by regularly removing the faeces, the breeding medium for flies will be removed as well.

4.1.3 Mushroom farming

A detailed section on the use of mushroom cultivation for development activities is provided later in this paper. A portion (50% by dry mass) of the dried spent grains from the brewing process as well as the solids removed from the filter beds is mixed with naturally occurring veld scrub grass, which grows abundantly on the farm where the project is situated. The addition of shredded cartons from the beer returns has also been successfully added as an ingredient in the substrate. This mixture of dried veld grass, spent grain, and shredded cartons is then reconstituted with clean water overnight, pressed to reduce moisture to 70% and bagged in black PVC bags. The bags are then pasteurised at a temperature of 70º-90º C for a period of six to eight hours. The reason for pasteurisation is essentially to sterilise the growing medium partially, thereby destroying any possible competing fungi which may be present. Pasteurisation is currently done in the factory in two brewing vessels, making use of excess steam supplied from the factory's boiler. After pasteurisation the bags are inoculated with the mother spawn, sealed and then placed in the mushroom house for a period of three to four weeks for the vegetative or spawn running phase (mycelium grows throughout the substrate during this phase). The bags are then opened and placed in a specially constructed fruiting house where they produce mushrooms over a period of about 4 weeks.

Bench trials, which were able to achieve an average 82% (in some bags up to 130%) in biological efficiency vs. the planned 50%, were successfully completed prior to commercial production. Full-scale commercial production producing up to 100 kg per week is scheduled to be fully on stream by June 2000. The yield will be sold to the local hospitality industry at a selling price of approximately N$ 25/kg.

4.1.4 Biodigester and algae basins

The grey water from the factory (sewage, ablution and general purpose cleaning in the canteen and office block) is piped directly into the biodigester at a rate of 200-300 litres per day. The returned beer from the market is added to this sewage at a rate of about 200 litres per day.

The flush water from the pigpens (constructed so that all water and faeces automatically drain directly into the biodigester) also flows into the biodigester through

a common inlet. Via the process of anaerobic digestion which takes place in the purpose built digester, the organic solids are decomposed and a valuable by-product in the form of methane gas is generated. In addition some of the organic materials are mineralised into nitrates, phosphates and potassium – valuable plant nutrients. During this anaerobic digestion process some of the harmful pathogens are also destroyed.

The methane gas is used as an alternative energy source as gas for boiling the grains prior to pasteurisation as a substrate in the production of mother spawn. The pasteurisation process of these grains (making use of an ordinary commercial pressure cooker) is also done by utilising this biogas.

Three modifications have been made to the original Chinese design of the biodigester in order to improve its efficiency, measured in terms of chemical oxygen demand reduction and biogas production. The first modification was the construction of an influent distribution box that divides the wastewater flow into four pipes. The second modification was to reduce the size of the anaerobic compartment by approximately 15% in order to reduce washout of the methanogenic bacterial culture contained in the digester. The third modification was the introduction of a digester effluent recirculation system. The system is composed of a pump, timer and approximately 300 m of black polyethylene piping that carries the digester effluent to the galvanised corrugated iron roof of the pigpen, where it is heated by solar radiation. The purpose of the recirculation system is to reintroduce partially degraded organic molecules to the digester and to increase the temperature of the digester content to the optimum for methanogenic bacterial activity.

The effluent from the biodigester is fed into a series of shallow algae basins as a part of the purification process where partial nutrient removal occurs. It would seem that we would enjoy an added benefit from this process in that any remaining pathogens will be destroyed by the high concentration of UV provided by our never-ending days of sunshine coupled with the fact that the basins are very shallow.

The effluent from the algae basins is piped (gravity feed) through a series of smaller algal ponds prior to utilisation for irrigating a variety of high value cash crops. In this manner we ensure that the water is utilised <u>five</u> times: once to brew beer and clean the plant, once to flush the pigpen, once to generate biogas, once to cultivate algae, and once to irrigate crops.

4.2   General observations and conclusions

During the construction phase, wherever possible, we recycled our residual building materials. For example, wooden form-work constructed to cast the concrete structure for the biodigester was used as cladding on the pigpen. As a result the only rubble which was not used on site was about a 1/4 m^3 of small wooden blocks which were supplied to the farm workers for their use as fuel.

Although there is still much opportunity for further development at this pilot site, operational management has been handed over to the breweries. Although we are not yet in a position to claim zero emissions, we are very close to being able to claim zero waste as the scale of operation increases. The co-operation between the brewery and university has been synergistic, the experiences gained have been invaluable and the

resultant effluent treatment system can be replicated at many other sites with similar organic effluents. Indeed, based on the success of Tunweni, the University of Namibia has moved forward in the development of the Ujams site outside of Windhoek.

5   The Ujams Integrated Bio-business Public/Private Partnership

The Ujams Water Treatment Works situated to the north of Windhoek is the designated treatment works for all effluents emanating from the northern industrial area of Windhoek. Namibia Breweries Ltd. and two meat processing companies, Meatco and Hartlief, generate 97% of the influent flow. The influent content is primarily organic with low levels of heavy metals, mainly chrome, and total organic halogens resulting from solvents utilised in the manufacture of paints or in panel-beating businesses in this area. The actual infrastructure of aerobic and anaerobic ponds will form the basis of the Ujams development.

The effluent from this treatment works is rich in nutrients which are currently not being extracted. In the longer-term perspective these represent an environmental hazard in the form of organic pollution of soil and groundwater. It is also believed that it may become necessary to upgrade this operation within the short to medium-term at an estimated cost of N$ 25.73 million.

In addition high levels of solid organic waste are generated by Namibia Breweries, Meatco and the city's main sewage treatment works at Gammans. At present this waste is either landfilled or alternatively utilised in uneconomical composting operations. Closure of a landfill site situated in relatively close proximity to this industrial area has meant a considerable increase in the costs, paid by these organisations, for the removal and dumping of these materials.

In terms of the ZERI concept these wastes present an opportunity of converting them into valuable resources which can be utilised as inputs in an integrated biosystem programme which adds value to the processes and at the same time minimises waste and ensures better utilisation of scarce resources, particularly water. The final goal inherent in the implementation is to achieve the ideal of zero waste and zero pollution. Although the initial pilot phase will employ a small number of personnel, when full commercialisation commences, it is foreseen that in excess of 70 persons should be employed. In addition it is intended that the facilities constructed will serve as a centre of excellence for capacity building and a base for training persons from other centres in order to facilitate the ideal of replication.

It is appropriate to mention that the long-term objective, particularly the replication aspect in terms of expanding the means of production, is aimed at reducing Namibia's dependency on imported fresh produce from South Africa (93% of all fresh produce consumed in Namibia is imported from South Africa) (Namibian Ministry of Agriculture, Water Affairs and Rural Development, personal communication). Also inherent in this ideal are the enhancement of food security and a reduction of ailments emanating from poor dietary practice due to the unavailability of reasonable quality fresh produce.

In order to create an appropriate vehicle for the practical and sustainable implementation of the envisaged operational technology, which ensures stakeholder

ownership and commitment to the stated ideals, the ideal of forming a public/private partnership was introduced. The establishment process has been completed and a limited liability (in terms of the implications as defined in the Namibian Companies Act) company is in the process of being formed.

6 Mushroom Cultivation in Namibia: Employment and Income-Generating Opportunities from Wastes, Turning Seaweed Wastes and Waste from the Brewing Industry into Valuable Oyster Mushroom Crop

Consumption of mushrooms in Namibia is not new. Two species in particular have been traditionally harvested and eaten for some time. The termite mushroom, *Termitomyces schimperi,* is collected in the north and north-east of the country after rains, and is often sold by the roadside. The desert truffle, *Terfezia pfeilii,* is harvested in the east of Namibia and exported. The harvested quantities of both of these mushrooms are unknown, as is the sustainability of harvesting (Mannheimer and Jacobson 1998). The trade in mushrooms is small, consequently, few employment and development opportunities exist for this activity.

The only way to increase mushroom yield, thus creating employment and income, is through cultivation. To date, the two species harvested in Namibia have never been cultivated, despite the best efforts of many scientists in various parts of the world. The reason for this is the very special relationship between these fungi and termites (in the case of the termite mushroom), and certain plant species (in the case of the truffle). Investing resources in this pursuit is not advisable as the time and money invested may never give any return. Cultivation in Namibia should concentrate on the tried and tested edible mushrooms that are grown all over the world: the button mushroom (*Agaricus bisporus*), the oyster mushroom (various *Pleurotus* species), the Shiitake mushroom (*Lentinula edodes*), the wood ear mushroom (*Auricularia polytricha*), and the paddy straw mushroom (*Volvariella volvaceae*).

Cultivated mushrooms have now become popular all over the world. In 1994 the world total production of edible and medicinal mushrooms was estimated to be over five million tons, which was valued at over US$ 14 billion (Chang 1997). The bioconversion of lignocellulosic biomass to food and useful products by mushrooms has already had an impact at national and regional levels in many parts of the world. The predictions in this regard are that this impact will continue to increase. Being without adverse legal, ethical or safety effects, this form of bioconversion technology has only favourable socio-economic and employment impacts.

Currently, there is very little cultivation of mushrooms practised in Namibia. There are some small oyster mushroom cultivation ventures that are showing promising results. The relatively small local market is mostly supplied with imported mushrooms. Globally, mushrooms are in demand and a mushroom crop is a high value crop, which can be exported once local markets have been supplied.

6.1 Substrate materials and choice of mushroom

For the most part, Namibia has a semi-arid to desert environment; consequently terrestrial biological production is low and therefore organic wastes from agriculture and the natural environment are not abundant. However, due to the highly efficient conversion from substrate to mushrooms, by mushroom producing fungi, large quantities of organic materials are not required for mushroom cultivation.

Mushroom-producing fungi need cellulosic or lignified substrates to grow (Robinson 1965). There are a variety of materials, industrial wastes and low value substrates available in Namibia which, in theory, should be suitable. Many parts of Namibia have a reasonable quantity of bush and scrub grass. The harder forms of grass are not suitable for grazing but it is this very quality that makes them suitable for mushroom cultivation. The small twigs and branches from bushes and trees that are not very useful for fire or charcoal manufacture are again ideal for the cultivation of many mushrooms.

A major and ongoing crisis facing agriculture in Namibia is bush encroachment, particularly in the central, eastern and northern areas. In these areas there has been an increase in the density of thin-stemmed woody species of bush which has decreased the overall productivity of the land. It is estimated that bush encroachment accounts for annual losses of over N$ 100 million on commercial farms alone (Seely 1998). Most of the techniques used for removal of bush such as mechanical removal or use of chemicals are not worthwhile financially (Richardson 1998). This removed bush would be a rich source of substrate material for mushroom and could make combating bush encroachment a financially viable activity.

In contrast to the terrestrial environment, the marine environment of Namibia is extremely productive, and supports a valuable fishing industry, which is one of the mainstays of the economy. On the coast of Namibia seaweed growth rates are amongst the highest in the world (Molloy and Bolton 1996; Molloy 1992) and this is only now being taken advantage of by the local seaweed industry. This industry collects beach cast seaweeds for agar production, fertilisers and soil conditioners, and also cultivates the agarophyte *Gracilaria gracilis* on floating systems. Inevitably not all of the raw material collected and grown is suitable for production and so, becomes waste. This waste can be added to substrates used for mushroom cultivation (Molloy *et al.* 1999).

Substrates suitable for mushroom production require a balance between easily available nutrients and nutrient sources that require more enzymatic breakdown. If a substrate is too rich, the fungus will exhibit prolific vegetative growth but may not necessarily produce a crop of fruiting bodies (the umbrella structures that are the mushrooms). A poor substrate will not support good vegetative growth, and therefore few or no mushrooms will be produced. Substrate combinations have to be tested to determine the most suitable; much of this work has already been done at the University of Namibia. Wastes from the brewing industry, seaweed industry as well as a large variety of bush and grass species have been tested.

The choice of mushroom species depends on a number of factors:

- *Environmental conditions*. Different species have different requirements for temperature and other environmental variables.
- *The available substrates*. Not all mushrooms can be grown on the same type of substrate.

- *Available expertise.* Some mushrooms are more difficult to grow than others. If there is little available expertise, start with an easy one.
- *Market.* Only produce a mushroom for which there is a market and will fetch a good price.

The most commonly cultivated mushroom is the button mushroom. This species is a temperate species and does not do well in hot climates such as inland Namibia. This species would, however, do well on the coast, providing there was sufficient substrate available. Cultivation of the button mushroom would be possible in old mine shafts, with which Namibia is well endowed. In these shafts, temperatures are lower than outside and humidity is higher, both requirements for successful mushroom cultivation. Care would have to be taken, however, to avoid mine shafts with water contaminated by heavy metals or other toxins.

Inland Namibia is more suited to the tropical mushrooms such as the oyster mushroom, which is the second most cultivated mushroom in the world. The oyster mushroom as well as the shiitake and paddy straw mushrooms are suited to high temperatures, but low humidity is a problem.

All of the mushroom-growing technologies we have today were developed in countries with high humidity and precipitation; fungi like moist environments. To transfer these technologies to an arid country such as Namibia was bound to be challenging. Humidity on the coast is often high enough, but inland humidity has to be artificially controlled. There are cheap ways of doing this in mushroom houses. The Biology Department and Multidisciplinary Research and Consultancy Centre of the University of Namibia, in collaboration with Namibia Breweries, have adapted and developed these technologies for the oyster mushroom, so that they work well in Namibia.

6.2   Personnel requirements for successful mushroom cultivation

Mushroom cultivation is not an activity that someone without any experience or training could undertake. Minimal training is required in order to allow the trainee to experiment with the resources they have locally available. Through the experience gained in this experimentation, the trainee should become successful. To be trained, basic education would be required to understand the concepts involved in mushroom cultivation, and to understand problems when they arise.

Mushroom cultivation involves the following steps:

- Pure cultures of the fungus are grown on agar media.
- The pure culture is used to inoculate grain; after the fungus has grown through the grain, this is called mother spawn.
- Mother spawn is used to inoculate the production substrate (either pasteurised or composted).
- The fungus is allowed to grow until it has completely colonised the substrate.
- Environmental conditions are changed to initiate fruiting (mushroom production).
- Harvesting, packing and sale.

A small-scale mushroom farmer would not be able to perform step one. This step requires access to a sterile working area; avoiding contamination at this stage is critical.

The small farmer can do step two if great care is taken. Though care has to be taken with the rest of the steps, they are straightforward enough.

Support is required for mushroom farmers, particularly in the initial stages of development of this type of farming. A good reliable supply of pure culture and mother spawn is necessary for the success of the small farmer. At the moment the only source of culture and spawn is the Biology Department at UNAM; in order for the mushroom cultivation to expand, a dedicated facility needs to be set up. There are moves in this direction.

Support in the form of training will always be needed and the first steps in this direction were funded by UNDP where, in November 1999 the first mushroom cultivation training workshop took place at UNAM. This workshop aimed at training people from rural Namibia that are involved in community development projects. During this workshop the first steps were taken towards forming a mushroom growers association of Namibia.

Mushroom cultivation can be done on any scale. Initial financial outlay need not be very much and the substrate materials are virtually free. Preparation of the substrates has a cost, but this is easily recouped by the high price of the mushroom crop.

Mushroom cultivation in Namibia, though very new, shows great promise. Through training and a good support infrastructure, this activity can lead to sustainable employment and income. At a later date, if production expands enough, mushrooms could become an export commodity earning foreign currency.

7 The Henties Bay Coastal Resource Research Centre

The Henties Bay coastal resource research centre is a multidisciplinary research project on the northern coast of Namibia. The infrastructure for this work was provided through the financial support of HE, the President of the Republic of Namibia and Chancellor of the University of Namibia, Dr Sam Nujoma. The Appendix Figure shows an artists' impression of the site at Henties Bay. The objectives of the project are to look at sustainable and responsible utilisation of Namibia's coastal resources for the benefit of all Namibians, with a view to developing, testing and transferring appropriate technologies in sub-Saharan Africa.

Namibia has an almost unique situation where there is a coastal desert next to a cold, nutrient rich, and pollution free current. In fact the Benguela current (originating in the southern oceans) is one of the strongest upwelling currents in the world and underpins the Namibian fishing industry. Produce coming from this area will be of high value and marketability due to the pristine, pollution free nature of the environment. These benefits will be passed on, particularly to land-locked countries in the SADC region.

7.1 Research activities to be carried out at the centre

The Henties Bay facility will be a multi-functional and multidisciplinary research centre. It will be a demonstration facility and a training hub; the concept will be replicable throughout southern Africa. Research activities will include:

- Harnessing local, natural *physical* assets which are currently under-utilised, e.g., sun, seawater, and brackisch water.

- Capitalising on the assets of local *human* resources, many of whom are currently under-employed and in need of training in appropriate skills technologies. This will include the demonstration of, and support for, the establishment of employment opportunities for entrepreneurs in the area. It has been said that up to 70% of the local Henties Bay population is unemployed for much of the year, with some seasonal labour only in the holiday season.

- Providing solutions to food security.

- Providing a demonstration centre for the use of alternative energy and sustainable agriculture, with the expressed potential for replicability throughout the SADC region.

We are looking to utilise the *biological assets* (natural resources) of Namibia to provide skills in coastal agriculture and alternative energy utilisation: seawater and brackish water irrigation, integrated mariculture (shellfish, fish and seaweeds), biogas production from anaerobic digestion of organic wastes (to address a local sewage disposal problem and provide energy), sun, wind and wave energy.

The centre will provide extension services in the region for local people, who will then go out and put what they have learned into practice, with extension help from the centre.

A number of the technologies we need to implement already exist elsewhere in the world (i.e., alternative energy technologies, expertise in mariculture, coastal agriculture, etc.). The centre needs assistance in implementing these with some local fine tuning, and where possible, local assembly and manufacture of components.

The University of Namibia is particularly seeking collaboration with local and international colleagues to put the vision of the centre into practice.

All of the buildings have been constructed as energy efficient as possible. Solar water heating is used, buildings are designed to use passive heating and cooling. Water efficiency is a primary consideration, and recycling is a design feature of the buildings. Biogas will be produced from organic wastes as a source of energy for heating and pasteurisation. Compost will be produced on site for local agriculture. Appropriate, alternative technologies of solar, wind and wave action will be investigated. Note that a number of different systems will be tested on site to determine the best materials and designs for Namibian coastal conditions.

7.2   From concept to construction

The construction of phase 1 of the UNAM centre was completed at the end of 1999. An amount of N$ 3.25 million was provided by the Namibian government for the construction of the initial three buildings: a laboratory with accommodation for visiting scientists, a multi-purpose building (conference/seminar venue, catering and residence for on-site staff), and a workshop/security/maintenance building. Note that each building has a tower capable of storing fresh, brackish, and/or salt water.

7.3   Selected suggestions for research areas

The following specific projects are initially outlined for implementation at Henties Bay with international co-operation. They merely represent suggestions which can be modified, added to, and expanded after discussion. The proposed projects fall under the major headings: research and development of capacity, technology transfer, and knowledge-based value addition to Africa's seaweeds. All of these projects include strong elements of international, south-north and south-south co-operation, and deal with integrated mariculture and appropriate use of available energy sources.

Perhaps it is worth mentioning that integrated mariculture requires in-flowing water recycled through various activities and that the quality of water returning to the sea should be the same as that coming into the system. Fish and shellfish can be grown in land-based ponds, raceways or floating cages. When grown intensively they produce high levels of dissolved wastes (nitrogen and phosphorus); these elements are food to photosynthetic organisms (i.e., algae), which are used to reduce the nutrients. The algae produced have a value as food or for the industrial gels they contain, or they can be used as a raw material food source to be fed back to herbivorous fish and shellfish. Integrated mariculture in developed countries often requires considerable energy inputs and we are looking to replace these through wind and solar applications.

A pre-requisite for any form of integrated mariculture is that there are facilities for producing juvenile stages (spawn, spat and seed stock). These have special larval feed stages (generally very small microalgae, e.g., *Nannochloropsis,* diatoms and small invertebrates such as rotifers and brine shrimp).

Objective: Namibia should be able to produce high quality fish and shellfish for local consumption and export within a period of five years. The skills for such production should provide local employment opportunities and improved livelihoods for Namibians.

An integrated system of fish, shellfish and algal production needs to be established, with research into ponds and raceways on land and cages and rafts anchored in the sea. Research is required to find the best locally available species for intensive cultivation and/or imported cultivated species. Quality and assurance testing needs to be performed locally to guarantee acceptance by overseas markets (especially EU). Research is required into the energy efficiency of pumping, aeration and turbulence using alternative sources of energy including: solar pumps, wind lifts, Archimedes' screw, etc., as alternatives to expensive electricity and compressed air.

The technology for intensive mariculture exists in several areas of the world. Namibia has a number of competitive advantages over other producers, e.g., coastal land availability, pollution-free seawater, sun, wind wave action, labour force, etc. We are seeking strategic alliances with institutions who are willing to transfer existing technology (in mariculture and alternative energy) for assessment in Namibia, and then to assist in training and research into local specific modifications (particularly in reduction of energy requirements). Namibia currently does not have the expertise to produce the necessary food sources for the various juvenile stages of commercially important fish and shellfish. A hatchery and food facilities are pre-requisites to the development of a viable industry.

- Once the products are produced they have to be of a high, certifiable quality for export.
- These technologies exist and can be transferred to Namibia.
- Employment opportunities at the coast are highly desirable, thereby reducing migration of people to the capital city in search of work.
- Coastal communities are relatively easily trained in technologies involving the sea.
- Dependency on natural fish stocks is dangerous. Integrated mariculture produces a sustained, predictable and high quality product.
- Namibia has abundant sources of wind and solar energy which could be integrated into a mariculture system. Namibia would welcome being a testing, demonstration and training ground for the replacement of conventional sources of energy in mariculture with more environmentally-friendly sources of wind or solar energy.

The Henties Bay facility is well located to provide basic training and extension services. The centre is one where skills, knowledge and attitudes will be passed on to trainees. Such trained persons would then establish their own production facilities. Resources for the establishment of the Henties Bay centre have been obtained through provisions made by the President of the Republic of Namibia. We now seek strategic partnerships and support for development and operation of this centre which will have an important role in training, improvement of living standards and transfer of appropriate, sustainable technologies for better livelihoods.

8   Knowledge-Based Value Addition to Africa's Seaweeds

Africa has a rich diversity of seaweeds (macroalgae) ranging from those adapted to warm, tropical waters to those found in cold, temperate waters. As a generalisation, diversity (number of species per unit area) is greatest and individuals tend to be smaller in the tropical regions, whilst in the temperate regions biomass (mass per unit area) is greatest and individuals tend to be larger. The colder waters also tend to be richer in nutrients, not least those coasts influenced by the cold, nutrient-rich, Benguela current which originates in the Southern Ocean.

It is unfortunate that the name seaweed is commonly (mis)applied to marine macroalgae. The term "weed" is usually reserved for those plants which are a pest, growing in areas where they can cause problems (e.g., fields or gardens). However, the vast majority of seaweeds are ecologically very important and play numerous roles in terms of ecosystem services (Lubchenco 1997). These photosynthetic residents of coastal marine waters play a major role in primary production (converting sunlight to energy or food for other consumer organisms), supplying food and resources for the natural food web of coastal waters. Some of the larger kelps form extensive underwater forests, with specific resident and visiting marine life, and are equally important ecologically as any natural forest on land!

Many seaweeds in Africa have considerable present (or realised) economic value either as animal and human food, or as raw materials as a source of gels or soil conditioners. The red seaweeds *Eucheuma* and *Gracilaria* are used for gels and produced in Tanzania and Namibia, respectively; the brown seaweeds *Ecklonia* and *Laminaria* are used for local production of soil and plant improvers and exported as raw material for production of the industrial gel alginic acid. A significant number of people

are currently employed in these activities, with important social consequences for improved quality of life.[1]

However, the potential economic value of many seaweeds in Africa still needs to be realised. Here we can consider the use of seaweeds as environmental indicators (accumulation of heavy metals in the marine environment), the use of seaweeds as sources of biologically active compounds (for use in food preservatives, pharmaceuticals and treatment of soil pathogens), nutrients, vitamins and fine chemicals, with applications in cosmetics, health foods and neutriceuticals (health benefiting natural products, but not registered as drugs, e.g., beta carotene, poly-unsaturated fatty acids).

Africa relies heavily on its natural resources. Too many of these natural resources (particularly in the marine environment) are utilised in a non-sustainable manner.[2] This has sometimes led to the over-harvest of natural populations and the collapse of the resource. In addition, much of the harvest is discarded as waste, or raw materials are exported for processing overseas resulting in the more expensive processed product being imported. More responsible management strategies should be employed which prize the value of natural resources and put efforts into increasing the biomass through cultivation techniques, with value-addition by processing or refining products locally.

In particular, there is a need to identify and characterise those seaweeds currently harvested and utilised and systematically develop systems for their cultivation. Commonly recognised land-based crops plants have been domesticated from wild species with useful characteristics (e.g., particularly important staple grain crops such as rice, wheat, oats, etc., which have been selected from grass species). The domestication of sea plants (seaweeds) to produce sea vegetables which can be eaten directly, used as animal feed or processed for internal gums and important chemicals must be considered. It is possible that new crops of significant value can be produced from seaweeds being farmed in the sea by various methods, or in tanks/raceways on land (see Ohno and Critchley 1997; Critchley *et al.* 1998).

The French use the word "valorisation" for the study of natural resources with the specific intention to create new products, industries and employment. They have been particularly successful in the region of Brittany where a number of new industries based around European seaweeds have developed in the past 10 years, through a concerted effort to study, cultivate, produce and market products from seaweeds. The centre responsible for co-ordinating these efforts are Centre d'Etude et de Valorisation des Algues (CEVA), based in Pleubian, France. This could be seen as a successful model for similar activities in Africa.

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[1] The creation of employment through seaweed cultivation itself has not been without problems. The introduction of *Eucheuma* cultivation in Tanzania required legislation to be passed to prevent children working in the *Eucheuma* farms during school hours. The seaweed cultivation activities were largely embraced by women, resulting in a significant swing in control of finance. Such phenomena require close study by social scientists.

[2] This statement is based on the situation in Chile where open access to natural beds of the red seaweed *Gracilaria* led to the collapse of the populations. This prompted research into cultivation and re-seeding and Chile is now a world leader in this regard, but nevertheless emphasises the "tragedy of the commons" phenomenon and the need for government control of resources.

One of the abundant biological resources available for sustainable utilisation in Namibia is the rich seaweed flora (containing a number of economically valuable seaweeds). UNAM has already carried out a considerable amount of research on Namibian seaweeds (e.g., production of foods, feeds, gels and beneficial, supplementary food additives such as iodine; see Ohno and Critchley1997; Critchley *et al.* 1998).

The University of Namibia has shown commitment to research in sustainable utilisation of natural resources, particularly in marine natural resources and specifically seaweeds, and has gathered together a significant team of experts in the field of applied marine (specifically seaweed) studies. Furthermore, Taurus Products have been particularly supportive of investigations into southern African seaweeds. Therefore Namibia is presented as the natural choice for this centre to be established, and UNAM the best qualified host. In addition, Namibia is currently the co-ordinating country for marine resources in the SADC region and is well placed to investigate, exploit, develop technologies and disseminate those techniques to partner countries in the SADC region. Such activities can only be strengthened through collaboration with international scientists in north-south and south-south co-operation programmes.

The objective of this section is to demonstrate the potential to harness the power and productivity of African seaweeds as a source of raw material for food and materials production, thereby creating job opportunities which would in turn contribute to alleviating poverty and providing some aspects of food security in the southern African region as a whole. Marine natural resources have long been prized as a valuable resource in this part of the world, and there is considerable expertise in methods of mariculture (fin fish, shellfish and micro-macroalgae).

8.1 Seaweeds under consideration

As with terrestrial crops, the worldwide commercially utilised number of seaweeds is relatively small compared to the existing diversity of seaweeds. As land plants are presently being screened for new uses and products, so too seaweeds must be examined for new uses and products and methods of production.

8.1.1 Seaweeds with a warm-water tropical distribution

Sargassum spp. – large brown seaweed. Has a number of known uses, from traditional medicine and herbal teas, to extracts to promote crop plant growth. Currently unused in Africa, although extensive populations are known to exist.

Eucheuma and *Kappaphycus* spp. – large red seaweeds which are the source of carrageenans (industrial gels) and may also be used in salads for human consumption. Currently the focus of a major cultivation industry and employment in Tanzania. The raw material is generally exported for processing, although a semi-refining process is being investigated in Tanzania.

Gracilaria spp. – large red seaweed and source of agars (industrial gels, agar, sugar reactive, biological grade and agarose for biotechnological applications). It is currently harvested from shore cast materials and is also cultivated on floating rafts in South Africa and Namibia. *Gracilaria* spp. are very widely distributed and its range spans both warm and cold-water regions. The raw material is exported for processing though

expertise for local processing exists and has been undertaken in Namibia and South Africa (currently closed down by foreign business concerns).

8.1.2 Seaweeds with cold-water distributions

Ecklonia and *Laminaria* (commonly referred to as kelps). These very large brown seaweeds are currently harvested from natural populations and from beach-cast materials. The biomass is used for the production of many products, e.g., raw material for the extraction of alginic acid, to produce the industrial gel alginate (wide applications include canned meat, paint, textile printing, pharmaceuticals, etc.). Currently, this raw material is exported. There is some beneficiation of kelps in southern Africa including the production of a liquid extract plant fertiliser (Kelpak 66, manufactured in South Africa) and a plant and soil improver (AfriKelp, manufactured in Namibia by Taurus Products (Pty) Ltd.). Both of these products have high export potential.

Kelps are known to be rich in vitamins and particularly iodine. These can be used in health food products and for specific deficiency syndromes, i.e., treatment of goitre and reduction in the incidence of cretinism. Addition of kelp meal can also significantly contribute to the nutritional value of animal feed.

Research at the University of Namibia has shown that commercially valuable mushrooms can be produced on waste from the processing of AfriKelp and *Gracilaria* (Molloy *et al*. 1999). This is a good example of the valorisation of Namibian seaweeds and application of ZERI-principles, whereby a waste product (seaweed after processing) can be used to produce a more valuable product (edible mushrooms, which are not only commercially valuable but may contain additional, beneficial dietary components because they are produced on a substrate including seaweed, rich in mineral nutrients and vitamins).

Porphyra spp. – red seaweed with a sheet-like appearance. Cultivation of this seaweed has been practised in the Far East for over 300 years; currently the industry surrounding P*orphyra* (Japanese name: nori) for human consumption in Japan alone is worth more than US$ 1 billion (Critchley 1997). Attempts have been made to market southern African *Porphyra* in the Far East. Unfortunately, local materials are currently viewed as too tough (the sheet of alga produces large amounts of binding jelly in order to survive in the harsh conditions of Africa, making the blade tough for human consumption). However, the fact that there is more jelly present is significant since *Porphyra* is also the source of a valuable industrial gel, porphyrin. *Porphyra* has recently been found to be an important part of the diet for the commercially valuable and cultivated shellfish, abalone (*Haliotis midae*), which is currently the focus of a blossoming mariculture industry in South Africa. As production of abalone increases, so too will the demand for *Porphyra* as a food source. However, the world market for human consumption should not be ignored and we are confident that cultivation of *Porphyra* in Africa will produce a more tender product than its wild harvested counter-part. This would then be more acceptable to the Far East markets as human food, where demand is ever increasing.

8.1.3 Other algae worthy of attention

The above-mentioned algae are those which have a current, known and exploited value. However, there is a large number of other alga which require study for potential uses:

– algae as sources of new seaweed foods, i.e., seaweed salads – *Griffithsia, Ulva, Enteromorpha, Gigartina, Grateloupia*, etc.
– algae as sources of biologically-active compounds – *Osmundaria, Hypnea, Gelidium.*
– algae as sources of agrofertilisers – there is great scope to produce fertilisers from combinations of red and brown seaweeds (e.g. *Hypnea* and *Sargassum*).

It should be remembered that hand in hand with the development of new products and methods for their cost-effective production, new markets, products and innovations must be sought to ensure long term viability, due to strong competition in the market place. Here strategic alliances with partners such as CEVA would help to improve existing production, but also to seek new markets which need to be supplied with materials.

It is evident from the above, that with a few notable exceptions, most seaweeds in Africa are exported as raw materials for processing elsewhere in the world, and the more expensive extracts are imported. There is a need for local beneficiation. There are many market forces acting on such activities, and it is true that small-scale processing plants have been established and subsequently decommissioned in Namibia and South Africa. The key to the success of such an operation would be to regionalise the production of raw materials, with well-developed supply systems to a regional processing centre, where the economy of scale would be greater, processing larger amounts of materials and supplying regional demands for processed products. Clustering of other key industries around such a processing plant (i.e., soap, glycerine and mushroom production) would enhance financial viability and be environmentally sound.

8.1.4 Microalgae

Microalgae are not seaweeds; nevertheless, these single-celled photosynthetic organisms play a major role in marine ecosystem services, perhaps the most important of which is primary production of food as the basis to all life. Without the microalgae, there would be no fish in the sea and our atmosphere would be deplete of oxygen! Microalgae are known to produce many beneficial products; they have a high nutritional value, and some produce pigments of very high value.

Namibia and the southern African region will be utilising more resources from the sea in years to come, and the development of a national mariculture programme for the production of fin fish and shellfish is essential. However, a pre-requisite to the production of commercially valuable stocks in cultivation will be the need to produce a feed source for the juvenile fish. Just as microalgae are the basis of fish production in the sea, it is essential that techniques exist for their large-scale production for fish farming.

Expertise in the fields of micro-, macroalgae and processing of products derived from algae is well developed in many countries, and strategic partnerships are sought to transfer such technology to southern Africa through co-operation with international counterparts.

8.2 A summary of applications for knowledge-based value addition to African seaweeds

8.2.1 A source of health products

Seaweeds have been categorised as being: "safe as GRAS" (Generally Recognised As Safe). Therefore their products can be safely included in food and cosmetics. The nutritional value of seaweeds has long been recognised, particularly in Asian countries, and as such there is demand for high quality materials globally. The position of Africa, as a source of materials from unspoiled coastlines (i.e., Namibia's position in the market with regard to cold, nutrient-rich, pollution-free waters) needs to be exploited and marketed effectively.

Africa's seaweeds would be ideally placed to be used as components in the ever increasing market for cosmetics and beauty products based on natural products; again the assets of pristine coastal and marine environments need to be emphasised in the marketing of these products.

In addition, the use of seaweeds from Africa as sources of biologically-active compounds should be researched in greater detail to provide compounds which may find use in neutriceuticals, food preservatives of even novel pharmaceuticals. We must actively investigate new ways in which seaweeds can be used and applied. This involves market research and developing positive attitudes towards the consumption of seaweeds, e.g., seaweed salads, etc. Assistance would be most beneficial in this regard, particularly in marketing products of high value throughout the world.

8.2.2 The use of seaweed (kelp) to treat dietary iodine deficiency disorders in southern Africa

Objective: To reduce the incidence of iodine deficiency disorders (goitre and cretinism) through use of Namibian seaweed resources rich in iodine.

The treatment of iodine deficiency disorders in southern Africa using Namibian seaweeds is an important example which is highlighted here to demonstrate the tremendous potential of south-north co-operation. Such a programme would have profound effects in a short period of time for large numbers of people in southern Africa.

Iodine deficiency is endemic in large parts of southern Africa; it is caused by its depletion in the soil and lack of transfer to crops. The effects of dietary iodine depletion is seen as goitre, which is most prevalent in women (>90% of sufferers). Pregnant and nursing women, in particular, are at risk since precious iodine is diverted from the mother to the foetus in pregnancy or the baby during breastfeeding. Lack of sufficient iodine to the foetus causes irreversible cretinism.

Dietary supplementation of iodine is attempted using potassium iodate. This application is not effective, as evidenced by the high incidence of goitre in southern Africa. Research at the University of Namibia has shown that kelps (large brown seaweeds), which are abundant in the cold waters off the west coast of southern Africa, contain large amounts of iodine. It is also known that some other seaweeds in the southern African flora are worthy of further research as sources of iodine (e.g., the

brown alga *Sargassum* found in sub-tropical waters). Seaweeds are an abundant, natural and renewable resource which can be used to provide a dietary supplement to treat iodine deficiency. Furthermore, seaweeds are known to contain many other beneficial dietary components such as vitamins and essential minerals. In addition, production of such commodities in a pollution-free environment would be very useful in marketing products internationally. Asian scientists in particular would be well placed to assist with such work on dietary supplementation using seaweeds.

Such work would make a significant impact on quality of life and well being of the people of southern Africa. In particular, if cretinism and goitre could be alleviated through such treatments, Africa's future generations would not be robbed of productive individuals.

8.3   Cultivation techniques and selection of strains for cultivation

Seaweed cultivation (on land, ponds/raceways, or in the sea) offers the potential to sustainably produce the required biomass for commercial utilisation without putting the natural populations at risk of over-exploitation. There is considerable international experience in mariculture (fish, shellfish and microalgae) and seaweed cultivation. Technology transfer from such partners would be extremely beneficial in developing the technology and industry in Namibia.

We should not be trying to design and engineer new technologies, but rather to transplant and make local modification for existing technology, with the added advantage of new insights application of ZERI-principles, i.e., use of wastes as resources and the reduction of energy inputs or replacement with sustainable alternative forms of energy (e.g., replacement of expensive energy inputs for water pumping and motion by solar pumps and windmills).

Too many of the world's economically important seaweeds are produced as monocultures, often as vegetatively produced clones. Such a small genetic base produces risks of susceptibility to pathogen attack (as can be seen in some of the densely cultivated populations of *Porphyra* in Japan and *Eucheuma* in Tanzania) (Oohusa 1997; Trono 1997). Hand in hand with the development of techniques for cultivation, just as land plant agriculture has been systematically improved by attention to selection and breeding, we too need to pursue the selection of new strains of seaweed for cultivation for higher yield, greater growth rates, resistance to disease. This can be achieved by techniques ranging from simple selection of strains to advanced biotechnological applications of active hybridisation and genetic manipulation.

8.4   Marine ranching and creation of new seaweed beds

Marine ranching offers many exciting possibilities to create new seaweed and associated resources (Ohno and Critchley 1997). As mentioned, Namibia and South Africa are influenced by the cold, pollution-free Benguela current off the west. This nutrient-rich current is responsible for large phytoplankton populations which in turn support fish populations, which in turn are exploited by the fishing industry. The cold waters are also responsible for the growth of large seaweeds such as kelps. However, these kelps are restricted by the availability of suitable hard substrata (e.g., rocks) on

which to attach. It is perfectly feasible to create new off shore reefs from specially designed concrete blocks which would then be seeded with algae to create new seaweed beds, i.e., ranching seaweeds in the sea! Assistance with this relatively new and advanced technology would be most gratefully received. As previously mentioned the ecosystem services (Lubchenco 1997) provided by such sub-tidal beds are very important for the healthy functioning of the marine environment. The seeded beds would soon become nursery grounds for juvenile fish and habitats could be provided specifically to encourage colonisation by commercial shellfish (rock lobsters) and molluscs (abalone). This system would be powered by the nutrients supplied through the services of the cold, nutrient-rich, pollution-free Benguela current, originating from the Southern Ocean. The marketing possibilities for products produced in such a manner are enormous.

8.5   Sources of hydrocolloids

New sources of hydrocolloids should be sought. This would include screening of potential new sources and also modification (hybridisation and selection) of new strains with favourable characteristics. An example would be to screen natural populations of agar-producing seaweeds to look for strains which produced greater quantities of agarose (agarose has a value 10 times that of agar). African *Porphyra* should be investigated as a source of gel porphyrin.

Concomitant investigation of a regional processing centre for gel extraction should proceed to develop economy of scale and to cluster industries along ZERI-principles. Extraction of colloids from seaweeds requires considerable energy; this could be produced through a boiler (using solar energy). Hot water is used to extract the gel, but the energy created can also be used in the production of soap, and if clustered correctly, the heat could be used to recover valuable glycerine, which is wasted in small-scale soap production. Once seaweed biomass has been used to extract gels, the residue biomass can be used as a substrate for mushroom production. This activity requires steam to pasteurise the substrate for mushrooms, which could be a bi-product of the production of hot water for the extraction of gels from the seaweeds.

8.6   Integrated mariculture and the production of sources of livestock feeds

This should be investigated in the broadest sense of land-based integrated mariculture technologies, using microalgae as a source of food for fish cultivation and then using the wastewater from the fish ponds as a source of nutrients for the production of seaweeds. In addition, seaweeds can be used as beneficial additives to feed stocks of animals (e.g., pigs, sheep, cattle and poultry) and cultivated shellfish (e.g., abalone).

8.7   Production of agrofertilisers

Seaweeds are rich in mineral nutrients and contain hormones (auxins, cytokinins, etc.) which promote higher plant growth, flowering and fruiting. New and novel applications of seaweeds would be researched. New combinations of African seaweeds could be

used to produce liquid and solid extracts for the benefit of crops. The presence of hydrocolloids in seaweeds makes them excellent natural, organic, super-absorbents which add water to soil and promote plant growth and reduce watering requirements.

9   Conclusion

Namibia has much to offer global science, technology and development communities. As can been seen from this paper, the scope for use and valorisation of Africa's seaweeds in combination with assistance from international collaborators in a co-operative programme is tremendous.

The technologies involved are already practised in various European countries. Southern Africa needs to take such technologies and adapt them for local conditions and circumstances. In doing so, new opportunities for marine agriculture (responsible and sustainable utilisation of marine natural resources), processing industries and employment can be created.

It is recommended that Namibia and UNAM's Coastal Resource Research Centre at Henties Bay would be the ideal focal point for such research on valorisation of Africa's seaweeds and their utilisation in Africa. Namibia has a critical mass of well-trained scientists and experience in research into seaweed resources. Scientists at the University of Namibia have clearly demonstrated a commitment to working in a multidisciplinary and collaborative manner with scientists in the southern African region and also Asia. Further close co-operation with scientists both internationally and regionally will be promoted by the free exchange of information and experiences.

Henties Bay would be a Centre of Expertise, offering regional operational services of demonstration, training, and extension services; advice would be rendered throughout southern Africa. In this regard, UNAM is well placed and has the stature to act as the implementing agent for the programme. It is able to co-operate with SADC universities and local industrial partners such as Taurus Products and Namibia Breweries.

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Appendix
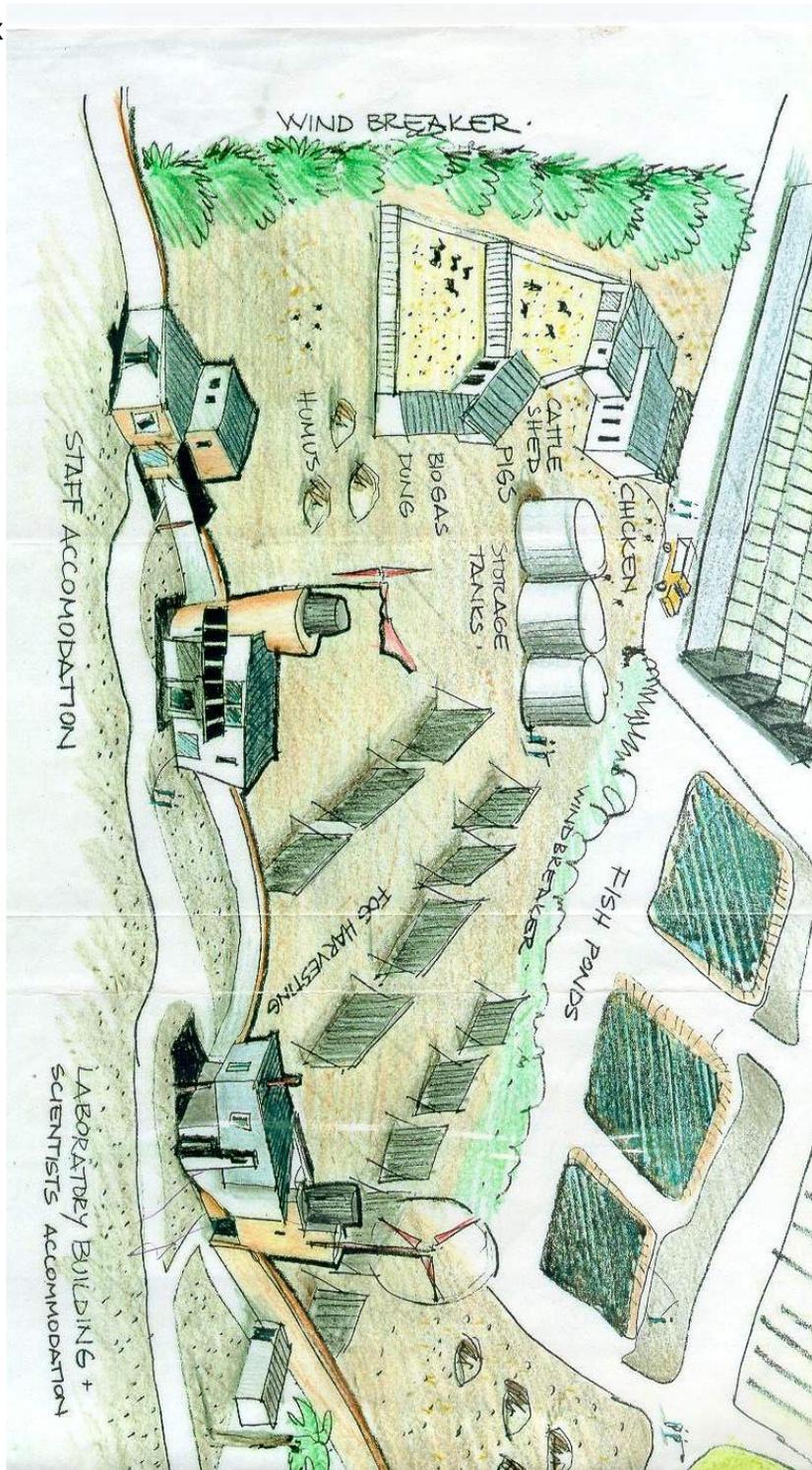
An artists' impression of activities which will develop at Henties Bay over a number of years. Each building is as energy efficient as possible, and will investigate the appropriate use of alternative energies (solar, wind, etc.). The efficiency and application of coastal fog harvesting will be investigated along with desalination to investigate technologies for the recovery of fresh water. Irrigation of seawater and brackish water tolerant plants will be used (e.g. *Salicornia*). Animals will be kept for meat and dairy production, their wastes being used in the biodigester. Ultimately the organic wastes will be used to improve the humic content of the soils. Fish, shellfish, microalgae and seaweeds will be grown in an integrated system, using alternate sources of energy (wind and sun) as some of the inputs for pumping and aeration.

PART III. POPULATION

NAMIBIA'S POPULATION POLICY

O.O. Arowolo

Abstract

Until Namibia became an independent nation, the country had no explicit population policy. Following independence in 1990, the new government adopted planning as a tool for development, and in the Transitional National Development Plan that was formulated shortly after independence, official view on the relevance of population issues to development planning began to unfold.

As a major step in institutionalising population in its planning process, the National Planning Commission in July 1993 created a Population Planning Unit, the long-term objective of which was to promote and sustain the development and implementation of a national population policy and the integration of population factors in the overall socio-economic development planning. Indeed, the country's First National Development Plan (1995/96-1999/2000) devotes a chapter of the document to population issues in development planning and sets a target to introduce population policy aimed at slowing population growth rate through choice by 1997. The target was met.

The population policy formulation process was participatory. Through a series of sensitisation missions and programmes of public education, the message of population in relation to family survival and national development was spread to the entire nation. In the end, the National Population Policy for Sustainable Human Development was launched in August 1997 at a conference that was to mark the beginning of programme design for implementing the population policy.

The major goal of the population policy is to contribute to the improvement of the standard of living and quality of life of the people of Namibia. The major population target is to reduce the growth rate of population from the 1995 projected 3.2% per annum (1991-1996) to 3.0% by the year 2006 and to 2.0% by the year 2025; reduce infant mortality rate from 57 per 1000 live births in 1995 to 30 per 1000 live births by 2015; reduce maternal mortality rate from the 1995 level of 225/100,000 live births to 112/100,000 by the year 2000; reduce total fertility rate from the 1995 level of 5.4 to 3.5 by the year 2015.

Strategies adopted in the policy for implementation include reproductive health and family planning; health, morbidity and mortality measures; promotion of gender equality, equity and empowerment; programmes of population information and education, legislative measures; and capacity building for research and employment promotion.

1   Introduction

In the literature on population policies, the distinction is made between an explicit and an implicit population policy. An explicit population policy is a statement or document by a national government announcing its intention or plan to influence one or a combination of any of the demographic factors in population dynamics; namely fertility, mortality and migration. Such a policy may be contained in documents by governmental ministries and commissions, legislation, sections of development plans, policy declarations of a ruling party, or statements by the nation's president or other high-level officials (Isaacs *et al*. 1985). The ultimate aim of such a policy is to influence the dynamics of the country's population; i.e. growth rate, composition and distribution.

By contrast, implicit population policies are those laws, regulations, and other directives which, although not necessarily issued for the purpose of affecting population dynamics, have the effect of doing so. Perhaps the major drawback of implicit population policies is the lack of co-ordination to reach a common goal. Since such policies tend to be implemented by various sectors and institutions, often with different goals and instruments, it is difficult to monitor progress in execution or evaluate the overall effect of policy measures on the population. This explains why most governments, particularly in the poorer countries of the world, where such policies are needed for integrated development planning, strive to formulate an explicit population policy (Arowolo 1993).

Due to differences in the political, social, economic, cultural and religious conditions among nations, it is difficult to envision a model population policy. However, most population policies all over the world tend to have some basic elements or characteristics in common, particularly regarding their evolution and content. The purpose of this paper is to describe and analyse these common elements within the context of Namibia's Population Policy for Sustainable Human Development, which was launched in August 1997 (GRN/NPC 1997).

2   The Process of Population Policy Formulation

2.1   Basic considerations

The formulation of a national population policy is one of the major steps in the process of achieving the integration of population with development planning. However, precisely when a country in the process of population-development planning integration takes this significant step depends on a number of factors. These, according to the ILO, include: "the magnitude, severity and relative priority of population problems such as rapid growth, high fertility and migration, the 'carrying capacity' of the national planning system, availability of data, research capacity, the perception of planners and policy-makers of the importance of population problems, and the feasibility of designing and implementing policy measures to influence population parameters in the desired directions" (ILO 1987:20).

Basically the process of population policy formulation involves: the establishment of a sound socio-economic and demographic data base; an inventory and appraisal of population and development interrelationships through research and policy studies;

awareness creation among policy and decision makers, powerful groups and the public at large; establishment of appropriate institutions to provide the technical and management support for policy formulation, programme design, co-ordination, monitoring and evaluation; and policy formulation (Ekanem and Arowolo 1994).

The government of Namibia immediately after independence embraced the idea that population and development variables are interrelated and should be so treated in the planning process. In this regard, the government considered the availability of good quality population and related socio-economic data as basic to population policy formulation and programme development for integration. Availability of relevant and timely data and research results is said to provide policy makers with a range of policy options (Wolle 1994).

2.2 Data and information dissemination

According to the policy document, preparations for the formulation of the national population policy started almost immediately after independence with the collection, analysis and dissemination of information on the population issues in Namibia through the 1991 Population and Housing Census (GRN/NPC 1993a, 1994a). In order to supplement the conventional data on labour force from census records, the Ministry of Labour and Human Resources Development conducted a sample survey of employment and establishments in the country during the census year (MLHRD 1994). The results of the labour force sample survey also provided valuable information on the problem of employment in relation to population dynamics. In order to provide further insight into the demographic and social characteristics of the population, the Ministry of Health and Social Services conducted the first national Demographic and Health Survey in 1992, the results of which were published and disseminated in 1993 (MHSS 1993). In addition, a number of ad hoc population-related studies by UN agencies (UNFPA, UNICEF, ILO, UNDP, etc.) and research works by the University of Namibia contributed to the stock of information available to planners (GRN/NPC 1997:16).

As more and better information became available on population and development matters, the government began to appreciate even better the linkages between population dynamics and the country's development prospects. The government, in collaboration with UNFPA and UNICEF, organised a workshop in June 1991 on "Women and Safe Motherhood in Namibia." This came up with far-reaching recommendations, some of which are still being implemented. It is noteworthy that Namibia, for the first time, celebrated "World Population Day" on 11 July 1991, and in collaboration with the UNFPA held a national workshop on population and development to mark the event (UNFPA 1991). All workshop participants agreed on the critical need for population and development planning to be integrated, and that population issues play a major role in development planning.

2.3 Institutional arrangements and advance preparations

As a major step in institutionalising population in its planning process, the National Planning Commission in July 1993 created a Population Planning Unit, the long-term objective of which was to promote and sustain the development and implementation of a

national population policy and the integration of population factors in the overall socio-economic development planning.

Promotion of knowledge of population and development interrelationships was considered important. Therefore, the government, in collaboration with UNFPA, established concrete programmes of population, information, education and communication. One programme was set up in the Ministry of Education and Culture in 1993 to promote population education in schools, and the other in the Ministry of Information and Broadcasting in 1994, to promote PIEC within the population at large (UNFPA 1995).

Concerned about the problem of youth in the population (listed as poverty, unemployment, teenage pregnancies, drug, alcohol abuse, rape, etc.), the government since independence mandated the Ministry of Youth and Sport to develop appropriate policies and programmes that would eradicate these problems and increase the contribution of the youth to the development process (MYS 1993). By the same token, the Ministry of Health and Social Services was created to address the problem of health in general with focus on reproductive health and family planning (GRN/NPC 1993d).

The government in mid-1992 also established a Committee on Population in response to the need to prepare for both the 3rd African Population Conference at Dakar, Senegal in December 1992, and the 1994 International Conference on Population and Development. In addition, Namibia is an active member of the Southern Africa Multilateral Working Group on Population and Development, which meets bi-annually.

All these population programmes and projects are being co-ordinated by the PPU with the assistance of the Inter-Agency Technical Committee on Population which was constituted by the NPC to provide technical advice and policy directives to the government in order to facilitate the process of population policy formulation and programme development. The IATCP brings together representatives of all on-going population project managers, and officers in charge of population-related activities in all the government sectors, parastatals and NGOs.

One of the ministries that responded immediately to the challenge of population and development planning was the Ministry of Labour and Manpower Development (now Ministry of Labour). Based on the 1991 population census and the results of the Ministry's labour force study, it was concluded that the high level of population growth implied that around 16,500 people every year would come into the labour market in the course of the transitional plan period to worsen the unemployment rate which was estimated at over 20% from the census. Since there was no population policy, the government simply proposed that those who did not find jobs in the formal sector should be assisted to have access to training and other income-earning opportunities (GRN/NPC 1993b).

Responding to the challenge of population, the Ministry of Health and Social Services also embarked upon a National Demographic and Health Survey in 1992 as a basis for health planning. The results of this study revealed the high level of fertility and mortality (especially infant, childhood and maternal) in the country, as well as the associated factors (such as generally low level of education, low rate of adoption of modern contraceptive methods, high incidence of teenage pregnancy, and general poverty of the majority of the population) (MHSS 1993).

MHSS therefore adopted the "Primary Health Care" approach immediately after independence. This approach is still being pursued in the current First National Development Plan for achieving the goal of "health for all Namibians by the year 2000" (GRN/NPC 1995a:361). This strategy has led to the evolution and promotion of many national health programmes in the country: Mother and Child Health and Family Planning Programme; Expanded Programme of Immunisation; Control of Diarrhoea Diseases; Control of Acute Respiratory Infections; Health Information, Education and Communication Programme; National AIDS Control Programme; National Nutritional Improvement Programme; School/Adolescent Health Programme; etc. With these and related developments, and considering the need to reduce the high level of fertility in the country and thereby effectively address related reproductive health problems, MHSS issued a family planning policy for Namibia in 1995. In the NDP1 document, MHSS has set specific targets during the current national development cycle to reduce incidence of morbidity, the level of infant, childhood and maternal mortality and raise nutritional standards, as well as increase contraceptive prevalence rate (GRN/NPC 1995a).

Population activities also featured in the policies and programmes of the Ministry of Youth and Sport soon after independence. In the TNDP, the government identified the major problems facing youth: lack of employment opportunities, high school drop-out rate, poverty, health-related issues such as HIV and AIDS, teenage pregnancies, drugs and alcohol abuse, hooliganism and vandalism, and rape. Considering that the youth constituted over 40% of the total population in 1991, the government argued that the high rate of population growth and consequent increase in the number of youth meant that their problem took on added importance. In support of the mandate of the Ministry of Youth and Sport, the government created the National Youth Council and formulated a National Youth Policy with focus on skills development and utilisation, promotion of health education and provision of recreational facilities for youth in the country (MYS 1995).

In both the TNDP and the NDP1, the government has recognised the issues of gender and development. Women make up little over 51% of the total population; but in spite of their numerical strength compared with men, their contribution to the overall social and economic development process is not being fully recognised and is being hampered by some legal and customary discriminatory practices. The government, in its efforts to enhance the status of women, therefore created the Department of Women Affairs in the Office of the President shortly after independence to play a co-ordinating role in respect to gender and development issues in Namibia (GRN/NPC 1995a).

In 1992 the Department of Women Affairs succeeded in launching the National Communication Strategy for gender development as well as the Ecumenical Women of Namibia. In the same year, the UN Convention of the Elimination of All Forms of Discrimination against Women was ratified (Department of Women Affairs 1993; UN 1979). Subsequently, the Programme Planning Committee and the Gender Network Committee were established to co-ordinate the activities of the different agencies in the field of gender and development. In terms of legal reform, the government in 1996 put in place the Married Persons Equality Act, which provides legal guarantees against various forms of inequity faced by women within marriage. Gender mainstreaming in development planning is being facilitated by the publication *Women and Men in Namibia* (GRN/NPC 1995c). Also in 1995, UNFPA provided support of the Department of Women Affairs' project on Gender, Population and Development, which is designed to address problems of capacity building, research and information dissemination. The involvement of Namibia in

the Beijing Conference on Gender and Development and the various gender-oriented planning activities of the Department of Women Affairs and related agencies have spurred the preparation of Namibia's Gender Policy Framework for Women and Development which has reached an advanced stage (UNFPA 1998).

Population variables have also been given careful consideration in the country's educational planning. The government, in the two development plans, has noted the high rate of supply of school-age population and the high but inadequate budget provisions for education over the years. The Ministry of Education and Culture initiated in 1993 activities which have led to a partial integration of population education into the school curricula, supported by a GRN/UNFPA project on population education which started early in 1995. A similar project is being supported by UNFPA in the Ministry of Information and Broadcasting to promote non-formal population information, education and communication in the population at large (GRN/NPC 1994b).

The NDP1 itself embodies many of the government policies and programmes aimed at achieving integrated population and development objectives over the plan cycle, 1995-2000 (GRN/NPC 1995a). Chapter 7 of the NDP1 document is devoted to population issues in development, and highlights the process to be followed in designing a population policy aimed at reducing the growth rate of population, through the promotion of strategies that will lead to improvement of health, increase adoption of family planning and development and utilisation of human resources, especially women and the youth. All the sector programme proposals are based on a careful consideration of the relevant population statistics and are designed to achieve sustainable human development (GRN/NPC 1995a).

2.4   Advocacy for national population policy

It was considered essential that part of the consultative process, which PPU/IATCP should pursue in the country in order to gain wider support for the national population policy and the measures, should start at the formulation stage. To this end the PPU and the IATCP, in collaboration with UNFPA, embarked upon a series of sensitisation missions to all the regional offices, followed by regional workshops that covered the country's 13 regions during a period of two years beginning mid-1993. In addition, one national workshop on population issues was organised for one week in May 1994. This whole process was concluded with the National Conference on Population Policy Considerations in Namibia. The Conference, which was conducted for one week in July 1995, brought together a wide range of experts, policy makers and planners (from government sectors, agencies, educational institutions, non-government organisations and the private sector). They exchanged views on the population situation in relation to development prospects in Namibia and offered suggestions for policy and programme development (GRN/NPC 1995b).

Following the recommendations of this conference, a Population Policy Drafting Committee was established, drawn from planners in the government sectors, the Inter-Agency Technical Committee on Population, the academic community and private bodies. The drafting committee, after a series of deliberations on the working draft, produced a second draft in December 1995. This draft document was sent to all the concerned sectors and bodies early in 1996, including regional offices for their inputs.

In order to give a clearer understanding of the intricacies and implications of the policy proposals in the draft document, the Population Planning Unit and the United Nations Population Fund including other GRN/UNFPA population project managers, went on an advocacy mission again to each region in support of this draft document with a focus on regional governors, line ministries, representatives of the people, as well as religious and opinion leaders.

2.5 Official approval

All the comments received were carefully studied by the drafting committee and accordingly reflected in the production of the final draft, which was then presented to the Director General of the National Planning Commission for onward transmission to the Commission. The draft document was considered and approved by the Commissioners in September 1996. Thereafter, the draft of the National Population Policy for Sustainable Human Development was presented to Cabinet, which also gave its approval in November 1996 (GRN/NPC 1997).

This process was clearly in line with the national policies and plans of action adopted by the International Conference on Population and Development, Cairo, 5-13 September 1994. Specifically the conference, which had a strong Namibian delegation, noted the growing recognition that population-related policies, plans, programmes and projects, to be sustainable, needed to engage their beneficiaries fully in their design and subsequent implementation. All nations in the process of formulating their national population policies and programmes were therefore urged by the Cairo conference to encourage the "active involvement of elected representatives of the people, particularly parliamentarians, concerned groups, especially at the grass roots level, and individual" (UN 1995:67).

3 Rationale for the Population Policy

For the purpose of this paper, and in order to have a broader perception of the nature and dimension of Namibia's population problem, three categories of indicators are distinguished; namely (i) demographic; (ii) social, and (iii) economic. The focus here is on these indicators as they relate to orientation of the National Population Policy for Sustainable Human Development. Table 1 shows these indicators for Namibia around 1991.

Table 1. Some indicators for Namibia (1991/1992). Source: GRN/NPC (1997:ii).

1. Population indicators			
(a) Demographic characteristics		**(b) Demographic factors**	
Population size (1991)	1,409,920	Total fertility rate (1992)	
Sex ratio (men/100 females) 1991	94.8	Country total	5.4
Growth rate (% per annum):		Rural	6.3
		Urban	4.0
1970-1981	2.9	Childbearing practices (1992):	
1981-1991	3.1		
1991-2000 (projected)	3.2	% girls (15-19) who are mothers	21.5
Percent of total pop 1991:		Contraceptive prevalence (all methods) (%)	26.0
Age 0-14 years	41.7	Mortality/health measures (1992):	
Age 15-30 years	53.5		
Age 65+	4.8	Infant mortality rate (5), per 1,000	56.6
Population distribution:		Maternal mortality per 100,000	225.0
	1.7	Births with trained attendants (%)	68.2
Population density (per km²)	28.2	Children <5 under-nourished (%)	28.4
Percent urban	72.0		
Percent rural		Life expectancy , both sexes, years (1991)	61.0
		Males	59.1
		Females	62.8
2. Social indicators			
(a) Education characteristics (1991)		**(b) Housing conditions (1991)**	
Literacy rate (any language, %)	77.7	Persons per household (average)	5.2
Literacy rate, in English (%)	49.0	% households headed by males	61.0
Enrolment rate, both sexes (%)		% households headed by females	39.0
Children age 6-9 years	75.0	% pop living in kraal (hut)	58.0
Children age 10-14 years	91.0	% pop living in impoverished home	7.0
Youth age 15-19 years	72.0	% households with safe water	65.0
Youth age 20-24 years	25.0	% households using bush as toilet	61.0
Retention rate (%), Primary		% households with own radio	59.0
Boys	28.2	% households with electricity for lighting	24.0
Girls	37.5		
Retention rate (%) Secondary			
Boys	19.5		
Girls	13.7		

3. Economic indicators			
(a) Economic performance		**(b) Human resource utilisation (1991)**	
Per capita GNP, 1992, in US$	1,670	Percent total population:	
% consumption of the 25% richest households of total consumption	70.0	Economically active	49.4
		Not economically active	50.6
% of households poor*	47.0	Percent labour force unemployed	20.1
% of household severally poor**	13.0	Percent employed in:	
Average per capital GDP growth, % (1990-94)	0.4	Agriculture	47.4
		Industry	16.1
Average annual rate of inflation, % (1980-92)	12.3		
Percentage GDP in 1992 contributed by:			
Agriculture	12		
Industry	26		
Services	62		

Notes:

1. (b) Estimates of vital rates obtained from the 1991 Population and Housing Census are slightly higher than those reported here which are based on the Namibia Demographic and Health Survey 1992, but the general indications are in the same direction.

2. (b) The operational categories used here are as employed at the period of data collection.

* household food consumption > 60% of total consumption.

** household food consumption > 80% of total consumption.

3.1 Population (demographic) indicators

Human beings (people) are both the means and ultimate beneficiaries of development. This explains why population indicators are perhaps the most sensitive in determining the extent to which the people have directly benefited from programmes of social and economic development. In terms of the implications of population dynamics for future development, demographic indicators provide evidence of aspects of population characteristics, which may accelerate or impede development in a broad sense. In this regard, two categories of population indicators are distinguished, namely, demographic characteristics and demographic factors. Because of its direct relevance to mortality, health-related indicators are considered jointly with measures of mortality.

Taken together, the demographic indicators for Namibia suggest a country at the initial stage of demographic transition; the fertility rate is high and ranks among the highest levels in the world; the overall level of mortality is still high but declining, which is why the growth rate of the population now estimated at 3.2% per annum is one of the highest among African countries.

One general question considering population indicators should be: How will population factors influence the prospects of sustainable human development in the country? Perhaps the single most important population factor in this regard is the growth rate. This is so because the growth rate of population affects the future size of the population, its age structure, labour force supply, rural and urban distribution,

overall and regional densities – all of which have implications for development. And because high rates of population growth often result from high levels of fertility, additional effects of high population growth rates can be traced to the health of women and their children, and family well-being in general – the capacities of families (and the government) to provide medical services, education, food, housing, water, security, and related facilities for the family, and the population in general. The higher the rate at which any given population is growing, the shorter the time period required for the population to double itself. At an annual growth of 1.0% a population will double itself in 70 years; if the growth rate is 2.0%, the doubling time reduces to 35 years.

Although the population of Namibia, estimated at 1.4 million in 1991, can be said to be small it is growing very rapidly and will most likely increase to about 1.9 million by the year 2000, and to 3.5 million in 2021. These figures should simply remind planners of the grim economic forecasts for the country and, as such, the capacity of the economy to absorb the future demands of the population. Even with 1.4 million people there are visible signs of development problems: unemployment and underemployment, ravaging poverty, inadequate health and education facilities, neglect of women and under-utilisation of the vast resources of the youth population. As the population size increases over the years, these problems are most likely to worsen.

Given the high rate of population growth, the youthful character of the population will get more pronounced over the years. One effect of that will be an increase in the youth dependency burden (i.e. ratio of youth aged 0-14 to the adult working age population 15-65 years). The youth dependency ratio which now stands at 78.2% will increase to 82.0% in 1996, 86.3% in 2001 and to about 90.0% in the year 2006.

This also implies a steady increase in the number of mothers and potential mothers which, under a high fertility regime as in Namibia, implies a continuing pressure of demand for support services and facilities, such as clinic/hospitals, schools, food, housing, etc. The problems of the youth (poverty, unemployment, drop-out from schools, drug related issues, etc.) get compounded by their increasing numbers (GRN/NPC 1997).

A high rate of population growth calls for an increase in health costs because the high fertility rate that promotes rapid expansion of the population requires more and more investments in clinical services and facilities, to take care of pregnant women and their children. It has been shown empirically that the early onset of fertility (teenage pregnancies) and the close spacing of births present health risks and prematurely intensify pressures on families and government to provide livelihoods for new generations of children (Population Council 1994). In Namibia the high incidence of teenage pregnancies contributes to the high fertility profile and also tends to encourage the spread of sexually transmitted diseases, particularly HIV/AIDS.

Regarding education, it has been argued that a high rate of population growth tends to generate a negative effect on the development of education. In 1985, some 286,407 pupils were enrolled in public schools in Namibia, and the number increased steadily to 511,784 pupils in 1992.[1] The number continues to grow. Yet the government budgetary

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[1] Please note that no mention is made of the enrollment rate. This is deliberate because the number enrolled may be larger than the base school age population, as quite a large number of 'overgrown pupils' are enrolled in school, having been deprived of the opportunity during the apartheid era. Hence the

allocation to education, although quite high (28.5% of the national budget 1993/94), cannot be sustained at the level of school population growth.

A rapid rate of population growth also leads to increases in the size of the labour force. For Namibia this is undesirable; already, the unemployment rate is over 20% of the labour force, while in rural areas where the majority of the population lives, underemployment is estimated to be as high as 41%. Unable to accommodate the backlog of unemployed and underemployed people, the dynamic force of growth has continued to release close to 20,000 new job seekers into the saturated labour market each year since about 1991 (NPC 1995).[2]

The negative social and political consequences of such a large army of unemployed able-bodied men and women (mostly young people) and their increasing number on the society are quite predictable. Youth, aged 10-29 years, made up 72.2% of the 99,239 unemployed persons enumerated during the 1991 population census. About 74.2% of the unemployed are either products of the primary or junior secondary education system, while 24.8% have no education at all. In essence, therefore, the skills of Namibian youth are poorly developed and hardly effectively utilised.

A high rate of population growth in poor societies also tends to increase the likelihood of "population overshoot" which in agriculture leads to soil erosion in the field, overgrazed pastures, and general deterioration of the ecological environment (Birdsall 1977). It has been shown for Namibia that a high rate of population growth and increasing densities under current agricultural and settlement patterns have contributed immensely to deforestation and consequent extensive degradation of the fragile ecological environment (Ashley 1994).

It also argued that the influx of population from rural to urban areas, which has depleted rural farm labour, increased the burden of family support on rural women (who head about 43% of rural households) and accelerated the rate of urbanisation of the population, requires policy intervention. The negative consequences of rapid urbanisation (the growth rate of the urban population is over 5.0% annually) are clearly manifested in the high rate of open unemployment, increasing insecurity of urban life, robbery and other violent crimes, particularly rape, and the emergence and rapid expansion of slums in the bigger cities, particularly the municipality of Windhoek (NPC 1995).

In general, therefore, the high rate of population growth constitutes a great challenge to the government in meeting the demands for social services and facilities, particularly in such areas as health, education, employment, housing, security and general well being. Raising the low status of women in the Namibian society is also a great challenge. If the resources of women are not properly developed through education then it means that the potentials of about half of the sum total of human resources are poorly developed and cannot contribute their fullest to the development process. Under such a situation, women tend to procreate excessively, thereby accelerating the growth of the population.

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numerator, i.e. number of enrolled children, may be larger than the denominator, i.e. the segment of the population expected to be still at school. The figures refer to primary and secondary education only.
[2] Please note that no time series of unemployment rates are available, as the 1991 census was the fist such exercise in post-independence Namibia. The previous censuses were partial estimates, with focus on the white population, so there is no statistical basis for computing unemployment rates for the population of Namibia before 1991.

3.2   Social indicators

Two broad categories of social indicators are employed here, namely, those measuring the overall level of educational development, and those measuring the housing situation in the population. In spite of the limitations of colonial experience, Namibia has performed quite well on the general education front. Literacy (in any language) is widespread (78% in 1991) even though less than 50% are literate in English, the official medium of communication. School enrolment is almost universal among the school-age population; but retention rate is poor, as less than 30% of the boys and about 38% of the girls who enter primary school ever complete the school programme to the end (GRN/NPC 1994b).

Reference has already been made to the effect of rapid population on education. Here emphasis is on the characteristics of learners. Retention rate among secondary school students is even worse; less than 20% of students enrolled ever graduate. Subscription to university education is a small affair; less than 2000 students were enrolled in 1992. Although there are vocational schools and a number of teachers' training institutions in the country, the overall supply of relevant skills by the education system is grossly inadequate as evidenced by the shortage of executive capacity and appropriate skills in most of the sectors of the economy (NPC 1995).

According to the results of the 1991 census, a total of 1,318,935 persons were enumerated in households in 1991, while 90,985 constituted the institutional population (persons living together in quarters, such as prisons, hospitals, hostels, hotels, convents, barracks). Average household size was 5.2 for the whole country, 5.4 in the rural and 4.7 in urban areas. Men head about 60% of all households, while women are heads of 40% of households. In the rural areas the proportion of female-headed households increases to 43%, suggesting that married men migrate in large numbers from the rural areas to the cities, leaving their wives behind to take care of the household.

Women make up over half (51.4%) of Namibia's population; but in spite of their numerical strength, their contribution to the overall social and economic development process is not being fully recognised and is being hampered by some legal and customary discriminatory practices. The National Planning Commission has argued that women should be educated and equipped with appropriate skills in an open market economy in which opportunities are not constrained by gender. Such a development will also enhance overall decline in the level of fertility and, hence, lead to reduction in the growth rate of the population (NPC 1995).

Regarding housing conditions, two contrasting forms were identified during the 1991 census: the Kraal (or hut) in the rural areas, and detached houses in towns and cities. The contrast is also shown in the type of amenities available: only 4.2% of rural households have access to electricity compared to 64% of urban households. And while 98% of urban residents have access to pipe borne water, in the rural areas about 75% depend on wells, boreholes, rivers, canals and lakes for drinking water. Again, while 86% of rural households use the bush as toilet, about 80% of urban households have the privilege of a water closet for toilet. These contrasting levels of access to social facilities and infrastructure have obvious implications for the health of the two population groups (Arowolo 1994).

3.3   Economic indicators

As shown in Table 1, economic indicators here are measured in terms of economic performance and the extent to which the available human resources are utilised for development. From the perspective of the conventional indicators of economic development, Namibia is judged to be one of the richest countries in Sub-Saharan Africa. With a GDP of US$ 2106 million, or per capita income of US$ 1610 in 1992, Namibia is firmly placed in the "middle-income" category of countries. Describing the economy, a World Bank report put it succinctly: "Namibia's physical infrastructure is comparable to that of a Western European country; its telecommunications system is one of the most efficient, and its public administration is highly developed" (World Bank 1991:1). However, the report notes that these overall summary economic indicators tell only part of the story.

According to the World Bank (1991), there are at least two Namibians: (a) The white population which makes up about 5% of the total, but which receives more than 70% of the country's GDP, is mostly urban and enjoys the incomes and amenities of a modern Western European country. (b) The black population, which makes up almost 90% of the total, is mostly rural and lives in abject poverty, even by Sub-Saharan African standards. The results of the 1994 survey of household income and expenditure in Namibia confirm this extreme disparity: the richest 1% of households consumes as much as the poorest 50%; the quarter richest households consume over 70% of total consumption (CSO 1996). This extreme dualism explains why the government declared an attack on poverty and inequity as its major objective in the development priorities of post-independence Namibia.

The economic base itself is weak and performance since the past three decades has been lacklustre. The 1970s did not register any growth and reports show that economic growth in the 1980s was low and erratic. The high rate of population growth of the order of 2.9% per annum was said to have contributed to a decline in the GDP by about 21% during the 1980s. Careful examination of the sectoral composition of economic growth in the country shows that from 1990 to 1993, growth has been determined by diamond mining and government; and that not only are overall aggregates too low, but they result mainly from increased diamond output. In essence, for the government, the tax base is narrow and heavily dependent on diamond and uranium revenues, therefore sensitive to price fluctuations (GRN/NPC 1993c).

As regards the indicators of human resource utilisation the evidence of poor performance is clear. In Section 3.1 of this paper, the effect of rapid population growth on the labour force and employment has been considered. The focus of this section is largely on the characteristics of the labour force and the features of unemployment among the different segments of the labour force.

In terms of activity status, the census enumerated 998,436 persons in the working age group (10 years and over), made up of 493,580 (49.4%) defined as economically active, or in the labour force, leaving over 50% of the working age population in the economically inactive category. Out of the economically active population, 99,239 or 20.1% are unemployed.

The majority of those unemployed, about 74%, are first time job seekers, most of them below 25 years of age but almost equally divided by sex. It is noteworthy that about 71% of the unemployed males and 78% of their female counterparts are products

of the primary and junior school system. Equally striking is the emergence of the university graduate unemployment syndrome, which needs to be watched carefully. Apart from open unemployment, it is estimated that the underemployment rate could be as high as 41% of the economically active population. Labour force participation rates are generally high, but considerable variations exist between males and females and according to age. Participation in the labour force is very limited among boys and girls below age 15 years, in part because of schooling (GRN/NPC 1994b).

In terms of employment capacity, agriculture is the predominant industry, or activity, engaging the workers in Namibia. About 47% of the workers are in agriculture, numerically made up of more males than females. It is also noteworthy that 96% of those workers in agriculture and fisheries are in the subsistence sector. The industrial sector (mining, manufacturing, construction, electricity, water and gas) remains a small segment of the economy in terms of employment (15%), and it is a male dominated sector. As already noted, the labour market problem is further compounded by the growth rate of the labour force, which is projected to be higher than the already high rate of population growth. These demographic, social and economic indicators together provide the rationale for Namibia's population policy.

4 Population within the Context of National Development Policy

4.1 National development policy

The Transitional National Development Plan was issued in 1993, shortly after independence, as a technical blue print to provide a short-term framework within which the government would seek to complete on-going projects, as well as start the implementation of new projects to address some of the pressing development problems inherited at independence (GRN/NPC 1993b). As articulated in the TNDP, and repeated in NDP1, the four government priority national development objectives were to revive and sustain economic growth, alleviate (eradicate) poverty, reduce inequalities in incomes, and create employment opportunities (GRN/NPC 1995a).

The TNDP spells out clearly the role of population in development. It states, *inter alia*:

These (population) statistics have important implications for the planning process. The population growth rate of 3 percent implies that an economic growth rate of over 3 percent is necessary in order to increase per capita incomes. Namibia's growing population is already putting the country's resources under pressure. Providing growing incomes for a growing population is one of the major challenges facing the Government. (GRN/NPC 1993b:8)

Indeed, in the review of 1991-93 and plans for the future, the document states succinctly that: "human development and economic development go hand in hand, one feeds the other. These twin developmental objectives find expression in the work of the various offices and ministries" (GRN/NPC 1993b:5). It is in NDP1, however, that the issue of population policy is well articulated. The NDP1 devotes a chapter of the document to population issues in development planning and sets a target to introduce population policy aimed at slowing population growth rate through choice by 1997. The target was met.

4.2   Namibia's Population Policy for Sustainable Human Development

4.2.1 Population policy goal

The major goal of the population policy is to contribute to the improvement of the standard of living and quality of life of the people of Namibia. This will be achieved through the harmonisation of the dynamics of Namibia's population (growth rate, age and sex structure, migration and urbanisation) with the country's resource potentials in order to accomplish development objectives (GRN/NPC 1997).

4.2.2 Population policy objectives

The specific objectives of this population policy shall be:

  i. To improve the quality of life of the people through population and development policies and programmes designed to alleviate poverty and promote sustainable development;
 ii. To improve the health and welfare of the people by reducing the incidence of morbidity and mortality, particularly infant, child and maternal mortality;
iii. To achieve general access to the necessary information and education that will enable couples to make rational choices regarding family formation (including marriage, number of children and timing of births) and create awareness in the people about population and development issues;
 iv. To achieve a reduction in the growth rate of the population by promoting family planning methods, (such as the pill, injectables, intra-uterine contraceptive devices, condoms, diaphragm, cervical cap, spermicides, surgical sterilisation, sexual abstinence, calendar rhythm, breastfeeding etc.) on a voluntary basis, to reduce the level of fertility;
  v. To ensure a balanced development of rural and urban areas in order to prevent mal-distribution of the population and excessive urbanisation;
 vi. To achieve people's effective contribution to the development process through proper education and training and by utilising effectively the available human resources through provision of adequate employment opportunities, particularly to women and youth;
vii. To achieve proper management and sustainable utilisation of the resources of the environment through reduction of both unsustainable consumption and production patterns and the development of appropriate policies and programmes;
viii. To achieve the integration of population factors in development planning by improving and sustaining the country's population and socio-economic data base;
 ix. To ensure the welfare of the people by promoting appropriate laws and encouraging positive socio-cultural practices.

4.2.3 Population policy targets

For the sake of conceptual clarity it is necessary to make a distinction between 'objectives' and 'targets' in population planning consistent with usage in other areas of planning. Population policy objectives are broad expressions of aim with or without a formal criterion of function. For example, a national population objective could be to

harmonise the rate of population growth with the rate economic development so as to ensure improved standard of living and sustainable development (NPC 1995).

Population change target, on the other hand, refers to more or less precise quantitative statements of the goal that is expected to be attained; viz., a 10% reduction in infant mortality rate over a five-year period; or a reduction in the annual growth rate of population from 3.0% to 2.5% in 10 years. The desired population target is therefore a time trajectory, coalescing the problems of levels, rates and timing (CICRED 1973).

One advantage of numerical targets is their clarity and simplicity as opposed to complex verbal statements. If based on realistic assumptions and accurate socio-economic and demographic data, population targets permit an estimation of the financial, human and material resources implied in the numerical target. For example setting targets for fertility decline may call for targets of acceptors to be achieved by a family planning programme based on estimates of the size and age structure of the population, couple years of protection by the use of certain family planning methods, and the number of births to be averted. The following represent the major targets of the population policy:

i. Reduce the overall growth rate of the population from the 1995 projected 3.2% per annum (1991-1996) to 3.0% by the year 2006 and to 2.0% by the year 2025.
ii. Reduce infant mortality rate from the current level of 57 per 1000 live births to 40 per 1000 live births by the year 2006 and to 30 per 1000 live births by 2015.
iii. Reduce maternal mortality rate from the current level of 225/100,000 live births to 112/100,000 by the year 2000.
iv. Reduce total fertility rate from the current level of 5.4 to 5.0 by the year 2006 and 3.5 by year 2015.
v. Reduce severe and moderate malnutrition amongst under-fives from the current level of 26% to 13% by the year 2000.
vi. Make quality reproductive health services accessible, affordable and acceptable to all sexually active persons.
vii. Increase contraceptive (modern methods) use from 23% in 1992 to 35% by the year 2000 and 50% by the year 2010 (GRN/NPC 1997).

As already noted, the major objective of the population policy is to improve the quality of life of the people through population and development policies and programmes designed to alleviate poverty and promote sustainable development. This in itself is a qualitative target.

4.2.4 Population policy strategy

In order to achieve the goals and objectives of this policy, including the targets, the population policy adopts a number of multi-sectoral strategies or measures. These strategies include:

(a) Reproductive health and family planning

i. The existing family planning services shall be strengthened and promoted, and the quality of reproductive health services shall be improved in terms of training, equipment and logistic support;
ii. Couples and individuals shall be empowered to exercise their reproductive rights such as to freely and responsibly decide the number of children they want to have and the spacing between children;

iii. The capacity of health workers to undertake more efficient and acceptable delivery of family planning services shall be enhanced through training and provision of adequate conditions of service;
iv. The active involvement of men in family planning practices shall be encouraged;
v. Family planning services shall be made accessible to all exposed persons;
vi. The existing programme of preventing and controlling the spread of sexually transmitted diseases, including HIV/AIDS, shall be strengthened;
vii. Reproductive health services in the country shall be strengthened and access to the services, especially to all exposed persons living in distant communities, shall be increased and the services of traditional birth attendants shall be recognised and their skills upgraded (GRN/NPC 1997).

(b) Health, morbidity and mortality measures

i. Promotion of proper nutrition and provision of safe water and appropriate sanitation shall be accorded a high priority by the government;
ii. The malaria control measures now in place shall be strengthened and access to malaria treatment improved;
iii. The existing tuberculosis control measures shall be strengthened;
iv. The existing programmes which protect/promote the health of children shall be strengthened;
v. The integration of people with disabilities into the mainstream of the Namibia society shall remain a priority;
vi. The existing measures to assist retired and elderly people shall be improved and strengthened;
vii. Adequate provision shall be made for housing and related facilities for urban and rural population (GRN/NPC 1997).

(c) Gender equality, equity and empowerment

i. Parents shall be encouraged to keep their children at school, both boys and girls;
ii. The school curricula shall be gender sensitive and avoid gender stereotypes;
iii. Women shall be empowered to acquire and dispose of property;
iv. Women shall be empowered to fully utilise their skills and resources in all walks of life so as to make their full contributions to the development process;
v. Men shall be sensitised on gender issues and paternal responsibility;
vi. Teenage pregnancy and marriage of girls under 18 years, shall be discouraged (GRN/NPC 1997).

(d) Population information, education and communication

i. Environmental education shall be promoted, with emphasis on efficient management of natural resources, at all levels of the educational system as well as in the population at large;
ii. The existing health education measures shall be strengthened on how to prevent communicable diseases including sexually transmitted diseases, particularly HIV/AIDS, tuberculosis, etc.;
iii. Communities shall be provided with adequate information on breastfeeding, immunisation, home management of diarrhoea and respiratory infections, as well as on better nutrition;

iv. The public shall be educated on the social and economic consequences of large families;

v. Population education, including sexuality, shall be incorporated into the school curriculum at all levels of the education system for the school-going population, while special population education programmes shall be designed to address the out-of-school population;

vi. The training of health workers, particularly on work ethics, counselling and communication skills shall be given priority (GRN/NPC 1997).

(e) Legislative measures

i. The reproductive rights of women and men shall be recognised legally;

ii. The traditional and family laws shall be reviewed in order to guarantee the reproductive rights of women;

iii. The Married Person's Equality Act shall be enforced nation-wide;

iv. Traditional and cultural practices which are positive, such as prolonged breastfeeding, shall be encouraged, while practices which militate against reproductive rights or against the new law shall be abolished;

v. The maternity leave shall be for three months, and with pay;

vi. Incentives, such as tax rebate, shall be considered for couples and individuals with fewer children;

vii. Legal provisions shall be made with regard to property rights for both orphans and children born out of wedlock;

viii. The age of mandatory retirement shall be reduced to 55 years and the entry point salary scale lowered in order to open up more job opportunities for young people.

ix. The existing laws, which militate against the establishment and growth of informal sector activities, shall be reviewed and new laws enacted to promote self-employment (GRN/NPC 1997).

(f) Human resource development and utilisation

i. Appropriate policy and programme for human resource development and utilisation shall be developed;

ii. Formal and non-formal education and training to produce adequate skills for the labour market shall be promoted;

iii. Employment opportunities for men and women, with focus on the youth, shall be developed;

iv. Establish and maintain the effective functioning of a labour market information system to ensure the effective management of human resources;

v. Integrated rural and urban development shall be promoted in order to reduce the rate of rural-to-urban migration and forestall parasitic urbanisation (GRN/NPC 1997).

(g) Data and research

i. The existing institutions involved in the collection, analysis and dissemination of population and related data for planning shall be strengthened;

ii. Capacity building for research and programme implementation shall be promoted by strengthening the existing institutions and through networking;

iii. The timely, and continuous collection, analysis and dissemination of population and civil registration data (births, deaths, marriages, international migration) shall be encouraged;

iv. Research on emerging issues such as orphanage, ageing, and socio-cultural factors affecting demographic behaviour, particularly sexuality, family formation, migration, gender discrimination, etc., shall be promoted (GRN/NPC 1997).

5   Institutional Framework for Policy Implementation

The policy recognises that the management of a national population programme is often a complex exercise, involving a wide range of multi-sectoral activities at the various levels of socio-political and regional aggregation. It therefore considers the active involvement of government sectors, non-government organisations, as well as the goodwill and political support by the government in mobilising adequate financial resources, critical to the successful implementation of the population policy and programme.

It is stipulated that Namibia's population policy and programme will be operated at national, regional, and community levels, with full government support and active participation by the concerned sectors and non-government organisations. Since the population policy is an integral part of the national development policy, its implementation will also be in conjunction with other government social development programmes. Overall the Cabinet through its conventional channels of operation, the Parliament, shall take decisions on the national policy.

The Office of the President is expected to continue to provide overall policy guidance in matters relating to this population policy as well as population and development issues in general, while the National Advisory Committee on Population and Sustainable Development will advise the Cabinet and the Office of the President on population matters from time to time. While all government sectors and institutions are expected to be involved in the policy implementation process, the policy defines the specific functions of 23 such agencies in population policy implementation.

The co-ordination of the population policy implementation plans and programme will be the responsibility of the National Planning Commission. It will advise the government on programme priorities and provide necessary advice to the NACPSD in mobilising local and international resources in support of population activities. The commission will ensure that the programme of policy is continuously monitored and evaluated periodically. The commission will also ensure that population and related socio-economic data will continue to be collected, analysed and disseminated by the Central Statistics Office to facilitate the full integration of population factors into the development planning process at all levels (GRN/NPC 1997).

6   The Next Steps

A review of population policy and planning activities in the less-developed countries of the world has revealed that many countries have adopted explicit population policy but only a few, if any, can boast of a national population programme designed to implement the policy (Arowolo 1997:41). The view was held at the official launching of the population policy that the government should pursue its plan to develop a comprehensive programme and action plan to implement the policy (GRN/NPC 1997).

To this end an orientation workshop was held immediately after the launch in 1997, followed by a programme design national workshop in August 1998. It is expected that a National Population Programme will be in place early in 1999.The real challenge to be faced then would be how to implement the population programme at national, regional and community levels as stipulated in the policy paper.

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FERTILITY IN NAMIBIA

O.O. Arowolo

Abstract

This paper examines the fertility situation by analysing data from the *1991 Population and Housing Census*, the 1992 *Demographic and Health Survey* and preliminary data from the *1996 Intercensal Survey* within the context of the 1997 *National Population Policy for Sustainable Human Development*. The overall distribution shows that Namibia is a high fertility country that has experienced a fertility decline within the last decade, from a TFR of 6.1 in 1991, to 5.4 in 1992 and 4.74 in 1996. There are significant fertility differences for rural and urban women, which correspond closely to regional differences. For instance, the highest TFR of 7.7 can be found in the completely rural administrative region of Ohangwena; a TFR of 4.1 can be found in the urbanised Khomas region (1991).

Fertility is closely related to socio-economic factors and coincides with the results of the analysis of nine selected social and economic indicators. The leading variable is education: the higher the education, the lower the TFR. The ranking continues with households with electricity, the urbanisation rate, and a weak negative correlation between TFR and female life expectancy at birth. Lack of modernisation is positively correlated with fertility. In this regard female education is particularly important, since it combines with other factors, such as delayed childbearing, higher age at marriage, etc.

It is, therefore, argued that the family planning targets – namely promoting higher contraceptive use – as designed in the Namibian Population Policy, which are supported by the National Family Planning Policy, are complementary to the social and economic development programmes pursued by the government since independence.

1   Introduction

Fertility as a demographic variable plays a critical role in population dynamics. Particularly in the less-developed countries of the world, fertility is known to be at the root of rapid population growth (Graham-Smith 1994; Srimvasan 1994). It is, therefore, necessary to understand the factors (social, economic, psychological, political, environmental, etc.) affecting the fertility configurations (that is, levels, patterns and trends) in a country in order to assure the design of appropriate policies and programmes within the context of integrated population and development planning.

Until the publication of the *Namibia Demographic and Health Survey 1992*, little was known about the fertility situation in Namibia. The NDHS report itself attests to the fact that "no national (fertility) data are available for the period before independence (1990)" (MHSS 1993:21). Data from the *1991 Population and Housing Census*

(GRN/NPC 1994b, 1994c) were not available until late in 1993, after the publication of the NDHS report. Available estimates of fertility, mortality and migration based on analysis of ecclesiastical records of marriages, baptisms and deaths obtained from parish registers are confined to a section of the country (Ovamboland), and only preliminary (unpublished) results are available (Notkola and Siiskonen 1996). Without any trend data on fertility in the country, current estimates of fertility levels and patterns are difficult to make, and must therefore await the results of the *1996 Intercensal Survey* (GRN/NPC 2000), which are still being processed.

In the absence of usable data from vital registration (marred by prolonged delay in registration and limited coverage), it is difficult to reconcile the differences in the levels of reported fertility in Namibia from the 1991 census and the 1992 NDHS. Nevertheless, data from both sources point in the same direction: Namibia is a high fertility country, and the social, economic and demographic characteristics of the population indicate that the high level of fertility is most likely to persist unless effective population policy measures are implemented.

This paper analyses the fertility situation in the country within the context of the *National Population Policy for Sustainable Human Development* (GRN/NPC 1997). There are five main sections on data sources and limitations; fertility patterns; policy implications; programming response; and conclusions.

2   Data Sources and Limitations

2.1   Vital registration

Vital registration (the continuous and timely registration of vital events, i.e. births, deaths and marriages), if complete and reliable, offers the best source of data for the computation of fertility, mortality and marriage rates in a country or region. The current system of vital registration by the Ministry of Home Affairs is based on the Marriage Act of 1961 as well as the Births, Marriages and Deaths Registration Act of 1963, both as amended by the Marriages, Births and Deaths Amendment Act of 1987 (Wallberg 1995). According to the provision of this Act regarding registration of births, every birth must be registered within 14 days; however, the practice has been that a birth must be registered within a year of the actual date of birth. Apart from the problem of delayed registration, the process of registration of vital events in general is bedevilled by chronic administrative and logistic problems which set a severe limit on the degree of reliability and the extent of coverage of all events. The result is that coverage is far from universal; it has been estimated that only 20.3% of the expected total live births in the country were registered in 1991, and 27.2% in 1992, with better coverage reported in urban than rural areas (Wallberg 1995). It is therefore safe to argue that any scientific analysis of the fertility situation in Namibia, for now, should rely on data outside the current registration system.

2.2   Population census

In the absence of reliable vital statistics, it is possible to estimate fertility rates indirectly from responses to census or survey questions on the number of children ever born live (cumulative fertility) and the number of live births in the preceding year (current fertility) to women aged 15 to 49 years (i.e. childbearing years). The 1991 Population and Housing Census collected information on cumulative and current fertility by age of women in their childbearing years, making it possible to derive an estimate of total fertility rate at national and regional levels, and by socio-economic characteristics of women. The reported number of children ever born live and children born 12 months preceding the census date by five-year age groups of women are given in Table 1.

Table 1. Reported distribution of women by age group and number of children born, Namibia 1991. Source: GRN/NPC (1994c:664,904).

Age group	Total women over age 15	Total number children born alive	Born from last year census 1991
15-19	84,169	13,521	4,841
20-24	67,264	69,043	11,956
25-29	57,825	123,795	12,062
30-34	45,625	160,341	9,175
35-39	34,488	158,561	5,641
40-44	28,058	155,458	2,615
45-49	22,302		1,137

2.3   Demographic sample survey

The only reported national demographic sample survey in the country so far has been the *Namibia Demographic and Health Survey 1992* (MHSS 1993). This was conducted by the Ministry of Health and Social Services, in collaboration with the Central Statistics Office, Namibia and Macro International Inc., Columbia, USA. The NDHS report was published in May 1993, some months before the results of the 1991 census were available. The National Planning Commission conducted the Namibian Intercensal Demographic (Sample) Survey, Incorporating Mid-Decade Goal Survey in September 1996. At the time of producing this paper, only the preliminary results are available; and it may take quite some time before the final results are published.

The 1992 NDHS was designed to collect reliable information on fertility, family planning, infant and child mortality, maternal mortality, maternal and child health and nutrition, based on the reproductive histories of 5,421 women aged 15-49 years, and on the health of 3,562 children under the age of five years. It was planned that the collected information would be used to provide estimates of fertility and mortality for the country

and each of the three *health regions* (north-west, north-east and central/south regions)[1] which constituted the main reporting domains. This classification itself makes it difficult to compare the regional estimates of fertility derived from the census (which is based on the 13 political regions) and the sample survey.

The 1992 NDHS shows that the survey had to contend with both sampling and non-sampling errors. While the sample was designed to yield a nationally representative probability sample of 5,000 completed interviews with eligible women, in the end the north-east region was deliberately over-sampled, implying that the sample was not allocated proportionally across regions and was not completely self-weighting. In addition, apart from the response errors commonly associated with questions on age of women and retrospective fertility in poor societies, the overall response rate in the survey was 84.3%.

In order to reduce sampling errors and the known problem of the displacement of births from five to six years preceding the survey, and to provide the most current information on fertility, the NDHS report was based on three-year age-specific fertility rates. The fertility measures derived are total fertility rate, general fertility rate, and crude birth rate. For some selected variables considered to be of primary interest, sampling errors are calculated and the results presented for the country, rural and urban areas, as well as the three regions north-west, north-east and central/south. Also presented with the sample statistic are the associated measures of dispersion and statistical test of significance. It is noted that in general, the relative standard error for most estimates for the country as a whole is small, except for estimates of very small proportions.

In anticipation of another census of population in the country in the year 2001, the NPC planned to conduct a National Demographic Sample Survey in September 1996. It was also envisaged that the NPC would collaborate with the Ministry of Health and Social Services in April 1996 to carry out the "Mid-Decade Goal Survey" to which Namibia was committed at the World Summit for Children in 1990. In order to maximise the utilisation of scarce resources, it was then decided that the two surveys should be integrated. The integrated survey was conducted nation-wide, based on a representative sample of 10,000 households, covering the 13 regions, rural and urban places and different population groups.

During the course of analysing the results of the 1996 survey data, some inconsistencies in the records of female respondents, particularly on their childbearing experience and history of child mortality, were discovered. Analysis of the data on fertility and mortality revealed levels and patterns that are questionable and difficult to justify. To address this problem, a response-validity check, based on 15% of the 205 primary selection units in the 1996 Survey Sample, was considered be cost-effective, as this would provide a reasonable basis for making any adjustments to the obviously defective data on fertility and child mortality already collected. All females aged 15-49 (childbearing ages) who were covered in 1996 were selected in order to match their responses to the same questions they were asked in 1996. Data collected from this

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[1] The north-west health region includes Oshana, Omusati, Ohangwena, and Oshikoto; the north-east includes Kavango and Caprivi; the central/south includes Kunene, Otjozondjupa, Erongo, Omaheke (central), Khomas and Hardap (south) administrative regions.

survey were analysed, and the results used to make necessary adjustments to the 1996 survey data.

2.4   Ecclesiastical records

The recording of marriages, christenings and burials in the parish register has been an important ecclesiastical function in Namibia since the colonial period. However, it was only recently (with the preliminary report of Notkola and Siiskonen 1996) that the possibility of using these church records to estimate vital rates was explored. The exploratory study was based on the Evangelical Lutheran Church parish record in Ovamboland, in the north-western part of Namibia. By using the family reconstitution method (family histories) the study selected a total of 6,428 marriages from 1925 to 1975.

Collecting baptism information, the parents were followed to their deaths or to the last available main book. Based on the data collected, measures of fertility were derived: general fertility rate, total fertility rate and age-specific fertility rates. The report, however, notes that the calculated total fertility rate was not fully comparable to the normal total fertility rate, due to "clear deficiencies in the data" (Notkola and Siiskonen 1996:57). Nevertheless, the study gives a glimpse of the possible past trend in fertility in Ovamboland.

3   Fertility Patterns

3.1   Regional variations

The different fertility patterns revealed by the data sources described above are presented and discussed in this section, with emphasis on regional and age differentials, and to some extent, on past trends. As already indicated above, the two major sources of data on fertility in Namibia, the 1991 census and the 1992 NDHS, differ in the way the regions were defined; one was based on the 13 political regions while the other preferred to employ the three health regions as domains of study. Regarding the census data, fertility estimates have been derived indirectly from tabulated responses by women (aged 15-49) to questions on children ever born live and number of children born live during the 12 months preceding the census date.

It is well known in the literature that average numbers for groups of women calculated from data on children ever born can be distorted either by errors in the number of children reported or by errors in the classification of women in particular groups (UN 1983:28). However, the availability of information about both cumulative fertility and current fertility from census/survey data provides a powerful consistency check, and also provide a method of adjustment for cases where the data are distorted by typical errors. This is the essence of the Brass or P/F ratio method, which seeks to adjust the level of observed age-specific fertility rates to agree with the level of fertility indicated by the average parities of women in age groups lower than 30 or 35, both of which are assumed to be accurate (Coale and Trussell 1974).

The P/F ratio method is used here to estimate the TFR from the 1991 census data for Namibia.[2] The database and details of the calculations for the country, based on the Coale-Trussell fertility model, an extension of the Brass P/F ratio method (Coale and Trussell 1974; UN 1983), are presented in Tables 1 and 2.

Table 2. Fertility estimation using the P/F ratio method. Author's calculations are based on data for total women and children born, obtained from the 1991 census. Source: GRN/NPC (1994a:81).

Age	Parity	Fert.Rate	Cumu.Fert.	Est.Parity	Ratio	Fert.Rate	Corr.Fert.Rate
	$P(i)$	$f(i)$	$O(i)$	$F(i)$	$P(i)/F(i)$	$f(i)$	$f^*(i) \times P(i)/F(I)$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
15-19	0.1606	0.0575	0.2876	0.1236	1.2998	0.0687	0.0884
20-24	1.0264	0.1777	1.1763	0.7973	1.2874	0.1864	0.2400
25-29	2.1407	0.2086	2.2192	1.8003	1.1891	0.2101	0.2705
30-34	3.5143	0.2011	3.2247	2.8331	1.2405	0.1986	0.2557
35-39	4.5976	0.1636	4.0425	3.7318	1.2320	0.1588	0.2044
40-44	5.5406	0.0932	4.5085	4.2759	1.2958	0.0846	0.1089
45-49	6.0409	0.0510	4.7634	4.7042	1.2842	0.0455	0.0586

Total   *0.9527*   *0.9527*   *0.12265*
Total fertility   *4.7634*   *4.7634*   *6.1324*
Correction factor – P2/F2   *1.2874*

Based on the 13 regions, the estimated TFR is presented in Table 3, while Table 4 shows the regional patterns according to the NDHS classification. The overall distribution shows that Namibia is a high fertility country, with a TFR of 6.1 in 1991 and a slightly lower TFR of 5.4 in the NDHS 1992 report. However, while the 1991 census estimate refers to the current period, the NDHS rates represent the average for the three years preceding the 1992 survey. The two reports are, therefore, not quite comparable. Nevertheless, the general conclusion that Namibia is a high fertility country is easily sustained by the two sets of data. Compared to other countries in sub-Saharan Africa, which is the high fertility region of the world, Namibia is one of leading countries.

Although the full details are yet to be seen, preliminary analysis of the 1996 Demographic Sample Survey shows a TFR of 4.74 for the whole country, a significant decline from a comparable estimate of 6.1 in 1991. Even with the NDHS estimate of 5.4, the report indicates that current fertility levels (indicated by the TFR) are slightly lower than the mean number of children born to women aged 40-49 years, suggesting a small fertility decline. In essence, the level of fertility in Namibia has been experiencing a downturn since the past decade or so.

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[2] Considered a more reliable indicator of the fertility situation in a population, TFR indicates the number of children a woman would have by the end of her childbearing years if she passed through those years bearing children at the currently observed rates. As a fertility measure it answers the question: how many children are women bearing these days?

Table 3. Regional pattern of fertility in Namibia 1991, 1996. Source: GRN/NPC (1994a:10-23).

Country / Region	Total Fertility Rate	
	1991	1996*
Namibia	6.1	4.7
Urban	4.7	3.9
Rural	6.8	5.7
Caprivi	6.7	5.8
Erongo	5.1	4.5
Hardap	4.9	3.6
Karas	3.8	3.8
Khomas	4.1	3.2
Kunene	6.2	5.5
Ohangwena	7.7	6.9
Kavango	7.1	6.6
Omaheke	6.1	5.5
Omusati	5.7	4.9
Oshana	5.6	4.8
Oshikoto	6.7	4.7
Otjozondjupa	5.7	4.1

* Preliminary figures.

Table 4. Regional pattern of fertility (TFR), Namibia 1992. Source: MHSS (1993:20).

Country / Region	Total Fertility Rate
Namibia	5.4
North-west	6.7
North-east	6.0
Central / South	4.1

The regional TFRs are even more revealing; except for Hardap, Karas and Khomas (containing 20.9% of total population), TFR for the 79.1% of the total population in ten regions is over 5.0 per woman. These ten regions closely correspond to the north-west and north-east regions in the NDHS survey, which reported TFRs of 6.7 and 6.0, respectively. These high rates also reflect the TFR of 6.3 estimated in the NDHS for the rural population, which make up 78% of the total population. If anything, the TFRs derived from the 1991census data seem to reflect the reality of the fertility situation in the country and are very much in agreement with the regional rates estimated from the 1992 NDHS study.

3.2 Rural and urban differences

Another striking dimension of the regional variations in fertility in Namibia is between rural and urban population. Namibia is predominantly rural, with 72% of the total population enumerated in rural areas in 1991 (GRN/NPC 1994b). The NDHS report shows that fertility varies widely between rural and urban women, indicated by TFRs of 4.0 for urban and 6.3 for rural residents. Indeed, the least urbanised regions, as indicated by the 1991 census data, are also the most highly prolific: Ohangwena with the highest TFR of 7.7 is completely rural, while Khomas the most urbanised region (88.0% urban) is also about the least fertile region with a TFR of 4.1. The correlation between urbanisation and fertility is very high, as shown later in this paper, implying that higher levels of urbanisation are associated with diminished fertility.

3.3 Fertility differences by age

It is of interest to understand the age pattern of fertility in a population as this gives an indication of the relative contributions of each age group of women to the observed fertility situation. It also gives a picture of the onset of fertility among childbearing women, whether it is "early" or "late." This is done by calculating age-specific fertility rates for women aged 15-49 years in the population, as shown in Figure 1.
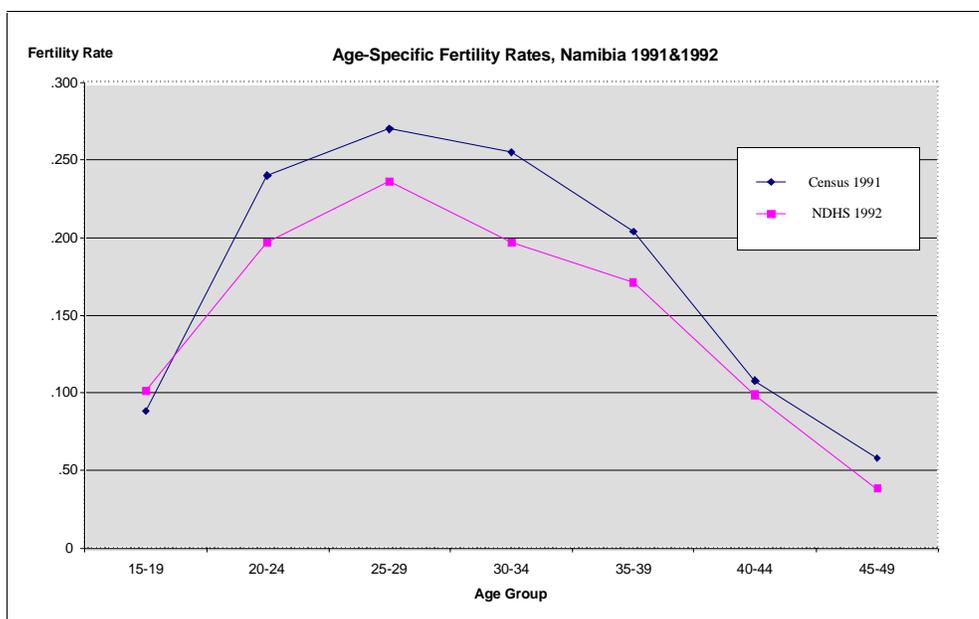

Figure 1. Age-specific fertility rates (per 1000), Namibia 1991 and 1992. Source: GRN/NPC (1994b) for 1991 and MHSS (1993) for 1992.

The age pattern revealed by the two data sets are remarkably similar, except at the lower end of the age profile (15-19) where the census tends to under-report the fertility of this age cohort of women, and at the upper end of the age spectrum (45-49) where the NDHS rate is lower. At the key fertility ages (15-49), women contributed about the

same proportion of all births; 88% of the births in the census data, and 87% in the NDHS report. Both of the data sets also confirm the extent of teenage motherhood in Namibia. According to the NDHS report, among women currently 20, about 40% became mothers before the age of 20, of which 2-3% gave birth before age 15 (MHSS 1993:25). The early onset of fertility among Namibian women is clearly evident.

It is conventional to measure differences in the age pattern of childbearing in terms of the median age of childbearing, or the mean age of childbearing among women. It is estimated that the median age of childbearing among women in Namibia was 21 years in 1992, quite low compared with 31.1 years for Ireland in 1961. Among all the interviewed women, 3.4% were classified in the zero parity, indicating the degree of permanent sterility among women of completed fertility (aged 45-49).

3.4   Socio-economic differences in fertility

The body of available data indicates the existence of marked socio-economic differentials in fertility among childbearing women in Namibia. Reference has already been made to differences in fertility by rural and urban background of women. In addition, women also exhibit variations in reproductive performance by levels of educational attainment, marital status, infant/child mortality experience, health status and variations in access to certain social and economic infrastructure and facilities. The NDHS 1992 report shows this relationship with three background characteristics: residence, region and education (see Table 5).

Table 5. Fertility by background characteristics of Namibian women, 1992. Source: MHSS (1993:20, Table 3.2).

Background characteristic	Total Fertility Rate for women aged 15-49 years	Mean number of children ever born to women aged 40-49 years
Residence:		
Urban	4.0	4.7
Rural	6.3	6.2
Region:		
North-west	6.7	6.5
North-east	6.0	6.6
Central/South	4.1	4.6
Education:		
No education	6.6	6.3
Some primary	6.1	6.1
Completed primary	5.2	5.5
Secondary/Higher	4.1	4.1
Total	5.4	5.7

As shown by the NDHS report, increasing level of education is associated with reduced fertility; women with no education reported a TFR of 6.6, compared with 4.1 for women with at least some secondary education.

Based on the 1991 census data, regional estimates of TFR and selected social and economic indicators are correlated to show how each of the nine independent variables is associated with fertility. The data and definition of variables are shown in Table 6. Of the nine explanatory variables, five are highly correlated with TFR: some secondary education; percent of women in households using bush as toilet; percent of women in households with electricity for lighting; percent of women living in urban places. The details are shown in Table 7. As expected, education of women is negatively correlated with fertility; so also are the other two indicators of modernisation, i.e. access to electricity and urbanisation. Female life expectancy at birth is also negatively associated with fertility, although the ratio is weak (r = -.399). By the same token, lack of modernisation is positively correlated with fertility, as shown by a positive correlation (r = .86) between TFR and women in households using bush as toilet.

Table 6. Total fertility rate and socio-economic indicators, by region, Namibia, 1991. Source: GRN/NPC (1994b:11-23,47).

REGION	TFR	URB	FHH	EDUC	HSW	IMR	BAT	ELC	MAR	FEO
Caprivi	6.7	15	39	23.0	51	106	90	5	44	54.5
Erongo	5.1	63	28	37.8	95	51	23	53	28	66.5
Hardap	4.9	44	28	35.0	98	72	33	30	32	61.5
Karas	3.8	45	27	42.7	97	70	25	41	39	62.0
Khomas	4.1	88	27	46.4	99	39	7	78	30	69.5
Kunene	6.2	25	34	16.4	79	59	66	16	27	64.5
Ohangwena	7.7	0	56	10.0	28	59	96	1	24	64.6
Kavango	7.1	17	33	15.2	48	84	89	5	45	59.0
Omaheke	6.1	16	27	21.5	98	78	59	22	25	60.3
Omusati	5.7	0	57	13.0	15	49	93	1	26	66.9
Oshana	5.6	26	53	21.6	57	62	74	8	22	64.0
Oshikoto	6.7	13	45	17.7	50	66	75	14	27	63.0
Otjozondjupa	5.7	46	24	26.9	98	67	42	39	25	62.6

Definition and Variables:

TFR	Total Fertility Rate (dependent)
URB	Percent population urban
FHH	Percent households headed by females
EDUC	Some secondary school education
HSW	Percent households with safe water
IMR	Infant mortality rate
BAT	Percent households using bush as toilet
ELC	Percent households with electricity for lighting
MAR	Percent of women 15 years and above legally married
FEO	Female life expectancy at birth

Table 7. Matrix of correlation. See Table 6 for definition of variables.

	TFR	BAT	EDUC	ELC	FEO	FHH	HWS	IMR	MAR	URB
TFR	-									
BAT	.860 .000	-								
EDUC	-.891 .000	-.937 .000	-							
ELC	-.776 .001	-.954 .000	.900 .000	-						
FEO	-.399 .088	-.397 .090	.236 .219	.477 .049	-					
FHH	.508 .038	.756 .001	-684 .005	-.704 .004	.142 .322	-				
HSW	-.666 .006	-.883 .000	.781 .001	.789 .001	.064 .417	-.904 .000	-			
IMR	.118 .351	.167 .293	.013 .483	-.319 .144	-.925 .000	-.253 .202	.097 .376	-		
MAR	-.006 .492	.049 .437	.188 .269	-.046 .441	-.633 .010	-.312 .149	-.007 .491	.684 .005	-	
URB	-.779 .001	-.936 .000	.912 .000	.963 .000	.420 .077	-.691 .004	.780 .001	-.258 .198	.033 .457	-

Marital status appears to have no relationship with fertility in Namibia; the correlation between the index of marriage and fertility is very weak, $r = -.006$. This is further confirmed by analysis of the census data; legally married women have, at the completion of fertility (45-49 years of age), an average of 6.3 live births compared to about 5.0 for never married women of the same age cohort. The evidence is further confirmed by the NDHS 1992 report; more than half of the women aged 15-49 in the study have never been married, and while all women interviewed have an average of 5.13 children. Those currently married show 5.44. The NDHS report therefore concludes that in Namibia, childbearing is not confined to marriage (MHSS 1993:22).

Based on Table 6, the mean and standard deviations of dependent and explanatory variables are shown in Table 8. The mean of TFR is 5.8. Close to 60% of all households in Namibia use bush as toilet. About 25% of the people aged 15 years and above had secondary schooling; 24.1% use electricity for lighting, a rather poor measure because the standard deviation of the mean is almost equally high (23.29). Average life expectancy at birth for females is about 63 years. The infant mortality rate is 69.5 per 1,000 live births. Close to 37% of households are headed by women. About 70% of all households have safe water; 30.3% of women aged 15 years and above are legally married; while the population is 30% urbanised.

Table 8. Mean and standard deviation of the dependant variable (TAR) and the explanatory variables. See Table 6 for definition of variables.

TFR	5.80	(1.13)	FHH	36.77	(12.04)
BAT	59.38	(30.32)	HSW	70.23	(30.04)
EDUC	25.11	(11.69)	IMR	69.54	(19.62)
ELC	24.08	(23.29)	MAR	30.31	(7.59)
FEO	62.99	(3.81)	URB	30.62	(25.57)

The regression on TFR on the nine explanatory variables shows that $R^2 = .971$ (adjusted \= .886). The details of the result are shown in Table 9. As can be seen from Table 7, some of the independent variables are very highly inter-correlated and this raises the problem of *multicollinearity* in a regression analysis; the greater the intercorrelation of the independent variables, the less the reliability of the relative importance indicated by the partial regression coefficients. As a solution, the analysis reliance can be placed on one of the variables in the highly correlated set to represent the common underlying dimension. Three of the nine variables (EDUC, ELC and BAT) jointly yield an $R^2 = .825$, while the correlation between TFR and EDUC is $r^2 = -.89$. (We therefore select education for detailed discussion as a partial solution to the problem of multicollinearity.)

Table 9. Regression on fertility (TFR) among women aged 15-49 years in the 13 regions of Namibia, 1991.

Variable	B	SE B	95% Confidence
BAT	-.102811	.077034	-.347964
EDUC	-.413950	.124372	-.809752
ELC	.104282	.042550	-.031128
FEO	-.381248	.285559	-1.290011
FHH	.198903	.093142	-.097511
HSW	.014506	.028789	-.077112
IMR	.008450	.049335	-.148552
MAR	.115599	.076604	-.128184
URB	.008218	.022273	-.062663
(Constant)	31.128558	25.094815	-48.733182

R	.986
R^2	.971
Adjusted R^2	.886
Standard Error	.383
Average TFR	5.8
Standard Deviation	1.134
F	11.35

Given these social and economic correlates of fertility, the question is: by what mechanism do these social and economic factors individually or jointly influence fertility behaviour and performance? Using the education variable as one of the leading variables in the highly correlated set to represent the common underlying dimension, the mechanism by which education affects needs to be explored.

The influence of education on fertility operates through several channels. Prolonged schooling necessarily raises age at marriage; and with rising age at marriage, fertility tends to decline. Education itself is directly related to rationality and planning, and these conditions are pertinent to the adoption of family planning and modern contraceptive usage. In addition, education is related to occupation and income; with higher education, opportunities for higher-income professions and white-collar occupations can be expected. All these are pertinent to the adoption of the small family norm or reduced fertility. It is this regard that female education is particularly important since the educated female is expected to engage in occupations that are not home-related, thus generating a conflict in her role as a worker and mother (Arowolo 1979).

4   Policy Implications

One of the stated objectives of Namibia's population policy is "to achieve a reduction in the growth rate of the population by promoting family planning methods, such as the pill, injectables, intra-uterine contraceptive devices (IUCDs), condoms, diaphragm, cervical cap, spermicides, surgical sterilisation, sexual abstinence, calendar rhythm, breastfeeding, and others on a voluntary basis to reduce the level of fertility" (emphasis placed) (GRN/NPC 1997:20). This policy position indicates that the government of Namibia plans to reduce the fertility level in the country through the "family planning approach."

This approach to fertility reduction is one that emphasises the provision of contraceptive supplies, services, and education in the belief that the number of couples desiring to limit family size is sufficiently large, and the intensity of their desire sufficiently strong, to bring the birth rate down to acceptable levels within a reasonable period of time (Ridker 1969). The approach is predicated on the assumption that if people are informed about the methods and are given good service, a significant number will accept family planning. Emphasis is on "knowledge and service" and the approach, in the words of Kingsley Davis (1967:731), "concentrates on providing new and efficient contraceptives on a national basis … under public health auspices."

The two areas of emphasis in the family planning approach, (i.e, provision of knowledge and service) require careful planning and investment outlays. The knowledge aspect calls for a well-designed programme of family planning, backed by family life or population education and an equally effective communication strategy. Evidence from many developing countries with a fairly long history of family planning programme efforts shows that family planning contributes to lowering fertility, and in a few cases the effect can be dramatic. A prevalence study conducted in Tunisia in 1981 estimated that the family planning programme accounted for 78% of the decline in the birth rate in the country from 45 per 1000 population in 1964 to about 35 in 1981. It is also reported that the national family planning programme in Mauritius accounted for about 70% of all the births averted in 1972, which brought the birth rate in the country

from 36 per 1000 at the start of the programme in 1965 to 22.7 per 1000 in 1973 (*Population Reports* 1985:751).

Many cross-national studies have also demonstrated the profound effect of family planning programmes on fertility reduction. Using sophisticated techniques of multivariate analysis, these studies have come up with the general conclusions that:

* Family planning programmes have a significant independent effect on contraceptive use, fertility, and fertility change beyond that attributed to socio-economic factors;
* Socio-economic factors also have a significant independent effect on contraceptive use, fertility and fertility change;
* The combined effect on fertility of both the socio-economic setting and the family planning programme is greater than the sum of these independent effects because of interaction between the two;
* In practice, this interaction generally means that a favourable social (and economic) setting strengthens and facilitates the operation of a family planning programme (*Population Reports* 1985:754).

The basic difference between family planning and non-family planning approaches to fertility reduction is, according to Weller (1973), one of degree of dependence and emphasis. This is because all non-family planning methods of attaining the fertility change target that have been proposed in the literature imply "changed contraceptive behaviour" as one of the intermediate variables through which fertility transition is to be effected (Weller 1973:80). It has also been shown empirically that family planning programmes in general tend to address the immediate needs of couples to achieve the *desired* size and spacing of children. However, individual family aspirations may be incompatible with the attainment of some national fertility change targets. As Kingsley Davis (1967:732) put it: "There is no reason to expect that millions of decisions about family size made by couples in their own interest will automatically control population for the benefit of society."

It is in this regard that non-family planning approaches which tend to focus on factors affecting family size motivations (taste for family size, small or large, viz. education, occupation, rural/urban living, etc.) should be seen as complimentary to family planning programmes. The effect of the non-family planning approaches is the lowering of desired family size, which motivates increased use of contraceptives. They include programmes of societal modernisation, offer of incentives for having small family size, increased female education and participation in modern occupations, rising age at marriage, effective national programmes of family life education, as well as, programmes on population information and communication. To these modernising factors may be added national advocacy strategy for promoting population issues.

5   Programming Response

5.1   Model of Fertility Change

Namibia's population policy plans to, among others, "reduce total fertility rate from the current level of 5.4 to 5.0 by the year 2006 and 3.5 by year 2015" (GRN/NPC 1997:21). As already noted, this fertility target is expected to be achieved through the provision

and promotion of modern family planning methods. It has also been suggested, on the basis of available data, that serious attention should be given to the family planning programme in Namibia in order to achieve fertility reduction at regional and national levels (Hamata and Tesfaghiorghis 1996). In order to achieve the fertility target in the national population policy, what should be the scale of programme effort? The answer to this question calls for analysis of the various components of a national family planning programme: policy and stage-setting activities; service and service-related activities; programme management; and availability and accessibility of family planning methods (Mauldin and Lapham 1989). This is a difficult question to answer, the complexity of which is far beyond the expected scope and purpose of this paper.

An important component of any family planning programme, which is relevant to the purpose of this paper, is the contraceptive prevalence required to reach a fertility target. Bongaarts (1984) proposed a simple model, and software has been developed for estimating the contraceptive mix and prevalence required to reach a fertility target. In this multiplicative model, the fertility-inhibiting effect of each of the principal proximate determinants of fertility is measured by an index that can only take values between zero and one. The central equation of the model is written as:

$$TFR = C_m \times C_c \times C_a \times C_i \times TF$$

where

TFR = total fertility rate;

C_m = index of marriage [C_m equals one if all women of reproductive age are in marriage or consensual unions and zero in the absence of such unions];

C_c = index of contraception [C_c equals one in the absence of contraception and zero if all fecund women in marital unions use 100% effective contraception];

C_a = index of induced abortion [C_a equals one in the absence of induced abortion and zero if all pregnancies are aborted];

C_i = index of postpartum infecundability [C_i = equals one in the absence of lactation and postpartum abstinence and zero if duration of postpartum infecundability is infinite]; and

TF = total fecundity rate [the total fertility rate in the absence of the fertility-inhibiting effect of marriage pattern, contraception, induced abortion, and postpartum infecundability].

The argument is that the level of fertility in a population is almost completely determined by the four "proximate determinants." Empirical tests of the model have led to the conclusion that contraceptive prevalence is by far the major determinant of fertility decline. This is why a family planning target is a useful means of population programme management.

5.2   Family planning target for Namibia's population programme

The target model requires data on: (i) total fertility rate; (ii) number of women aged 15-49 years; (iii) contraceptive method use effectiveness, discontinuation and consumption;

(iv) contraceptive method mix; and (v) proximate determinants. For this exercise, these inputs were derived from the 1991 census data and the report of the 1992 NDHS survey.

Regarding marriage, it has already been pointed out that childbearing in the country is being done by all sexually active women regardless of age or marital status, hence the assumption that 85% of women aged 15-49 are married (or sexually active/exposed to the 'risk' of pregnancy and child birth). The duration of postpartum infecundability is also assumed to be 10 months, declining over the period as women increasingly substitute bottle-feeding for breastfeeding.

There are also no data on abortion rates in Namibia, nor are there national data on abortion for African countries in general. However, published records elsewhere show a worldwide abortion rate of 37-55 per 1000 women between the ages of 15 and 44 years (Tietze and Henshaw 1986:29). Since most of the data reviewed refer to the advanced countries of the world, it is difficult to locate any African country within the range reported. Given the generally low level of development in Namibia, and the fact that abortion law in the country has always been restrictive, the abortion rate is assumed to be 5% in 1991, increasing over the years as shown in the summary of assumptions in Table 10.

Table 10. Input data and assumptions for the family planning target model for Namibia's population programme. First year = 1992; last year = 2015.

	1992	1997	2002	2007	2012	2015
TFR	5.40	5.05	4.67	4.26	3.80	3.50
Women aged 15-49 (thousands)	351.70	411.10	471.90	542.30	646.70	714.70

METHODS

Method	Effectiveness		Discontinuation		Consumption	
Pill	0.90		0.00		13.0	
IUCD	0.95		0.15			
Female sterilisation	1.00		0.01			
Male sterilisation	1.00		0.01			
Injectables	0.98		0.00		4.0	
Other	0.70		0.00		120.0	

METHOD MIX

	1992	1997	2002	2007	2012	2015
Pill	29.00	28.13	27.26	26.39	25.52	25.00
IUCD	7.00	7.65	8.30	8.96	9.61	10.00
Female sterilisation	26.00	26.87	27.74	28.61	29.48	30.00
Male sterilisation	1.00	1.87	2.74	3.61	4.48	5.00
Injectables	27.00	24.39	21.78	19.17	16.57	15.00
Other	10.00	11.09	12.17	13.26	14.35	15.00

PROXIMATE DETERMINANTS

	1992	1997	2002	2007	2012	2015
Prevalence (%)	23.30					
Percent WRA married	85.00	85.00	85.00	85.00	85.00	85.00
Duration of postpartum infecundability (months)	10.00	9.80	9.60	9.30	9.10	9.00
Induced abortion rates per 1000 women 15-19	5.00	6.09	7.17	8.26	9.35	10.00
Pathological sterility rates (% childless at age 49)	3.40	3.40	3.40	3.40	3.40	3.40

Table 11 provides an overall summary of the expected contraceptive prevalence level and the corresponding number of all users each year that would be required if total fertility is to fall from 5.4 in 1992 to the target level of 3.5 in year 2015. It shows that the prevalence rate will have to more than double over the period, from 23% in 1992 to about 52% in 2015. Based on the contraceptive method mix proposed in Table 10, detailed calculations of the number of women using contraceptives and consumption requirements were also generated in the output of tables but are considered too detailed to be included in this paper. Perhaps, the major advantage of these model calculations is that programme managers have a valid statistical basis for making realistic budgets for contraceptive supplies, and related programme efforts.

Table 11. Output table for all methods from all sources.

Year	Percent MWRA using	Number using (thousands)	Year	Percent MWRA using	Number using (thousands)
1992	23.3	69.7	2004	36.9	155.7
1993	24.3	75.2	2005	38.2	165.4
1994	25.4	81.1	2006	39.5	176.0
1995	26.5	87.1	2007	40.8	187.9
1996	27.6	93.5	2008	42.1	200.9
1997	28.7	100.2	2009	43.4	214.9
1998	29.8	107.2	2010	44.8	229.7
1999	31.0	114.5	2011	46.1	245.1
2000	32.1	122.1	2012	47.5	261.3
2001	33.3	130.1	2013	49.0	278.5
2002	34.5	138.3	2014	50.4	296.5
2003	35.7	146.8	2015	51.9	315.1

6   Conclusions

It has been shown with available data that Namibia is a high fertility country. Given the generally low level of social and economic development and prospects for the future, the environment of poverty which envelopes the majority of the population is most likely to persist and continue to sustain high fertility culture in the absence of an effective policy intervention. As already argued, the programmes of social and economic development being vigorously pursued by the government and the private sector since independence will ultimately contribute to the lowering of desired family size, thereby motivating increased use of modern contraceptives. It is in this regard that Namibia's Population Policy for Sustainable Human Development is complimentary to the development efforts proposed in the First National Development Plan (GRN/NPC 1995).

The population policy places emphasis on wider contraceptive use among all sexually active people as a means of achieving fertility reduction in the country. The population policy on fertility reduction is further supported by the National Family Planning Policy, which seeks to increase access to family planning information and service in order to increase contraceptive prevalence and thereby reduce total fertility (MHSS 1993:8). In order to translate these policies into actual practice, it is imperative

that appropriate programmes of policy implementation be designed and executed within the context of NDP1.

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MIGRATION AS A POPULATION DYNAMIC IN NAMIBIA

Wade Pendleton and Bruce Frayne

Abstract

The interaction of population, development and environment is marked in Namibia, where at least 65% of the population is rural, and where drought and marginal agricultural land are commonplace. In response, both rural and urban households have developed a range of complex coping strategies as a means of improving survival and adapting to the infiltration of a global culture. Migration is one such coping strategy employed. This paper explores the complexity of both the causes and consequences of migration in Namibia. This dynamic phenomena is placed within the context of urbanisation and development, and the pervading situation of environmental degradation which is evident in most rural areas of the country. The paper argues that migration and urbanisation in Namibia are part of the global trend toward an urbanised world, and that while economic survival and access to services are important components of the migration dynamic, the infusion of a global and urban culture plays a significant role in the process. Given the multi-variate nature of migration in Namibia, coupled with a high population growth rate, the declining *per capita* agricultural resource base and the modest macroeconomic performance of the country, rural to urban migration will persist well into the next century. In addition, the paper argues that current policies of government decentralisation to regional and local levels, and rural development, are inadequate to effectively manage inevitable urbanisation. What is called for is a national urban policy which acknowledges the limited means of local authorities to adequately meet the increasing demands resulting from migration and natural growth, particularly as the majority of migrants are poor and have limited skills. Proactive planning and financing of urban areas as a central government function is key to improving the standard of living of the new urban populations of Namibia, while assisting urban managers to better protect the fragile natural environment by improving service provision to the burgeoning low income urban sectors.

1   Introduction

The trend is towards a future planet where the majority of people will live in urban settlements. However, the percentage of people living in towns and cities in sub-Saharan Africa is still a relatively low 31% (1994), although the urban population growth rate is the highest in the world. The percentage of people living in towns and cities in sub-Saharan Africa may be over 50% by 2025 (UNDP 1997:227). Even in Namibia with its estimated 1996 population of about 1.68 million people (Namibian Broadcasting Corporation 1996:4), about 35% of the population live in urban areas and the rate of urban population growth is estimated to be 5.4% per year (Melber 1996:5)

The ability of the society to cope with this rural-urban transition will depend on many factors, not least of which will be the interaction between population growth and migration patterns, and the natural resource base of the country. As the migration and urbanisation trend continues in Namibia, all sectors will be impacted, some positively and some negatively. The degree to which the complex dynamics within and between each sector are able to be managed in a positive way, enhancing the socio-economic development of the population, will depend on the degree to which natural and capital resources can be used in a sustainable manner to achieve long term development goals. However, the basis on which long term development goals for a country are set often does not consider the consequences of the PDE interactions of different policies, but are rather based on ideological or shorter term political objectives.

This paper examines migration in Namibia around various themes. First, the background section looks at the colonial legacy and the impact it had on urbanisation and migration. This is followed by a section on migration theories which presents a model for Namibian migration. Demographic data on migration is presented in the next section and used to identify migration patterns based on census data. Windhoek, the capital of the country, is a major migration destination and details about migration to Windhoek are discussed. The paper concludes with a policy focus regarding migration. This paper attempts to provide a more objective and quantitative basis for decision-making in the urban policy arena by examining migration in Namibia around various themes.

2 Historical Background

Just as migrations took place in South Africa as a result of colonial domination by the Cape Colonial Government (Lau 1987), the colonial occupation of Namibia first by Germany and later South Africa forced the migration of people. People were required to leave their ancestral lands by colonial armies, to live in designated rural, communal areas (later to be called 'homelands' in the apartheid era), to work on white owned farms, and to work in the newly established settler towns. During this early period of Namibian colonial history, some chose exile rather than live under German colonial rule. The Ngamiland Herero of Botswana are the descendants of Herero who escaped the German genocide of the 1904 war and fled to Botswana.[1]

As the South African colonial administration of the country was formalised, the northern districts[2] of the country (the former Owamboland, Kavango and Caprivi - SER A) were effectively segregated from the rest of the country which was referred to as the 'police zone.' These northern communal districts experienced little development, and emigration was only permitted for those who had labour contracts which required their return when the contract was over. During the peak of the contract labour system, Voipio

[1] See Bley (1971), Goldblatt (1971), and Pool (1991) for more details about this period of Namibian history.

[2] Namibia now makes use of both district and new regional areas. Many regional areas are the same as the older district areas such as Kavango (Okavango) and Caprivi. In some cases former districts are split between two regions such as Damaraland (also called the western communal area) which now falls within both the Erongo and Kunene Regions, and Hereroland East (in Omaheke Region) and Hereroland West (in Otjozondjupa Region); both Hererolands are also referred to as the eastern communal area. The former Oshakati and Ondangwa Districts are now separated into four regions: Omusati, Ohangwena, Oshana, and Oshikoto; previously called Owamboland. Namaland in the south is also called the southern communal area.

(1972) estimated that possibly 50% of the adult men were away from the former Owamboland working on labour contracts in the towns, farms and mines. A 'veterinary' cordon fence was established along the northern boundary of the commercial farming area which controlled the movement of cattle and people into central Namibia. Within this 'police zone' communal reserves were established in the south for the Nama (Namaland), the east for the Herero (Hereroland), and the west for the Damara (Damaraland) - SER B. Most of the arable land in central and southern Namibia was sold to whites (primarily Germans and Afrikaners) for the development of farms. Towns were established within the 'police zone' primarily to service the settler economy, and most business, transportation and government functions were centralised in the capital, Windhoek (SER C). Population movement was controlled by a system of permits required for residence in the 'settler' towns, and travel from the communal reserves and farms. Other repressive laws governed marriage, employment, and basic civil rights. Not until 1980 were most of the apartheid laws abolished in Namibia, but it was not until independence in 1990 that the full impact of living in an independent, post-apartheid country was fully realised.

3   Migration Theories

In Europe and North America rural-urban migration took place within a context of industrialisation with job creation and capital expansion, and progress in rural agricultural productivity. The history of migration in Africa is a very different story. Rural areas have been economically stagnating while loosing populations to urban centres; however, the urban centres are not developing due to industrialisation with increasing opportunities for wage labour employment (Amin 1995:38) as was the case in Europe and North America. African urban centres are often characterised by high levels of poverty, unemployment (in the formal sector), and a growing informal sector. For example, Narman (1995:173) estimates that by the year 2000 three-quarters of all new urban employment in Nairobi will be in the informal sector.

The migration experience in Africa is complex and diverse. There are many migration experiences and strategies, and there have been many attempts to understand and classify the phenomenon (e.g. Aina and Baker 1995:11-25; Becker *et al*. 1994:87-134). Classification of migration patterns includes origin and destination criteria such as rural-urban, urban-urban, rural-rural, international and internal, but the major migration pattern in Africa is rural-urban (Amin 1995:30).

Attempts to explain the complexity of African migration by reference to one major variable such as wage labour employment or urban bias have been unsuccessful and heavily criticised in the literature (e.g. Weeks 1994:389-407). Commenting on the 'rational' economic choice model, Amin (1995:31) suggests that it explains nothing about the complexity of the migration experience.

The popularity of the urban 'bias' model has also lost support. The model suggested that bias in government policies provided incentives for urban migration (particularly to capital cities) just as it provided advantages for long term residents. As formulated by Lipton (1977), the bias argument suggested that producers and consumers in urban areas enjoy advantages because of government policies which are biased against agricultural development; that urban development has encouraged the decline in agricultural productivity; and that the urban economy is subsidised to a greater extent than its rural counterpart. The bias encourages significant investment in urban public services and

infrastructure, concentrating public employment and investment in the cities, and encouraging policies which promote manufacturing and other non-agricultural production by artificially increasing their value. Criticisms of the urban bias model include the idea that urban bias in Africa is more related to colonial capitalism and exploitation than development, as well as the fact that migration also takes place to urban centres which have little bias (Weeks 1994:391-394). Becker *et al*. (1994:244) argue that urban sectors can play a part in agricultural development, and that priorities for development should be assigned on the basis of their potential for development success rather than past history. However, they also suggest that some of the urban resource investments could produce equal or better returns if invested elsewhere (Becker *et al*. 1994:94).

A model of African migration which offers the greatest explanatory possibility recognises that it is a complex phenomena with many local variations. The causes are also not mutually exclusive. The many diverse causes of migration include but are not limited to:[3] (1) natural disasters such as droughts, wars, epidemics – migration as a survival strategy; (2) poverty and unequal development due to capitalist modernisation resulting in regional inequalities of economic development and incomes – migration to earn money; (3) population pressures – migration due to lack of land or other productive opportunities; and (4) poor agricultural productivity – migration because crop and livestock methods are inadequate for maintenance of the household and inadequate for cash generation. The major attraction of the urban area, as a major migration destination, are real and perceived opportunities: education, trade, crime, safety, jobs, health facilities, social amenities, and for some, alternative life styles. However, there is some agreement among scholars about the importance of work opportunities in African migration and the over-representation of young males in the migration process (Aina 1995:48). Gender, age, education, as well as other characteristics also play a part in the complexity of the characteristics of migrants.

4   Namibian Migration Influences

The Namibian migration situation is examined below by presenting information on each of the migration factors suggested above in order to evaluate to what extent the above model is applicable.

4.1   Migration and survival

Three topics are discussed under this heading which have had an impact on migration: wars, droughts, and HIV/AIDS.

4.1.1 *Wars*

Wars have played a role in the migration of Namibian people. The colonial wars referred to in the historical background had a major impact on limiting the movements of people and establishing patterns of regional inequality which still exist. However, the Namibian War of Liberation had a significant influence on ending the colonial period by forcing a diplomatic and political solution (Brown 1995). The Namibian War of Liberation started

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[3] This list is adapted from Aina (1995:48) but has been expanded to include additional factors. It also includes some of the causes discussed by Pomuti and Tvedten (1998:4).

during the 1960s and lasted until 1989 shortly before Namibian independence in 1990. The military wing (PLAN) of the SWAPO fought against the South African Defence Force and the South West African Territorial Force. Over the 23 years of conflict, primarily along the Namibian border with Angola and Zambia, many people were forced to migrate for their own safety, and many were required to move by military forces. Melber (1996:8) comments that the effects of the war were devastating on the rural subsistence economy and may be irreversible, and that there were also dramatic ecological impacts on the land as a result of the war. It is ironic that the war created temporary employment opportunities for some, and that with the end of the war many had to seek work outside the area because of the decline in employment opportunities.

During the liberation struggle many Namibians went into exile. Over 40,000 Namibians returned to the country in 1989 prior to Namibian independence.[4] Thus, prior to Namibian independence, the colonial administration and the conflicts that occurred due to the 'illegal' occupation[5] of the country, had radically altered the geography of the country, and internal immigration and emigration were severely influenced.

4.1.2 Droughts

Periodic droughts resulting in low crop production and livestock mortality have also played their part in the migration of people. Namibia experiences frequent drought years often with devastating consequences. The 1992/93 drought was particularly severe; for example, almost half the households that planted maize in 1991/92 harvested none at all, commercial production of maize dropped by 36%, and goat herds in communal areas declined by half (Devereux *et al*. 1993:59). The southern part of the country receives little rainfall even in good years. However, because of the difficulty of moving out of one's area as a response to drought during the pre-independence period, people probably did not migrate out of their districts as a response to drought. For example, only after independence did Damara, who were forced to relocated to a particularly arid part of Damaraland during the 1950s, trek with their animals back to the Khomas Region to try to find better land which received more rainfall (see Naeraa *et al*. 1993:107-110). If they had tried to do this during the apartheid era, the police would have forced them back to Damaraland. For some, household migration is a coping strategy in response to drought; however, in some cases individuals migrate to urban areas in search of employment so that they can send money to their rural household to help sustain them during the drought period.

Since independence the government has implemented various plans to assist communal people during drought years: emergency relief in the form of direct food aid, seed for next year's planting, supplementary feeding programmes for drought animals, and livestock purchase before the animals die. For example, in 1996 the government allocated N$100 million for emergency drought needs (UNDP 1997:3). These drought relief efforts may have prevented some people from emigration since they offer hope for being able to resume crop and livestock farming after the drought.

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[4] See Preston *et al*. (1993) for a comprehensive study on exiles, returnees and war-affected people.
[5] The United Nations tried unsuccessfully to force South Africa to relinquish control over the country starting in 1945.

4.1.3 HIV/AIDS

The influence of major epidemics on migration is not documented for the Namibian past. However, Namibia is now experiencing a major HIV and AIDS epidemic which may yet achieve a dramatic relationship to population migration. AIDS was ranked ninth as a cause of death in 1992, and by the end of 1996 it had moved to first place. AIDS is the leading cause of death among Namibians, having replaced malaria and tuberculosis (UNDP 1997:36-37).

Jakobsen has developed a model to predict the possible impact of HIV/AIDS on future Namibian populations based on six input components: the base population of the 1991 census, fertility levels by age of mothers, mortality levels by age and sex, HIV prevalence rates, HIV infection rates, and HIV progression rates (Jakobsen 1998:1; Jakobsen in this volume). The Jakobsen model is processed on an Excel spreadsheet, but the results are similar to a model proposed by Warren Sanderson programmed in Gauss, although the data sources are different. Figures 1 and 2 show projections for the impact of HIV/AIDS on future Namibian populations. Figure 1 projects a future population not much larger than the present population due to the impact of HIV/AIDS; this projection is based on most people having unprotected sex and about 75 sexual encounters per year. Both assumptions are in line with the current sexual behaviour of Namibians as reported in recent studies of condom use; it is estimated that less than 0.5% of Namibians use condoms (UNDP 1997:64). Figure 2 is based on 80% unprotected sexual activity, fewer sexual encounters, and shows a significant increase in the future Namibian population and by implication shows the dramatic impact that a change in sexual behaviour may have. The impact of the first scenario (Figure 1) on Namibia's future is that: (1) life expectancy is significantly reduced and child mortality will increase, and (2) significant percentages of people between 25 and 40 years of age will die depriving society of educated, productive people.

What will be the impact of HIV/AIDS on the future migration of Namibian people? HIV/AIDS is generally reported to be an urban epidemic and urban areas will experience the greatest impact of increased morbidity and mortality (Way 1994:435). As more migrants come to town and adopt urban lifestyles and behaviours, they risk exposure to HIV, which puts their survival in question. In the Namibian context, many urban migrants maintain relationships with rural kinsmen and family; some male migrants have a wife and children in rural, communal areas. Periodic visits to the rural areas create the possibility for urban contracted HIV to be spread to the rural areas. Urban migrants who develop AIDS symptoms may return to rural areas for care which will add a severe burden to households which have the least resources. An unintended consequence of the HIV/AIDS epidemic in Namibia may be increased urban migration resulting in urban morbidity and mortality, and increased rural poverty associated with providing AIDS care.[6] In addition, the decline in human capital available for agricultural production will impact the rural economy negatively, with resultant food shortages in both rural and urban areas.

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[6] A detailed analysis of all the issues and costs of the HIV/AIDS epidemic in Namibia is beyond the scope of this paper. For more details, refer to UNDP (1997).
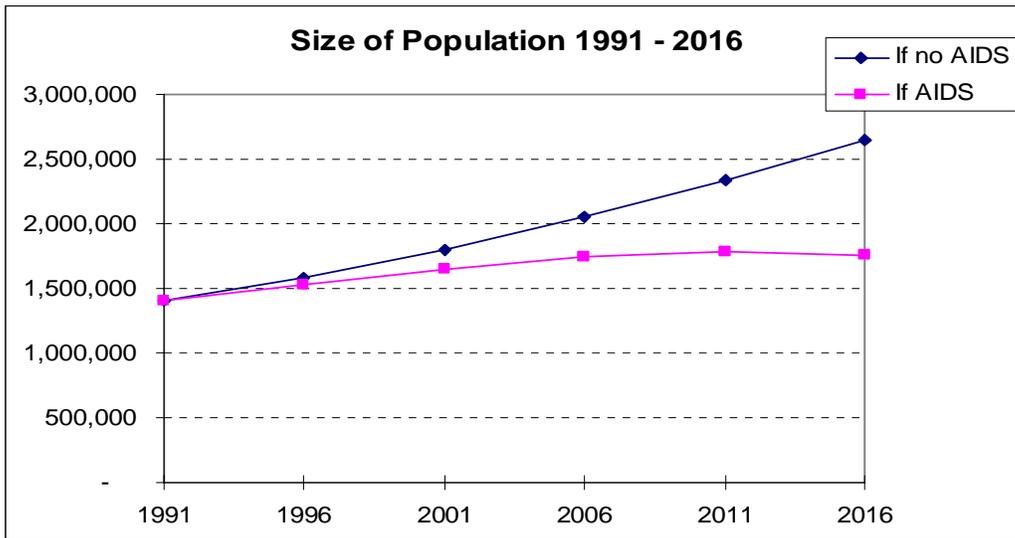
Figure 1. Projections for the impact of HIV/AIDS on future Namibian populations. Parameters: Average 75 sexual encounters per year, constant condom use of 1%. Source: Jakobsen (1998).
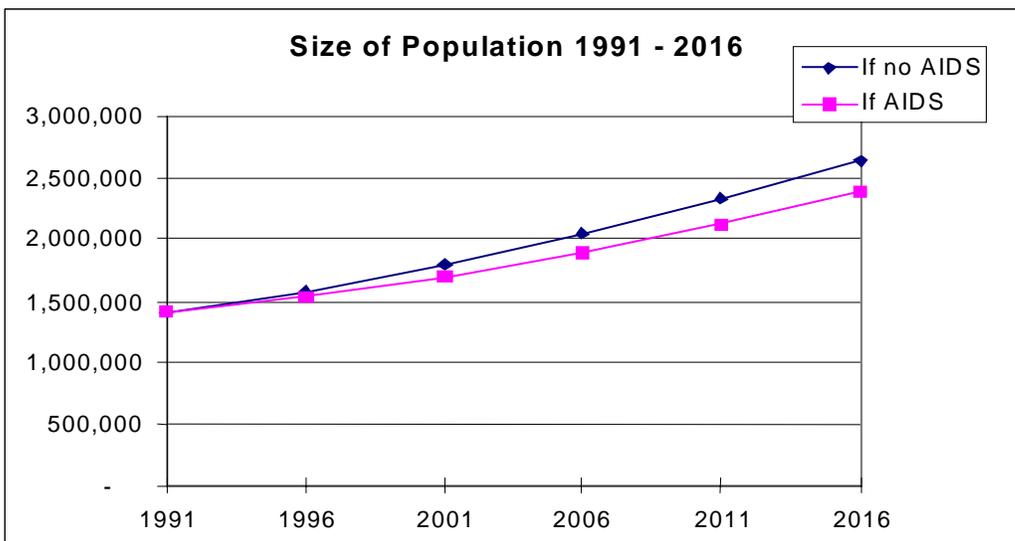

Figure 2. Projections for the impact of HIV/AIDS on future Namibian populations. Parameters: Average 25 sexual encounters per year, constant condom use of 20%. Source: Jakobsen (1998).

4.2   Migration to earn money

Namibia is a good example of a country that developed on the basis of a capitalist colonial economy which excluded the majority population from development, and which created massive inequalities in development and income which still exist today. This inequality is reflected in a very skewed distribution of annual private household consumption (a Gini

coefficient of 0.7); 10% of households consume 44% of total private consumption while the remaining 90% of households consume about 56% (CSO 1996:143-144).[7] Annual per capita income for people living in the northern and the central/southern communal areas is less than N$2,000; in comparison, annual per capita income of people in urban households is over N$7,500 (CSO 1996:147). The Human Development Index and the Human Poverty Index are based on indicators of longevity, knowledge, and a decent standard of living. These indices reveal a pattern of inequality along urban/rural, regional, linguistic, and gender lines. The communal areas have low HDIs, high HPIs, lower than average literacy rates, employment opportunities, and access to health care (UNDP 1997:26). The above data reflect the situation that there are limited opportunities to earn money in the communal areas; many people who want to earn money must migrate to the towns, mines, and farms. Employment opportunities, in both the formal and informal sectors, are also greater in the former 'police zone' than in the under-developed northern regions.

4.3   Migration due to population pressures

Not withstanding the possible effect of HIV/AIDS on future Namibian populations, Namibia has a high population growth rate and the population is expected to double by the year 2020 (Frayne 1997:12). The population is young with about 50% under 20 years of age (CSO 1996:36). The population is not evenly distributed across the country. Over 60% of the population live in communal areas in the north on about 20% of the land. Almost half of the country is occupied by commercial farms (44%) which are owned under private tenure primarily by whites; the farm-worker households make up about 9% of the population (124,821 people) (Devereux *et al.* 1996:3,7). The remaining communal areas in the south, east and west occupy some of the most marginal land in the country.

There is increasing evidence that land deterioration is taking place. The demand for firewood is causing forest depletion, overgrazing is stripping land of vegetation, and the burning of farmland are all having a negative effect. Growing populations need more land, wood and water resources; however, Namibia may be unable to meet these demands due to limited natural resources (Moorsom *et al.* 1995; Marsh and Seely 1992). Migration may be the only viable option for many.

4.4   Migration due to poor agricultural and livestock productivity

Do rural people migrate due to their inability to produce sufficient crops and keep adequate numbers of livestock? Do people migrate because communal household economic systems are unable to provide an adequate living for their members?

Most households in communal areas support themselves as subsistence farmers, growing crops and/or keeping livestock. They also derive modest cash income from various sources: informal and formal sector work, home production activities, animal and crop sales, pensions, and remittance income. Most of the household income is spent on

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[7] There is some evidence that the greater the relative deprivation of poor, rural households, the greater may be the perceived need to increase their income (Stark and Taylor 1989; Stark 1991). With Namibia having one of the most skewed income distributions in the world, the relative deprivation factor may be of considerable importance as a migration 'pull' factor.

food consumption which is typically a large percentage of the total household consumption. About 50% of rural households have a food consumption rate of 60% or more; only about 16% of urban households have comparable food consumption rates (CSO 1996:180). If the percentage of food consumption is high, this means that there is relatively little left to satisfy other household needs such as housing and health.

Writing about the Kavango, Yaron *et al*. (1992:28) report that agriculture generates less than 20% of total household income (in kind) with most households consuming what they produce; income from crop sales is insignificant. Remittances and pensions are important sources of income for households. Income from animal sales is more important, accounting for 11% of household income; however, most meat is sold to informal sector butchers because of an inadequate meat marketing system. Livestock from the northern regions cannot be transported across the 'veterinary' cordon fence into central Namibia which denies northern livestock owners access to a commercial market of auctions and a commercial meat marketing network. The Kavango study describes over 50% of households as living in poverty below a general subsistence level and about 40% as food insecure. The study recommended that development programmes should focus on creating non-agricultural employment as well as increasing agricultural productivity (Yaron *et al*. 1992:31,35).

The situation in the other northern areas is typical of what has been described above for the Kavango region. Within central and southern Namibia (within the former 'police zone') communal areas exhibit some variation from this picture. Households in the eastern communal area earn more money from the sale of livestock than households in the northern areas (it is the major source of household income next to pensions), and household income is slightly higher than in other communal areas (Iken *et al*. 1994:32; CSO 1996:188). However, over three-quarters of households purchase their food from shops reflecting their reliance on cash rather than food production. The southern communal areas are sparsely populated, no crop production is possible because of little rainfall, and the sale of animals is not an important source of household income. The major sources of household income are pensions and remittances (Directorate of Rural Development 1992:30-31). This situation applies equally to the hostile western communal areas of Namibia.

The picture which emerges for all the communal areas is that poverty is widespread, sanitation facilities are inadequate, availability of potable water varies, most households do not have electricity, and access to educational opportunities are limited.[8] Households are dependent on cash sources from wages, pensions, and remittances; many households purchase food rather than produce it (UNDP 1997:25). For some, urban migration is part of a strategy which may contribute to maintaining a marginally viable rural household, and it may also be part of a strategy to provide remittances, enabling rural homesteads to be more productive. For others migration may be a way out of increasing rural poverty.

4.5 Migration due to the attraction of the city

Towns and cities offer opportunities and many amenities which may be attractive to rural migrants: the possibility of a job with cash income; better access to water, sanitation,

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[8] The Namibian Poverty Profile (Devereux *et al*. 1995:22) identifies poverty as a major cause of migration.

health and educational facilities; an improvement in the quality of their life; the promise of a better life in the future; a temporary solution with a chance to return to the rural area; and the possibility to live a different, alternative life style to that in the rural area. Urban migration provides some with a chance to start their lives over again in a social setting where they may be strangers without a past, something not possible in their rural communal village or homestead. Although some who migrate maintain ties with family and kinsmen in the rural areas, others use the opportunity to sever ties and lead new lives with new possibilities.

5 National Migration Patterns

The most recent data available to evaluate national migration patterns in Namibia is the 1991 population census. Miranda (1998) provides a detailed analysis of migration patterns based on this data; however, as he points out (Miranda 1998:1), this is lifetime migration data which only captures one move since the analysis is based on comparing the place of residence in 1991 with the place of birth.[9] Intermediate moves would not be identified in data of this kind. Thirty migration patterns are identified which are based on the migration of more than 2,000 people.

Migration patterns are shown in Table 1 which involve more than 2,000 people. The first and most important, accounting for about 25% of all moves, is the migration pattern to and from Ondangwa and Oshakati Districts (ranks 1 and 4, respectively). This migration probably captures moves made primarily because of the Namibian War of Liberation which forced many Owambo people in these districts to relocate.[10] It also reflects the use and decline of military employment in the area. It captures both rural-rural and rural-urban migration since many people migrated to the Ondangwa/Oshakati peri-urban area.

The second pattern of migration is from these north-central districts to other areas of Namibia. Almost half (42%) of all migration patterns revealed in Table 1 are from Ondangwa/Oshakati districts (Owambo people) to towns inside the former 'police zone': Windhoek (rank 2 and 3), Grootfontein (rank 9 and 19), Lüderitz (rank 10 and 23), Swakopmund (ranks 12 and 15), Tsumeb (rank 17 and 21), and Okahandja (rank 27). Walvis Bay was not included in the 1991 census, but probably would have ranked as high as Swakopmund as a migration destination if it had been included. The major reason for these moves is probably employment; however, as will be discussed in the next section, it would be overly simplistic to try and explain migration solely as a response to employment alone.

The third pattern is migration to Windhoek accounting for 37% of all moves and shows people coming to Windhoek from all parts of Namibia: the north (Oshakati, rank 2; Ondangwa, rank 3), the south (Rehoboth, rank 5; Mariental, rank 13; Keetmanshoop, rank 14), and the east (Gobabis, rank 6; Hereroland East, rank 29). Other patterns are also revealed in the analysis of Table 1: migration to Damaraland (ranks 7, 20, and 28) probably as a result of land being made available for settlement as part of the

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[9] Other analyses of the 1991 census data for migration patterns will be found in Tvedten and Mupotola (1995) and Melber (1996).

[10] It is not always possible to distinguish rural-urban from rural-rural migration in Table 1 since district census data may include both communal and urban areas. However, in most cases knowledge of the district enables an identification of the primary pattern to be made. For a description of the Oshakati/Ondangwa area, see Pendleton *et al*. (1992).

implementation of the recommendations of the Odendaal Commission Report (Melber 1996:8) and migration from the Okavango to Grootfontein (rank 8) and Caprivi (rank 30).

Table 1. Main lifetime internal migration patterns. From Miranda (1998:7). Source: GRN/NPC (1993).

District born in	District resident in	Rank	Number	Primary Type of Migration
Ondangwa	Oshakati	1	22959	R-R and R-U
Oshakati	Windhoek	2	18884	R/U-U
Ondangwa	Windhoek	3	15747	R/U-U
Oshakati	Ondangwa	4	12966	R-R and R-U
Rehoboth	Windhoek	5	7159	U-U
Gobabis	Windhoek	6	4071	U-U
Outjo	Damaraland	7	3809	R-R
Kavango	Grootfontein	8	3746	R-U
Oshakati	Grootfontein	9	3673	R/U-U
Oshakati	Lüderitz	10	3604	R/U-U
Windhoek	Hereroland East	11	3320	U-R
Ondangwa	Swakopmund	12	3179	R/U-U
Mariental	Windhoek	13	3044	U-U
Keetmanshoop	Windhoek	14	3021	U-U
Oshakati	Swakopmund	15	3018	R/U-U
Windhoek	Rehoboth	16	3006	U-U
Ondangwa	Tsumeb	17	2879	R/U-U
Gobabis	Hereroland East	18	2798	U-R
Ondangwa	Grootfontein	19	2763	R/U-U
Windhoek	Damaraland	20	2760	U-R
Oshakati	Tsumeb	21	2749	R/U-U
Windhoek	Oshakati	22	2742	U-U
Ondangwa	Lüderitz	23	2694	R/U-U
Windhoek	Okahandja	24	2654	U-U
Keetmanshoop	Namaland	25	2436	U-R
Windhoek	Hereroland West	26	2366	U-R
Oshakati	Okahandja	27	2354	R/U-U
Omaruru	Damaraland	28	2229	R-R
Hereroland East	Windhoek	29	2080	R-U
Kavango	Caprivi	30	2076	U-U

6   Migration to Windhoek

In order to gain a better insight into the reasons for migration the following case study of migration to Windhoek is presented. The population of Windhoek, the capital of Namibia, has been growing at an annual rate of 5.4% between 1991 and 1995, the largest annual growth rate in its history. The 1997 population of Windhoek is about 200,000 people almost half of all urban residents in the country.[11] Most of the population growth is taking place in Katutura, the large African township located to the north-west of the city, where about 60% of the urban area's population live on about 20% of the urban area's land. Most of the growth in the Katutura population is due to migration. Central Katutura is the older more established part of the township; the North-West areas, where most of the informal, shanty housing is located and much of the growth is taking place, surrounds central Katutura to the north and west (see the Appendix map of the Windhoek urban area). Virtually all the people who live in Katutura are black Namibians.[12]

It is estimated that the population of Windhoek will double by 2010 (Municipality of Windhoek 1996a:Vol.1:20). Most of this growth will come from migration and the Katutura area will be unable to absorb it; considerable growth in the form of shanty housing will take place to the west and south of Windhoek. It is estimated that in the future 50% of the Windhoek urban area's housing may be shanties (Municipality of Windhoek 1996b:22).

The attraction of Windhoek and Katutura as a migration destination is easy to understand. Windhoek is a place of opportunity with better access to education, health, water, electricity and especially work opportunities. Subsidies also contribute to the attraction making the costs of food, housing and medical care cheaper for urban residents. Private and public sector activities are centralised in Windhoek and account for 40% of the total labour force (economically active including both informal and formal sectors of the economy) in urban areas in the country (CSO 1996:60,221). The 'primacy' of Windhoek with all its advantages and disadvantages is due in part to the fact that secondary towns received little development during the South African apartheid era; what development took place was primarily to benefit white business activities and the commercial farming sector.

Windhoek accounts for 45% of Namibia's urban population. In other words, it is almost the same size as all the urban areas in the country combined. It is the predominant economic, service, manufacturing, and political centre of the country. Based on data from 1992/93 for the entire country, Windhoek accounts for 51% of manufacturing activity, 94% of communications and transport, 96% of utilities, 82% of business and financial services, 68% of social and community services, and 56% of construction and trade activities (Municipality of Windhoek 1996a:6). The Namibian development budgets for recent years also reflect the dominance of the central region and Windhoek. The per capita spending on development projects in the central region[13] (which includes Windhoek as a major target) is N$659 for 1995-96, which is about double the per capita expenditure in the

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[11] A 1995 survey of Windhoek estimated the population at 181,696 (Municipality of Windhoek, 1996a:4); a 1994 survey by the Central Statistics Office put the population at 150,000 (CSO 1996:20).

[12] For more information about Katutura and Windhoek refer to Frayne (1992) and Pendleton (1996).

[13] Region in the development budget reports refers to clusters of regions; the regions identified are North, Central and South. Central includes Erongo, Khomas, Omaheke and Otjozondjupa. Reference to the actual development projects shows the centrality of Windhoek, which is located in the Khomas Region, in the development process.

other regions. Similar levels of expenditure are reported for 1995-96 and 1997-98 (GRN/NPC 1995a, 1996, 1997). The allocation of funds to the Khomas Regional Council (where Windhoek is located) is over ten times the amount allocated per capita to councils in other regions, and the importance of shifting development away from Windhoek to achieve more balanced regional development is discussed in the most recent UNDP (1997:25) report. However, as is shown below, Windhoek and Katutura are not equally attractive to people from different parts of Namibia.

The 1996 Katutura population was about 54% male, reflecting the fact that more male than female migrants come to the area. Oshiwambo speaking people (Owambo) are the majority ethnic group in Katutura making up about 40% of the 1996 population. There have been small increases in the percentages of Lozi (Caprivi) and Kwangari (Kavango) speaking peoples in Katutura which may reflect a pattern that could increase in the future (see Table 2).

Table 2. Language group, gender and work status.

	1991		1996	
	#	%	#	%
Language Group (people)				
Otjiherero	359	19	439	20
Nama	179	10	171	8
Damara	351	19	400	19
Oshiwambo	781	42	866	40
Kwangari	4	0	24	1
Lozi	1	0	28	1
Afrikaans	83	4	154	7
German	0	0	1	0
English	2	0	9	0
Other	96	5	63	3
Total	1856	100	2155	100
Gender (people)				
Male	982	53	1158	54
Female	876	47	1005	46
Total	1858	100	2163	100
Work Status (adults)				
Working	610	56	785	65
Not working	251	23	287	24
Seeking work	177	16	106	9
Ill	20	2	11	1
Retired	31	3	17	1
Total	1089	100	1206	100

Almost three-quarters of the adult 1996 Katutura population are migrants with about half having moved there within the last five years (Table 3).[14] About 40% of the migrants move to the North-West areas. The age/sex structure of adult migrant and non-migrant populations show important differences: the migrants have larger percentages of people in the 25 to 44 age categories and are more male (55%) than female (45%). When migrants first arrive in Katutura they usually stay with relatives (69%).

Table 3. Years in Katutura and age.

	Non-Migrant		Migrant		Total	
	#	%	#	%	#	%
Years in Katutura						
0 - 2	25	14	131	30	156	25
2 - 5	15	8	93	21	108	17
5 -12	32	18	111	25	143	23
12+	111	60	107	24	219	35
Total	184	29	442	71	626	100
Age						
25 - 19	146	29	87	8	233	15
20 - 24	97	19	164	16	261	17
25 - 29	61	12	214	21	275	18
30 - 34	50	10	168	16	218	14
35 - 39	56	11	138	13	193	13
40 - 44	28	6	100	10	128	8
45 - 49	20	4	64	6	84	5
50 - 54	19	4	38	4	57	4
55 - 59	11	2	28	3	38	3
60 - 64	6	1	9	1	15	1
65 - 69	7	1	7	1	14	1
70 - 74	0	0	4	0	4	0
75+	1	0	4	0	5	0
Total	501	100	1025	100	1526	100
Fields/Livestock in rural area						
Fields	7	3	72	8	79	7
Livestock	19	8	174	19	193	16
Both	16	6	185	20	201	17
No	200	83	506	54	707	60
Total	242	100	938	100	1180	100

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[14] All factual data about Katutura comes from the Katutura research project; for details about the 1991 and 1996 Katutura surveys see Pendleton (1991, 1996, 1997). Adult in this paper refers to people 16 years of age and older.

Why are migrants leaving other areas? The migrants themselves report the major reasons are jobs/money (64%) with secondary reasons education (15%) and social life (8%); however, about 13% report a diversity of other reasons reflecting the complexity of causes. Why are migrants coming to Katutura? The reasons are similar to why they left other areas. The migrants say they have come to Katutura for economic reasons (jobs/money, 63%) with other less important reasons being education (16%), a better future (6%), and modern life (2%); however, 7% report other reasons reflecting diverse causes. About 4% of migrants report they came to visit and stayed (Table 4). Migrants also report in interviews they have come for trading and hawking.

Table 4. Gender and migration.

	Male		Female		Total	
	#	%	#	%	#	%
Gender Reasons Left Rural Area						
Jobs/Money	406	72	246	54	651	64
Education	77	13	80	18	157	15
Social Life	33	6	44	10	78	8
Medical/Health	3	1	5	1	8	1
Other	51	8	80	18	131	13
Total	570	100	455	100	1025	100
Gender Reasons Came to Katutura						
Jobs/Money	410	72	239	52	649	63
Education	73	13	90	20	163	16
Medical/Health	5	1	9	2	14	1
Housing	3	1	10	2	13	1
Visits	21	4	20	4	41	4
Modern Life	4	1	12	3	16	2
Better Future	24	4	36	8	60	6
Other	30	5	40	9	70	7
Total	569	100	456	100	1025	100

How successful have the migrants been in finding jobs? There are important differences in their occupational profile when compared to non-migrants (Table 5). A larger percentage of migrants work in the informal sector and as labourers than non-migrants, but migrants actually have a lower unemployment percentage (24%) compared to non-migrants (32%). Many migrants have found employment as professional, technical, clerical, skilled worker and civil servants. Average monthly income for migrants is about N$986 compared to N$1253 for non-migrants. Migrants appear to be more willing to take unskilled and informal sector work and to earn less money than non-migrants which supports the information above that migrants say they have come to work.

However, many migrants remain unemployed. Thirty-three percent of the unemployed are migrants living in the north-west areas; the median number of years of unemployment

is two. People who are unemployed report that they simply cannot find work of any kind. Evidence of migrants looking for work is easy to find in Windhoek; every day of the week there are hundreds of primarily Owambo men sitting on street corners in all the suburbs of Windhoek waiting for people to come by and offer them day work.

Table 5. Occupation.

	Non-Migrant		Migrant		Total	
	#	%	#	%	#	%
Professional	19	7	67	8	86	8
Technical	19	7	32	4	51	5
Clerk	16	6	36	4	52	5
Skilled	25	9	9	12	123	11
Labourer	10	4	103	13	114	10
Civil servant	23	9	57	7	80	7
Sales	7	3	24	3	32	3
Service	32	12	63	8	95	9
Housewife/retired	12	5	36	4	49	4
Informal	21	7	107	13	127	12
Unemployed	88	32	202	24	290	26
Total	2,741	100	824	100	1,098	100

Men and women come to Katutura for the same reasons, but the relative importance of reasons is not the same; women come less for jobs/money (52%), and more for education (20%), a better future (8%), a modern life (3%), and a higher percentage of other reasons (9%) (Table 4). Of the adult female migrants, almost half have moved in the last two years indicating a substantial increase in urban migration by women. Significant changes in gender equality for women are taking place in Namibia, such as the passage of the married person's equality bill, which may influence some women to seek alternative urban life styles.

The place of origin of migrants reveals an interesting pattern which is primarily rural-urban and secondarily urban-urban. Table 6 shows the place of last residence, the population size of the various areas from which people migrate, the annual per capita income in those areas, and the distance to Windhoek. Inspection of Table 6 shows that in relation to the percentage of population represented in each migration sending area, migration sending areas vary, with most under-represented and a few over-represented. Katutura is a more popular destination for people from some areas more than others.

Similar regional inequalities exist in development between the developed Khomas Region of central Namibia (Windhoek) and the underdeveloped rural, communal areas of Kavango, Caprivi, the north-central (the Omusati, Oshana, Ohangwena and Oshikoto Regions), the east, west and south. Reference to Table 6 will show that the annual per capita income is less than N$2,000 for each of these communal areas. However, the north-central accounts for about 40% and the Kavango and Caprivi together only about 3% of Katutura migrants; the north-central is home to about 45% and the Caprivi and the Kavango about 16% of the population. The Caprivi is about twice as far from Windhoek as

the north-central, but the Kavango is about the same distance from Windhoek as the north-central. Migrants from the western and eastern communal areas are represented in the Katutura population in greater percentages than their population would suggest; these areas are closer to Windhoek than the northern communal areas and people from these areas have a long history of migration to Windhoek to work.

Table 6. Last residence, population, and distance to Windhoek. From CSO (1996:147,274).

	Last Residence		Population		Per Capita Income	Distance to Windhoek
	#	%	#	%		
Commercial farmworkers	27	3	124,821	9	1,971	Varies
Other towns	127	12	251,325	18	7,651	Varies
North-central*	443	43	621,513	45	1,531	800 km
Kavango*	14	1	125,033	9	1,763	800 km
Caprivi*	22	2	91,434	7	1,598	1,400 km
Kunene	93	9	100,000	7	2,203	300 km
Otjozonjupa / omaheke*	49	15	20,000	1	3,801	300 km
Karas*	19	2	10,000	1	1,500	700 km
Other	130	13	44,891	3		
Total	1,025	100	1,389,017	100		

* Population figures based on CSO (1996:37) adjusted for rural communal dwellers only.

Although the percentage of people who say they come to Katutura for jobs/money is high, it is not uniform; about 70% of migrants from the northern communal areas report jobs/money as a primary reason for migration. Those from the south, east, farms and other towns report about 50% come for jobs/money, and for migrants from these areas other causes such as education and a better future are more important reasons to come to Katutura.

Why are the Owambo so strongly represented in the Katutura population? A long history of labour migration by Oshiwambo speaking people (primarily men) dates back to the German colonial period in Namibia, and into the South African colonial period when the South West Africa Native Labour Association recruited men for migrant labour contracts to work in Windhoek, other towns, commercial farms and the mines. In spite of the fact that migrant contract workers could not obtain legal residential status in Windhoek during the apartheid years, many Owambo people managed to stay. After independence, the popularity of Windhoek/Katutura as a destination for Owambo people increased and the attraction of commercial farm work declined significantly (Devereux *et al.* 1996:7). Owambo people come to Katutura in part because there is an established Owambo community where they have kinsmen with whom they can initially stay; this in part explains how hundreds of Owambo men can sit all day on the streets of Windhoek waiting for day work and still have a place to stay and food to eat when they return home without having found work. There is also population pressure and family pressure for Owambo

people to find work outside the north-central communal areas and send remittances home to support relatives and in many cases a family. Almost half the population of Namibia lives in the north-central communal area which increasingly is unable to support this growing population due to declining water, wood and arable land resources (Marsh and Seely 1992).

No strong tradition/history of migration to central Namibia exists for the Kavango or Caprivi Regions. In the past, migrant workers from the Kavango were recruited for work on South African gold mines, but this practice stopped over 20 years ago. All communal areas experience poor agricultural productivity, periodic drought, population pressures, need for land to accommodate expanding populations, poverty, lack of income producing activities and in the case of the Caprivi flooding from the Zambezi even during a drought year.[15] But it is primarily the north-central communal areas from which people migrate in large numbers to Katutura.[16] With the Trans-Caprivi Highway almost paved, this road will provide easier access to Windhoek for Caprivi, Angola and central African peoples. It would not be surprising to find larger percentages of people from these areas in a future Katutura population.[17] The eastern and western communal areas are closer to Windhoek than the north and also have a long history as sending areas for Katutura. Ancestors of the Damara and Herero who live in these areas were among the first people to migrate to Windhoek during the German colonial period when both were forced to come to Windhoek to work (Pendleton 1996:24-31).

A significant percentage of migrants come to Katutura from other towns (12%). Their reasons do not differ significantly from those given by rural people in spite of the fact that the annual per capita income of people in other towns is at least three times greater than people in rural areas. The lack of development of secondary towns and the primacy of Windhoek must be an important attraction for those who are already urban dwellers.

7   Conclusion and Policy Focus

Various migration patterns were identified in this paper: rural-rural, urban-urban, and rural-urban. The first two major migration patterns involve Owambo people and are moves within the north-central regions related to the Namibian War of Liberation, and migration from the north-central regions to towns in the former 'police zone.' The third major pattern is migration to Windhoek, primarily to Katutura, and involves migrants not only from the north-central regions, but from other towns, other rural, communal areas, and commercial farms. The popularity of Windhoek as a migration destination is discussed within the context of the colonial history of Namibia and the primacy of Windhoek as a capital city. The rate of urban population growth, primarily due to migration, is expected to continue if not increase. Major reasons for migration are employment expectations; however, a

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[15] The southern communal area is an exception to this statement. The population of this area has been declining due to out migration.

[16] Although the percentage of migrants coming from north-central Namibia appears to have declined between 1991 and 1996, the percentage of Owambo people in Katutura has remained the same at about 40%. Possibly Oshiwambo speaking people living elsewhere in Namibia have also been migrating to Katutura.

[17] For comparison, the City of Windhoek Survey (Municipality of Windhoek 1996a:63) reports larger percentages of migrants to Katutura from Caprivi (3%) and Kavango (3%) as well as small percentages of people from these areas as well as other African countries living in other areas of Windhoek.

diversity of reasons would seem to be part of the migration strategy of people including access to facilities such as education and health, amenities such as clean water, sanitation, and electricity, and participation in modern, alternative life styles. In addition, as Frayne (1997:6-7) comments, urbanisation is simply a more effective solution to improving living standards of large numbers of people – the urban migrants know this, and so should the policy makers.

What policies exist at the government level regarding urban migration and urbanisation in Namibia? No national urbanisation and urban migration policy currently exists for Namibia. Melber (1996:29), in his analysis of the First National Development Plan (GRN/NPC 1995b), identifies seven government goals, four of which are central to this paper: (1) slow the rate of rural-urban migration (by promoting rural development), (2) create a town planning development policy, (3) expedite the proclamation of towns and villages, and (4) improve services in towns, villages, and settlements. These goals argue on the one hand for reducing rural-urban migration through rural development, while at the same time implementing policies for the expansion and development of urban areas.

No evidence exists in the development literature for sub-Saharan Africa that rural development will reduce the rate of rural-urban migration; it would be unrealistic to expect that this would occur in the Namibian context. This is not an argument for neglecting rural development; rural development, especially in the rural communal areas throughout Namibia, have the least resources and the largest percentages of people who live in poverty. Rural development is a necessary national priority. However, to base policy on the assumption that it will reduce rural-urban migration may be erroneous. A reduction in rural poverty and job creation will most probably enable some people to remain in the rural areas, but poverty and job creation are not the only reasons people migrate. The shanty areas of Katutura have the highest unemployment rate in the Windhoek urban area and many households live in poverty, yet people continue to migrate to these areas.

Melber (1996:11-14) makes a strong plea for public sector reform including decentralisation, greater roles for regional and local authority councils, and a balanced sustainable development. Decentralisation of public and private activities away from Windhoek may have an effect on migration. As previously described, Windhoek receives a large percentage of development resources and a more balanced regional development of the country might disperse urban migration more evenly around the country. The development of secondary towns and the improvement in their services will possibly attract future migration away from Windhoek/Katutura, especially if many new jobs are created. As part of a strategy for development in the north, Devereux and Tapscott (1995:146) comment on the possibility of establishing central government ministries in the north and Pendleton (1996:169) even suggests making Oshakati a second capital of Namibia. However, decentralisation, orderly urban development, and rural development will not stop urban migration. It may slow it down or re-direct it, but it is part of a global phenomenon which cannot be reversed.

Urban migration and urbanisation have important consequences which urban policy development must take into account: (1) decentralisation will place additional financial responsibility and pressure on local authorities, (2) most migrants are poor people who are unable to contribute to the orderly growth development of the towns, and (3) the current pattern of urbanisation means a per capita reduction in urban resources and may result in some local authorities becoming bankrupt. To reduce the negative impact of a

decentralisation policy, subsidies will be needed by local authorities to insure their financial viability and their ability to develop. Urbanisation will remain a key PDE transition sector for decades to come. Without subsidies, urban growth will mean increased poverty and a non-sustainable financial situation for local authorities.

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Acknowledgements

Appendix

MAP: WINDHOEK URBAN AREA

SCALE 1:80 000
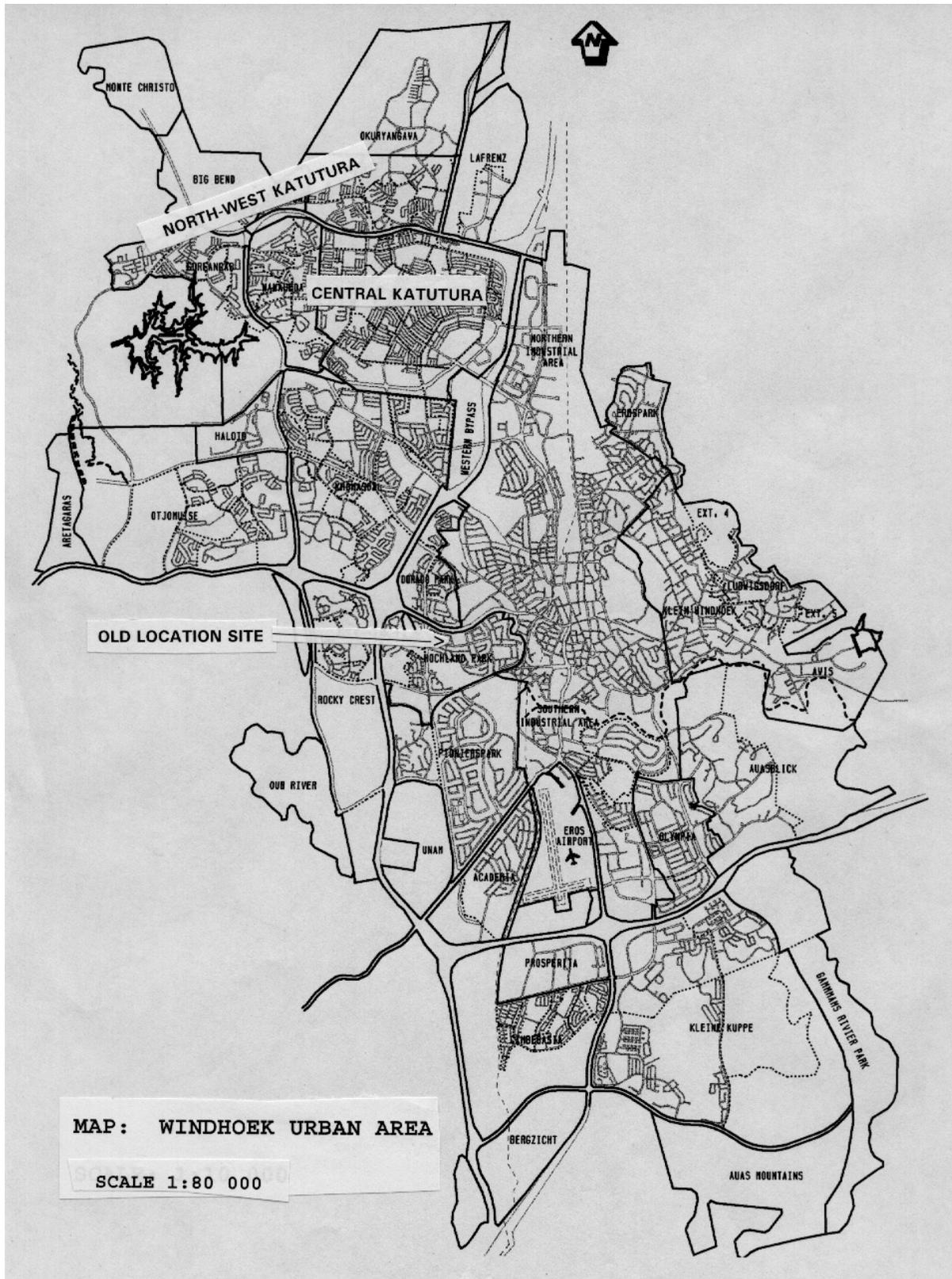
A MODEL FOR STUDYING THE IMPACT OF HIV/AIDS ON THE SIZE AND STRUCTURE OF THE NAMIBIAN POPULATION

Oddvar Jakobsen

Abstract

The paper presents a demographic model built in standard spreadsheet software[1] for the purpose of studying the impact of the HIV/AIDS epidemic on Namibia's population. The model combines information on fertility and mortality with assumptions and facts regarding the spread of the virus and the progression of HIV infection to AIDS. It attempts to draw causal lines to factors of relevance to population planning and health education, such as sexual habits and prevalence of other STDs. By re-interpreting available demographic data and by introducing the HIV/AIDS impact, the model produces population projections that are considerably at variance with previous projections, but appear more realistic in the case of Namibia. The model can be used as a sensitivity tool to demonstrate the effects of various assumptions regarding both demographic and HIV/AIDS parameters. It is in the process of being applied to data from other SADC countries.

1   Background to the Model

The immediate motive for the construction of the model was the need for updated inputs into the construction of the Human Development Index[2] and the Human Poverty Index[3] in connection with the publication of the *Namibia Human Development Report 1998* (UNDP 1998b).

UNDP is UN's development agency, promoting world development. Sustainable human development is a complex, multi-dimensional measurement of progress, of lasting betterment of human living conditions. One of the instruments used to measure it is the HDI – an index of the extent to which the populations in various countries are able to lead long, healthy, comfortable and knowledgeable lives.

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[1] Microsoft Excel

[2] HDI is an index of development, composed of three components: Life expectancy at birth, income, and educational attainment, measured as a combination of literacy rate and school enrolment.

[3] HPI is an index of poverty, measured in terms of deprivation, composed of three components: Proportion of population not expected to live beyond the age of 40, illiteracy rate, proportion of population deprived of certain basic needs, namely: access to safe water and to basic health facilities, and adequate nutrition for children, measured by their weight-for-age. For a comprehensive presentation of the HDI and HPI, please see any of UNDP's global *Human Development Reports* later than 1997 (published by Oxford University Press, New York).

In the world context, African countries find themselves towards the bottom of the world development ranking list, with Namibia towards the top of the African countries.

- What drags Africa <u>down</u> is the income aspect. GDP growth has not kept pace with population growth; African countries lack vibrant expanding economies.
- What lifts Africa <u>up</u> are massive efforts (and achievements) in health and education.

When UNDP published its first *Human Development Report* in 1990, most African countries had seen three decades of economic stagnation. With the exception of a few countries, and of privileged groups in most countries, most Africans were <u>not</u> better off in 1990 than they were in 1960, measured in terms of access to material goods.

This rather gloomy picture had one very important moderating aspect. In spite of frail and failing economies in 1990, almost all African countries had achieved considerable improvements in health and education, resulting in improved life expectancy at birth. Life in Africa had become increasingly poor, but also longer and more knowledgeable. The opening sentence in the overview chapter in the very first *Human Development Report* makes a point out of this fact, stating almost triumphantly that "Life expectancy in the South rose from 46 years in 1960 to 62 years in 1987" (UNDP 1990).

Starting around 1990, this picture changes radically, as illustrated by Figure 1. Life expectancy rates in African countries, which have been climbing steadily over 20-30 years, take a virtual nose dive during the last decade of the century. The HIV/AIDS epidemic is playing havoc with hard-won gains achieved during decades of adverse economic conditions. It is somehow ironic that it takes the 1998 *Human Development Report* (UNDP 1998a) to make the world aware of this fact. The Botswana government, for one, reacted strongly to what would appear as the report's "shortening of life expectancy of its citizens."
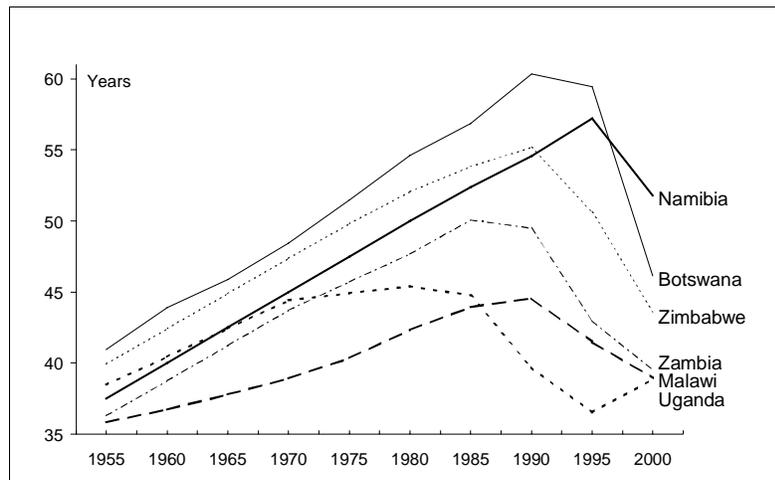
Figure 1. Projected life expectancy at birth in selected sub-Saharan countries 1950/55–1995/2000. Source: UN (1999).

The epidemic has been with us for two decades, and the HIV/AIDS experts have been sounding the warning bell, unfortunately at times to an overly alarmist tune,

predicting virtual demographic collapse. Demographers, on the other hand, have been very slow in realising the profound distortion the epidemic has brought to their "model" populations. As late as in 1998, the UN Population Division distributed a report on *World Population Projections to 2150*, focussing on fertility projections, ignoring mortality, and not even mentioning AIDS (UN 1998).

Perhaps the best example where data from health and demographic sources are inconsistent, is the UNAIDS' series of epidemiological fact sheets, presenting compressed, "factual" data country by country. According to UNAIDS/WHO (1998) Zambia had an estimated population of 8.478 million in 1997, an estimated crude death rate of 10 in 1996 (i.e., 84,780 Zambians are estimated to die each year), and an estimated number of AIDS deaths of 97,000 in 1997!

The purpose of developing the model was to demonstrate that it ought to be possible to express the basic facts of the AIDS epidemic in credible demographic terms. The result will enable the calculation of the epidemic's development "cost" as measured by the Human Development and Poverty Indices.

2 Official Population Projections

Drawing on the information from the census, the Central Statistics Office produced population projections up to 2021 (GRN/NPC 1994a).

The <u>mortality</u> trends are based on the assumptions that:

1) The age-specific patterns of present and future mortality in Namibia are adequately described by standard Model Life Tables, using the West model as the one best fitting Namibia (Coale and Demeny 1983).
2) General improvement in health education, health services, nutrition and child care, etc., will extend the life expectancy at birth by 0.5 years every year.

<u>Fertility trends</u> are all assumed to be downwards, described as three different scenarios: quick, moderate and slow, reaching 3.0, 4.0, and 5.0, respectively, by 2021.

Applying the above assumptions, and using the moderate scenario for fertility decline as the most likely one, the population by age and sex in 2016 was projected as illustrated in Figure 2.

A major weakness in these projections is that the fertility rates appear over-estimated. A virtual baby boom is projected starting from 1991. In 1991 the size of the 0-4 year cohort is 14% above the 5-9 year cohort, jumping in 1996 to an improbable level of 48% (Figure 4d). The jump is visible throughout the projection period, as shown in the pyramid for 2016 (Figure 2), where there are 47% more 20-24 year olds than 25-29 year olds. A baby boom at independence is likely, but the magnitude and the persistence of it over 25 years are very unlikely, and indicate overestimation of fertility rates.

The technique used in estimating age-specific fertility rates is internationally accepted, drawing on information both on current fertility (number of children born last 12 months), as well as parity data (number of children ever born). Information from the two sources are combined in a way that provides a correction factor on the current fertility, in Namibia's case, adjusting the estimated Total Fertility Rate upwards by some 21%.
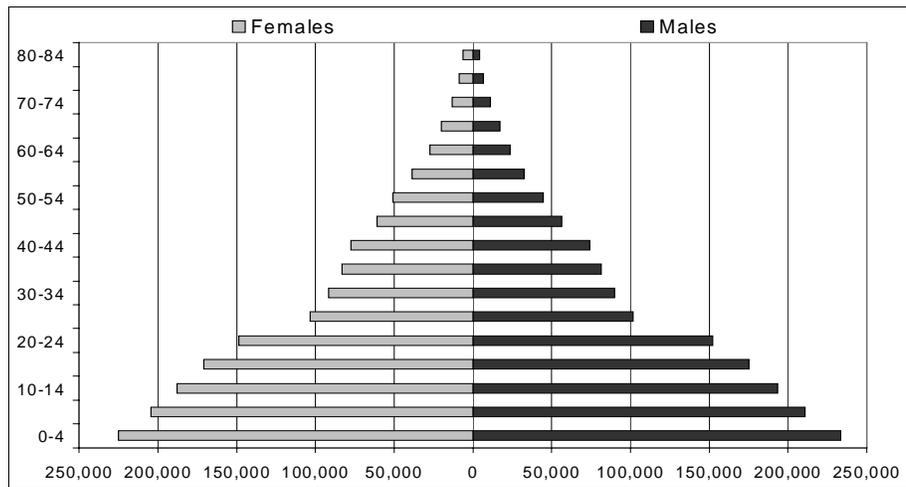
Figure 2. Population projections for 2016. Source: GRN/NPC (1994a).

3　An Alternative Model for Population Projections

In 1998, the official demographic data on Namibia, and in particular population projections, were becoming increasingly outdated, and increasingly out of tune with realities. There are two reasons for this. First, key demographic parameters were based on the 1991 census (GRN/NPC 1994b), undertaken immediately after independence, which brought peace to the densely populated north, and which also brought back from exile large numbers of Namibians. It would appear that the special circumstances related to this situation also impacted on the quality of the information provided to the census enumerators. Second, the demographic projections based on the 1991 census did not take into account the impact of the HIV/AIDS epidemic, which in 1998 had spread to some 20% of the adult population, according to data from sentinel surveys.

The model aims at improving the population projections. It starts with the most obvious, almost mechanical cause-effect relations, and expands through stochastic or probabilistic relations, into almost speculative or guesswork relations. The guiding principle, though, is one of searching for factors with either high explanatory power, and/or factors that are amenable to planning, or intentional change.

The model uses 5-year time intervals, starting in 1991, and 5-year cohorts (except for age groups 0 and 1-4). Population projections are defined by three and only three factors:

1. Births: Crude Birth Rate = number of births per 1,000 population
2. Deaths: Crude Death Rate = number of deaths per 1,000 population
3. Migration: At national level is regarded as negligible

Number of births depends on:

1. Number of women in childbearing age (drawing on 1991 census information on population structure, i.e., age and sex)
2. Number of children each woman bears – using Age-Specific Fertility Rates. It is assumed that the TFR is falling from 4.76 to 4.00, with a constant age profile (see Figures 3a and 3b).
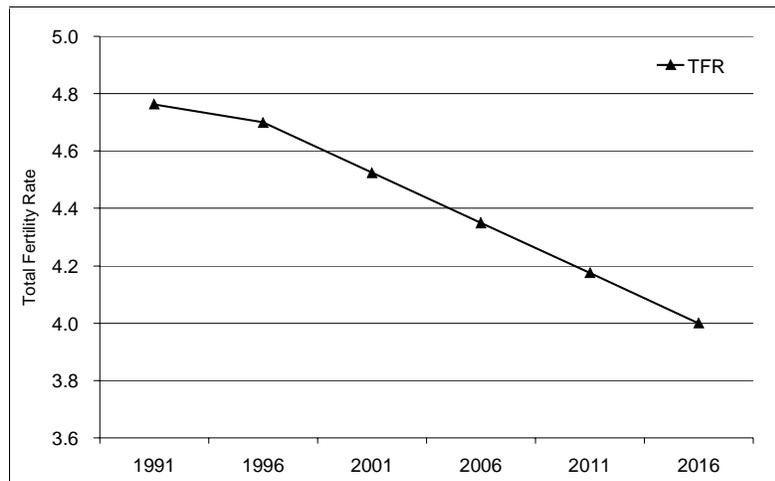
Figure 3a. Assumed falling Total Fertility Rate, 1991-2016.
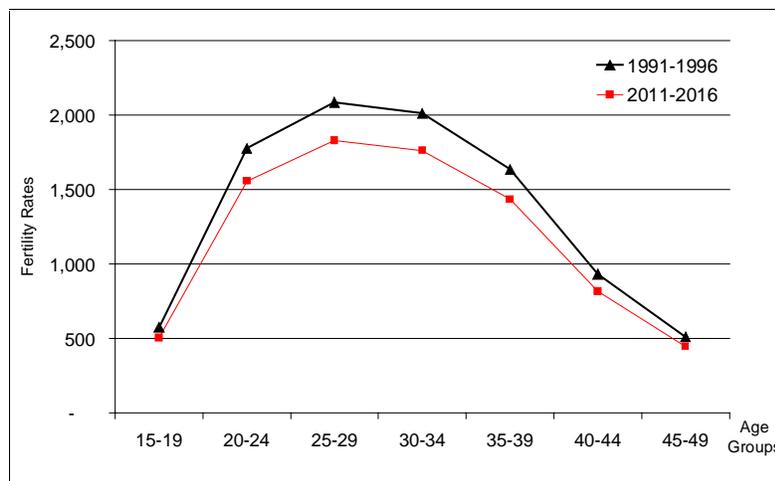
Figure 3b. Age-Specific Fertility Rates.

The number of <u>deaths</u> depends on the risk of dying by age and sex – expressed as Age-Specific Mortality Rates. The ASMRs for Namibia are defined from the Standard Model Life Tables (West) based on child mortality (Coale-Demeny functions, see Coale and Demeny 1983).

The Standard Model Life Tables mentioned above represent the critical point for understanding the failure of the CSO projections to detect HIV/AIDS impact. African countries do not have operational, reliable population registers, i.e., records of births and deaths. They depend on Model Life Tables. Information on child mortality helps find a suitable life table. Once the "best fit" life table has been identified, it provides estimates of life expectancies, survival rates, etc.

In order to project the future mortality levels, we resort to the same Model Life Tables, but this time <u>making life expectancy at birth the input variable</u>, saying we want Namibians to live longer. Life expectancy becomes a planning variable, expressing a

target. We want to improve health services, health education, nutritional information, etc., to levels that are likely to increase life expectancy at birth for Namibians by 0.5 years every year, and identify the best fit life table to provide us with the corresponding ASMR.

Population projections are produced by applying ASFR and ASMR on a base population:

- ASFR tells us how many new citizens are entering the 0 and 1-4 age groups five years later.
- The life tables (including ASMR) tell us how many persons in each age group will pass away over five years; the survivors then comprise the next cohort five years later.

This model addresses the two weaknesses in the CSO population projections in the form of two components:

- **Component 1**: Revisit the **population projections**, using a simple spreadsheet based model incorporating general knowledge about demographic processes.
- **Component 2**: Incorporate into the model the general knowledge about the demographic **dynamics of HIV and AIDS**.

3.1 Component 1: Adjusting fertility

The model presented here uses a simplified approach to fertility estimation, relying on the current fertility data as reported in the census. In other words, applying a fertility correction factor of 1.00, and using the life tables corresponding to the estimated life expectancy at birth, results in much more likely projections than the official ones made in 1994, as also evidenced by subsequent surveys.

Figure 4a shows the Namibian population as per the 1996 Intercensal Survey and Figure 4b as per the 1997 Labour Force Survey. Although there are reasons to believe the Labour Force Survey has not captured adequately the child population, the absence of the baby boom is conspicuous in both surveys. The model's projections (Figure 4c) are obviously a significantly better fit than the projections presented in Figure 4d.
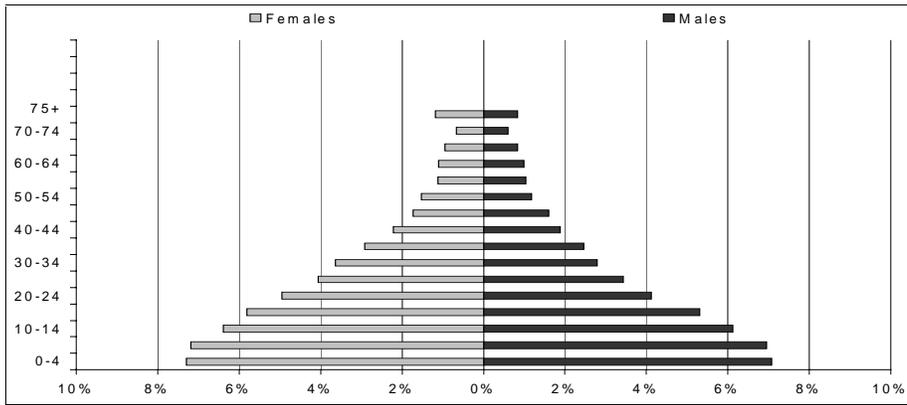
Figure 4a. 1996 population, according to the Intercensal Survey. Source: GRN/NPC (2000).
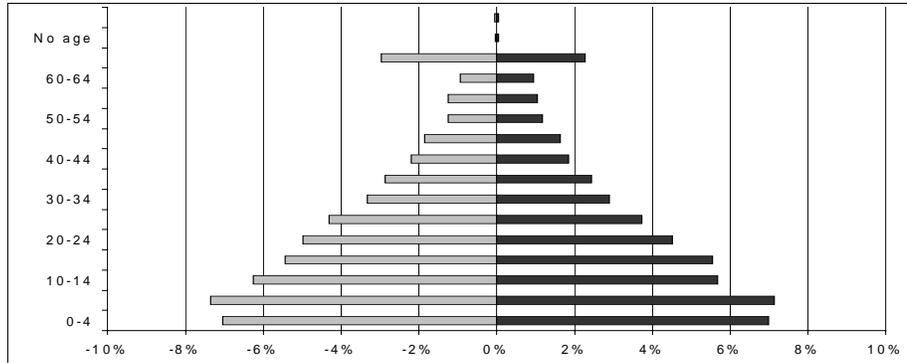
Figure 4b. 1997 population, according to the Labour Force Survey. Source: Ministry of Labour (1999).
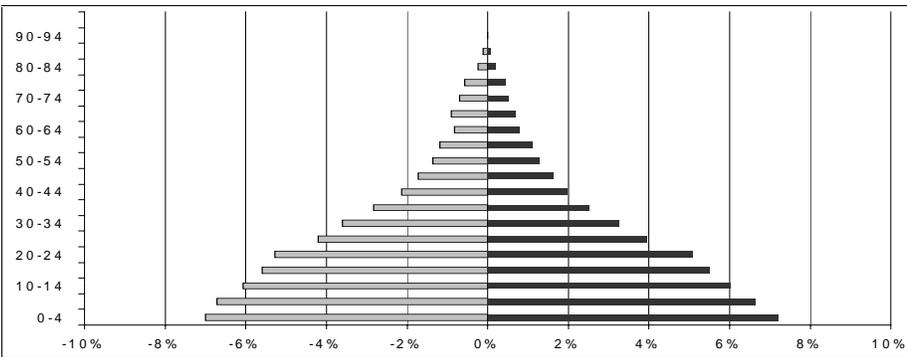
Figure 4c. 1996 population, according to the model projection.
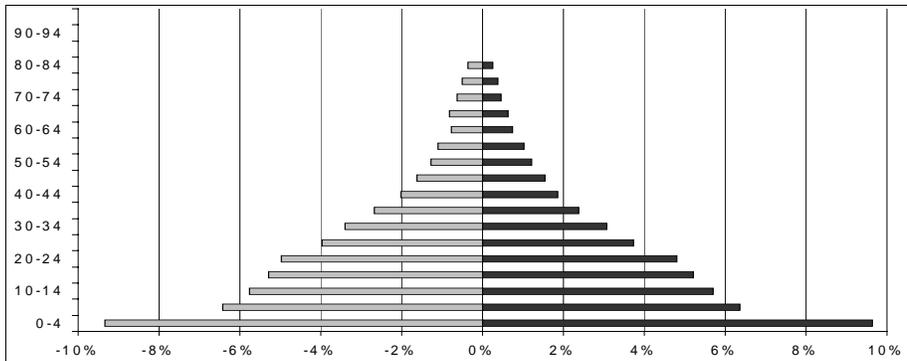
Figure 4d. 1996 population, according to the CSO projection (from GRN/NPC 1994a).

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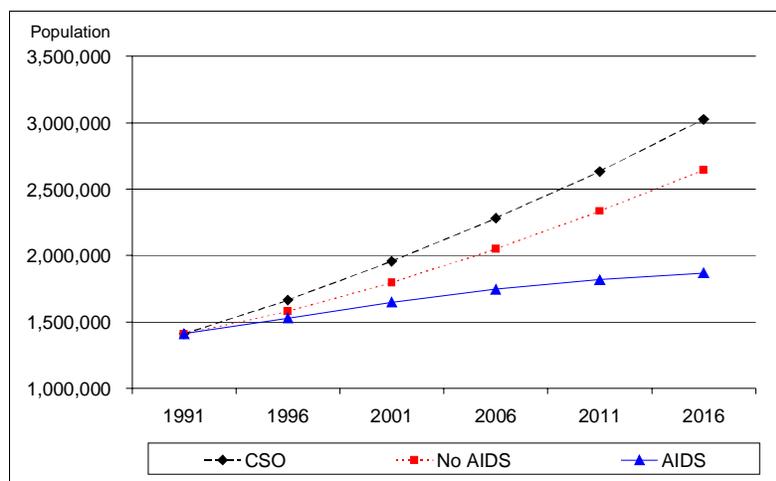Figure 5 shows the trend in total population as projected by the CSO, and by the model over the period, 1991-2016.

Figure 5. Namibia's population 1991-2016, according to three different projections
Source: GRN/NPC (1994a).

Both the official projections and this model rely heavily on model life tables, and both assume improved mortality rates corresponding to planned increased life expectancy at birth. But whereas the official projections assume this to apply to the whole population, the model assigns additional mortality risks to the HIV infected sub-populations.

3.2   Component 2: Introducing HIV/AIDS

The second reason for the official population projection data becoming increasingly out of tune with reality in Namibia, is the spread of HIV/AIDS. It impacts on the population through increased mortality among infected adults and children in a way not reflected in the life tables used in demographic projections. It also impacts on fertility rates of infected women. In 1991 the epidemic had not yet reached proportions that would significantly impact on mortality levels. Even in 1996, AIDS deaths would only marginally have altered the mortality pattern. With HIV prevalence now in the region of 20%, AIDS mortality is introducing a significantly new and different impact on the level and structure of mortality, which was not, and could not have been, envisaged when the life tables were constructed.

HIV/AIDS is introduced into the model primarily through the impact of the epidemic on mortality, by altering ASMR. It also impacts on fertility, as HIV positive women are assumed to have fertility rates reduced by 30% (see Box 1).

The AIDS deaths are added to the non-AIDS deaths to produce new mortality tables, which are then used to construct the estimated life tables incorporating the epidemic.

Box 1. Five facts about HIV/AIDS, and the impact on population projections.

What do we know about AIDS?

1. AIDS is deadly and there is no cure.
2. AIDS is caused by a virus (HIV).
3. The virus is spread through sexual contacts.
4. The virus is also transmitted through birth.
5. HIV lowers fertility.
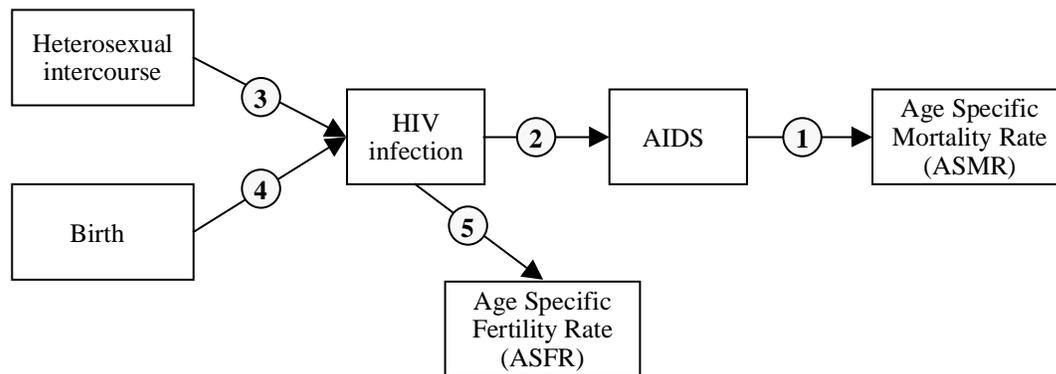
1. Defined by the AIDS mortality pattern. Generally 1-3 years after outbreak of disease.

2. Incubation period and drugs may delay disease for 5 to 15 years.

1 and 2 combined may be expressed as the 'progression rate' from infection to death. It is assumed to be different for adults and children (see Figures 6a and 6b).

3. Depends on:

   ➢ HIV status of partner, expressed as the prevalence rate of the opposite sex in the matching age group, assuming females are on average five years younger than males.
   ➢ Level of protection (condom use) assumed to be 2% in 1991, increasing by 1.5% per year.
   ➢ Average number of intercourses, assumed to be 75 per year.
   ➢ Transmission risk during unprotected intercourse, assumed to be 0.6% for male to female, and 0.2% female to male.

4. Depends on:

   ➢ HIV status of mother, measured as the prevalence rate of females by age group.
   ➢ Transmission risk from HIV positive mothers, assumed to be 1/3.

5. HIV infection is assumed to lower fertility rates by 30%.

Box 2. Technical note on the calculation of HIV incidence in the population.

The incidence rate expresses the probability that an HIV negative person converts to HIV positive during a given period of time. It is expressed as a function of the following factors:

$$i = f(s,r,p,c)$$

where

i = incidence rate
s = sexual activity level
r = risk of virus transmission during single, unprotected intercourse
c = condom use, level of safer sex practice
(1-c) will then express 'exposure level'
p = HIV prevalence level in the population

The probability of contracting the virus during a single sexual encounter becomes:

Seroconversion risk = $r * p * (1-c)$

The risk is the product of:

- the risk during unprotected sex with an infected partner,
- by the probability that the partner is infected,
- by the probability of exposure (level of non-protection).

The probability of NOT converting during a single encounter thus becomes

$$1 - (r * p * (1-c))$$

The probability of not converting even once, during a series of encounters can be expressed as

$$(1 - (r * p * (1-c)))^s$$

where

s = number of sexual encounters over the period.

As one single conversion is sufficient to become infected, the probability of becoming infected any time during the period can be expressed as

$$1 - (1 - (r * p * (1-c)))^s$$

which then becomes the incidence rate.

- r is differentiated between r_m and r_f, expressing female-to-male transmission risk, and male-to-female transmission risk, respectively.
- p is referring to the prevalence level of the opposite sex in the most likely age group, and thus consists of an array of values, depending on age and sex, and changing over time as the epidemic spreads or contracts in the population.
- p_{ma} refers to the prevalence level among **m**ales in age cohort a. The value of p over time is calculated by the model, basically as the result of infection rates and mortality rates for the different age groups.
- s expresses the level of sexual activity, and is the product of the proportion of the age and sex group that is sexually active, and the activity level of that group. The model allows the level and age profile of sexual activity to change over time.

The incidence rate for *males* in age cohort a over the period from year y to year $y+5$ can be expressed as:

$$i_{may+5} = 1 - (1 - (r_m * p_{fya} * (1-c_y)))^{S_{may+5}}$$

Prevalence rate indicates the proportion of HIV positive persons in a given population. It is determined by past years' incidence, which <u>increases</u> prevalence, and by the mortality (progression rate) of the infected population, which <u>reduces</u> prevalence. Prevalence rates are calculated as the number of persons living with HIV as a percentage of the total population in the same age and sex group.

Incidence rate indicates the probability of HIV conversion in a given population (see Box 2). It applies only to the HIV negative sub-population, and can occur only once for each individual. <u>Child</u> incidence (mother-to-child transmission of virus) is estimated as a percentage of children born to HIV positive mothers. It is assumed to be 30%, but may be reduced over time as medical advances in this area appear to offer some hope for effective preventative care. Given the indication that heterosexual intercourse accounts for an estimated 95% of virus transmission in <u>adults</u> in Namibia, the incidence rate among adults is determined by prevalence rates and sexual habits. More precisely, it is the product of four factors:

1. Transmission risk during unprotected intercourse (probably between 0.1% and 1%). It is assumed to be three times higher for male to female, compared to from female to male, and depends heavily on prevalence of other sexually transmitted diseases.
2. Level of protection (use of condoms) (probably between 2% and 10%, and hopefully increasing by 1-2% per year).
3. Number of intercourses per year (probably between 50 and 100). Insufficient information is available on this crucial variable, but the figure is not likely to change radically over time.
4. HIV status of partner (either negative or positive). Possible variations over time in the level of infectiousness of infected persons are not taken into account.

The incidence rates are influenced by the past period's prevalence rate in the transmitting group. For mother-to-child transmission, it relates to the prevalence among childbearing women. For heterosexual transmission, the transmitting group is the opposite sex of the corresponding age group. Partners are assumed to be roughly of the same age, females on average five years younger than males.

The population is split in sub-populations according to HIV status. The HIV infected population is further divided in terms of time elapsed since infection. The HIV positive population is exposed to the same mortality risks as the HIV negative, but in addition faces the mortality risk as expressed in the HIV/AIDS **progression rates**. Figures 6a and 6b show likely progression rates for horizontal (adult) and vertical (mother-to-child) transmitted infections, respectively. The figures illustrate the mortality risk, year by year, and cumulatively, as a function of time elapsed since sero-conversion.

The total number of deaths over each five-year period (by age and sex groups for the two sub-populations) is subtracted from their respective groups thus enabling the calculation of a new life table. Standard demographic assumptions are applied regarding timing of deaths within each cohort. These recalculated life tables contain the vital output of life expectancy at birth, and non-survival rates beyond the age of 40, as required for the production of the HDI and HPI.
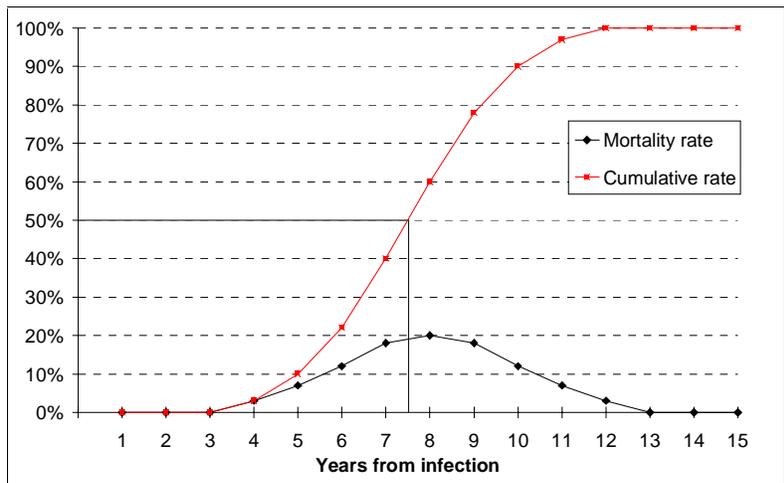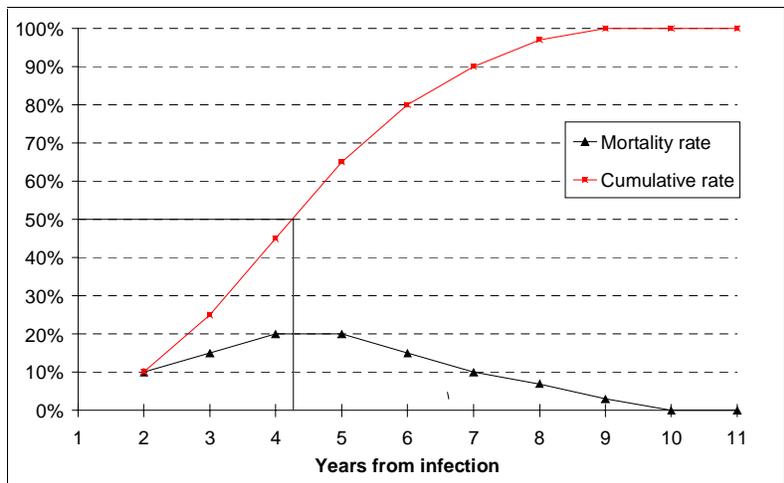
Figure 6a. Progression of HIV/AIDS in adults.

Figure 6b. Progression of HIV/AIDS in children.

The resulting age pyramids illustrate what the population is expected to be in future years, as well as what it would have been, had AIDS not intervened. An example is given in Figure 7 for the year 2016, showing the inner pyramid as the projected population by age and sex, and the outer one as what the model projects in the 'without AIDS' scenario. The difference between the two is the 'AIDS impact'.

It is important to note that the AIDS impact is not the same as the AIDS death toll. The **AIDS death toll** is the number of persons who die from AIDS over a given period, for instance during a year. The **AIDS impact** is the effect on the population at a given point in time, and consists of three distinct populations components:

1. The population that is not alive in a given year because they have died from AIDS during previous years, before they would have died from other causes. They constitute part of the accumulated AIDS death toll, and are shown in the age group they would have had, if they had survived to that point in time. Those who are

expected to die from AIDS before 2016, but who would have died from other causes by 2016 anyway, do not appear in the pyramid as AIDS impact. They contribute to the AIDS death toll, though, but not directly to the AIDS impact.

2. The population that was not born because their 'would-be' mothers died from AIDS before they were born.

3. The population that was not born because their 'would-be' mothers were HIV infected, and hence had reduced fertility.

The two 'unborn' populations are shown in the age groups they would have been, had HIV not prevented their existence.

Figure 7 illustrates that the AIDS impact on the <u>population</u> after 25 years is most marked among the younger and the middle aged, and significantly higher among women than among men.
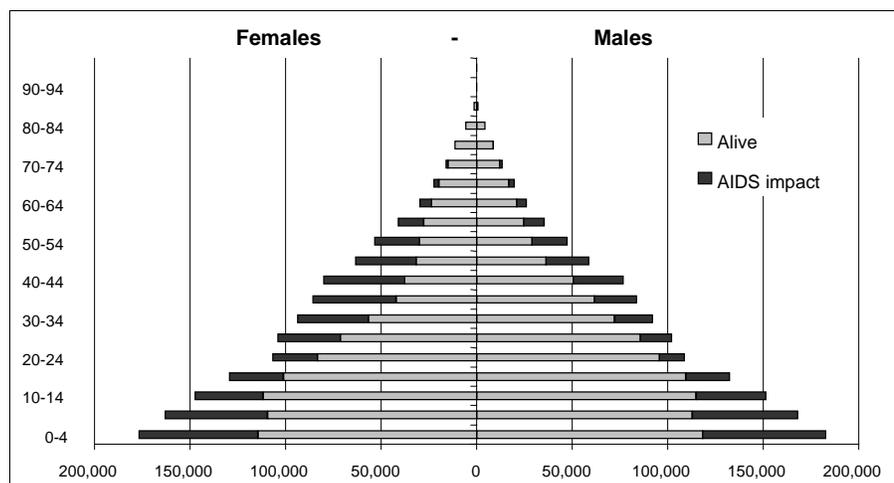
Figure 7. AIDS impact on the Namibian population by 2016.

The age footprint of the AIDS impact is the result of the AIDS death toll hitting hard and sudden among children infected at birth, and a similar, but more prolonged death toll among the younger section of the parent generation. The impact on <u>life expectancy</u> at birth as illustrated in Figure 8 is dramatic. It is the result of a considerable proportion of adults who have their expected remaining life spans shortened from, say 40 to only five years. However, HIV infected children contribute relatively much more towards shortening the average life expectancy at birth, as each infected child represents a full life span lost.
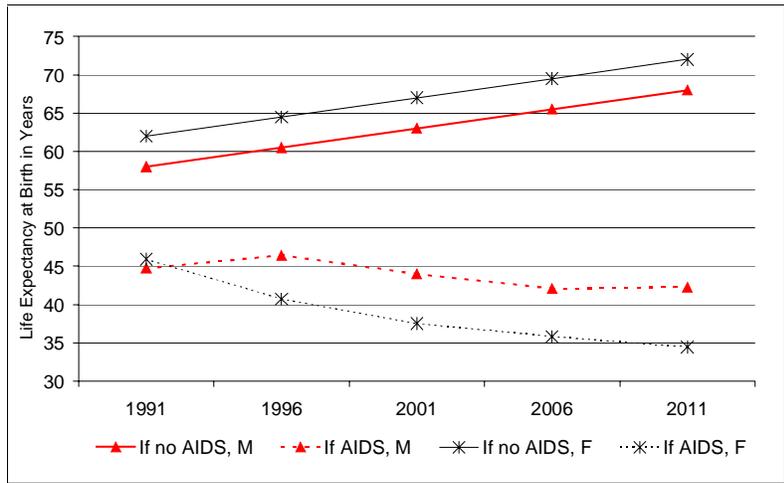
Figure 8. AIDS impact on life expectancy at birth, 1991-2011.

Because of the child impact, as well as the fact that part of the adult HIV population will survive beyond retirement age, the AIDS impact on the dependency ratio is insignificant (see Figure 9). With or without AIDS, the population structure is projected to change towards lower dependency levels.
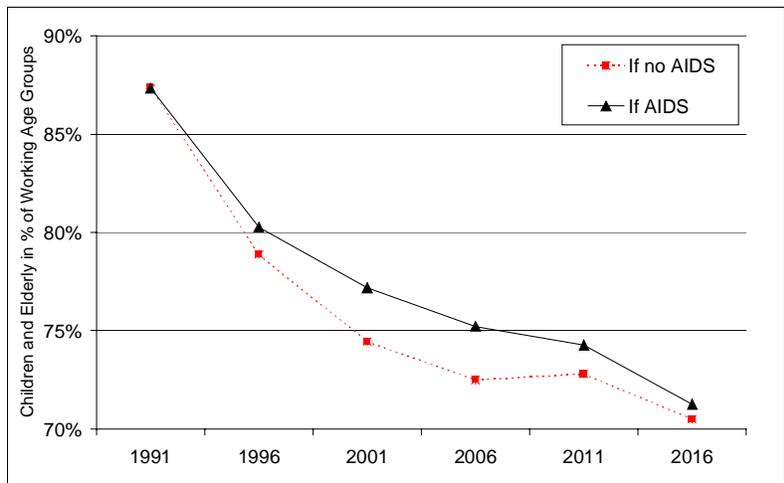

Figure 9. AIDS impact on dependency ratios.

The disproportionate burden of the AIDS impact on the female population is primarily the result of the higher infection risk for women during unprotected sexual encounters. In addition, the assumption that women are on average younger than their male partners expose them earlier to infection risks.

However, it is reasonable to assume that men and women have significantly different behaviour patterns in terms of number of sexual partners. The proportion of women who have none or one partner is probably higher than among men. Similarly, the category of 'few partners' may have more men than women, whereas the category 'many partners'

may have more women than men. The model does not factor in any of these assumptions, nor any pattern regarding assortative vs. non-assortative mixing in relation to these groups. Once the model is refined in this respect, the gender bias of the AIDS impact will decrease.

In its present form, by entering what appear probable values of the various input parameters, the model produces prevalence levels that level off below 30% over the 25-year period (see Figure 10a). The rate of population change remains positive, but falling, as Figure 5 shows. Namibia's population is heading towards a figure below 1.9 million in 2016, compared to 2.6 in the non-AIDS scenario, quite different from the 3.0 million predicted in 1994. It will have almost a 'developed country' age structure, with a narrow bottom, but with a distinct AIDS footprint in the form of a slim waistline (see the 'inner' pyramid in Figure 7).
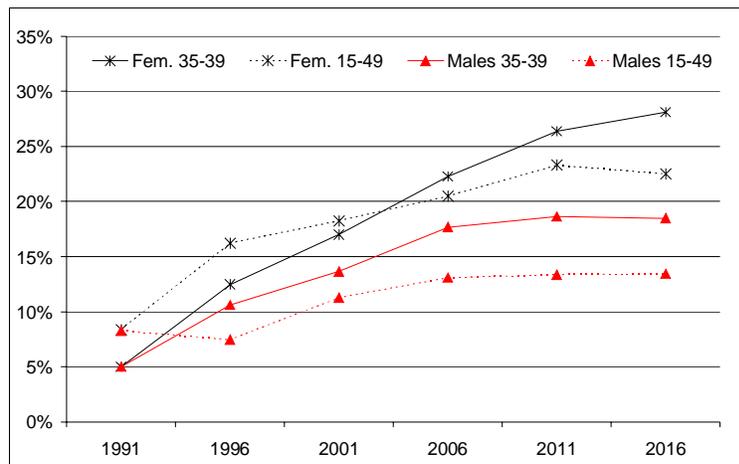
Figure 10a. Prevalence rates in the most likely scenario regarding changes in SSP.

3.3 Sensitivity to input values

By varying the values of the parameters, the model can assist in sensitivity analysis. As expected, the major determinants of a successful fight against AIDS relate to sexual behaviour patters, in particular the level of sexual activity. The model is further very sensitive to variations in the risk of infection during a single encounter, which is directly related to prevalence of other STDs, constituting a case for preventative as well as curative health care. Safer sex in the form of condom use is still at such a low level (perhaps below 2%) that even doubling the level will have only marginal effects. The tables and figures assume an increase of 1.5% per year, reaching some 40% after 25 years. Considerable efforts are needed in order to bring condom use up to a level where it has a significant impact on curbing the AIDS epidemic. Figures 10b and 10c illustrate the impact on prevalence rates if annual increase in condom use (safer sex practices) is set at 1% and 2%, respectively.
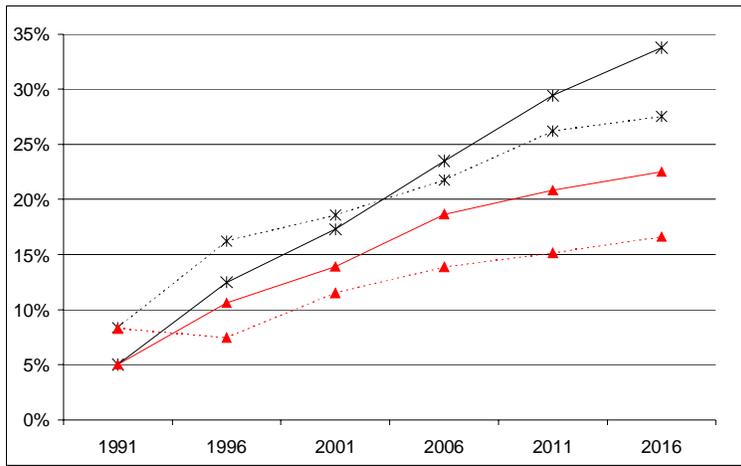
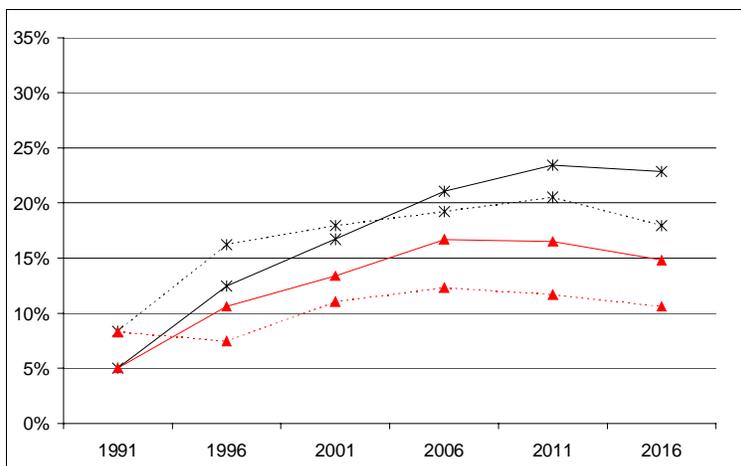Figure 10b. Prevalence rates in a scenario of slow improvement in SSP.

Figure 10c. Prevalence rates in a scenario of quick improvement in SSP.

The model does not factor in the contraceptive effect of condoms. Hence higher level condom use results in lower HIV infection rates, and eventually higher population growth (see Figure 11).
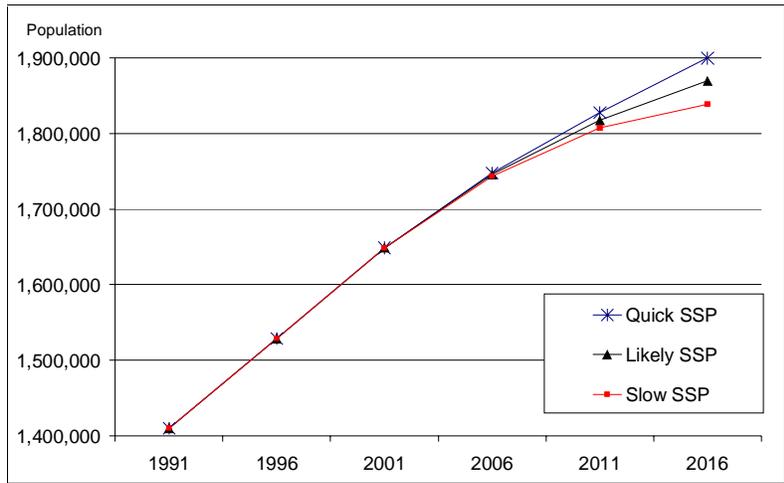
Figure 11. Impact of safer sex practices on population growth.

Improved medical care, nutrition and lifestyles among the HIV positive population may change the progression pattern, and significantly extend their lives. Whereas this intuitively would improve life expectancy levels for the population at large, the model shows that the effect is actually negative, because longer HIV survivors imply higher prevalence rates, which also increase the incidence rates. The model does not take into account any changes in sexual behaviour resulting from sero conversion. If the model is refined in this direction, it is likely to demonstrate a very effective entry point for AIDS control. If the HIV positive population adopts safer sex practices, the incidence rates will drop significantly. Such an effect can, however, only be expected once HIV testing reaches a significant proportion of the population.

The model has the facility to factor in differences in sexual activity levels between the sexes, and among the different age groups, as well as changes in these age-specific sexual activity profiles over time. No data has yet been found to feed into this part of the model. Figure 12 shows hypothetical relative sexual activity levels for males and females, by age groups. Males start earlier, but on average females are the younger partners.
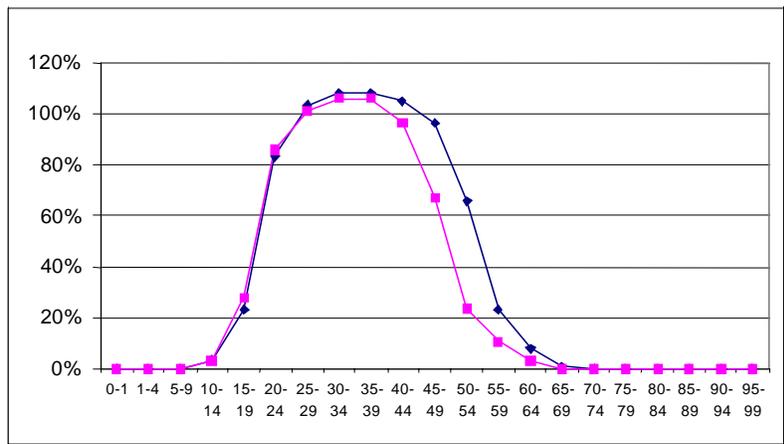

Figure 12. Age-specific sexual activity.

Figure 13 illustrates the resulting impact on the population by 2016. The relatively higher sexual activity level among the younger adult population, and in particular women, results in a relatively large missing female population after some years.

Sexual activity levels are a combination of two factors: Proportion of sexually active population in the age group, and level of sexual activity among those who are sexually active. Using 75 as an estimate of 100% yearly activity level produces the following picture of the population and the AIDS impact in the year 2016:
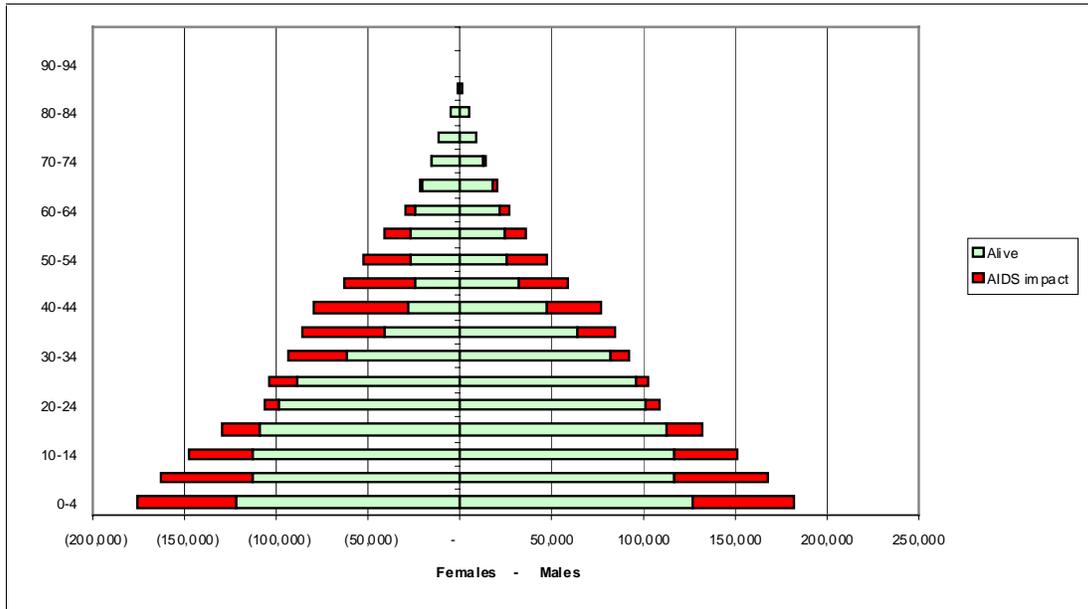

Figure 13. AIDS impact on the population by 2016, based on hypothetical age-specific sexual activity levels.

As a general model, it can be adopted to any population. HIV infection levels are extremely high in southern Africa, and UNAIDS reports indicate that SADC countries have more than half of the world's populations living with HIV (UNDP 1995). The region accounts for only some 5% of the world's population. Seven out of ten newly HIV infected persons world-wide are reportedly living in sub-Saharan Africa. There is ample justification to apply more rigid demographic analysis to verify such statistics, as well as to analyse and project the implications of the actual levels. If the problem is indeed of such magnitude, it will have far-reaching and fundamental implications for any developmental efforts anywhere in the region.

The model represents an attempt in support of putting the AIDS epidemic in a credible demographic perspective. It has been applied to Namibian data, and is being tested out on data from other SADC countries.

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