

**Working Paper**

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**Studying the Demography of Sustainable Human Wellbeing:  
Empowered Life Years (ELY) as Sustainability Criterion**

***Outline of a new ERC Advanced Grant Project***

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## Abstract

This paper presents the outline of a new project which was recently approved as an Advanced Grant by the European Research Council (ERC). It will apply two distinctly demographic concepts to address questions that go far beyond demography. It will study the indicators of and the conditions for sustainable human wellbeing. The wellbeing indicators proposed here will be based on life table methods and the recently operationalized concept of Demographic Metabolism – modelling social change through the replacement of generations – will be used to get a quantitative analytical handle on the temporal dynamics of improving human wellbeing.

The project will theoretically develop, empirically estimate, test and forecast indicators of human wellbeing that are based on life table methods and hence reflect the basic – but often overlooked fact – that being alive is a necessary prerequisite for enjoying any quality of life. But since mere survival is not sufficient as an ultimate goal for most people the person years lived at each age will be weighted with four different dimensions of empowerment: health, literacy, happiness and being out of poverty. These are four dimensions of an indicator tentatively called ELY (Empowered Life Years). ELY will also serve as the explanandum of a global level econometric estimation of the determinants of wellbeing considering human, manufactured and natural capitals as well as knowledge and institutions.

The global level analysis is complemented by a set of strategically chosen in-depth systems-analytical case studies in Namibia/Western Cape, Nepal, Costa Rica and historical Finland modelling the population-development-environment (PDE) interactions including feed-backs e.g. from environmental degradation to wellbeing and taking the trends of ELY in different sub-populations as sustainability criteria. They will also include stake holder involvement and science-policy interactions.

The paper also includes an appendix which introduces the theoretical foundations and empirical calculation methods of Happy Life Expectancy, one of the components of ELY.

## **Note**

This proposal was submitted to the European Research Council in August 2016 and approved in April 2017. The 5-year project is scheduled to start in September 2017.

## **About the Authors**

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# **Studying the Demography of Sustainable Human Wellbeing: Empowered Life Years (ELY) as Sustainability Criterion**

## ***Outline of a new ERC Advanced Grant Project***

Wolfgang Lutz

with an Appendix on “Calculating Happy Life Expectancy” by Erich Striessnig

### **1 The research question**

This project proposes to make an unconventional cross-disciplinary contribution to advancing the discussion around and search for broadly acceptable and empirically measurable quantitative **indicators of socioeconomic progress and long-term human well-being that can serve as criteria for judging whether developments are to be considered sustainable or not.**

The project will likely **bring the discussion to a new level through two genuinely demographic concepts** that can make a decisive difference to overcome some key difficulties of the field. The well-being indicators proposed here will be based on life table methods considering the fact that survival is a prerequisite for enjoying any quality of life and the recently operationalized concept of Demographic Metabolism – modelling social change through the replacement of generations – will be used to get a quantitative analytical handle on the temporal dynamics of improvements of the chosen indicators and their determinants along cohort lines. **These innovations can help to overcome some of the inconsistencies and shortcomings of existing indicators that are not fit for operationalization as sustainability criteria.**

Much has been written about development indicators over the past couple of decades, a discussion that has been prominently highlighted through the 2010 report “Mismeasuring our lives” by Josef Stiglitz, Amartya Sen and Jean-Paul Fitoussi (2010). There is a widely acknowledged need for quantitative indicators of progress to assess and compare conditions over time and across populations. Such comparisons are most easily performed on the basis of a single indicator such as GDP per person or the Human Development Index (HDI). Recently, however, the international discussion has gone into the direction of using multiple indicators such as the Multidimensional Poverty Index (Alkire & Robles 2015) or the indicators chosen by the UN to monitor progress toward the Sustainable Development Goals (SDGs) (United Nations 2016). In March 2016 the UN Statistical Commission decided on a set of 230 indicators to monitor the 169 targets specified under the 17 SDGs. While each of these indicators covers different aspects that matter in one way or the other for long-term human wellbeing there is a real danger of a lack of priority and that people will not see the wood for the trees. Furthermore, such wide ranges of indicators cannot be modelled for the future nor meaningfully be converted into sustainability criteria.

This project will hence try to go into the opposite direction and **theoretically develop and empirically estimate holistic indicators of long-term human wellbeing, test their acceptability and applicability, assess their determinants in the most comprehensive way possible – including feed-backs from environmental changes – and forecast them under alternative scenarios.** These comprehensive indicators should also be applicable for monitoring progress in specific sub-populations such as defined by gender, ethnicity, socioeconomic

characteristics or other dimensions considered relevant. In order to serve this purpose the new indicator/**family of indicators must have several properties:**

- a) They need to be based on **characteristics of people** that can be flexibly aggregated to **sub-populations**,
- b) They need to have a meaning in their absolute value in order to make them **comparable over time and across sub-populations**,
- c) They need to be **fit for serving as the dependent variable** in a regression model/“production function”.
- d) If possible, they should have a substantive interpretation in terms of some **real life analogy** rather than just being an abstract index.

The family of indicators proposed here is tentatively labelled Empowered Life Years (ELY) and rests on the likely ubiquitous desire for longer life (avoidance of premature mortality). But since mere survival is not enough the age-specific person years lived (in life table terminology) will be weighted with empowerment indicators including literacy, health, being out of poverty and subjective wellbeing/happiness. Beyond developing, estimating and evaluating ELY for time-series of as many countries as possible this project will also embark on the even more challenging task of comprehensively assessing the social, economic and environmental determinants of ELY and project them into the future based on alternative scenario narratives. This will be done at the global level as well as for specific in-depth systems analytical case studies that will also try to model feed-backs (such as the impacts of environmental degradation on human life support systems) and include stake holder consultations. Because of their high complexities and place specificity these latter two analyses can only be done through the proposed case-study approach. The Demographic Metabolism model will be applied to all components of the project to appropriately capture the temporal dynamics of flows and stocks along cohort lines in the studied populations.

In a nutshell **the main research question** to be answered by this project is: ***What are the most appropriate comprehensive indicators of long-term human well-being for judging genuine progress and how can they be empirically estimated and projected based on the broadest possible understanding of their determinants through social, economic and environmental factors including essential feed-backs?***

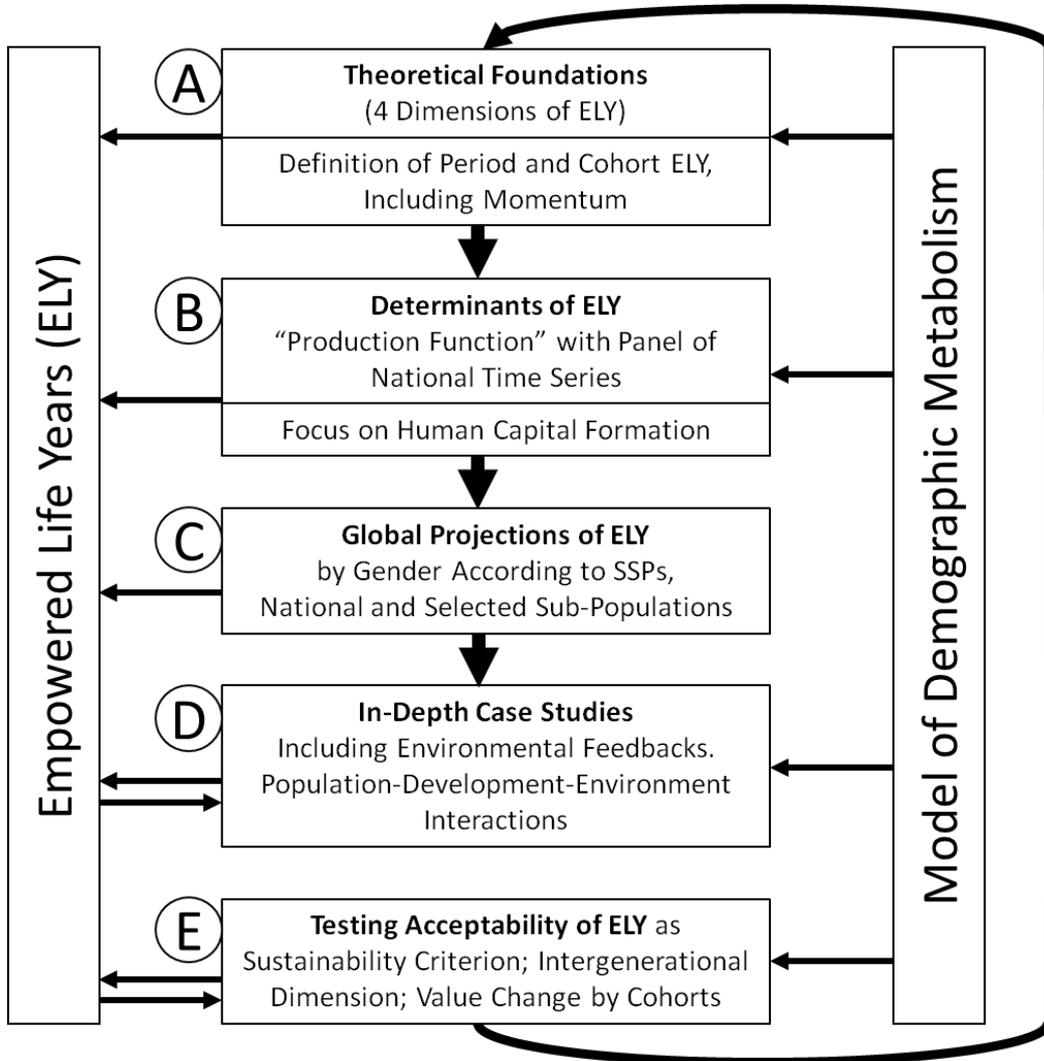
This **proposed disciplinary cross-fertilization** of the study of long-term human wellbeing and its determinants through two demographic concepts that can help to overcome current limitations is a high potential impact project with relatively low risks of failure. Figure 1 outlines the conceptual structure of the project indicating how these two demographic concepts influence the answering of the posed research question.

## **2 Modeling the determination of long-term wellbeing**

Myriads of specific studies on often very particular aspects of population-development-environment interactions have been published in the rapidly expanding body of literature in sustainability science. Bettencourt and Kaur (2011) in a review of the state of the art in Sustainability Science mention that they identified 21.5 million documents on the theme of sustainable development alone. Most of these studies serve a purpose, but have not been sufficient to answer the most important underlying question of how the different factors jointly affect human wellbeing and what are the policy priorities for improving the human condition of current and future generations. Or in the words of Geoffrey West: “No overarching integrated framework has yet been developed that can provide a long-term picture uniting the many highly inter-related themes underlying sustainability. Existing approaches have, to a large degree, failed to come to grips with the essence of the long-term sustainability challenge; namely, *the pervasive interconnectedness and interdependency of energy, resources, environmental, ecological,*

*economic, social and political systems.*” (West 2010, p.11). And there have been no broadly acceptable indicators of long-term human wellbeing that could be operationalized as sustainability criteria and have the four above described properties (a) to (d).

Figure 1: Schema: Components of the Project



In order to make further progress towards such a comprehensive assessment, we need to have an overview of which are the most serious potential threats to long-term human wellbeing. Vaclav Smil in many of his writings (2005) has addressed this issue and compared different dangers for future well-being, ranging from pandemics to nuclear war to meteorite impact. Groups such as the “Copenhagen Consensus” have tried to explicitly address this question by asking where a given dollar would be better invested in terms of delivering better outcomes for human well-being. Much progress has been made in the field of global level integrated assessment modelling, such as the GISMO Model (Hilderink et al. 2008) and the Pardee International Futures Model (Hughes & Hillebrand 2006). Yet, none of these efforts have done so in a comprehensive systems-analytical way that has clearly specified ultimate ends (well-being indicators), a clearly specified well-being “production function” that explicitly takes population heterogeneity/inequality into account together with a clearly structured and documented

transparent systems model on the various feed-backs that is applicable for specific settings. This is what the proposed project aspires to do.

Currently, the field is dominated by so-called **Integrated Assessment Models (IAM)** which tend to be very strong and detailed in terms of modelling energy systems, land use change and agriculture as well as water and air, but are less detailed on the human side, with population size often being the only variable considered. And population size is often only used as the denominator for per capita measures. The recent joint effort of many IAM groups to develop SSPs (Shared Socioeconomic Pathways) goes well beyond this restriction to just population size by specifying alternative population scenarios by age, sex and level of education (O'Neill et al. 2014; KC & Lutz 2014) and will be used in Component C of the project.

This study will also **build on two lines of research shaped by the PI** over the past decades and which are essential for meeting the ambitious objectives of this project. Firstly, it will build on the history of place-specific Population-Development-Environment (PDE) case studies that take a comprehensive approach and use the tools of dynamic systems analysis. In the early 1990s a pioneering study of this sort developed a very detailed model including population, socioeconomic development, water, land use and many other dimensions for the island of Mauritius over the period 1960-2030. It, thus, combined a validation of the model for the past with alternative scenarios for the future (Lutz 1994). Mauritius which can be viewed as a micro cosmos with good statistical information had served as a text book example of a country trapped in the vicious circle of poverty, population growth and environmental degradation. Yet, it managed to escape it, a fascinating experience that was also used to assess the validity of the Ehrlich versus Simon arguments about the effects of population growth. Similar case studies were then carried out at IIASA (lead by the PI with funding from DG-Development) for the Yucatan Peninsula, Namibia, Botswana, and Mozambique, all including policy exercises and resulting in scientific reports (for a summary see (Lutz et al. 2002). Another series of population-environment case studies was carried out in the context of the MacArthur Foundation-financed Population-Consumption-Environment (PCE) Initiative which commissioned more than 30 case studies in this field and published a special issue of *Ambio* (Curran et al. 2002). The methodologies for comprehensive population and environment modeling have been described in a book entitled "Population and Climate Change" with a comprehensive assessment of the role of population and development in both mitigation and adaptation (O'Neill et al. 2001) and a special issue of *Population and Development Review* on "Population and Environment: Methods of Analysis" (Lutz et al. 2002). Over the past 15 years PERN (the Population and Environment Research Network, set up by the PI in 2000 and hosted by CIESIN of Columbia Univ.) has maintained an online platform with cyber seminars that has been the main forum for scientific discussions on the topic. It is also affiliated with the "Future Earth" research network and maintains large data base of research in the field.

The search for, estimation of and analysis of the determinants of sustainable human wellbeing is also closely linked to another main research interest of the PI, namely the controversial discussion about whether international development aid may actually do more harm than good (Easterly 2006; Moyo 2010) and what should be the development priorities that minimize external influence and neo-colonial dependencies. The argument that international development assistance should be clearly focused on basic empowerment of people to then being in the position to sort out their matters independently is explicitly made in the forthcoming inaugural contribution to PNAS of the PI tentatively entitled "Global sustainable development priorities 500 years after Luther: the *sola schola et sanitate* principle". This need to focus on basic health and education in empowering people to help themselves and others without the need to impose colonial dependencies or Western life style has been previously published as an hypothesis (Lutz 2009) alluding to Luther's *sola* principles 500 years ago. It suggests that human capital (consisting of health and cognitive abilities) is the root cause of development. Over the

past years this hypothesis has already been successfully tested for certain aspects of development, i.e. with respect to economic growth (Lutz et al. 2008), with respect to mortality and fertility (Lutz & KC 2011) and most recently with respect to disaster vulnerability (Lutz, Mutarak, et al. 2014).

### 3 The application of two innovative demographic concepts to answer the research question

#### 3.1 Empowered Life Years (ELY)

Based on a synthesis of the different approaches to conceptualizing and measuring human well-being (see extensive discussion under Component A – Theoretical Foundations) the decisive innovation of the proposed approach is a radical focus on survival/avoidance of premature death through the application of demographic life table methods. This accounts for the very basic fact that **being alive is a fundamental prerequisite for enjoying any quality of life** and well-being. Under this approach, the person years lived (in life table terminology) are the basis for the proposed quantitative indicator of well-being which, however, needs to be complemented with further dimensions/aspects of quality of life, since mere survival is typically not seen as sufficient for constituting well-being.

**Definition:** “Empowered Life Years (ELY)” is the name given to the family of well-being indicators to be developed, elaborated and estimated for as many populations as possible at different times. Technically, they are calculated by weighting in a life table the age-specific person years lived with age-specific proportions of men and women who have certain chosen features of empowerment. It will start with applying the so-called “Sullivan Method” which combines a period life table with cross-sectional prevalence data and then will try to further develop the method into a direction that will allow the study of ELY from both a period and cohort perspective. It will build on and further extend the existing work on “Healthy Life Expectancy”. Another specific example for such a life table based indicator is “Literate Life Expectancy” which can be interpreted as the number of years a man or woman is expected to be alive and be able to read and write. Since functional literacy (which is not identical with having attended school and can also decline as a function of old age disability) may be viewed a basic prerequisite for empowerment, this specific indicator already comes close to what should be measured here. In addition to literate life expectancy and healthy life expectancy the project will elaborate two further isomorphic indicators: “Happy Life Expectancy” (weighting the person years at each age with the proportions stating in surveys that “all things viewed together” they are happy) and finally “Poverty Free Life Expectancy” to cover the economic aspects of well-being by weighting with age-specific proportions not in poverty according to both absolute and relative measures of poverty. Since most surveys only assess poverty at the household level, special efforts will be made to translate this into individual age- and gender-specific poverty rates. These **four indicators (three of which are original innovations of the PI) can be considered as the health, cognitive, emotional, and material dimensions of ELY** and shall be estimated empirically for time series of as many populations in the world as possible.

**Estimation:** The four indicators will initially be assessed separately and shall each be differentiated by gender and level of education wherever data permit to do so. Due to their differential empirical availability the different individual components of these indicators will have to be estimated for different lengths of time series and for different sets of countries. For age- and gender-specific survival rates for all countries the estimates produced by the UN Population Division from 1950 onwards can be used. For literacy by age and gender global census data have been collected by UNESCO but they require some harmonization and cleaning. For an increasing number of countries IPUMS also provides micro level census data. For health status by age and

gender the Global Burden of Disease study, the World Health Surveys and other health related surveys can be used and in many cases the surveys also allow for differentiation by level of educational attainment. But these data are mostly limited to the most recent years as are survey data on subjective well-being and happiness. For selected big and heterogeneous countries special efforts will be made to compile the data by provinces or other sub-populations. **The compilation of the most comprehensive possible consistent data base on these indicators is a major research effort and value for the research community in its own right.** It will be made available as an open access resource similar to the Wittgenstein Centre Data Explorer (<http://www.wittgensteincentre.org/en/index.htm>) resulting from the previous ERC project of the PI.

**Innovation:** The proposed family of indicators will be **unique in meeting all four specified criteria:** (a) Applicability to sub-populations: Given that all four empowerment indicators refer to micro-level characteristics that are observable at individual/household level one can indeed flexibly aggregate them to refer to whatever sub-populations are under consideration. Also, the age-specific mortality rates underlying a life table can in principle be estimated for any sub-population of sufficient size which is different from e.g. GDP based measures that cannot be assessed for sub-populations. (b) Comparable over time and across sub-population: An indicator such as Literate Life Expectancy (the mean years a person is expected to be alive and able to read and write) is assessed in its absolute value and is hence very appropriate for comparisons across sub-populations and over long periods of time. (c) Use as dependent variable: ELY can be measured for sets of time series and as single indicators can be easily operationalized for estimation through multi-variate models. Correlations and interdependencies between the four aspects of ELY will be studied and different ways for possibly combining them in a multidimensional form of ELY will be explored as part of the project. (d) Real life analogy: ELY has an intuitive substantive interpretation is easy to understand, rather than just being an abstract index based on some implicit weighting schemes.

### **3.2 The Model of Demographic Metabolism through cohort changes in the population composition**

The notion of “Demographic Metabolism” was introduced by Norman Ryder (1965) as a name for the social change induced by inter-generational change. He viewed the continuous emergence of new participants in the social process and the withdrawal of their predecessors as the main forces of social transformation. Lutz (2013) goes beyond Ryder in relaxing the assumption of strong cohort determinism through possible changes over the life course (age and period effects) and in quantitatively operationalizing the concept through the application of the powerful tools of multidimensional cohort component analysis (Rogers 1975; Keyfitz 1985). It quantitatively models how societies change as a consequence of the changing composition of its members with respect to certain characteristics that once established are sticky along cohort lines.

This potentially revolutionary concept of modelling and forecasting social change is still in its infancy and to date has only been applied for forecasting educational attainment distributions and the prevalence of European identity in the EU (Lutz 2013; Lutz et al. 2006; Striessnig & Lutz 2016). In this project it will play an important role in two different ways: First it helps to understand and model the temporal dynamics of changes in ELY and its determinants. Literacy, for instance, is something that is typically acquired at young age and is then maintained throughout the life cycle of cohorts until it potentially declines through functional disability at high ages. Hence, **a pure period perspective that only covers snapshots of age-specific indicators at specific points in time does not provide an appropriate representation of the potential improvement of the wellbeing indicator** that is already embedded in the inter-cohort differences of that period (e.g. the young cohorts being to a higher degree literate than the older cohorts due to recent educational expansion). This understanding is essential for appropriately

capturing both the temporal dynamics of changes in ELY as well as in some of its determinants studied.

A second way in which this concept matters for the project is still less well understood. The model can also be applied to perceptions, attitudes and behaviors that relate to factors that matter for the determinants of wellbeing, provided that significant cohort effects can be identified. The project will explore different potentially relevant sources of data ranging from conventional surveys such as the World and European Value Survey to big data such as Google searches. This can potentially help to answer what some call the biggest puzzle for the sustainability transition, namely why – despite of all the evidence that is on the table and existing no-cost solutions or even negative costs - people often do not change their behaviors. If this should turn out to be something that is driven by cohort- and possibly education-specific mind-sets and differential perceptions of the evidence and attitudes that go along with behavioral patterns then the Demographic Metabolism model could make a highly innovative and hugely important policy relevant contribution to understanding the underlying mechanisms affecting the proximate determinants of human wellbeing.

#### **4 Developing the theoretical foundations: Objective, subjective and eudaimonic well-being**

This project will have a strong theoretical component on the conceptualization of human well-being. It will develop a solid theoretical foundation of the quantitative demography-based indicators that then will serve as criterion variables in the rest of the project. The approach chosen here will be closely related to the needs based approach (Gough 2014) as well as the capabilities approach (Nussbaum & Sen 1993).

**State of the art:** One can distinguish between three fundamentally different theoretical approaches with respect to well-being (Gough 2014). This project aims at theoretically developing a concept that combines the strengths of all three approaches. The first is based on objectively measurable indicators that can be assessed empirically. In the economic tradition these have been mostly GDP based measures which despite of serious criticisms with respect to leaving out important dimensions (Dasgupta 1995; Stiglitz et al. 2010) still tend to dominate the field. Quite independently a health based tradition of objective measures of well-being has developed which tends to focus on disability free life expectancy and survival in general. A third tradition of objective measures focusses on the preconditions of well-being such as empowerment through education (Sen 1989). These three dimensions of objective well-being have also been combined in what is today the most prominent composite indicator, namely the Human Development Index (HDI) (UNDP 2011). Widely spread and applied by the UNDP it gives equal weight to education, health, and income indicators and works on a relative scale, hence cannot be compared over time. **By primarily relying on survival/life expectancy this project will develop an objective indicator that can be unambiguously assessed.**

A very different line of research has focused on subjective indicators such as happiness and life satisfaction. With more survey data becoming available that asked comparable questions and showed rather consistent patterns even economists have become quite interested in these questions (Easterlin 2001; Layard 2010). In a way this goes back to Bentham's postulate of the greatest happiness for the greatest number. It is also reflected in (Kahneman 2003) hedonic psychology. **One of the dimensions of the proposed new indicator will directly refer to happiness.** But the confounding effects of intra-personal comparisons on a relative scale and cultural biases in reporting happiness pose problems for comparisons across countries and over time. Hence psychologists have come up with the concept of eudaimonic well-being which is based on Aristotle's notion of Eudaimonia, which refers to fulfilling one's own true nature (daimon) through actualization of human potentials. Building on writings of Maslow, Rogers and other humanistic psychologists this view poses the emphasis on autonomy, competence and

relatedness as dimensions of self-actualization and in consequence well-being. In a way this eudaimonic approach comes back closer to objective measures and can be related to Sen's capabilities approach. **By focusing on empowerment through education and health this project will cover two key capabilities.**

**Ultimate ends:** Another conceptualization in the context of defining indicators of human well-being, which has been prominent in the field of systems analysis, is the distinction between means and ends made by Herman Daly and later elaborated by Donella Meadows (1998). More specifically, this framework distinguishes between ultimate ends (human well-being) and intermediate ends (human and social capital) as well as intermediate means (built and human capital) and ultimate means (natural capital) (Meadows 1998). Following this approach, we are looking first for indicators of ultimate ends. While the literature abounds with a very wide range of sustainability indicators, they often mix ends and means and are often difficult to interpret. In the well-being indicators chosen here we will try to focus as much as possible on measuring the ultimate ends.

**Relation to current indicators:** ELY will be assessed and compared in many ways to the widely used and accepted Human Development Index (HDI by UNDP) which combines in one index number the realms of education, health and income, giving equal weight to each of the sectors with indicators measured on a relative scale (This means that e.g. life expectancy is not taken in its absolute value but relative to the current maximum life expectancy). It also mixes indicators that primarily matter for the future (such as school enrollment) with others that reflect current and recent past conditions (such as survival as measured by period life expectancy). While very useful for comparing countries at any given point in time, the HDI due to its relative scale is problematic for long-term trend analysis and, therefore, not appropriate for serving as a long-term sustainability criterion. As an abstract index it also lacks an intuitive analogy of real life in a way that ELY offers. The Multidimensional Poverty Index (Alkire & Santos 2014) recently promoted by UNDP can also not be used for the purpose of forecasting because of its very broad spectrum of specific empirical indicators which only exist for the recent past without meaningful methods for projecting them into the future. The Happy Planet Index (Abdallah et al. 2012) which is calculated by multiplying life expectancy at birth with an index of life satisfaction and divided by the ecological footprint of a country comes in its intention rather close to the idea of this project. ELY goes in several dimensions beyond this Index by **fully integrating survival and happiness** in an age- and gender-specific way and not seeing the environmental impact as a completely separate end in itself but rather trying to identify **feed-backs from environmental change** to human survival and the chosen empowerment dimensions including happiness.

Initially all four components of ELY will be studied in separation and the interrelationships among these four dimensions will be studied carefully. A straightforward way to combine all four dimensions in one indicator without having to assume a (necessarily somewhat arbitrary) weighting scheme is to **consider a year of life as empowered only in the case that all four dimensions are positive, i.e. if the person at a given age is healthy, out of poverty, able to read and write and has high life satisfaction.** The project will also conduct extensive empirical analysis to test the acceptability of this indicator across different cultures, religions and populations at different levels of socioeconomic development.

## 5 Determinants of ELY and Human Capital Formation

When focusing on the determinants of ultimate ends of human well-being, the project is guided the operationalized form of a well-being function (Box 1) proposed by William Clark (2012) to estimate the contributions of the different “capitals” to human well-being. The empirical analysis of the determinants of ELY will be performed primarily on a panel of national level time with a whole array of independent variables that are available on that level and cover relevant aspects of the different Capitals listed in the Box. But since some of the variables are likely to not be fully independent of each other we expect various identification problems that will have to be addressed using IV models or other solutions when empirically estimating the effects. The analysis will also focus on finding “natural experiments” or shocks that cause variations in some but not other factors and give attention to the temporal lag structure. In general, this component will try to estimate the “production functions” (the term is broader here than in its specific economic usage) of ELY that will range from linear models (with instrumental variables) to more general functions with different returns to scale and different elasticities of substitution.

Special consideration will be given to the question of causality. Since in the social sciences causality can at best be established for specific historical settings and never at a universal level, this project will refer to the more pragmatic approach of “functional causality” as defined by Lutz and Skirbekk (2014) in the context of education-specific population projections which only has to assume that the for the time horizon considered the observed plausible associations continue and that alternative explanations, such as selectivity or reverse causality, have been ruled out.

The project will give specific attention to the modelling of human capital formation building on previous work of the PI (Lutz & KC 2011) which clearly shows that an age-cohort specific specification of changing educational attainment distributions is essential for **capturing the effects of human capital** in the right way. This has been demonstrated with respect to economic growth ((Lutz et al. 2008) where cohort-specific indicators of education could help to resolve the age-old puzzle that global economic growth regressions based on inappropriate education indicators often did not show the consistent positive effect of education that theory predicted. Since the same can be expected for models trying to explain improvements in ELY that is a field where the Demographic Metabolism model of human capital formation will be of key importance.

**Note on data:** The project will collect relevant data for as many countries as possible back to 1970. Where useful for addressing the above mentioned identification problems, we will also use sub-national data. It will use all available international databases from international organizations, in particular the United Nations and World Bank. Data for age- and sex-specific mortality/survival rates will be taken from the database of the UN Population Division which estimated life tables for all countries in the world since 1950. Data on age- and sex- specific literacy will be taken from UNESCO’s statistical yearbooks as well as directly from national census volumes and, in particular, the set of public use samples of time series of censuses for a rapidly increasing number of countries as assembled by IPUMS. Information on health and disability will be taken from the series of World Health

### Box 1: William Clark’s (2012) Wellbeing Function

Formalizing Brundtland’s “meet the needs...”:

$$W = f(C_i, I, K)$$

W is ‘human well-being’ (intra- and inter-generational)

$C_i$  are ‘Capital assets’ (from which services flow)

–  $C_m$  is ‘manufactured capital’ (factories, homes, roads)

–  $C_h$  is ‘human capital’ (population, health, education)

–  $C_n$  is ‘natural capital’ (ecosystems and their services)

I is ‘Institutions’ (laws, rules; norms, expectations)

K is ‘knowledge’ (scientific, practical; innovation)

Surveys conducted by WHO as well as from the Global Burden of Disease studies. Data on life satisfaction and happiness is given on the largest scale by the different waves of the World Value Survey which have already been used recently for the doctoral dissertation of Erich Striessnig at the WU (who will also join the project team). The most comprehensive time series information on poverty is available from many waves of household surveys assembled by the World Bank. As mentioned above, here a special task will be to translate the information provided for households into age- and sex-specific information for individuals. Since household size and the number of adults living in the households is mostly given, this can be the basis for a conversion formula.

Since the assembly of a consistent global level set of national level time series on indicators of the different “capitals” as well as institutions and knowledge/innovations will be a major challenge, a significant proportion of research time is dedicated to this effort. The project will opportunistically utilize all available reliable international time series on these indicators, again mostly from the World Bank as well as UNDP and other UN agencies. For the human capital data our own recent reconstructions of educational attainment levels by age and sex for most countries in the world back to 1970 will be used (Lutz et al. 2007; Springer et al. 2015). For some of the institutional indicators we will also utilize data of NGOs such as Freedom House etc. For the environmental indicators databases of UNEP as well as IIASA’s own data will be used. The assembly of such a comprehensive and consistent set of time series data is an important end in itself and will be made available in a well-documented form on the web for the research community at large.

## 6 Projections of ELY based on alternative future narratives

**State of the art:** The Intergovernmental Panel on Climate Change (IPCC) has recently finalized its Fifth Assessment Report (AR5). In this context recently the global modelling community on Integrated Assessment (IA) and Vulnerability, Risk and Adaptation (VRA) has agreed to refer to a new common set of Shared Socioeconomic Pathways (SSPs) that describe alternative future worlds with respect to social and economic mitigation and adaptation challenges. Unlike the previous generation of SRES scenarios (Nakicenovic et al. 2000) that only considered total population size and total GDP as relevant socio-economic factors – which essentially reduced population to a scaling factor for the denominator of different variables – this new set of scenarios provides a much richer socio-economic content including alternative population scenarios by age, sex, and six levels of educational attainment for all countries in the world. The main reason for moving to much more detailed characterizations of the socio-economic aspects of global change is that the SSPs are not any more designed primarily for the description of the factors contributing to CO<sub>2</sub> emissions (the challenges for mitigation) but should equally well describe the capabilities of societies in terms of differential vulnerability and adaptive capacity to climate change. In this respect demographic dimensions such as age, sex, level of education and urbanization were considered key factors to be explicitly included in the scenarios.

The SSPs were designed in a lengthy process involving most leading global change modelling teams in a process that was guided by the objective to comprehensively describe alternative possible future global trends with respect to socio-economic challenges associated with climate change mitigation and adaptation (O’Neill et al. 2014). In addition to population, education and urbanization, the scenarios also covered several dimensions of the economy and, in particular, energy consumption and the carbon intensity of possible alternative future technologies. The “human core” of the SSPs has been developed by IIASA’s World Population Program under the PI’s ERC grant and consists of projections by age, sex and six levels of educational attainment according to different SSP narratives (KC & Lutz 2014). Five scenarios were defined: **SSP1** (Sustainability – Rapid social development): This scenario assumes a future that is moving toward a more sustainable path, with educational and health investments accelerating the demographic transition, leading to a relatively low world population. There are

major improvements in human capital and fertility in OECD countries is moderately high. **SSP2** (Continuation – Medium Social Development): This is the middle-of-the-road scenario in which trends typical of recent decades continue, with some progress toward achieving development goals, reductions in resource and energy intensity, and slowly decreasing fossil fuel dependency. In demographic terms it is identical to the medium scenario in the new global human capital projections produced by the Wittgenstein Centre for Demography and Global Human Capital (Lutz, Butz, et al. 2014). **SSP3** (Fragmentation – Stalled Social Development): The scenario portrays a world separated into regions characterized by extreme poverty, pockets of moderate wealth, and many countries struggling to maintain living standards for rapidly growing populations. In demographic terms this is a low education and stalled demographic transition scenarios for the countries that still have high fertility. In addition, **SSP4** (Inequality) and **SSP5** (Conventional Development) describe pathways of high vulnerability of large segments of the population (high adaptation and low mitigation challenges) and of being stuck in carbon intensive conventional economic growth (high mitigation and low adaptation challenges).

**Innovation:** While the SSPs do not explicitly include comprehensive indicators of human well-being, this project will go beyond the state of affairs in projecting alternative future trajectories of ELY that result from the different determinants of ELY which are explicitly defined and the five different SSP pathways. This will directly build on results of the previous component B. The methodology will be developed in analogy to a recent effort by Crespo Cuaresma and Lutz (2016) to produce projections of a slightly modified version of HDI (that allows for comparability over time) for all countries that correspond to the SSP narratives. While trajectories for education and life expectancy were directly taken from the SSPs, for the projections of income per capita they used the estimation of effects of human capital by age and sex on economic growth as given in Lutz et al. (2007). In this project the general approach of this recent pilot study shall be carried out on a much broader basis and with a focus on ELY instead of HDI. Since the determinants of ELY considered will also include institutional and environmental factors this will be a much more demanding effort than projecting the HDI. The projections to 2060 (with possible extensions to 2100) will be done for of all 175 countries for which country-specific SSPs exist.

## **7 Case studies with systems-models that include environmental feed-backs**

**State of the art:** While the SSP approach is based on defining alternative consistent narratives in which certain future pathways of the different “capitals” of the above described production function (human, manufactured, natural, institutions and knowledge) are bundled together, they do not allow to study in more detail how the different capitals interact and how different combinations of such interactions impact on human well-being. Such a task can only be performed by full systems models that quantitatively capture the most relevant feed-back loops and interactions in functional form. Because such interactions tend to differ greatly from one country to another – not only as a function of different environmental conditions but also due to cultural and political conditions – such detailed models can most meaningfully be applied to specific case studies. While the general approach of such systems models is still inspired by the early world models of the 1970s (most prominently the “Limits To Growth” of the Club of Rome), much has been learned over the past decades in terms of the need to be much more specific in order to come up with meaningful scenarios as well as in terms of methods applied for both estimating the functional relationships and modeling their interactions in the future. Based on the IIASA experience with applied systems models over the past two and a half decades this project will produce a next generation of such systems models with a much clearer focus on the impact on well-being indicators and population heterogeneity.

As part of this project we propose a set of three forward looking and one historical case study. The functional relationships assumed will be partly based on the above described analysis

and partly derived from existing domain-specific knowledge as embedded in several other IIASA models on climate, energy, air pollution, land, water, biodiversity and others. The project will also build on and closely collaborate with other ongoing global level integrated assessment modelling, such as the GISMO Model (Hilderink et al. 2008) and the Pardee International Futures Model (Hughes & Hillebrand 2006), models which are less explicit on the human well-being side. There will also be an innovative specific focus on population heterogeneity and inequality in the distribution functions further developing the example of the PEDDA (Population-Environment-Development-Agriculture) developed by Lutz et al (2004) for several case studies for the UN Economic Commission for Africa. In addition, it will build on a recent IIASA cross-cutting project which introduces heterogeneity of human agents into existing IIASA models on energy and air pollution.

**Innovation:** Here we will for the first time operationalize the systems analytical case study approach to comprehensively assess the interactions and feed-backs among the key determinants of human wellbeing with respect to a clearly defined indicator. In the systems models proposed **here the sustainability criterion will be the absence of a decline in long term levels of the ELY indicators (in a forward looking cohort sense) over long time horizons and for significant sub-populations.** Since the complex Population-Development-Environment interactions tend to differ significantly from one setting to another they can only be meaningfully explored through in-depth case studies for specific locations/populations for which there are sufficient data and local research capacity available. Four case studies on four continents were selected strategically following three criteria: (a) They should be representing important ecosystems spanning the range from arid regions to mountains, to grass land and tropical rain forests; (b) They should illustrate different social structures and, in particular, show different degrees of population heterogeneity that can have direct effects on differential development paths within countries and different kinds of institutional and policy frameworks; (c) The case studies need to be feasible in terms of sufficient high quality data available and, in particular, in terms of having established research contacts that assure access to data and facilitate the successful implementation of the research plan. This is particularly important for the stakeholder involvement and science-policy interactions where credible local partners are absolutely essential for a high quality process.

A careful screening of several possible candidates for case studies and weighting of the three above stated criteria resulted in the following proposal for case studies: 1) Namibia and the Cape Provinces of South Africa as a largely arid and sparsely populated region which is characterized by one of the highest population heterogeneity and income inequality of the world. Good contacts based on previous collaboration exist with the University of Namibia and University of Stellenbosch. 2) The mountain region of Nepal which aside from the Kathmandu valley is home to a rather poorly developed population in remote areas that are difficult to access and highly vulnerable to different kinds of natural hazards. 3) Costa Rica as a tropical ecosystem with one of world's highest levels of biodiversity that used to be greatly endangered but recently has seen significant preservation efforts. Its population is rather homogeneous with an intermediate level of development and its government is firmly committed to sustainable development; 4) a historical case study on Finland to understand and model quantitatively how one of the poorest corners of Europe in the mid-19<sup>th</sup> century became one of the most developed with very high levels of human wellbeing.

**Note on data:** For the case studies internationally available national level data will be complemented by sub-national level data either available from the national statistical offices or through special studies carried out by specific individuals or agencies. Since many of these data and studies in developing countries tend to be part of the grey literature, special care is required in assessing the validity of such data. In the assessment of changes in land use, settlement structures and other aspects that can be captured by remote sensing the project will also use satellite data and aerial photography. For the historical case study on Finland the project will be

able to use excellent historical demographic records and good data on a spectrum of social, economic and environmental indicators since the second half of the 19<sup>th</sup> century.

The systems models will be likely programmed in the simulation language VENSIM although other alternatives will be assessed also with respect to the preferences of the local partners. The local partners are also of critical relevance for the chosen case studies in terms of helping to get access to the local research community and hence the best available data as well as helping to arrange the interactions with local stake holder groups and policy makers. Therefore, the following listing will give special attention to the selected local partners.

## **7.1 Historical Case Study on Finland**

Finland up to the late 19<sup>th</sup> century was one of the poorest corners of Europe. It had a cool climate and virtually no natural resources except for slowly growing trees. In 1867-68 Finland experienced the last big “Malthusian” famine in Europe with more than a third of all children dying. As a consequence, the Lutheran Church together with state officials launched a major literacy campaign, in which couples were not allowed to get married unless they could read a page of the catechism in a test. Over the following 30 years the number of elementary school teachers increased by a factor of ten. This all happened in a completely rural context with no changes in the economic structure of the country but it presumably laid the basis for rapid socio-economic development thereafter. A reconstruction of the historical interactions among the population and education trends with economic, institutional and environmental factors (including certain important feed-backs) which in the end led to very significant increases in human well-being will be the focus of this historical case study. What brought a country from being the poorest and most desperate corner of today’s EU to one of its innovation leaders? There is enough good historical data to do some serious analysis of the population-development-environment interactions over more than two centuries. Finland has the longest continuous national level demographic time series of any country existing today. The dissertation of the PI was entitled “Finnish Fertility since 1722” (Lutz 1987) and had already assembled long historical time series and many social and economic indicators which shall be updated and complemented with environmental data. These long time series data also allow us to cover the full life cycle of many individual cohorts with respect to relevant characteristics and thus give the temporally most extensive application and assessment of the explanatory power to the model of Demographic Metabolism.

This study will be carried out in the context of the planned establishment of a Uusikaupunki (Nystad) Peace annual Summer School on Population and Sustainable Development. The 1721 peace treaty of Nystad which ended the Great Northern War between Russia and Sweden was the direct reason for starting to collect systematic demographic data from 1722 onwards in order to plan the reconstruction of the devastated land (In 1749 this system was established for the entire Swedish Kingdom). To prepare for the 300 year anniversary of this important event the PI together with the City Council of Uusikaupunki has launched an initiative for regular research and training workshops on global population and sustainable development analysis. Former Finnish president Tarja Halonen has already to give her strong personal support to this effort. The planned regular summer workshops in Uusikaupunki (which will be funded separately) will bring together young scholars in the field of population, development and environment from around the world and will be a platform to discuss and demonstrate not only the Finnish historical case study but all the proposed case studies as well as the more general topic of human wellbeing and sustainable development.

## **7.2 Nepal Case Study**

Nepal has special challenges through its topography with remote mountain areas and the fact that high proportions of young men work outside the country, mostly in the Gulf States. This case

study will not build on any previous IIASA PDE study but will greatly benefit from the scientific and political networks of Samir KC, a Nepalese who has been a close personal collaborator of the PI for the past seven years and co-author of many high-profile papers as well as co-editor of the recent Oxford University Press book (Lutz, Butz, et al. 2014). The local collaborating institutions will be the National Statistical Office (NSO) as well as the National Planning Commission which have both expressed interest in collaboration with this project. Furthermore, there is already established collaboration with Ministry of Health and Population. Nepal had also hosted the high-fertility expert group meeting for the education-specific world population projections produced under the PI's recently completed ERC Adv. Grant. The structure of the systems model will be similar to earlier PDE studies but with a strong emphasis on agriculture an agriculture and transport/communication links to remote valleys. Because of the great topographical and climatological differences within the country, the model will distinguish between the mountain, hill, and Terrai regions, with the mountain region being of highest interest in this study. Again, a truly innovative feature of this case study will be the implementation of a "production function" of wellbeing (as measured by ELY) including all the mentioned capitals and feed-backs and an active interaction with local stake holders to assess the acceptability of the chosen sustainability criteria and their consequences for development policy priorities.

### **7.3 Namibia/Cape Provinces (South Africa) Case Study**

This case study will focus on Namibia and the Western and Northern Cape provinces of South Africa. These historically closely associated regions also have similar population structures and ecosystems, although they now are different nations which also allows to study the impact of institutions. The study will be carried out in close collaboration with the University of Namibia, the University of Cape Town as well as the Stellenbosch Institute of Advanced Studies where the PI was visiting fellow in 2015. The University of Namibia had also been the key national collaborator in the EU funded PDE project on Namibia carried out by IIASA in 1998-2001 (Sanderson et al. 2001). Lazarus Hangula who then worked with the interdisciplinary research center of the university and served as our main collaborator is now the vice-chancellor of the university. He will help to facilitate the contacts to the leading academics in the country as well as the stake holder meetings. At the University of Cape Town the PI has established collaboration with the population group under the leadership of Rob Dorrington who also hosted the high-mortality expert group meeting for the education-specific world population projections produced under the PI's recently completed ERC Adv. Grant. This case study of Namibia as well as the Western and Northern Cape Provinces will serve as an example of a mostly arid region. It has also specific challenges in having one the world's highest income inequalities and HIV prevalence rates of around 15 percent. The earlier IIASA study had developed the concept of "socio-ecological regions" which blend administrative, social and ecological criteria such as watersheds in defining the regional level in which the study is being carried out. For Namibia 12 such regions had been defined which will also be used in this study. Again, in addition to being an update of the earlier study on Namibia, the new study will be very different in terms of implementing, estimating and projecting according to different scenarios the proposed sustainability criteria and specifying them separately for some of indigenous population groups as well as slum populations around the cities.

### **7.4 Costa Rica Case Study**

Costa Rica was the first country in the world to include the goal of sustainable development in its constitution. It is an island of rather high wellbeing and peace in Central America and one of the few countries in the world without an army. It is a case study of a tropical country with one of the highest levels of biodiversity which is in part threatened by economic development. Yet, on the other hand eco-tourism is a strong economic force favoring environmental preservation. The

project will be carried out in close collaboration with the Centro Centroamericano de Poblacion (CCP) at the University of Costa Rica in San Jose which also recently hosted the low-mortality expert group meeting for the education-specific world population projections produced under the PI's recently completed ERC Adv. Grant. The project will link with other departments of the University in carrying out this study as well as with NGOs and government agencies. There will also be close collaboration with the Tropical Research Station La Gamba (at Golfo Dulce on the South Western Coast of Costa Rica) which is run by botanists from the University of Vienna and of which the PI is a supporting member.

Substantively, this case study will focus on modelling the ecosystems services that the environmental resources provide for human wellbeing. While the genuine value of biodiversity is hard to quantify in a model there are plenty of specific benefits linked to an intact environment ranging from clean water and flood control to eco-tourism for which quantification can be meaningfully attempted. Given the strong focus on biodiversity in this case study the model will be more detailed than in other cases on the interactions between socio-economic development, land cover and changing habitat of specific endangered species.

## **8 Testing the acceptability of ELY as sustainability criterion**

In close interaction with the theoretical component which will critically assess the conceptual issues involved in this project, there will be an empirical component testing how the concept of ELY and its components are being accepted by different expert and stakeholder groups and how they relate to preferences and values expressed in big international surveys such as the European and World Value Surveys. While a *prima facie* exploration of tabulated data from these surveys suggests, that indeed health and survival of oneself and close relative is on the top of things that people across cultures value and worry about and that the other proposed dimensions of ELY are also top ranked, this needs to be assessed carefully at the level of the broadest available empirical evidence with a special focus on possible differences in views between different socioeconomic and religious groups. Hence, this project will assemble the broadest possible set of international value surveys and carry out extensive statistical analysis on the basis of individual level data.

In addition to this analysis of existing survey data there will be targeted focus group discussions to explicitly challenge and discuss the hypothesis that indeed Empowered Life Years is the most universally agreed ultimate ends of development. While it seems plausible to assume that avoidance of premature mortality and survival in an empowered state is something that even a Wall Street broker, a Buddhist monk and a resident of Nairobi slums could agree about, this assumptions needs to be systematically challenged and tested if it is to be the basis for a broadly accepted sustainability criterion. This will be done through structured focus group discussions posing similar questions in the most diverse settings possible. In Europe and the US this will include three kinds of groups: (a) scientists ranging from anthropologists and psychologists to economists and environmental scientists. This will be organized through the various science academies of which the PI is a member. (b) Representatives of political parties and NGOs ranging from the extreme right to the extreme left. This will be done through direct contacts (to be established) with the party/NGO training and communication departments. (c) with the broadest possible spectrum of religious leaders ranging from the established churches to new charismatic and free religious groupings. Similar focus group discussions will be arranged in the context of the in-depth case studies in Nepal, Namibia/Cape Provinces and Costa Rica. Here in addition to national experts on development special efforts will be made to directly solicit the views of local village people, including the most marginalized ethnic and social groups. This will be done very carefully with the support of the local partners and without personally identifying the individuals involved in the discussions. For designing these focus group discussions the assistance of experienced anthropologists and qualitative sociologist from the University of Vienna and the Austrian Academy of Sciences will be sought.

## 9 Science-policy interactions

Science-policy interactions will in first instance happen in the context of the case studies and will include groups of relevant government officials as well as community level stakeholders. It will be done in two waves, one at the beginning of the case study analyses in order to identify the specific perceived major wellbeing and sustainability challenges in the study area and again in the late phases when the results of the systems models will be shared with the stake holders and policy implications will be discussed. It will draw on the vast experience of previous IIASA projects in science-policy-stake holder communication. In particular, IIASA's Risk, Policy and Vulnerability Program has elaborated models for such interactions which will also be applied here. Key results from these stakeholder interactions will then be generalized and communicated to the policy community.

As to the international sustainable development community, the finding from the project will directly inform several of the high level fora that the PI is involved in, mostly through IIASA. Particularly relevant in this context is a new global initiative to study the synergies among the SDGs – called “The world in 2050” – and lead by IIASA together with the Stockholm Resilience Center and the Sustainable Development Solutions Network (lead by Jeffrey Sachs) with over 30 other international organizations participating (<http://www.iiasa.ac.at/web/home/research/researchProjects/TWI2050.html>). More specifically and directly linked to this project, in 2019 at the occasion of the 25<sup>th</sup> anniversary of ICPD (International Conference on Population and Development) in Cairo in 1994, another high level global scientific panel will be assembled following the examples of the panels organized by the PI for the 2002 World Summit on Sustainable Development in Johannesburg (Lutz & Shah 2002) and for Rio+20 (Lutz et al. 2012). This new panel can serve as an effective platform to communicate the most relevant findings of this project to the international policy making community.

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# Appendix: Calculating Happy Life Expectancy

By Erich Striessnig

## Introduction

Scientists have for long tried to find attractive social indicators to describe people's quality of life (QOL) within entire nations at a given point in time by just one number. The goal was to make comparisons across countries at a certain point in time, but also, to see how different sets of policies affected quality of life over time.

QOL can mean a lot of things. Some think it is best assessed by measuring GDP per capita. GDP per capita has the obvious advantage of having a very intuitive and straightforward real world interpretation, referring to the amount of goods and services that the average person in the economy can purchase. Yet, the concept has also been heavily criticized because just like every other average number it does not tell us anything about the distribution of income, nor does it speak about non-material goods that can reflect QOL, e.g. the population's health and educational attainment, or the extent of the rule of law and civil liberties (Stiglitz et al. 2010). In addition to that, GDP per capita is purely input-based, meaning it does not measure QOL itself, but the inputs that are provided to achieve QOL, which would be the actual output that we are interested in measuring. Finally, another shortcoming is that GDP per capita does not inform us about what people can actually do with these inputs in different parts of the world, nor does it tell us, for how long they can expect to do it.

This critique has led to the well-known capability approach, voiced by Amartya Sen, Martha Nussbaum and others (Nussbaum & Sen 1993; Sen 1999), and it led to the Human Development Index (HDI), that is now the most common alternative to GDP. Other than GDP per capita, HDI does measure non-material determinants of QOL, like life expectancy and educational attainment. Yet resulting from the combination of three very different concepts – income, longevity, and empowerment through education – it lacks the clarity and straightforwardness of the interpretation of GDP per capita. What does an HDI of 0.84 even mean? Also, the HDI mixes up means and ends of social development: GDP per capita measures inputs for QOL, life-expectancy clearly is an output, and education something in between, as it increases our possibilities to improve QOL, but at the same time can be an end in itself (Klugman et al. 2011).

As immediately becomes obvious, we cannot include everything that has ever been associated with QOL. Thus when thinking about what specific contribution demography can make to the QOL debate, we have to be aware of the properties that would make for a desirable indicator. The genuinely demographic indicator of QOL that we want to propose in this article is called "Happy Life Expectancy" (HLE). We want to show the *status quo* of HLE in international comparison, before looking at how HLE is expected to change over coming decades.

First suggested by Ruut Veenhoven in a 1996 article of the same name in Social Indicators Research (Veenhoven 1996), this indicator in fact overcomes many of the afore-mentioned shortcomings. A first major advantage of HLE is its very clear interpretation, namely as the average number of years a person can expect to live in a state of happiness under current happiness-conditions. Secondly, by combining the basic social development aspects of survival and happiness, it looks at QOL only in terms of outputs, not inputs or combinations of inputs and outputs. Both life and happiness are ends, not means to something else and both life and happiness seem to be valued pretty universally among human societies. Unlike GDP per capita, HLE can be derived for men and women separately, which makes it appropriate for studying gender-specific issues of well-being within and across societies. Making use of demographic life-table techniques, we can incorporate information on the composition of the population by age and various other characteristics, like urban-rural status, different ethnic groups or level of education, provided that we have happiness-scores and life-tables for these different sub-populations. This ability to

differentiate sub-groups within countries is another great advantage over the HDI, which only gives us a national total that is also restricted by an upper limit of 1. HLE, for its part, can theoretically increase just like life expectancy which makes it more adequate for comparisons across time.

In this Appendix, we will focus on differentials in HLE by level of educational attainment which up to this point has not been received much attention. We will then project HLE into the future for different education sub-populations on the basis of other, well accepted forecasts to illustrate both the path dependence of development, as well as realistic prospects for future human development.

## Literature

Despite its desirable properties, HLE has not been used widely in the literature. A few studies report evidence for the idea that HLE differs by determinants of social status, such as race or gender. Perenboom (2004), for example, shows important male/female differences in the Netherlands, while more recent research by Yang (2008) reveals that between 1972 and 2004 changes in HLE within the US population have greatly differed by age and race. Education, another important marker of population heterogeneity, has not been studied in similar detail.

This is despite the fact that education has for a long time been seen as closely connected to the possibility of living a happy life. In an environment of secularization and a shrinking belief in the omnipotence and impenetrability of divine intervention, ancient Greek philosophers initiated an emancipatory process to arrive at a definition of what they called “the good life”. The widespread conviction inherent to this idea, most prominently brought forward by Aristotle in his *Nicomachean Ethics* (~350 BC) but shared and modified by many others, was that happiness could be made more persistent and robust to external influences by living in accordance with our virtues, in fact, happiness was defined as activity in accord with virtue (Michalos 2007): “[...] the Good of man is the active exercise of his soul’s faculties in conformity with excellence or virtue, or if there be several human excellences or virtues, in conformity with the best and most perfect among them.” The “best and most perfect”, in fact the essential capacity that distinguishes humans from all other species, however, is reason and the key to refining one’s reason, the primary means to “help people develop their best selves” (Noddings 2003, p.23) is education. This led Aristotle to the conviction that “the good life” can be identified with the *bios theoretikos* or *vita contemplativa* by its Latin translation.

The Aristotelian view has of course always been disputed. In the writings of Epicurus and the Stoics, education was seen as rather detrimental to the lasting pleasure of *ataraxia*, the robust tranquility of the soul, because it includes better knowledge of negative facts that can induce pain, which is to be avoided if happiness is to be achieved. But even Epicurus sees the necessity of education to teach us the difference between the fleeting *kinetic* pleasures, that appear to be pleasures but bring pain in their wake, and the enduring *katastemic* pleasures (compare Morse 1998). Likewise, stoicism propagates the need to gain wisdom through education as a form of self-control and independence from disquieting external influences. The eventual goal is a correct view of both our physical surrounding, as well as of the Gods to facilitate a genuine piety without superstition (compare Reydams-Schils 2010).

In the context of Christian scholasticism, to know more about the world is often seen as disturbing and “in trying to submit God’s mysteries to reason, one *could be tempted* to forget their transcendency and yield to *a kind of naturalism*” (Wiebe 1991, p.204, italics in original) which would be in contradiction to the goal of pure faith. Thus, if ignorance is bliss, then education ought to be avoided. Nevertheless, many medieval friars spent their days studying in the libraries of their convents.

To put this into slightly more “secular” terms, education does of course also have measurable effects on QOL. Most directly, education enhances our cognitive abilities, as well as our capacities for self-reflection (Skirbekk et al. 2012), it leads to higher per capita income and material well-being (Lutz et al. 2008), and is related to reduced mortality and morbidity (KC & Lentzner 2010). We would therefore expect strong HLE differentials by level of educational attainment.

## Data and Methods

Although Veenhoven knew about the more sophisticated demographical approach, weighting the age-specific life table person years lived ( $L_x$ ) with age-specific proportions at different levels of subjective happiness, usually referred to as the “Sullivan method” (Sullivan 1971), he preferred to simply multiply the given life expectancy at birth with an index of happiness, assuming that happiness was not age-dependent. This shortcoming has since been overcome (Perenboom et al. 2004; Yang 2008). Rather than focusing on the differentials in the prevalence rates of happiness by gender and race, we will compare happiness scores across countries and over time by level of education.

Data on proportions of population “happy” by age, gender and education is taken from the World Values Survey (WVS), which represents the largest source of information on values, norms, and quality of life to date with a total of roughly 500,000, not repeated individual observations. The WVS has been carried out in six waves since 1981 – the latest of which (2010-2014) has so far not been used widely for statistical research. Starting out with a heavier focus on European countries, over the years the WVS has become ever more global in scope. In total, representative national surveys with between 1,000 and 3,000 individuals from the entire resident population above the age of 18 have been conducted in almost 100 countries accounting for close to 90 per cent of the world population. Country-level weights are provided reducing sampling bias and ensuring that the data for each country-wave combination are representative. Detailed information on the sampling strategy, questionnaire wording, as well as data access and publications making use of this data can be obtained at [www.worldvaluessurvey.org](http://www.worldvaluessurvey.org).

Respondents in all survey waves of the WVS so far were asked to give an assessment of their “Feeling of Happiness”: “Taking all things together, how happy would you say you are?” The four response possibilities, “not at all happy”, “not very happy”, “rather happy”, and “very happy”, were coded in descending happiness order from 4 to 1. The precise wording of the question has not been altered across survey waves in any of its translations. Concerns have been raised about the possibility of differential item functioning, i.e. subjective assessments regarding one’s level of happiness might not be comparable across different nationalities, cultures, or even members of different sub-populations within nations as the response category cut points might differ (e.g. Uchida et al. 2004). One remedy proposed in the more recent literature against the resulting reporting bias are anchoring vignettes (King et al. 2004; Kristensen & Johansson 2008; van Soest et al. 2011), however, these have not yet been included in the generation of the WVS data.

A simpler approach to remedy this potential problem consists in dichotomizing the answer categories. As shown by Van Herk et al. (2004) comparing evidence from six European countries, response styles vary particularly with regard to the likelihood of extreme responses – while in some cultural contexts people tend to be very frank about their state of happiness and thus choose the extreme answer possibility straight out, in others they tend to be more modest preferring answers that are closer to the midpoint of the rating scale. Similarly, Veenhoven (2012) points out that although respondents sometimes change answers when asked repeatedly about their subjective well-being, they rarely cross the midpoint and even less often change from one extreme to the other, i.e. from “very happy” to “not at all happy.” Thus exploiting the very clear distinction between positive and negative outcomes in the case of the happiness survey item ,

following Deeming and Hayes (2012) the response categories are dichotomized to jointly distinguish the “very happy” and “quite happy” (called “happy” in the analysis) from the group of the “not very happy” and “not at all happy” (referred to as “unhappy”). Redrawing the cut point at this more significant divide on the one hand reduces the influence of possible differential item functioning and increases the results’ robustness with respect to random distortions in people’s answering behavior. On the other hand, it is also indicated by the rather small number of people claiming to be “not at all happy”.

In addition to the happiness prevalence rates, we need population-shares by age and education, as well as age- and education-specific life tables. We get both of these inputs from population projections by age, sex, and educational attainment, provided by the Wittgenstein Centre for Demography and Global Human Capital (IIASA, VID/OeAW, WU) (WiC) (Lutz, Butz, et al. 2014) and readily available for download at <http://witt.null2.net/shiny/wic/>. The original data is disaggregated for six education-categories, yet, in order to maintain a high enough number observations in each age and happiness cell, we dichotomize education distinguishing “less-than secondary” from “at-least secondary” and aggregate the data by 10-year age-groups. Finally, we combine the 52 countries – where we have both happiness and education data – to eight world regions (a table with the countries within the eight regions is available in the appendix).

Building on the empirical evidence and using the population projections by highest level of educational attainment, for the first time we are able to produce projections of HLE for different education scenarios and all countries of the world, although in this paper we will only illustrate the method for selected countries from different continents and cultural spheres. This way we will be able to give a more detailed picture of how long people in different parts of the world will be able to live and live happily.

## Results

Figure A1 shows the age- and education-pattern of the proportion “Happy” for different regions of the world according to the WVS. The proportion of happy people among the highly-educated is bigger in every region at almost any age than among the low-educated. The only region where happiness appears to decline with age is Eastern Europe, possibly reflecting cohort differences between people that experienced the traumatic events leading up and following the fall or the Iron Curtain with different intensity (Lelkes 2006; Lelkes 2008). In most other regions, the age-dimension does not matter as much. In Africa, at least the highly educated show a strong upward trend which could be due in part to selective survival of people reporting to be happy. An explicit treatment of age, period, and cohort effects is difficult as only four countries report data on happiness from two survey waves that are sufficiently far apart.

In a next step, these prevalence rates can then be combined with the life table information provided by the WiC to create “Happy Life Tables.” Table A1 exemplifies the derivation of the indicator using Sullivan’s method with the data for Eastern Europe. The leftmost part of the table shows the regular life table columns, life-years lived by age-group and total life-years lived ( $T_x$ ). But this can be derived separately for different sub-populations, as for example low- and highly-educated people. Since there are no people with at least secondary education under the age of 15, the number of life-years lived here is zero, although at later stages of the life course of this synthetic cohort their share in the total number of years lived becomes bigger. These age- and education-specific life years can then be weighed by the corresponding proportions of people reporting to be happy. Since there are no children in the survey, we assumed that they are as happy as 15-19-year old individuals without formal education. Likewise, we only have one number for the elderly, which is the proportion of people happy aged 65 and over. Happy life-years lived ( $HL_x$ ) in the next column then is the weighted sum of the years contributed by highly and low educated and the last column,  $HT_x$ , reports the total life-years lived in a state of happiness beyond

age  $x$ . Dividing  $T_0$  by 100000 we finally get happy life expectancy at age zero ( $HLE_0$ ). Since not all years lived are years lived in happiness,  $HLE_0$  is always smaller than conventional life expectancy ( $LE_0$ ).

Since the WiC provides projections of population by age, sex, and level of educational attainment for all countries of the world until 2100, assuming for simplicity that national age- and education-specific prevalence rates remain at their most recently observed levels, we can project  $HLE_0$  into the future. The results of this exercise are shown in Figure A2. The big gains in life expectancy combined with the vast education-differentials in happiness lead to strong predicted increases in  $HLE_0$  in all regions, but most pronounced in Africa. Apart from that, however, we find no clear sign of convergence among world regions. People in the rich OECD countries, as well as the more developed parts of Asia continue to be those that can expect to live the longest in a state of happiness. While China and India, as well as Pacific Asia can expect to catch up to those global forerunners, other regions only maintain a constant distance (e.g. Latin America and Middle East and North Africa), whereas Eastern Europe falls further behind. Considering the possibility of older, less happy Eastern European cohorts being replaced by today’s young who already reported to be much happier, this gruesome prediction most probably will not materialize.

Figure A1. Proportion “Happy” by Age and Education. Source: WVS, 2005-2007 wave.

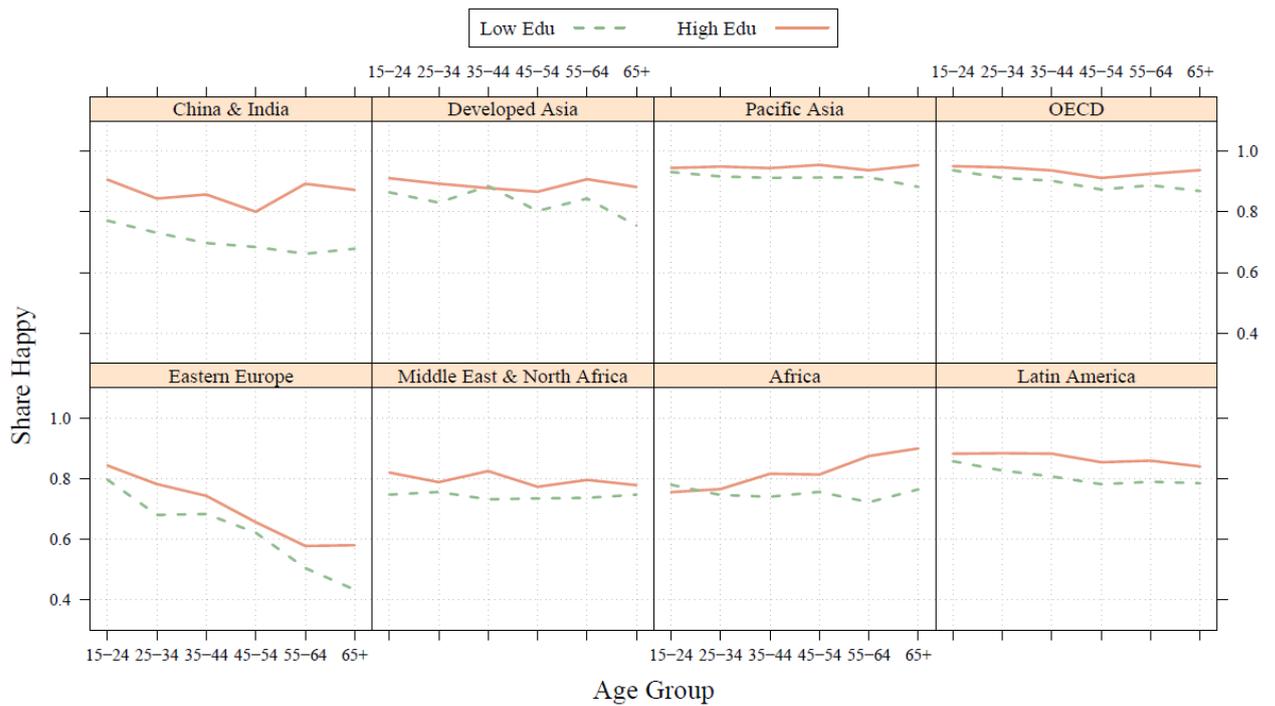
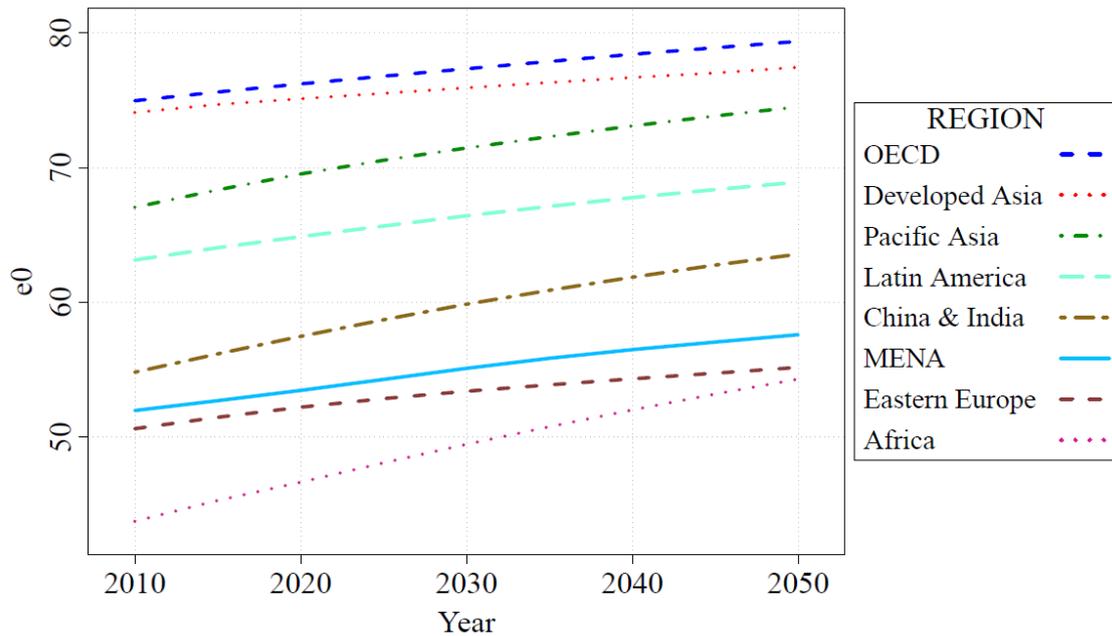


Table A1. Example of the calculation of happy life expectancy for Eastern Europe, 2010.

Age	Regular Life Table		Edu-Decomposition		Share Happy by Edu		Happy Life Table	
	$L_x$	$T_x$	$L_x^{Low}$	$L_x^{High}$	$HP_x^{Low}$	$HP_x^{High}$	$HL_x$	$HT_x$
0 - 4	466570	7132031	466570	0	0.80	0.80	371842	5043013
5 - 9	461424	6665462	461424	0	0.80	0.80	367741	4671171
10 - 14	460889	6204038	460889	0	0.80	0.80	367314	4303431
15 - 19	490227	5743149	100424	389803	0.80	0.80	390696	3936116
20 - 24	488487	5252922	6892	481595	0.80	0.84	411804	3545420
25 - 29	485000	4764436	9669	475331	0.68	0.78	378483	3133617
30 - 34	479840	4279435	11109	468731	0.68	0.78	374299	2755134
35 - 39	472493	3799595	8576	463917	0.68	0.74	350883	2380835
40 - 44	463367	3327102	6091	457277	0.68	0.74	344245	2029952
45 - 49	449155	2863734	5608	443547	0.62	0.66	294805	1685707
50 - 54	433062	2414579	7533	425530	0.62	0.66	284169	1390901
55 - 59	411647	1981517	13070	398576	0.51	0.58	237150	1106732
60 - 64	383780	1569870	19271	364509	0.51	0.58	220578	869581
65 - 69	349304	1186091	40111	309193	0.43	0.58	196966	649003
70 - 74	295898	836787	57696	238202	0.43	0.58	163371	452037
75 - 79	238361	540889	62848	175513	0.43	0.58	129201	288667
80 - 84	163656	302528	48266	115390	0.43	0.58	87958	159465
85 - 89	92321	138872	37732	54589	0.43	0.58	48077	71507
90 - 94	36164	46551	18310	17853	0.43	0.58	18315	23430
95 - 99	9015	10387	5341	3674	0.43	0.58	4452	5115
100 +	1372	1372	906	465	0.43	0.58	664	664
$LE_0 = 71.32$							$HLE_0 = 50.43$	

Figure A2. Happy Life Expectancy by Region. Source: WiC and own calculations.



## **Discussion**

In this section of the working paper, we have introduced a new indicator of quality of life, namely happy life expectancy. The indicator has several desirable characteristics, most importantly its intuitive and straightforward interpretation as the number of years a person can expect to live happily. Yet HLE also reveals new dimensions of sustainable development not covered by conventional development indicators. The results presented are still very preliminary and further analysis is needed to reach a more conclusive picture.