Working Paper

Neglected Dimensions of Global Land-Use Change: Reflections and Data

Gerhard K. Heilig

WP-93-73
December 1993

IIASA

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ABSTRACT

The main objective of the paper is to question the conventional approach in studying land-use changes, which is focused on agriculture-related alterations driven by population growth. It will show that there are numerous other types of land cover modification, such as those caused by certain lifestyles, man-made catastrophes, wars, urban infrastructure expansion, industrial production, or fossil resource exploration and transportation. The paper argues that we can only understand the underlying causes of global land-use change if we widen our conceptual focus. We have to abandon the oversimplified model of a linear relationship between "population growth, increase of food demand, agricultural expansion and intensification, leading to deforestation and land-cover modification."

While the expansion and intensification of agriculture and livestock production certainly affects large surface areas of our globe, it is only one of several *derivative* processes. They are just the most visible outcome of more fundamental, but less obvious, social, economic and technological changes. Some of these originate from currently rather unexplored domains, such as changes in communication and transportation technology, international trade regulations, or political and military strategies.

Even where we find *agricultural* expansion and land-use change it is very often *not* caused by growing food demand (as people often assume), but by changes in lifestyles and food preferences. The paper will present FAO data which indicate that more than 22 percent of the arable land worldwide is cultivated for lifestyle-related products, such as drugs, tobacco, sugar beet, sugar cane, coffee, cocoa and tea. Obviously, none of these agricultural products (for which we spend huge areas of arable land) is needed for providing basic subsistence to a growing population.

The paper begins with a brainstorming exercise that collects "everyday knowledge" about different forms of land use. Then it presents a conceptual framework which brings together various--seemingly unrelated--processes and driving forces of land-use change. This is followed by an examination of land-use data on some 150 countries for the period from 1961 to 1990, focusing on possible interaction between population and land use. The paper finally reviews some historical trends which show that changes in land-use patterns are frequently linked to changes in lifestyles.

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Gerhard K. Heilig

1. Introduction

Reading papers and books on land-use change is a somewhat monotonous exercise. Over and over again the authors treat just two subjects: *deforestation* and land-cover change due to *agricultural modernization and expansion.* There are hundreds of publications adopting this approach,[2/3/4/5/6] but a most typical example is a recent report of the Human Dimensions of Global Environmental Change Programme (HDP) published by the International Geosphere-Biosphere Programme (IGBP).[7] While the authors of this booklet have stressed the need for analyzing the *underlying* demographic, cultural, economic and social causes of land-use change, they mostly *describe* trends in deforestation and agriculture. One chapter is explicitly titled "underlying human driving forces" but it deals mainly with large-scale investments in *agriculture.* And the main illustrative case in the IGBP report is the deforestation of the Amazon. No one would doubt that this is a region of serious land-cover modification, but is it also the place where change is triggered? Is the surface of our earth really shaped by poor slash-and-burn farmers, agribusiness and logging companies?

The main objective of this paper is to question the conventional approach in studying land-use changes, which is focused on agriculture-related alterations driven by population growth. The paper will show that there are numerous other types of land cover modification, such as those caused by certain lifestyles, man-made catastrophes, wars, urban infrastructure expansion, industrial production, or fossil resource exploration and transportation. Hence, we can only

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[1] A preliminary version of this paper was presented at the New York Academy of Medicine's Forum on Population, Environment and Development, New York, 22-23 September 1993.

[2] Houghton, R.A., Lefkowitz, D.S., and Skole, D.L. 1991. Changes in the landscape of Latin America between 1850 and 1985. I. Progressive loss of forests. *Forest Ecology and Management* 38:143-172.

[3] Bartlett, H.H. 1956. Fire, primitive agriculture, and grazing in the tropics. Pages 692-720 in W.L. Thomas, ed. *Man's Role in Changing the Face of the Earth*. Chicago: University of Chicago Press.

[4] Allen, J.C. and Barnes, D.F. 1985. The causes of deforestation in developing countries. *Annals of the Association of American Geographers* 72(2):163-184.

[5] Bilsborrow, R.E. and Okoth-Ogendo, H.W.O. 1992. Population-driven changes in land use in developing countries. *Ambio* 21:37-45.

[6] Brouwer, F.M., Thomas, A.J., and Chadwick, M.J., Eds. 1991. *Land Use Changes in Europe.* Dordrecht: Kluwer Academic Publishers.

[7] Turner, B.L., Moss, R.H., and Skole, D.L. 1993. *Relating Land Use and Global Land-Cover Change: A Proposal for an IGBP-HDP Core Project.* A report from the IGBP/HDP working group on land-use/land-cover change. IGBP Report No. 24; HDP Report No. 5.

understand the underlying causes of global land-use change if we widen our conceptual focus. While the expansion and intensification of agriculture and livestock production certainly affects large surface areas of our globe, it is only one of several *derivative* processes. They are just the most visible outcome of more fundamental social, economic and technological changes. It is a noble (and necessary!) scientific task to *monitor* and *describe* the global trends in deforestation and agricultural land-use change, but we will only understand what is actually going on, when we abandon the oversimplified model of a linear relationship between "population growth, increase of food demand and agricultural expansion and intensification, leading to deforestation".[8] Our physical world is actually shaped by many other, less obvious forces. Some of these originate from currently rather unexplored domains, such as changes in lifestyles, food preferences, or political and military strategies.

We begin with a brainstorming exercise that collects "everyday knowledge" about different forms of land use. Then we develop a conceptual framework which brings together various--seemingly unrelated--processes and driving forces of land-use change. This is followed by an examination of land-use data on some 150 countries for the period 1961 to 1990, focusing on possible interaction between population and land use. We then explain, why we think that global changes in land-use patterns are *not* primarily a matter of population growth, (Third World) farming or forest exploitation.

2. The Diversity of Human Land Use--A Brainstorming Exercise

To get a fresh perspective on a settled scientific subject it is often a good idea to start with a commonplace list of what we all know but might have forgotten in the heat of the academic debate. Here is the author's inventory of human land use. Apart from agriculture and livestock production, we use land for

- housing (cities, villages)
- manufacturing and industrial facilities (factories, car-testing sites)
- the food supply infrastructure (stores, shopping centers)
- wholesaler and trading shows (commercial centers, trade fairs, markets, etc.)
- the water and energy supply infrastructure (dams, pipelines, power plants, oil fields, coal mines, gas stations)
- recreation and sport (Disney Land, zoos, parks, Las Vegas, ski slopes, sports stadiums, golf courses, race tracks, swimming halls, ice skating, hunting, etc.)
- tourism (hotels, beaches, hiking trails)
- waste deposition and sanitation (landfills, sewage treatment facilities, municipal and industrial waste deposits, slag heaps of coal mines)
- education and training facilities (university campuses, schools)
- military purposes (restricted areas, shooting facilities, military airports and harbors, training grounds, barracks)
- transport infrastructure (streets, airports, car parking space, railroads, harbors)
- health care infrastructure (hospitals)
- storage facilities (oil tanks, water reservoirs)

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[8] A most typical example of questionable correlation exercise is a paper by Allen and Barnes, who wrote: "Deforestation from 1968-78 in 39 countries in Africa, Latin America, and Asia is significantly related to the rate of population growth over the period and to wood fuels production and wood export in 1968; it is indirectly related to agricultural expansion and not related to the growth of per capita GNP." The authors conclude, that "in the short term deforestation is due to population growth and agricultural expansion, aggravated over the long term by wood harvesting for fuel and export". See: Allen and Barnes, 1985, *op. cit.*

- production of drugs (marihuana fields, coca fields, etc.)
- cultural and religious facilities (museums, temples, churches, cemeteries)
- administration and government buildings (UN-city)
- communication facilities (telephone, TV, radio).

This list, while still incomplete, shows a broad range of human activities that could trigger land-use change. However, most of these activities are usually ignored in the recent debate, because their impact is considered to be negligible as compared to changes caused by *agricultural* expansion and modernization. Says the IGBP/HDP report on land-use and land-cover change: "The two largest land uses, in terms of their spatial domain, are arable cultivation and livestock production."[9]

Table 1. Human-induced conversions in selected land covers. Source: Turner et al., 1993; based on Meyer and Turner (1992).[10]

Covers	Date	Area ($x10^6 km^2$)	Date	Area ($x10^6 km^2$)	% Change
Cropland**	1700	2.8	1980	15.0	+435
	1700	3.0	1980	14.8	+393
Irrigated Cropland	1800	0.08	1989	2.0	+2400
Closed Forest	pre-agricultural	46.3	1983	39.3	-15.1
Forest and Woodland	pre-agricultural	61.5	1983	52.4	-14.8
Grassland/Pasture***	1700	68.6	1980	67.9	-1
Drained Land			1985	1.6	
Settlement					
Urban			1990	2.5****	
Rural			1990	2.1	

Notes: * The variation in dates and significant digits reflects the various sources from which they were taken; ** Estimates given from two different sources; *** Includes some areas often classed separately as shrub and arid land; **** Includes substantial areas not built up.

Indeed, if one consults available statistics, one can easily get the impression that global land-use change is mainly a matter of agriculture and forest exploitation. Table 1, for instance, is reproduced from the above mentioned IGBP-Report. It shows that (as the authors say) "the two

[9] Turner et al., 1993, *op cit.*, p. 18.

[10] Meyer, W.B. and Turner, B.L. 1992. Human population growth and global land-use/land-cover change. *Annual Review of Ecology and Systematics* 23:39-61.

largest land uses, in terms of their spatial domain, are arable cultivation and livestock production. Around 14-15 million km^2, an area about the size of South America, is in some form of cultivation. An additional 70 million km^2 is used for some form of livestock production, as either rangeland or pasture. In contrast, settlements of all kinds and their infrastructure (e.g. roads) cover only a few percent of the world's land area. *Understanding global-scale patterns in land-cover change therefore requires detailed investigation of the changes in the rural land use*" (italics by Heilig).[11] Other authors[12] have come to similar conclusions: Grübler stresses the point that "the area covered by artifacts of our technological civilization most likely cover less than one percent of the Earth's land area. In contrast, the areas used for agriculture and pasture cover close to 40 percent of the global land area".[13]

While these statistics are indeed widely cited, one could be a little suspicious about their validity. If one *excludes* areas which are uninhabitable for all practical purposes, such as the North Pole, the Antarctic, very steep mountain areas, or extremely unpleasant regions in Siberia and Northern America, the ratio of land covered by human structures is probably *much* higher--maybe up to 7 percent. For instance, in the Netherlands 6.3% of the lands are used for "parks and recreational areas", 10.5% for "infrastructures, residential buildings, industry and commerce" and 10.8% for "other uses". In other words, **almost 28% of the country's land area is under some kind of human use other than agriculture or livestock production.** Forests, on the other hand, cover just 9.7% of the land, and the famous agriculture needs only 22.6%.[14] In Austria, more than 2% of the land area is covered by streets and highways.

But even if we assume (contrary to our belief) that land use for human infrastructure is minor in size as compared to agriculture-related land use, we should not focus all our attention on this sector. We do not live in a rural world--a world that is shaped by (poor) farmers, agribusiness and logging companies. The fundamental global change currently underway is not primarily driven by increasing food demand of a rapidly growing population or by the profit interest of agribusiness.

For instance, what is the "real" driving force of deforestation in the Amazon? Is it population pressure that drives the landless rural masses to the frontier? Or is it the greed for profit that fuels the logging practices of international enterprises? What is the role of technology? Would the deforestation of the Amazon be possible without the advanced construction machinery that was used to cut the Transamazonica through the forest? How do the politicians influence the process? Did not Brazil's leaders trigger the widespread land cover change of the Amazon when they dreamed about developing the country's vast interior areas?[15] In 1960, when the country's capital was moved to Brasilia, which is located right in the middle of Brazil's vast and empty Savannah region, a dense network of roads and other infrastructure was built. Only then was the remote area opened for mass migration of the urban poor. We should not forget the military!

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[11] Turner et al., 1993, *op cit.*, p. 18.

[12] Meyer and Turner, 1992, *op. cit.*

[13] Grübler, A. 1992. *Technology and Global Change: Land-use, Past and Present.* WP-92-2. Laxenburg, Austria: International Institute for Applied Systems Analysis, p. 1.

[14] All data are from Grübler, 1992, *Ibid.*

[15] Mahar, D.J. 1989. *Government Policies and Deforestation in Brazil's Amazon Region*. Washington, D.C.: World Bank.

They had their own interests for making the northwestern parts of Brazil "accessible". The observation that farmers and logging companies are about to destroy one of the last natural rain forests does not reveal anything about these hidden motives, nasty strategies, or structural forces behind the scene. Hence, collecting more detailed inventories of land-cover change in the Amazon (or anywhere else) will not help us to understand what is actually triggering the change. We have to penetrate to the human driving forces of land-use change.

3. Human Driving Forces: A Theoretical Framework

To understand the rapid change of the earth's surface at the turn of the 21st century, we must take into account (at least) **four basic trends**: (1) the rapid spread of the scientific-technological revolution;[16] (2) the historically unprecedented increase of population; (3) worldwide and fundamental changes of lifestyles which affect not only small elites but large sections of the population; and (4) the effects of current geopolitical, economic and military structures and strategies. These fundamental trends drive mechanisms which could be called the **proximate determinants** of land-use change. They include worldwide driving forces, such as (1) the expansion of transportation networks and infrastructure; (2) the increases in mobility and tourism; (3) the expansion and modernization of agriculture and livestock production; and (4) the growing demand for (commercial) energy and natural resources. And these forces, in turn, are linked to certain **alterations of the land surface and its biotic cover**, such as (a) deforestation,[17] (b) drainage of natural wetlands, (c) regulation of river systems and artificial lakes, (d) man-induced desertification, (e) sealing of land through artifacts (air fields, streets, buildings). In the end these land-cover modifications can change the (regional) hydrology,[18] reduce biodiversity, influence the biogeochemical cycles (including the emission of radiative trace gases such as CO_2 and CH_4), or even affect the climate. They can trigger soil erosion and increase sediment transport (see Figure 1).

It is evident that--everything else being equal--population growth has an impact on global land use. More people require more food, more houses, more power, more roads and railways, more of everything. The critical phrase is *"everything else being equal"* because things are usually *not constant* in human affairs (if we forget about a few near-neolithic societies in remote areas). People have always tried to improve (agricultural) *technology* or adapt to changes in climate or population density. There was always *migration* as a mechanism for moving away excess population in cases of over-population or environmental disaster. In human history, as we know it, *trade* and *cultural exchange* between societies always worked as mechanisms of facilitating adaptation and change. The carrying capacity of the earth is not a natural constant--it is a dynamic equilibrium, essentially determined by human action. This is why studying dependencies between population growth and land use in isolation is a rather irrelevant approach.

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[16] Grübler, 1992, *op. cit.*

[17] Palo, M., Mery, G., and Salmi, J. 1987. Deforestation in the tropics: Pilot scenarios based on quantitative analyses. Pages 53-106 in M. Palo and J. Salmi, eds. *Deforestation or Development in the Third World.*

[18] Ryszkowski, L., Kedziora, A., and Olejnik, J. 1991. Potential effects of climate and land use changes on the water balance structure in Poland. Pages 253-274 in F.M. Brouwer, A.J. Thomas, and M.J. Chadwick, eds. *Land Use Changes in Europe. Processes of Change, Environmental Transformations and Future Patterns.* Dordrecht: Kluwer Academic Publishers.

Figure 1. Theoretical framework for analyzing human driving forces of global land-use change.

Global Driving Forces	Proximate Determinants of Land-use Change	Land-cover Modifications
- A - Global Spread of Scientific Methods & Advanced Technology	(1) Rapid Expansion of Transportation & Communication Networks	(a) Deforestation & Forest Modification (b) Draining of Wetlands
- B - Geo-political & Economic Structures and Strategies	(2) Increases in Mass-mobility and Tourism	(c) Dam Construction, River Regulation (d) Man-made Desertification
- C - Changes in Lifestyles	(3) Modernization & Expansion of agriculture & livestocks	(f) Soil Erosion, Land Slides (g) Chemical & Nuclear Contamination of Soils and Water Bodies
- D - Population Growth	(4) Growing Demand for Commercial Energy	(e) Land Sealing (buildings, streets, etc.)

Today the most powerful driving forces that can modify the relationship between population and land are science and technology. They are about to change life even in the most remote parts of our world. Eskimos use *automatic* rifles to hunt; Chinese paddy rice farmers apply *more nitrogenous fertilizers* on average than their European colleagues; agricultural and land-use data in Egypt are collected for a Geographical Information System with the help of *satellite navigation* devices;[19] the oil-producing desert countries in Western Asia have the highest density of *desalination plants* in the world; high *yield varieties of rice* and corn are used in most of the modernized Asian agricultures; cars and motorbikes are everywhere (in Java, people use the term "Honda revolution"); the *direct-dial phone connection* between Bali (Indonesia) and Vienna (Austria) is a matter of seconds or minutes; and so on. At the moment we can observe a rapid spread of the scientific-technological revolution from Northern America, Europe and Japan to most parts of the Third World--only Africa is lagging behind. The spread has triggered a fundamental change in agricultural productivity. Most Asian countries, including China, India, and Indonesia, have doubled or tripled food production in the past 20 years. This "Green Revolution" has already established a new balance of people and land.

Technology has also contributed to the rapid expansion of transportation and communication networks. This not only encourages mass tourism and migration, it also contributes to the spread of "western" values and lifestyles to many parts of the world. The Indonesian farmer who twice a week watches a TV show from the US or Germany in which people drive around in Mercedes or Chevrolets will probably modify his aspirations in the not-to-distant future. The global trend of using motorbikes and automobiles is certainly one of the most powerful driving forces of land-use change. There is also a global trend to animal-based food in many parts of the world (even if the people in parts of Europe and Northern America tend to reduce meat consumption). China, for instance, has had a spectacular increase of meat consumption over the last two decades. The trend to meat will require livestock expansion (or intensification of production methods) in large parts of Asia.

The increase in mobility and changes in lifestyles will probably increase energy consumption--even if mitigation technologies and regulations for saving energy will be implemented. There is no reason why the Third World (especially Asia) should not follow the trends of the already affluent societies. We will build more dams and river regulations for hydropower generation, expand networks of energy distribution, build more oil and gas pipelines, expand the road networks, etc. All this will contribute to change the land cover of our earth.

4. Data on Land-Use Change

Before we continue to analyze human driving forces of land-use change it might be useful to check some available statistics. We have used data from the FAO AGROSTAT data base system (see Appendix Tables A7-A18). They are derived from official government reports and one should bear in mind that "definitions used by reporting countries vary considerably and items classified under the same category often relate to greatly differing kinds of land."[20] While methodological problems of FAO's land-use data might restrict their use in detailed quantitative studies they seem to be quite adequate for getting an overall picture.

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[19] Personal communication: Roger C. Avery, International Health Institute, Brown University, Providence.

[20] FAO. 1991. *FAO Production Yearbook*. Vol. 44. Rome, p. ix.

4.1. Global Trends

Worldwide, "forest wood land" and "other land" account for about 31 and 32 percent of the land area; 37 percent is classified as agricultural area, but only 10 percent of the land is arable--most of the rest (26%) is used as permanent pastures. Less than 1 percent of the land area is covered by permanent crops; only 1.8 % is irrigated (see Appendix Table A7). Between 1961 and 1990 "forests" and "other land" declined by about 5% and 2.5%, respectively. This decline of some 333 million hectares was mainly due to an increase in "permanent pastures" (+192 million hectares) and--to a much lesser extent--to the expansion of "arable land" (+94 million hectares). The area of "permanent crop" production increased only moderately in absolute size (+19 million hectares), but significantly in relative terms (+26%). Irrigated agriculture expanded significantly, both in absolute (+98 million hectares) and relative terms (+70%) (See Figure 2).

Figure 2. World: Land-use changes, 1961-1990.

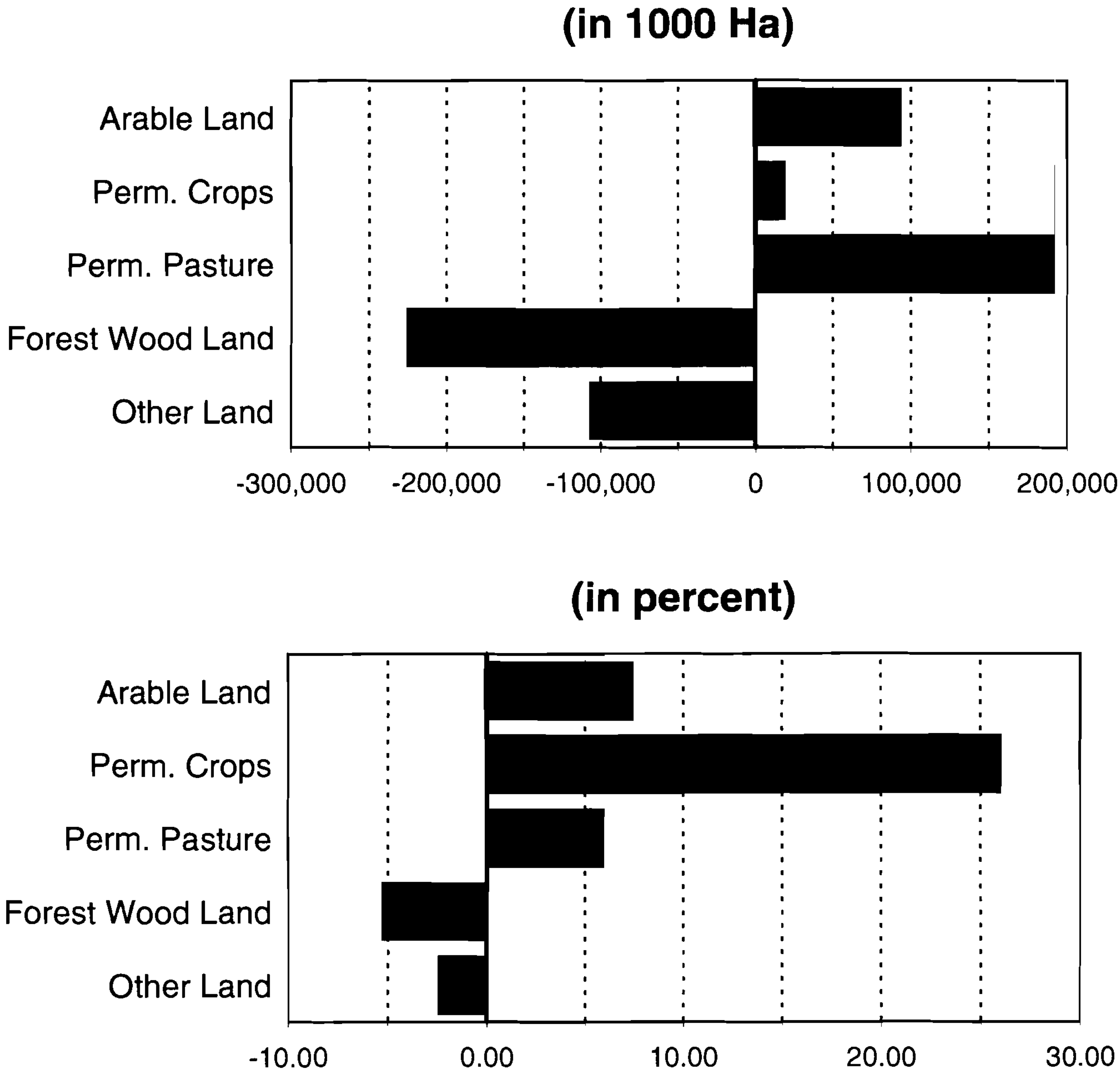
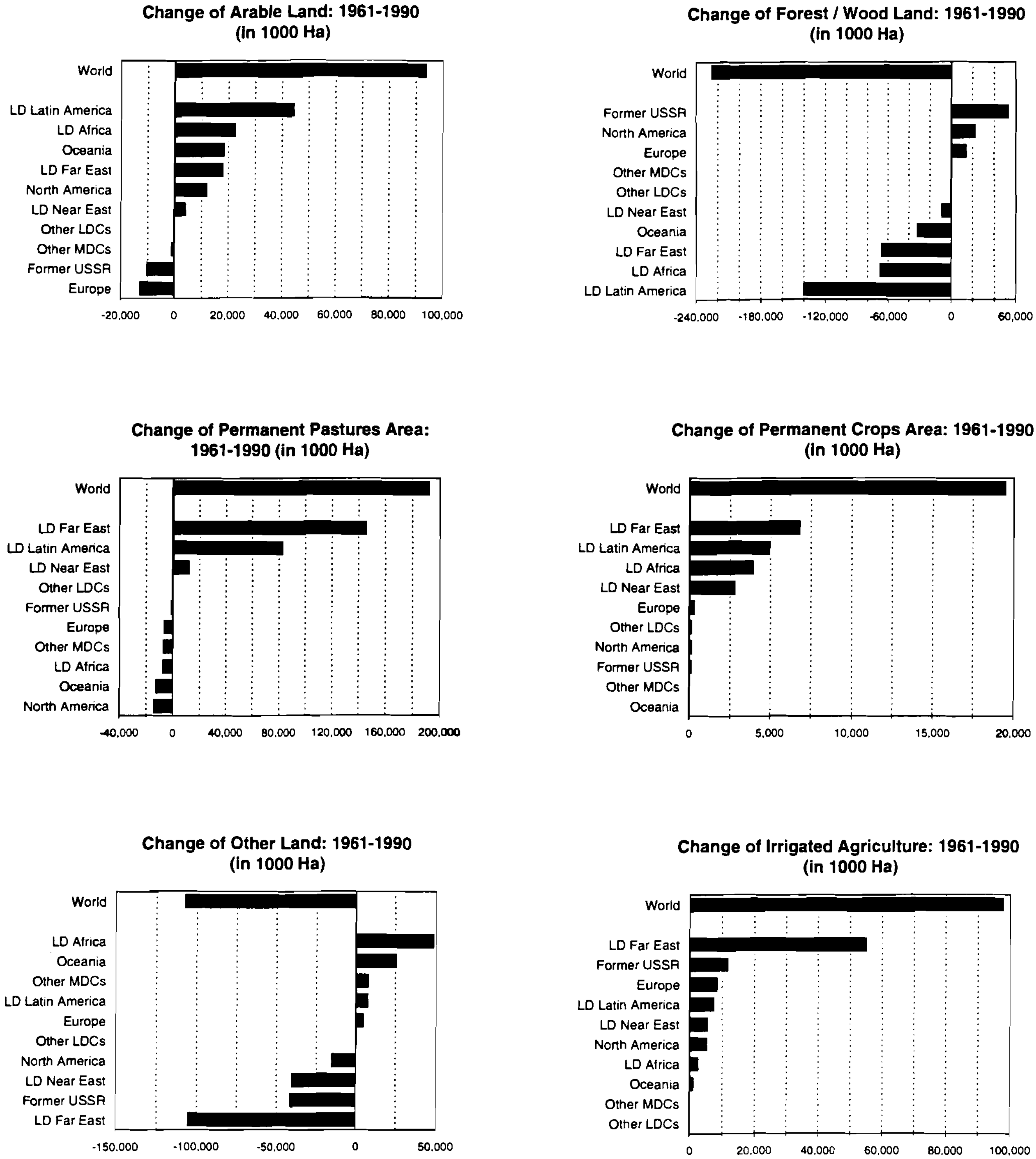


Figure 3. Land-use changes by region.



4.2. Regional Trends

Trends were markedly different by region (see Figure 3): While the *arable land* expanded in Latin America, less-developed Africa, Oceania, less-developed Far East, North America, and less-developed Near East, it shrank in Europe and the former Soviet Union. In Europe (where statistics are probably more valid than in the former USSR) explicit policies have been formulated for transformation of cropland and pastures into "natural" land. Only between 1988 and 1991 countries of the European Community removed almost 1 million hectares from agricultural production. In East Germany nearly 13% of the arable land was taken out of production in 1990/91.[21]

There was a similar dichotomy in the changes of *forest wood land:* it declined in Latin America, less-developed Africa, less-developed Far East, Oceania, and less-developed Near East, but it increased--if the statistics are correct--in the former Soviet Union, North America, and Europe.

Contrary to the worldwide trend *permanent pastures* declined in North America, Oceania, less-developed Africa (!), Europe and other more developed countries, while they significantly increased in the less-developed Far East, Latin America, and less-developed Near East.

There are also divergent trends in changes of *other land* (which includes barren land, built-on areas, roads, etc.): it rapidly expanded in Africa and Oceania, while it significantly declined in the less-developed Far East, the former Soviet Union and the less-developed Near East. These divergences are even larger on the country or province level.

4.3. Country Trends

As seen from a global perspective only a few countries have reported significant land-use changes. There are about two dozen nations or less that reported land-use changes of more than 1 million hectares between 1961 and 1990.

In Figures 4 to 7 we have selected only countries with land-use changes of *more* than 1 million hectares. Among those countries with significant change in *arable land,* Brazil, Australia, India, Thailand, the USA and Argentina reported the largest increase; China reported the largest decline. In just 15 countries worldwide the size of *forest and wood land* has changed more than 1 million hectares since 1961; in all other countries, where we have data, the change was only minor (see Appendix). Canada and India reported the largest increase in forest and wood land; Brazil, Australia, China, Mexico, Thailand, the USA, and Algeria reported the biggest declines. Among the 180 nations that reported changes of *permanent pastures* only 29 had changes of more than 1 million hectares. Especially China and Brazil increased their permanent pastures; the largest decline was reported from Uruguay, Australia, and Mexico. Worldwide, only 7 countries reported an increase or decline in their *permanent crop area* of more than 1 million hectares (see Figure 7a and 7b). Syria, Brazil, Paraguay, China, Argentina, and India reported top increases; Iceland reported the only major decline.

Many countries increased the area of *irrigated agriculture*--only Poland, Hungary, and Japan reported declines. However, in only 12 of the 180 countries analyzed the increase was more than 1 million hectares: in India, China, Pakistan, USA, Indonesia, Rumania, Bangladesh, Thailand, Brazil, Mexico, Iraq, and Spain.

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[21] Bundesministerium für Raumordnung, Bauwesen, und Städtebau. 1991. *Raumordnungsbericht 1991 der Bundesregierung.* Bonn, p. 63.

Figure 4. Arable land: Changes by country (in 1000 hectares), 1961-1990.

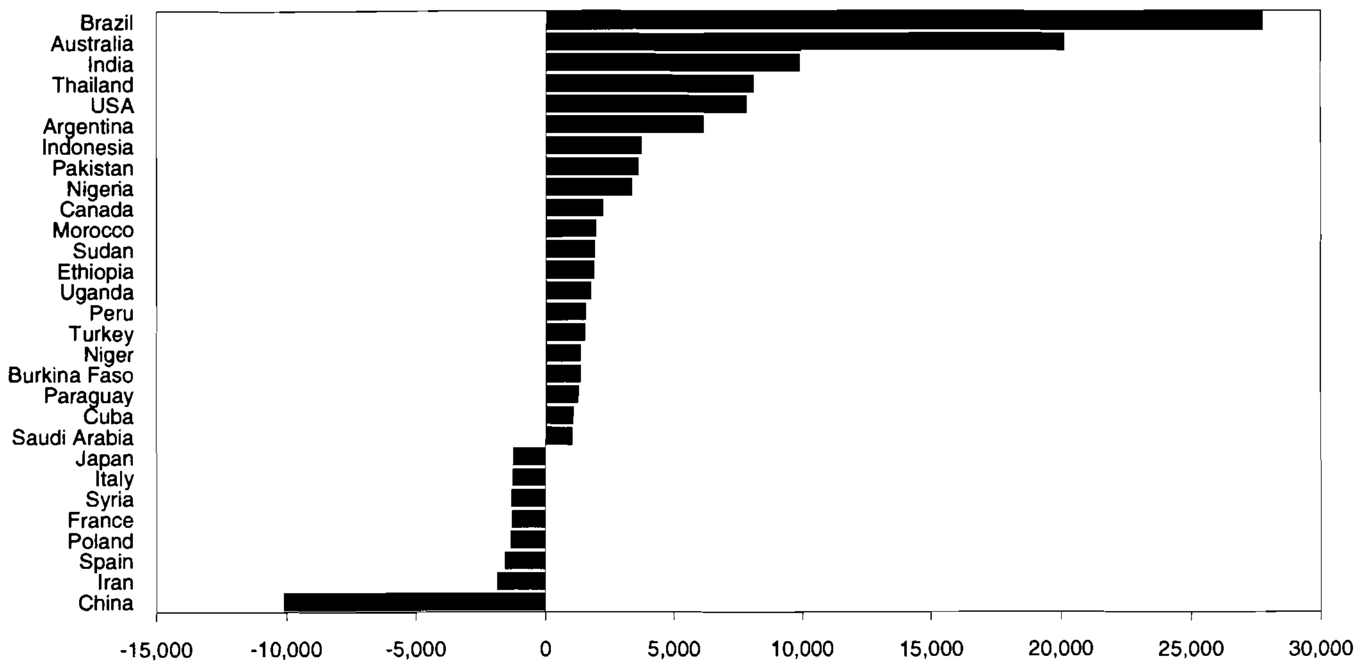


Figure 5. Forest and wood land: Changes by country (in 1000 hectares), 1961-1990.

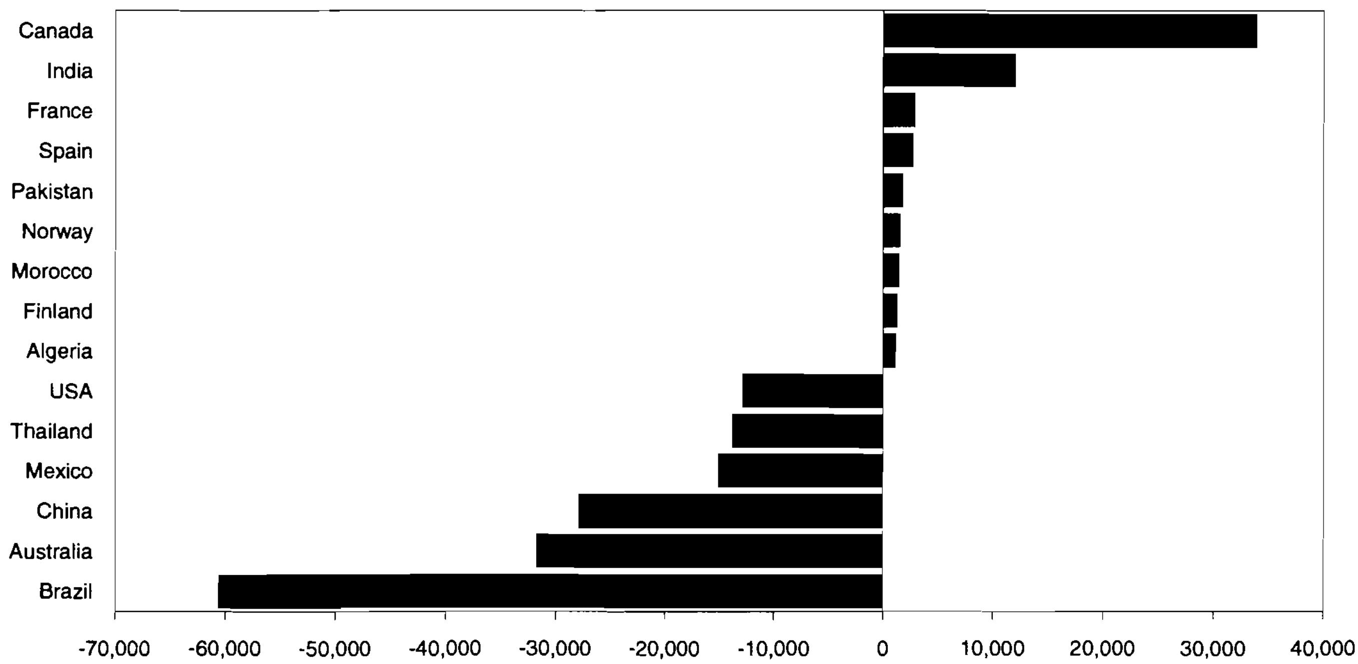


Figure 6. Permanent pastures: Changes by country (in 1000 hectares), 1961-1990.

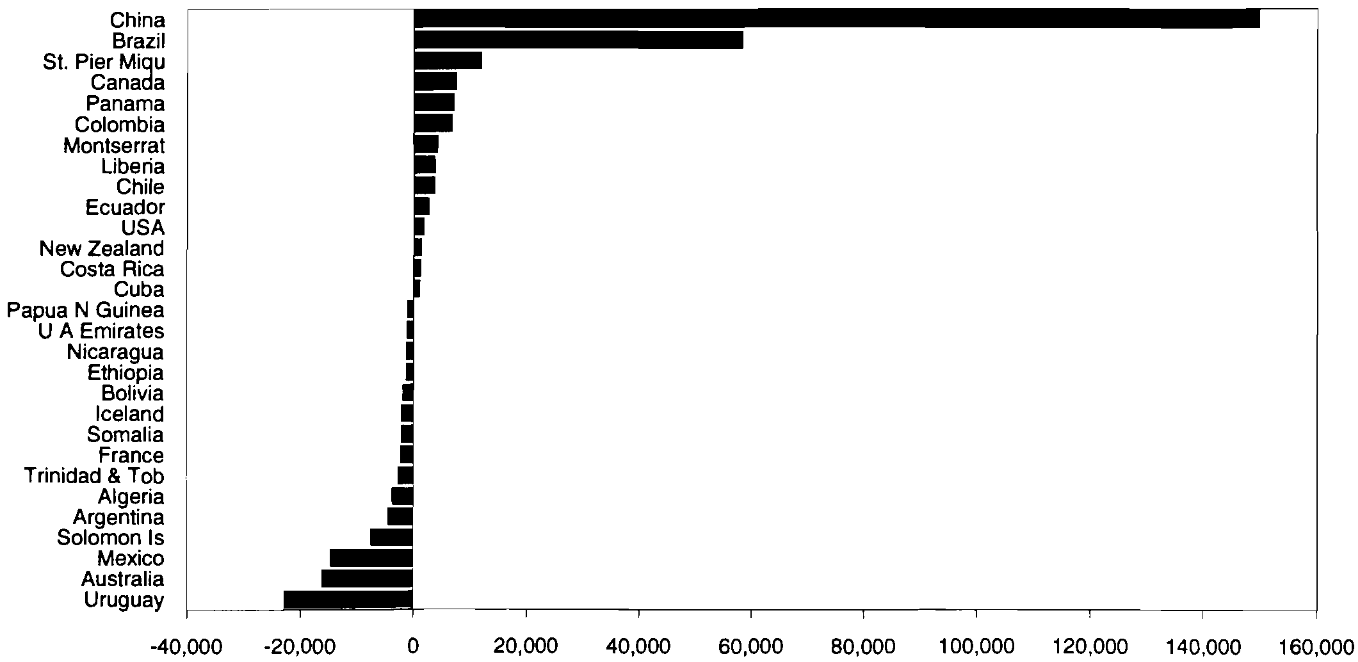


Figure 7. Permanent crops: Changes by country (in 1000 hectares), 1961-1990.

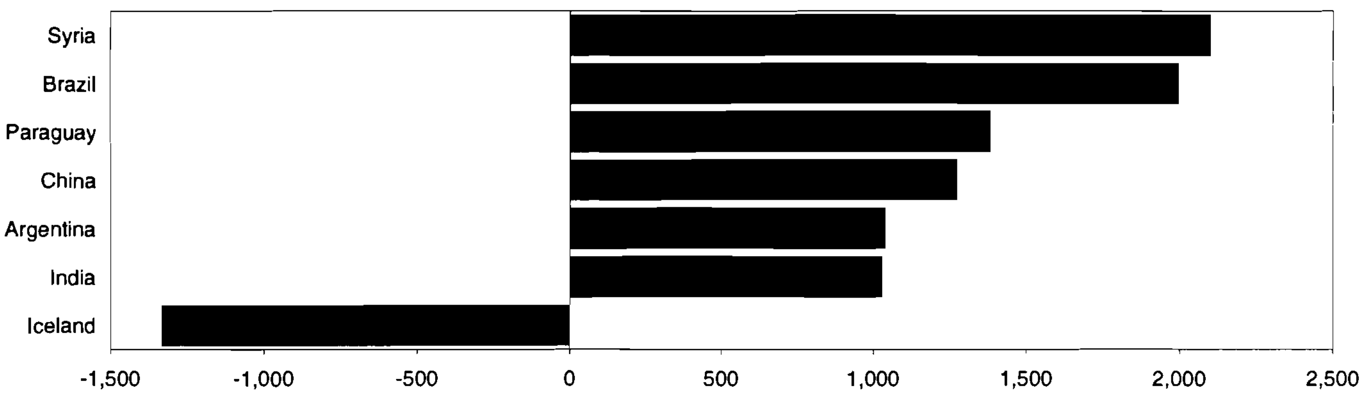
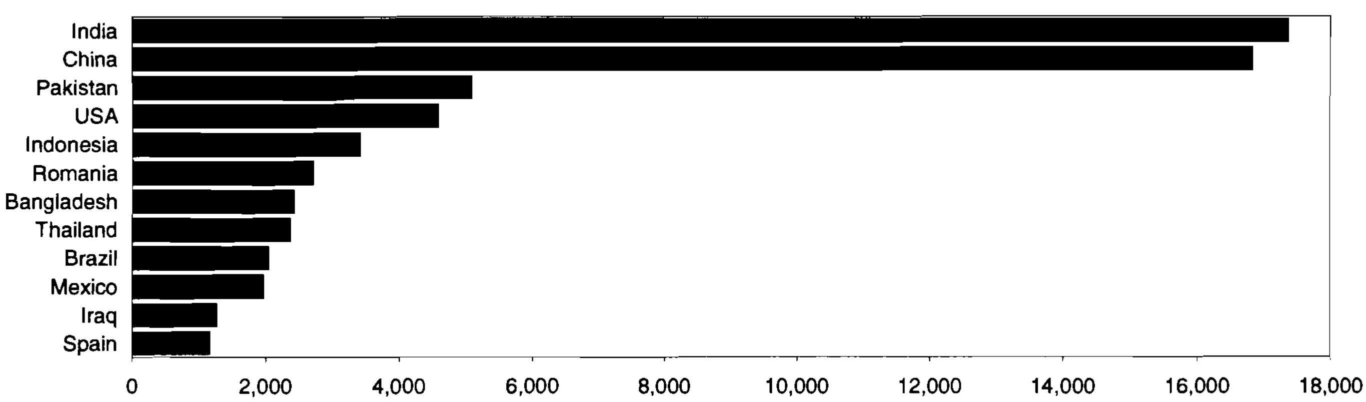


Figure 8. Irrigated agriculture: Changes by country (in 1000 hectares), 1961-1990.



4.4. Intensification

According to FAO's (crude) categories there is surprisingly little agricultural land-use change. However, a closer look reveals dramatic changes in the *methods of cultivation.* For instance, the consumption of nitrogenous fertilizers exploded from 11.3 to 75.3 million tons; farmers applied much more pesticides and fungicides; the number of agricultural tractors increased from 14.8 to 26.5 million; and the area of *irrigated agriculture* more than doubled from 140 to 238 million hectares. Worldwide, average cereal yields increased from 1.4 to 2.7 tons per hectare area harvested.

The exploitation of *forest* also amplified. Between 1961 and 1990 the global trade volume[22] of forestry products grew from 12.8 to 208.8 billion $ US; the production of roundwood increased from 2.1 to 3.5 billion cubic meters.

Similar trends of intensification can be observed in livestock production. Between 1961 and 1990 the worldwide stock of cattle increased from 947 to 1,294 million heads; the number of sheep grew from 997 to 1,216 million and the stock of pigs more than doubled from 407 to 856 million. It is hard to imagine how the statistics were collected, but the FAO says that, worldwide, the number of chickens increased from 3.9 to 10.8 *billion* (!) during the past three decades. The rapid expansion of livestock affected the land threefold: (a) demand for *feed* crops skyrocketed and triggered further expansion of feed-crop areas and/or intensification of production; (b) in some parts of the world permanent pastures expanded; and (c) the rising tide of manure led to (ground) water pollution and soil degradation in some areas of high livestock concentration, such as the Netherlands.

4.5. Population Growth and Land-Use Change

Population growth is frequently considered a major driving force of global land-use change. A simple method to study a possible relationship is to prepare cross-tabulations of the variables, which can also be represented in scatter plots (see Figures 9, 10 and 11).[23]

Figures 9, 10 and 11 show changes in population and changes in the size of forest wood lands (both measured in decennial growth/decline in percent). It is obvious that no correlation exits between these two variables in the 150 countries analyzed. We also plotted population changes against changes in the size of *irrigated agriculture* and against changes in the size of *arable land.* We did this for the same 150 countries, separately for the three decades from 1961 to 1990. The results were equally as unimpressive as the figures above. There is simply no statistical correlation between these three variables.

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[22] Import + Export

[23] Of course, this simple, bivariate method can be heavily biased. In a set of several related variables one should use multivariate statistical methods (such as multiple regression analysis, cluster analysis, factor analysis, etc.), which take into account the partial correlation between the variables. However, for a first "screening" we consider the two following scatter plots to be adequate.

Figure 9. Scatter plot: Population growth/decline (in %) versus growth/decline in forest wood land area (in %) for 150 countries, 1961-1970. Source: FAO, 1993, PC-AGROSTAT.

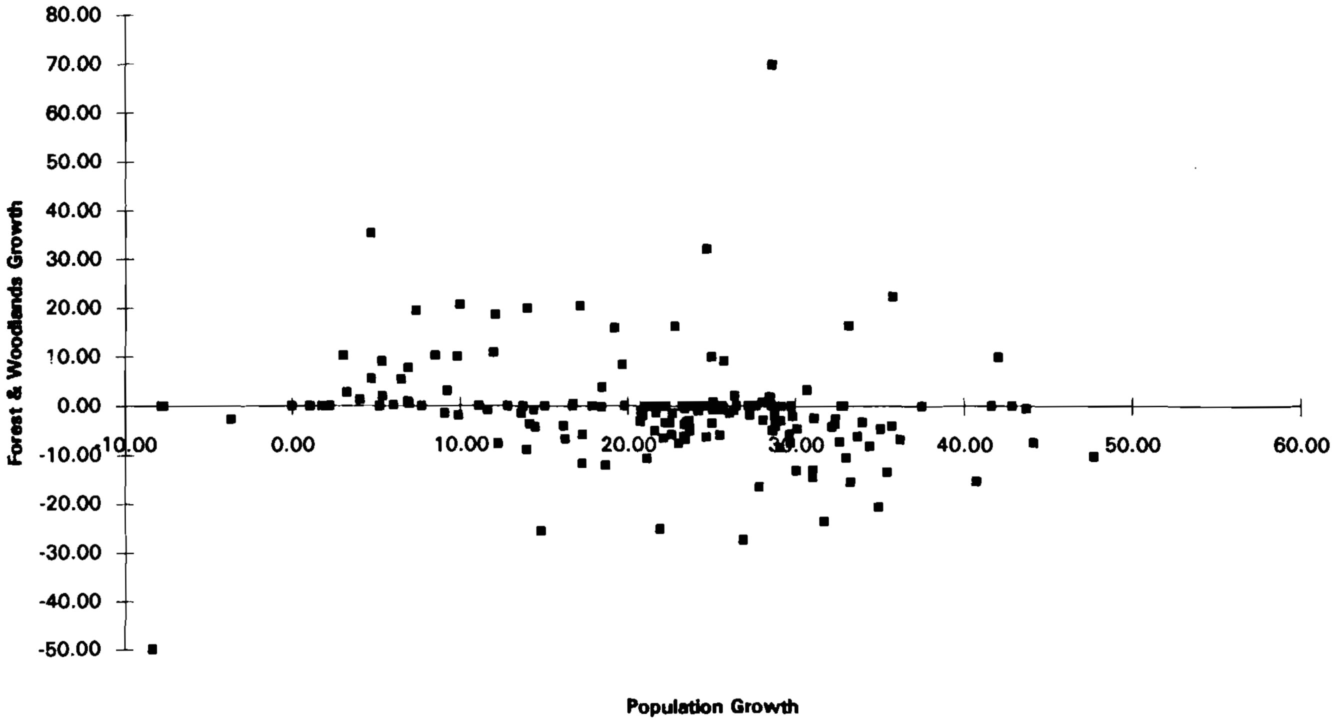


Figure 10. Scatter plot: Population growth/decline (in %) versus growth/decline in forest wood land area (in %) for 150 countries, 1971-1980. Source: FAO, 1993, PC-AGROSTAT.

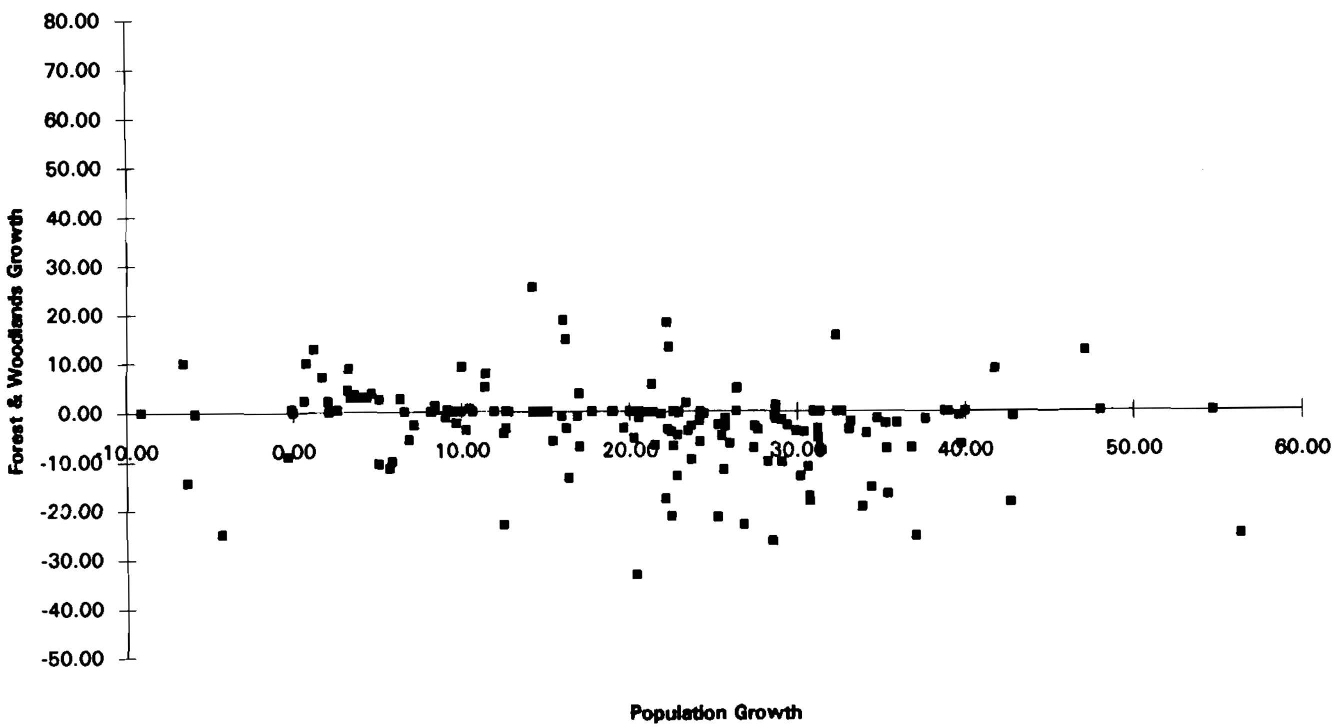
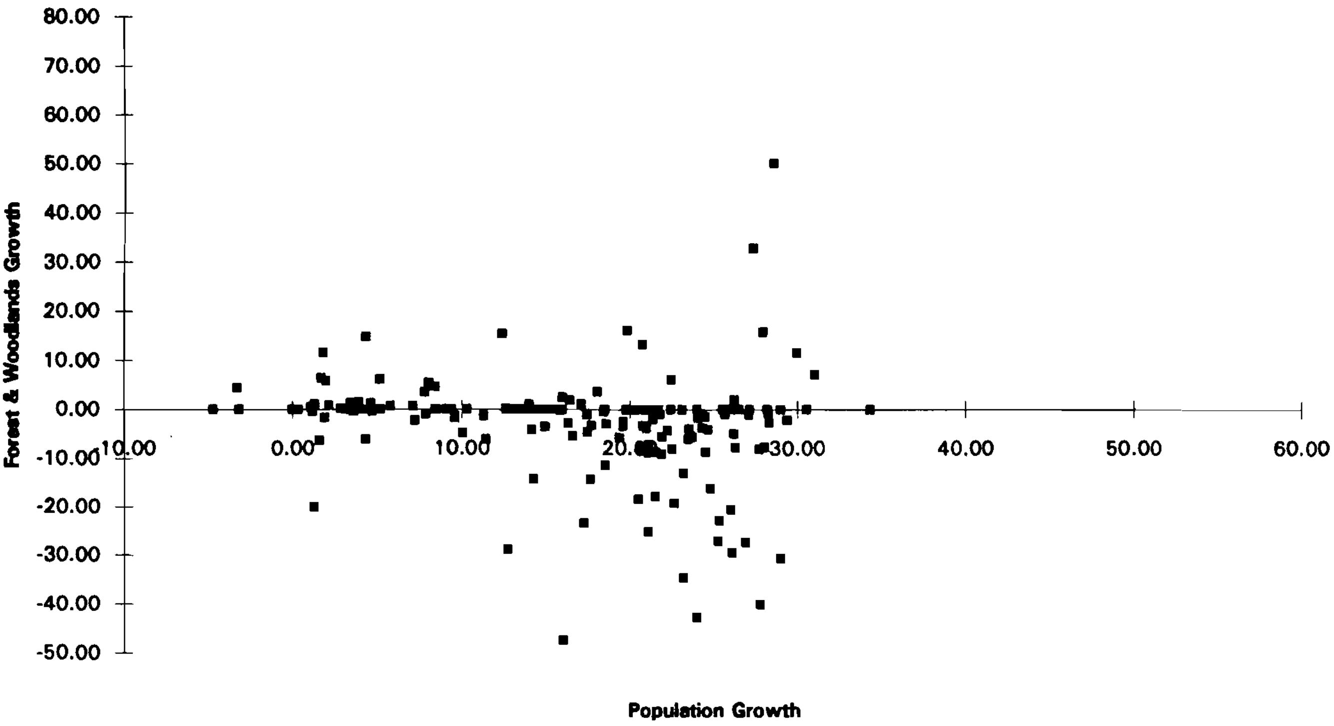


Figure 11. Scatter plot: Population growth/decline (in %) versus growth/decline in forest wood land area (in %) for 150 countries, 1981-1990. Source: FAO, 1993, PC-AGROSTAT.



In a next step we inspected some countries in greater detail (see Appendix Tables A1-A6), but the results were similarly unimpressive. For instance, contrary to expectation, there was rapid deforestation in countries with relatively low population growth (and density). On the other hand we found substantial forest *expansion* in countries with high population growth--a fact which certainly contradicts the widely published argument of population growth driving deforestation.

- Australia, for example, experienced one of the most rapid *declines* of forest wood land in the 1970s (it shrank by 23% between 1971 and 1980), yet the country's population growth was only moderate (12% for the whole decade). There was also only a minor expansion of agriculture--arable land grew by just 7%. In comparison, Brazil had one of the highest growth rates of arable land (plus 42%) during the 1970s, yet the forest area declined only moderately (-3.9%).

- Ireland, on the other hand, had a very low rate of population growth in this decade, but experienced one of the *highest* growth rates in forests and wood lands (the forest area *increased* by 25% between 1971 and 1980).

- Even more surprising is the case of Algeria: this country reported very high rates of population growth during the 1970s--and one of the largest *increases* in forest and wood lands (while the population increased by 32%, the forests grew by 15%).

Figure 12. Brazil: Land use and population growth, 1961-1990.

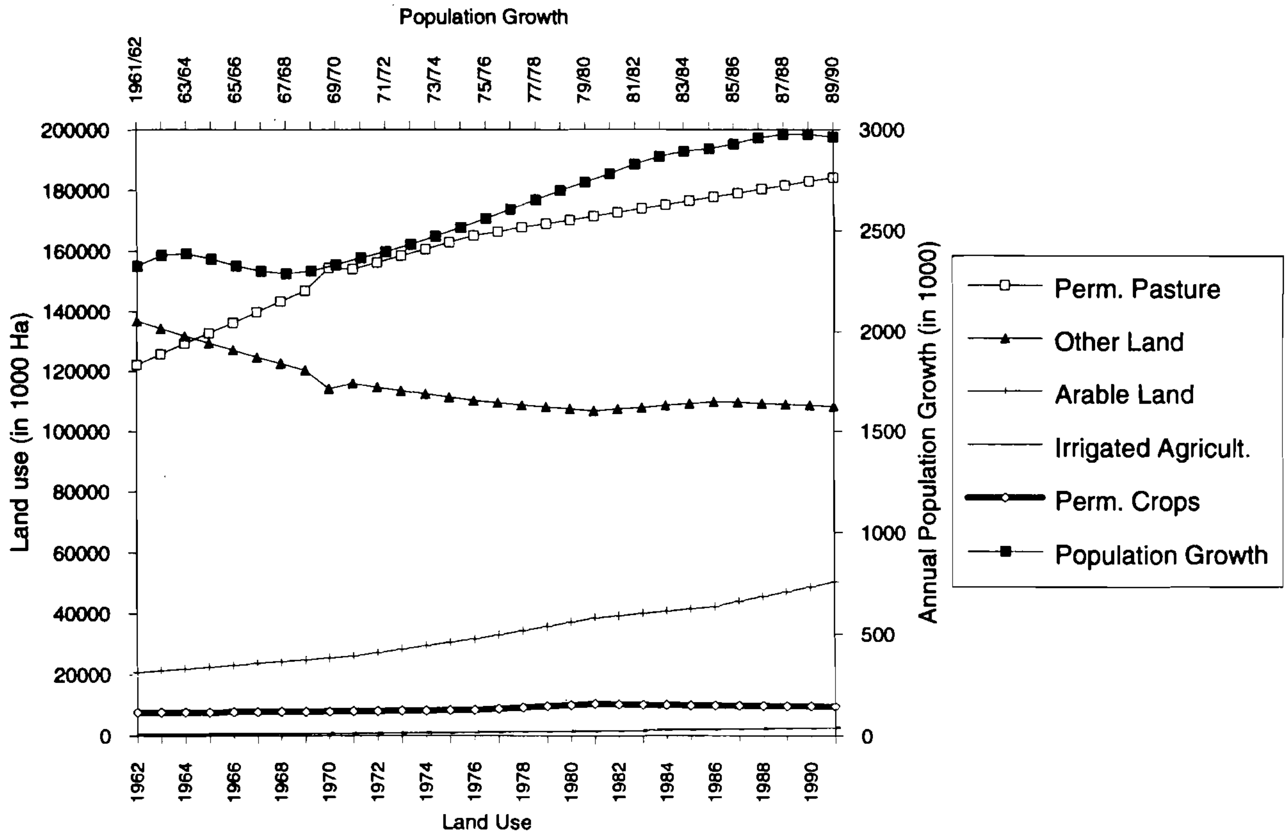
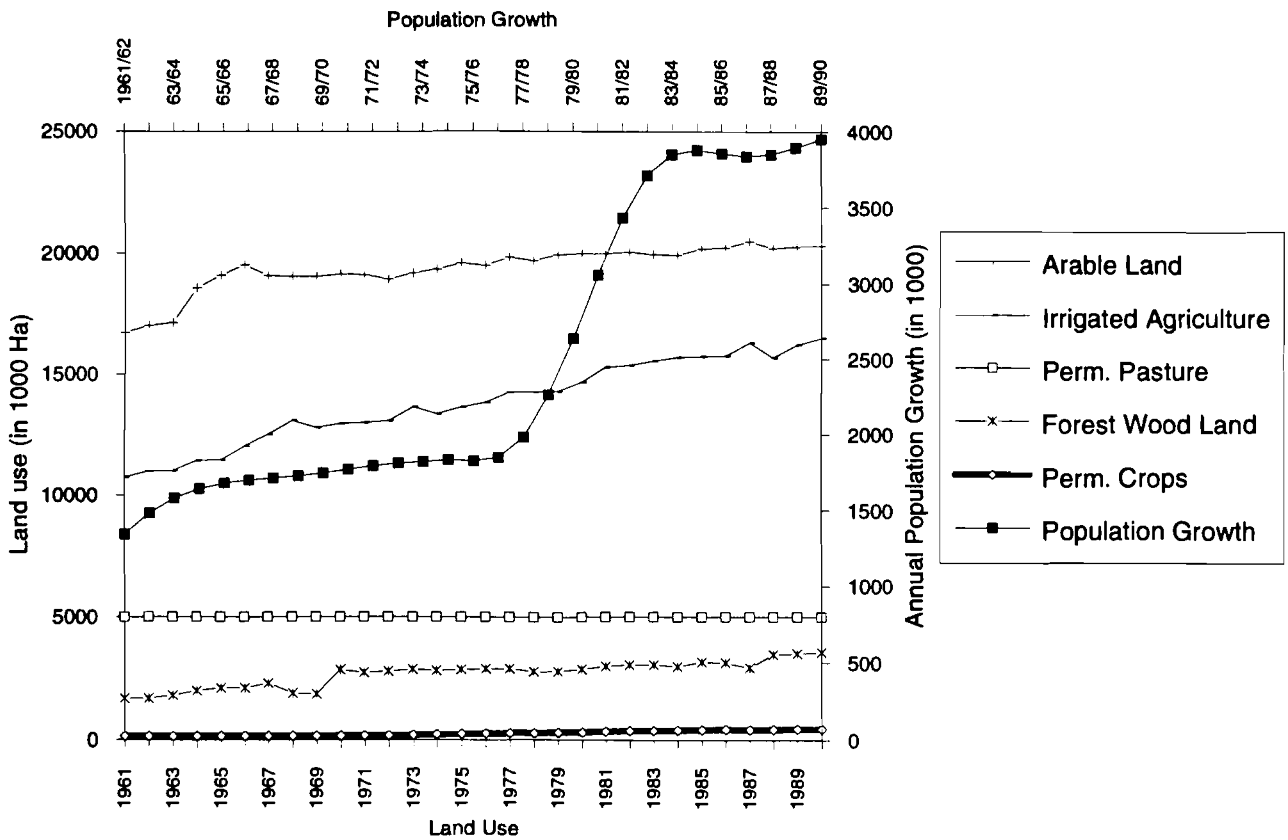


Figure 13. Pakistan: Land use and population growth, 1961-1990.



- We also found only minor expansion of arable land in countries with considerable population growth, and high expansion in countries with low population growth. For instance, in the 1960s Gabon's population grew very slowly (the population expanded by just 2.2% between 1961 and 1970)[24] yet Gabon's arable land doubled. It was the highest growth rate of arable land in the 1960s *worldwide.*

- Brazil, a country with most significant changes in land use, rapidly expanded its *permanent pastures* during the 1960s; during this decade the country experienced a rare slow down (!) of population growth. In the 1970s and 1980s population growth increased, yet the expansion of arable land was slower than in the 1960s (see Figure 12).

- A most interesting case is Pakistan: Between 1976 and 1984 the country experienced a dramatic acceleration of population growth. The total population added each year more than doubled (from 1.7 to 3.8 million). However, contrary to expectation, the country did not report an expansion of arable land or permanent pastures, but an increase of forests and wood land (see Figure 13).

This obvious lack of correlation in our country-by-country analyses, of course, does not prove that there is no interdependency at all between population and land. There might be inconsistencies in the FAO data which could explain some (but not all) of the results. Another problem is the high level of aggregation (all data are on a national level) which might level out divergent trends in different parts of a country. Yet we are still convinced that our results are basically correct. They confirm the thesis that there are other--*intermediate*--variables which fundamentally modify the interaction between population and land-use practices.

There are a number of studies that have tried to *quantitatively* examine interdependencies of agricultural development, population growth, and land-use patterns with more sophisticated statistical methods than we have applied here.[25] Probably the methodologically most advanced analysis is a book by Hayami and Ruttan, that originally appeared in 1971.[26] The authors developed an economic model which included important production factors: labor, land, livestock, fertilizer consumption, agricultural machinery, general and technical education. Using empirical data from 43 countries for these variables, the authors estimated agricultural production functions. The relative weight of the coefficients in these functions explains which factors have the greatest impact on agricultural productivity. The study is far too complex to be reviewed here, but its major deficit is the obvious lack of clear results. The reader is drowned in an ocean of statistical details, but the few conclusions that can be expressed in everyday language are often trivial. The authors, for instance, compared the "old" agricultures in Europe with the "new" in Australia, Canada, New Zealand and the USA, and concluded: "These findings seem to suggest a hypothesis that the comparative advantage in agriculture of the new continental HDCs (= new high-income developed countries)[27] was not based solely on their favorable land-labor ratio but also on the greater intensity of agricultural research and extension that facilitated rapid

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[24] Note that we are talking about an overall increase of 2.2%--not about a 2.2% annual growth rate.

[25] For instance: Allen and Barnes, 1985, *op. cit.*

[26] Hayami, Y. and Ruttan, V.W. 1985. *Agricultural Development. An International Perspective.* Revised and Expanded Edition. Baltimore: The Johns Hopkins University Press.

[27] The "new" HDC are: Australia, Canada, New Zealand and the USA. They are compared with the "old" HDCs in Europe.

developments in land-saving technology in order to take full advantage of favorable resource endowments."[28] It is doubtful that this kind of result is of great use to the student of global land-use change.

4.6. Conclusion

If FAO's AGROSTAT data are at least roughly correct we can conclude that global land-use change is a rather complex phenomenon. Popular catchwords, such as "worldwide deforestation" and "agricultural expansion" are inadequate to describe the situation. There are three major findings:

First, the data indicate rather **divergent trends in various regions and countries**: While, for instance, governments report expansion of arable land in some developing countries (especially in Latin America), we have significant declines in Europe and the former Soviet Union. This is also true for FAO's other land-use categories.

Second, FAO data on agricultural production indicate **dramatic changes of land-use practices within the same land-use category**: Worldwide, the cultivation of arable land has become much more intensive during the past three decades. A similar **trend to intensification** can be observed in **livestock production.**

Third, the **FAO data do not indicate that population growth is a major direct driving force of (agriculture-related) land-use change.** Both on the global and national level we can find evidence *against* the hypotheses that land-use change is primarily caused by population growth. There are countries with massive land-use changes but low rates of population growth (Australia); and we can find countries with rapid population growth but low rates of land-use change.

5. The Trigger Effect of Transportation and Communication Infrastructure

As mentioned before, the conversion of natural land into streets, railroads, airports, harbors, satellite launching sites, aerial transmitting facilities, canals, stations of caravan routes, and other man-made structures for transportation and communication accounts for only a small fraction of the worldwide land cover change. Accurate statistics are not available, but it is estimated that all products of our technological civilization--including buildings and streets in urban areas and cities--most likely cover less than one percent of the earth's surface.[29] If this is correct, then the amount of land we use for transportation and communication infrastructure is negligible. Yet it is precisely this kind of land use that is of paramount importance for the alteration of the globe's surface.

Just consider what a small road can do to a remote forest area. It might open it for loggers, oil explorers, poor farmers, prostitutes, land speculators, gold diggers, butterfly catchers, tourists. They will flood the area and change it within a few years. A small intervention with minor loss of natural vegetation and animal life (due to the construction of the road) is followed by massive alteration of land through successive exploration and colonization.

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[28] Hayami and Ruttan, 1985, *op. cit.*

[29] Grübler, 1992, *op. cit.*, p. 1.

Railroads were probably the single most important man-made structures for the conversion of the earth's surface in the last one and a half centuries. Since February 1804, when Richard Trevithick for the first time put a steam engine on rails to drag five wagons from Pen-Y-Darran to Abercynon in Wales, this technical device has changed the world. Railroads opened up the vast North American continent. They made it possible to efficiently exploit the European colonies in Africa and Asia. Railroads, built by the English colonists, are still the backbone of India's transportation system. The Dutch-built railroad from Jakarta to Bandung and further to Surabaya made Java's interior highland accessible--and triggered a massive conversion of natural land into plantations.

It is interesting that very often the original motive for building transportation and communication infrastructure is unrelated to the subsequent land development. Very often *military considerations* play a crucial role in the opening of remote areas. Governments might want to control separatist movements or guerilla activities (as in the forest areas of northern Guatemala, northwestern Thailand or Nicaragua). They might also plan ahead the logistics of war, such as the "Nazi" government of Germany at the onset of World War II. The country's highway network ("autobahn") which greatly contributed to the development of Germany's less accessible regions, emerged as a result of pre-war preparation. The building of the "Transsib" railway, which connects the western republics and the far east of the (former) Soviet Union, was also driven by military strategy. The knowledge that adequate transportation infrastructure is essential for a rapid deployment of troops is as old as war. Both the Roman and the Napoleon empires could only dominate such huge areas because they spent considerable efforts in the construction and maintenance of road systems--which, at the same time, amplified the development of peripheral regions.

Making private profit, of course, is also a very strong motive for building transportation and communication infrastructure, which in turn triggers further colonization. During the colonial era many parts of today's Third World were opened for private (or semi-private) exploitation through development of (technical) infrastructure. Africa's and India's railroad systems are good examples.

6. Lifestyles and Land-Use Change

Many languages have words and sayings that could tell us a story about the relationship between lifestyles and global land-use patterns. There is, for instance, the "silk road", an ancient trading connection which opened the Far East for Europe's economic activities. The name reminds us that *clothing fashion* was a powerful driving force of land-use change throughout history. The Mulberry tree, which feeds the silkworm, came first from India to (southern) Europe at the times of Trajan (52-117). It began to spread rapidly in the 10th century as Europe's noble classes began to favor silk dresses. The tree also spread to large areas in China where silkworm breeding had a real boom in the 12th century--partly due to increasing demand from Europe. Even more impressive is the spread of the *cotton* plant on our planet. In the ancient world, animal products--wool, skin, fur--were usually used for clothing. However, when cotton became the cloth of the masses during the 17th century in southern France, huge areas worldwide were transformed into cotton plantations.

Food preferences have an equally important impact on global land-use patterns. Before 1450 the coffee bush was an unnoticed plant in Ethiopia. Historical documents show that people began to drink coffee during the 15th century in the cities of Aden and Mecca. During the 17th century the habit spread throughout most of the Islamic world. Venice's citizens had their first cup of coffee around 1615, and the people of Paris first enjoyed this stimulant in 1643.[30] Today (1990) we cultivate some 11.5 million hectares of coffee plantations worldwide.[31] But coffee is not the only stimulant that changed global land-use patterns. In 1610 a ship of the "Oost Indisch Companie" brought the first tea leaves to Amsterdam. The British, who became promotion agents for this Asian product during the next centuries, learned about the "new fashion" around 1657, when their coffee-houses began to introduce the new drink.[32] As of the 18th century, tea became a product of mass consumption. But we all know how this changed the lands of Sri Lanka (the former Ceylon) or Northern India. Today, tea plantations cover an area of some 2.4 million hectares worldwide.[33]

Most of us do not know that even the diets of our great-grandparents were still rather different from what we eat today. Chocolate, for instance (both as a drink or bars), was rare in Europe during the 18th and 19th century. Around 1768 in Paris only the noble class drank chocolate. We have no records on how much land was used in Mexico for growing cocoa beans at that time (the place from where the product was imported), but it was certainly not much. This has changed dramatically. Today, some 5.5 million hectare worldwide are used to grow cocoa beans in order to supply our appetite for candy bars, chocolate bunnies, milk shakes, and all the other cocoa products.

While on the subject of sweets, we should also mention that enormous amounts of land are today used for growing sugar cane (to be precise: 17.6 million hectares worldwide)--a plant which was first cultivated large-scale in 8th century China. Since the 16th century it has been considered food in Europe; earlier it was used in small quantities as medicine. But sugar consumption really began to boom only in the 20th century. Between 1961 and 1990 the harvest area of sugar cane more than doubled.

Changing food preferences continue to trigger widespread land-use change. Currently the demand for vegetable oils is booming (since dieticians have declared animal fats a risk to our health). As a consequence the sunflower cultivation area more than doubled since 1961 to about 16.8 million hectares worldwide. Cultivation of other oil seeds is also expanding rapidly.

There are, however, many other fashions and habits that can affect the global patterns of land use. Not too long ago the noble elite in Europe began to enjoy a strange form of stimulation (which they learned from the "primitive" people in their colonies): they burned leaves which were rolled in thin paper and inhaled the smoke. Today we cultivate some 4.8 million hectares of tobacco plants worldwide. No one knows how much of the arable land farmers spend to cultivate coca, opium and other drug plants. Some people think that in some places most of the arable land is used for drug production. Drug consumption has become a multi-billion business in Northern America and Europe, and has fundamentally changed the land-use patterns of Northern Thailand, Burma, Colombia, and many other places.

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[30] I have all these historical data from the excellent books of Fernand Braudel. Braudel, F. 1990. *Socialgeschichte des 15.-18. Jahrhunderts. Der Alltag.* Munich: Kindler Verlag. Original: *Civilisation matérielle et capitalisme, XV-XVIII siécle. Le structures do quotidien: Le possible et l'impossible.* Paris, 1979.

[31] FAO, PC-AGROSTAT, 1993.

[32] Braudel, 1990, *op. cit.*, pp. 264-265.

[33] FAO, PC-AGROSTAT, 1993.

Altogether, we use more than 214 million hectares for the production of lifestyle-related and non-food products, such as stimulants, sugar, tobacco, oilseeds, and soy, a crop which is mainly used for feeding animals (see Table 2). (Heavy consumption of meat is a trend of the 20th century.) Including the (unknown) area of drug production, this would probably be equivalent to some 20% of the world's arable land.

Table 2. World: Lifestyle-related and non-food agricultural production, 1961-1990.

	Area Harvested			**In Percent of**		**Per Capita Production**		
	(in 1000 Ha)		Growth (in %)	**Total Arable Land**		(in kg per person)		Growth (in%)
	1961	1990	1961-90	1961	1990	1961	1990	1961-90
Drugs (Marihuana, Coca)	?	?	?	?	?	?	?	?
Wine	?	?	?	?	?	7.0	5.5	-21.6
Tobacco Leaves	3,397	4,794	41.1	0.3	0.4	1.2	1.4	24.8
Hops /*	55	81	47.8	0.0	0.0	0.0	0.0	11.4
Tea	1,318	2,439	85.1	0.1	0.2	0.3	0.5	50.2
Coffee	9,718	11,501	18.3	0.8	0.9	1.5	1.2	-19.6
Cocoa Beans	4,244	5,537	30.5	0.3	0.4	0.4	0.5	24.2
Sugar Beets	6,917	8,657	25.2	0.6	0.6	52.1	58.0	11.4
Sugar Cane	8,915	17,600	97.4	0.7	1.3	145.6	198.0	36.0
Flax Fibre	2,075	1,114	-46.3	0.2	0.1	0.2	0.1	-40.1
Hemp Fibre	699	274	-60.8	0.1	0.0	0.1	0.0	-69.3
Jute, Jute-like Fibres	2,629	2,211	-15.9	0.2	0.2	1.1	0.7	-37.4
Linseed	7,638	4,144	-45.7	0.6	0.3	1.0	0.5	-47.0
Rapeseed /*	6,277	19,856	216.3	0.5	1.5	1.2	5.1	339.5
Sunflowerseed	6,667	16,870	153.0	0.5	1.2	2.2	4.3	93.2
Seed Cotton /*	31,879	33,445	4.9	2.5	2.5	8.9	11.3	27.5
Sesameseed /*	5,051	6,590	30.5	0.4	0.5	0.5	0.5	-1.0
Soybeans	23,802	56,505	137.4	1.9	4.2	8.7	20.4	133.6
Castor Beans	1,233	1,660	34.6	0.1	0.1	0.2	0.3	34.1
Groundnuts	16,641	20,238	21.6	1.3	1.5	4.6	4.4	-3.5
Total	139,155	213,516	53.4	11.1	15.8	236.7	312.8	32.1

Source: Food and Agricultural Organization (1993): PC-AGROSTAT. Rome /* 1961-1991

There are other trends in modern societies that trigger widespread modification of the earth's surface. *Mass tourism* is one of these. There are big industries that have only one objective: to open the last untouched areas of our globe for the leisure and excitement of tourists from affluent societies. There is, for instance, a travel agency in Bavaria, Germany, that is specialized in organizing bus trips for elderly women across the Sahara[34] or to Katmandu in Nepal. They also organize special bus trips to the reservation of Aborigines in the northwest of Australia's "outback". Trekking tours in the Himalayas, (photo) safaris to the Tsavo National Park in Kenya, or sightseeing tours to the Mayan temples in Tikal, a place in the Petén area of northern Guatemala can be booked in any European travel agency. Thirty years ago Sulawesi--the former Celebes--was a mostly untouched place where endogenous tribes celebrated cannibalistic rites and lived in a society not much different from the later Stone Age. Today this Indonesian island

[34] It is hard to believe, but these special buses equipped with air conditioning, cooking facilities and sleeping trailer, can be met in the middle of African or Australian deserts, carrying an exhilarated group of elderly widows.

has not only been changed by the Javanese settlers of the "Transmigrasi" program, who are continuously expanding their (quite infertile) fields into the island's rain forests. Even more severe could be the long-term impact of an "exploding" adventure tourism to the island. When some of the traditional villagers celebrate their most colorful cremation ceremonies, thousands of tourists are lining up in the dirt roads. "Camera teams" of European tourists are virtually blocking the road for the procession.

Here is another example: When the Mayan temples of Tikal were re-discovered, they were located in a virtually untouched remote forest area of northern Guatemala. A few years after the excavation, tourism started. A dirt road was built from Flores to El Cruce and to Tikal. Guest houses along the road and in Tikal opened. Unfortunately the trip from the main tourist centers in Guatemala (such as Lake Attitlan or Chichicastenango) to Tikal was long and tiresome. So an airfield was cut into the forest near Tikal to promote tourism. The road was paved and extended to Uaxactún, which is another temple site north of Tikal. Most likely Guatemala's military was not unhappy about this. The development of a tourist attraction provided them with infrastructure they could use to quickly deploy troops to the northern territories which they considered "unsafe". Without regulation from the state this place would probably evolve into some kind of Disney Land in the middle of a jungle. Entrepreneurs would build hotels and restaurants. After a while there would be tennis courts, golf course and swimming pools. Poor Indios from the area would move to the place in search of work. This would be the beginning of a small Shanty town.

This kind of secondary land reclamation around tourist centers can be easily observed in places such as Bali, Thailand, or the Maldives. Tourism can be a trigger of land-use change, because it requires good infrastructure which is then used by others to explore the region.

Leading this trend in modern tourism are the juvenile backpack globetrotters. One could easily be mistaken to believe that they are just a few. It is hard to estimate their number, but to the author's own experience it must be hundreds of thousands that are underway all over the world at any given time. Certain exotic places in Thailand, Indonesia, India, the Philippines or Latin America are virtually flooded by thousands of young people from Europe (and Northern America). Of course, these tourists and globetrotters would not consider themselves as catalysts of global land-use change--and they are also rarely mentioned in scientific studies of the problem. But they are more important than one would think. They are the explorers of our times--frequently opening the place for mass tourism.

7. The "Myths of Harmony" in Population-Land Interactions

Many studies of today's global changes in land-use patterns seem to have a somewhat bitter attitude. There is an inflation of words like "crisis", "destruction", "loss", "doom", or "breakdown". But are we really about to destroy a paradise which our ancestors have preserved through the centuries?

Discussion of these matters is hampered by hard to abolish myths, such as the "good old times" when the environment was healthy and humans lived in harmony with nature. Nothing could be more wrong. Much of human history, as we know it, was a succession of ruthless exploitation and destruction of natural resources. For instance, the mellow garden landscape of England with its typical grassland is not a product of unspoiled natural evolution, but a result of brutal logging practices in the pre-industrial era. For centuries England's forests were transformed into ships that made Britain great on oceans throughout the world.

England was not the only nation that exploited its woodlands. During the reign of King Louis 14th ("the Sun King") the forests of France were plundered to supply the wharfs, produce charcoal for the emerging iron industry and provide fuel wood. In addition farmers cleared large areas of woodland for agriculture. This deforestation reduced French forest *some 350 years ago* (!) almost to its present size. It is interesting in this context that between 1600 and 1786/87 the transport capacity of European merchandise fleets increased from some 600,000 to 3,372,000 tons.

It is also a myth that food supply in former generations was usually possible without a major change of the natural environment. Already during the Han-Dynasty, in the fourth and third century *before* Christ, the Chinese started to transform natural landscape into rice paddies. It was one of the earliest large-scale reclamation and irrigation schemes, "scientifically" planned and coordinated by the dynastic bureaucracy. This transformation of natural land was an epochal process which reached its climax during the 11th and 12th century.[35] We also have the example of the Mayans. Some scientists have argued that the decline of the Mayan empire was largely the result of a self-induced ecological degradation, which caused a subsequent decline in agricultural productivity.

There is also the myth that only recently mankind has started to destruct the environment for purely criminal reasons or as a consequence of war. We were all shocked when Iraq's military produced an environmental disaster by setting fire to Kuwait's oil wells. Most of us probably thought that this was an unprecedented case of environmental crime--quite typical for the ruthlessness of the present generation vis-a-vis nature. But then there were the American bomber airplanes which sprayed the defoliant "Agent Orange" over large parts of Vietnam in order to destroy the natural cover of the Viet Cong. The areas still suffer from this massive chemical pollution. It was intentional land-use change from questionable motives. However, the natural environment not only suffered in wars of the 20th century. During the Thirty Years War (1618-1648), Swedish troops cut down huge forest areas in Pommern[36] and sold the timber in order to fill their war chest.[37] Drifting sand replaced the forest and shaped a peculiar landscape that can be seen still today.

People say that the history of human societies is a succession of wars against each other; but it is also a sequence of incidents to conquer, modify or destroy previously untouched nature. The colonization of America not only caused a genocide among the endogenous populace, but also triggered a near-eradication of many plant and animal species. The buffalo population, a basis of the Indian's food supply, was decimated by the settlers from some 60 million in pre-columbian times to less than 1000 individuals in 1895.[38] In their contempt of these creatures the early settlers frequently organized "shooting parties", killing a few hundred buffalos just for fun.

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[35] Braudel, 1990, *op. cit.*, p. 159.

[36] This is an area in today's Eastern part of Germany.

[37] Lütge, F. 1966. *Deutsche Sozial- und Wirtschaftsgeschichte.* p. 335.

[38] Thornton, R. 1987. *American Indian Holocaust and Survival. A Population History Since 1492.* University of Oklahoma Press, p. 52.

8. Conclusion

First: If the FAO AGROSTAT data are at least roughly correct we have to conclude that global land-use change is a fairly complex phenomenon. There are rather **divergent trends** from region to region and country to country. Moreover, we can observe **dramatic changes of land-use practices within the same land-use category**. Agricultural cultivation has become much more intensive during the last three decades. There is also a worldwide increase of livestock production which clearly affects land-use patterns.

Second: We should not focus all our attention on slash and burn farmers, logging firms and agribusinesses in Third World countries! They are *not responsible* for changing the surface of our globe. They are just agents (or victims) of powerful driving forces in the background. They do the "dirty work" of deforestation and agricultural expansion or intensification, but they are driven by others. They respond to international markets; they have to use tools and machinery that were developed somewhere else; they often do it with capital from outside. They frequently use infrastructure (such as streets or railroads) which was built into the remote area for other reasons. They make a profit by supplying markets with agricultural and forest products--but they are not responsible for the food preferences and lifestyles in the affluent societies which have triggered this demand. Population pressure may be an important factor of land-use change in some (local) areas, but on a national scale we could not detect a correlation between growth rates of population and arable land.

Third: The scientific-technological revolution which is spreading to even the most remote areas, is a major driving force of global land-use change. It provides the tools and the know-how to open previously unaccessible areas. Railroads, pesticides, nitrogen fertilizers, high yield seeds, water pumps, air planes, air condition, trucks, satellite telephones, tractors, caterpillars--these are the tools that change our world. They have triggered the intensification of agricultural cultivation and the explosion of worldwide tourism. They help us to utilize our land more efficiently, and if implemented with care, could help us to reserve large areas of natural habitats despite the exploding demand of a rapidly growing world population.

Fourth: In the past *agricultural* expansion and land-use change were very often not caused by growing food demand (as people often assume) but by changes in lifestyles and food preferences. We have demonstrated that more than 22 percent of the arable land worldwide is cultivated for lifestyle-related products, such as drugs, tobacco, sugar beet, sugar cane, coffee, cocoa and tea. Obviously, none of these agricultural products (for which we spend huge areas of arable land) is needed for providing basic subsistence to a growing population.

Facing a 10 to 14 billion world population we probably cannot avoid the *modification* of large surface areas of our globe: We have to produce more food, provide more housing, reserve more space for human recreation. We probably need more space for transportation infrastructure, resource exploration, and energy generation (even solar energy needs large areas for converters). But at the same time we will (hopefully) develop and implement technologies that save space, reduce pollution, and minimize environmental impact. As the author has shown elsewhere we could easily feed a 10 to 15 billion world population *without* major agricultural expansion if we only could implement advanced agricultural technology and management everywhere.[39] We are forced to modify our physical world, but we can shape it to the better or worse.

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[39] Heilig, G.K. 1993. *How Many People Can Be Fed on Earth?* WP-93-40. Laxenburg, Austria: International Institute for Applied Systems Analysis.

APPENDIX:

List of Tables

All data in the appendix were extracted from:
Food and Agricultural Organization (1993):
PC-AGROSTAT Data Base, Rome

Table A1: Decennial Growth / Decline of Selected Indicators (in percent): 1961-1970

	Population	Arable Land	Irrigated Agriculture	Forest Wood Land	Permanent Pasture	Permanent Crops	Agric. Prod. Net Trade	Forestry Prod. Net Trade	Cereal Yields	Fertilizer Consumpt.	Tractors in Use
Australia	21.02	37.86	47.45	0.00	2.03	8.13	51.48	39.05	12.26	44.71	
Bangladesh	26.51	2.36	148.36	0.00	0.00	6.00	-121.26	0.00	-0.89	521.74	
Brazil	28.08	25.30	62.45	-2.98	26.20	4.43	70.99	269.83	4.64	271.11	
Burundi	17.13	35.69	800.00	20.45	1.49	15.71	98.00		9.46	0.00	
Canada	16.72	1.16	20.29	0.47	19.00	0.00	22.06	80.82	114.30	99.50	
China	24.64	-3.20	25.40	-6.31	14.71	31.05	-176.90	-1401.58	76.97	505.36	
Ethiopia	23.66	13.91	3.33	-3.00	-0.97	48.15	69.15	1024.73	17.12	400.00	
Finland	3.25	-0.30	700.00	2.80	50.00		42.91	45.97	27.25	100.83	
France	9.98	-11.16	13.64	20.66	1.98	-6.39	-65.87	377.70	48.27	91.95	
Gabon	2.23	100.00		0.00	-2.97	81.82	146.15	36.04	0.00	0.00	
India	22.78	3.08	23.31	16.34	-1.59	3.67	-117.24	-20.52	19.80	567.75	
Indonesia	22.64	6.56	7.90	-1.44	0.00	89.00	-32.44	-348.50	29.77	76.47	
Ireland	4.68	-13.40		35.36	1.75	6.33	55.01	113.85	15.64	108.37	
Kenya	33.65	17.63	107.14	-6.16		-2.70		236.11	2.75	354.55	
Malaysia	29.05	10.84	14.91	-8.37	0.00		45.34	587.00	13.70	157.33	
Mexico	34.37	-3.26	19.43	-8.14	0.60	0.00	27.73	220.76	39.43	181.68	
Nigeria	30.05	3.86	0.25	-13.11	0.00	0.00	-2.77	-201.97	-2.88	600.00	
Pakistan	28.60	14.56	20.45	69.95	36.92	13.45	-956.52	36.16	43.59		
Philippines	32.61	-4.71	19.71	-7.29	0.00	16.98	33.19	208.77	35.54	183.10	
Sudan	21.61	8.26	9.80	-5.04	0.00	50.00	80.36		-21.08	32.00	
Sweden	6.95	-14.07	65.00	0.54	-11.80	9.79	76.94	85.93	15.20	66.01	
Tanzania	31.11	3.56	90.00	-2.43	0.00	60.00	72.41	-481.81	-28.77	400.00	
Thailand	31.69	18.27	20.91	-23.37			19.37	-464.24	23.95	350.00	
USA	11.63	4.49	14.29	-0.89	4.32	1.69	-10.66	-30.51	25.07	103.18	
Zaire	26.04	3.04	0.00	-1.52	-1.66	-9.09	-40.56	-83.40	1.16	0.00	

Table A2: Decennial Growth / Decline of Selected Indicators (in percent): 1971-1980

	Population	Arable Land	Irrigated Agriculture	Forest Wood Land	Permanent Pasture	Permanent Crops	Agric. Prod. Net Trade	Forestry Prod. Net Trade	Cereal Yields	Fertilizer Consumpt.	Tractors in Use
Australia	12.46	7.11	2.04	-23.11	-0.73	-10.40	296.02	154.20	-16.54	8.80	0.18
Bangladesh	28.75	0.34	49.43	-1.66	0.00	15.57	501.00	-288.85	26.69	265.79	85.02
Brazil	23.49	42.55	88.24	-3.91	9.67	29.93	328.53	1228.52	22.07	274.09	197.11
Burundi	16.20	9.04	60.00	14.81	28.17	14.04	147.83		4.35	0.00	2150.00
Canada	11.40	4.40	36.38	4.90	21.31	0.00	200.32	258.42	-0.19	120.34	10.26
China	17.00	-2.46	16.09	-7.05	20.14	28.24	-737.76	-2416.41	34.79	235.85	216.77
Ethiopia	23.68	2.98	3.23	-2.99	-0.96	0.00	182.11	142.50	41.56	760.00	25.00
Finland	3.64	-3.94	200.00	3.51	9.33		660.77	353.34	9.92	-3.36	32.50
France	5.13	2.44	18.42	2.60	-7.77	-12.97	1100.03	288.56	25.28	13.08	15.32
Gabon	54.70	52.63		0.00	-4.08	47.27	799.06	304.36	22.22	0.00	56.25
India	21.34	2.87	23.72	5.57	-2.83	4.90	917.42	295.70	18.83	108.24	167.74
Indonesia	22.49	9.23	20.67	-4.08	0.00	27.75	374.73	1145.04	38.35	416.74	2.67
Ireland	14.20	-18.71		25.49	3.45	3.53	360.72	393.72	13.62	43.10	61.40
Kenya	39.75	7.83	25.00	-6.62		0.00		-23.65	-2.05	31.91	11.12
Malaysia	23.68	7.53	14.70	-9.73	0.00		548.05	563.63	14.88	164.91	45.77
Mexico	29.07	5.41	32.80	-10.19	-11.79	0.00	-364.78	819.81	43.07	101.30	23.98
Nigeria	34.37	1.57	2.61	-15.34	0.00	0.00	-866.62	915.61	56.03	1833.33	126.32
Pakistan	26.41	4.60	13.04	4.78	4.95	4.85	696.78	323.00	34.81		305.72
Philippines	25.25	-3.36	41.09	-21.53	0.00	13.97	260.18	63.55	27.15	59.81	46.05
Sudan	31.22	5.08	7.93	-5.35	-17.88	33.33	-38.93		-11.90	113.16	64.95
Sweden	2.62	-2.36	89.19	0.43	10.97	73.95	209.12	234.07	-0.47	-7.81	-0.44
Tanzania	35.25	2.66	200.00	-2.50	0.00	1.56	50.84	262.47	44.09	111.76	-40.82
Thailand	26.79	32.85	43.16	-23.11			510.89	799.55	-4.16	114.84	701.65
USA	9.68	0.33	27.29	-2.37	4.12	1.50	1278.49	-57.53	1.23	37.87	-9.72
Zaire	29.07	3.52	0.00	-1.62	-6.51	-4.64	101.06	-556.44	10.06	60.00	78.91

Table A3: Decennial Growth / Decline of Selected Indicators (in percent): 1981-1990

	Population	Arable Land	Irrigated Agriculture	Forest Wood Land	Permanent Pasture	Permanent Crops	Agric. Prod. Net Trade	Forestry Prod. Net Trade	Cereal Yields	Fertilizer Consumpt.	Tractors in Use
Australia	14.49	13.48	14.87	0.13	-4.94	13.38	17.57	87.23	22.89	1.75	0.00
Bangladesh	27.44	-0.83	78.95	-15.15	0.00	12.50	118.19	-1264.52	28.57	133.25	15.56
Brazil	21.20	27.92	58.82	-4.41	6.66	-7.25	-13.45	83.45	8.95	14.35	26.54
Burundi	29.00	0.90	24.14	6.45	0.44	11.22	16.62		24.34	100.00	40.00
Canada	9.25	-0.37	37.60	4.82	-2.88	0.00	-28.31	67.48	12.02	6.58	18.61
China	12.95	-4.44	6.31	-5.70	17.30	-0.15	-110.82	203.94	39.43	78.69	3.85
Ethiopia	24.37	0.00	1.25	-3.21	-0.99	0.00	-99.76	-53.81	7.71	143.48	-1.27
Finland	3.79	-4.09	6.67	-0.42	-24.22		302.30	84.79	70.85	-3.49	11.93
France	4.13	2.64	25.81	1.49	-10.89	-9.42	133.50	42.23	28.27	2.03	-1.32
Gabon	39.36	1.72		0.00	0.00	0.00	-0.63	86.51	-10.00	-50.00	14.96
India	21.17	0.31	10.94	-1.07	-1.26	11.11	59.13	66.48	35.59	106.43	136.51
Indonesia	19.55	12.28	40.27	-2.72	0.00	30.14	669.08	255.06	25.79	72.63	83.43
Ireland	1.74	-13.20		6.85	21.67	-7.53	167.02	2.39	35.17	16.72	12.16
Kenya	39.04	5.46	35.00	-7.14		2.78		139.49	3.69	39.76	54.71
Malaysia	26.79	1.96	3.64	-8.08	0.00		14.52	82.33	-9.21	138.00	51.08
Mexico	22.78	0.05	3.19	-10.23	0.89	0.00	23.73	-38.02	6.97	-0.13	18.82
Nigeria	34.00	6.88	4.82	-18.49	0.00	0.00	-85.30	-79.68	-25.07	87.79	30.68
Pakistan	38.78	1.52	7.84	18.73	-17.82	3.45	-184.63	84.60	5.78		137.26
Philippines	25.83	1.56	22.93	-15.53	0.00	10.19	-111.52	-120.36	18.37	83.75	4.82
Sudan	30.73	3.55	6.15	-5.68	3.77	0.00	101.02		-39.67	8.00	-5.34
Sweden	2.96	-4.53	52.00	0.25	-5.83	54.75	63.27	88.35	29.73	-32.37	-3.51
Tanzania	39.57	0.77	25.00	-2.57	0.00	4.55	-36.95	-35.55	45.73	65.52	-28.42
Thailand	16.67	12.73	35.60	-12.38			11.92	274.30	-5.89	233.55	77.13
USA	8.60	-0.46	-8.80	-0.98	2.61	2.96	-32.15	114.87	11.68	-5.20	1.11
Zaire	31.75	2.14	42.86	-1.68	-7.19	-7.27	22.05	-9.29	-7.58	-25.00	20.00

Table A4: Decennial Growth / Decline of Selected Indicators (absolute): 1961-1970

	Population (in 1000)	Arable Land (in 1000 Ha)	Irrigated Agriculture (in 1000 Ha)	Forest Wood Land (in 1000 Ha)	Permanent Pasture (in 1000 Ha)	Permanent Crops (in 1000 Ha)	Agric. Prod. Net Trade (in 100,000 $)	Forestry Prod. Net Trade (in 10,000 $)	Cereal Yields (in Tons / Ha)	Fertilizer Consumpt. (in 1000 Tons)	Tractors in Use (in 1000)
Australia	2,217	11,429	475	0	8,760	13	7,058	-52,511	133	300	
Bangladesh	13,970	205	632	0	0	12	-867	0	-15	120	
Brazil	21,011	5,249	306	-16,650	32,003	339	6,854	37,158	63	732	
Burundi	515	273	24	9	10	22	98		90	1	
Canada	3,055	500	71	1,529	3,600	0	1,001	1,153,271	1,126	400	
China	164,200	-3,304	7,721	-9,880	35,000	575	5,889	46,182	933	3,679	
Ethiopia	5,860	1,530	5	-900	-450	234	390	-2,818	122	4	
Finland	145	-8	14	610	50		-481	367,800	513	244	
France	4,609	-2,189	90	2,399	260	-115	5,794	-398,615	1,099	2,228	
Gabon	11	90		0	-150	45	-57	13,032	0	0	
India	102,970	4,804	5,755	9,275	-200	180	959	8,136	188	1,919	
Indonesia	22,206	800	320	-1,800	0	259	-1,036	82,726	459	104	
Ireland	132	-213		64	2	5	939	-32,279	492	220	
Kenya	2,895	245	15	-180		-1		-9,475	34	39	
Malaysia	2,443	90	34	-2,160	0		1,373	231,908	287	118	
Mexico	13,497	-732	583	-4,770	840	0	1,027	-58,183	436	347	
Nigeria	13,073	1,020	2	-2,700	1	0	-89	-32,882	-21	6	
Pakistan	14,612	2,436	2,199	1,166	24	39	660	-4,330	373		
Philippines	9,231	-231	136	-1,251	0	90	843	175,039	354	130	
Sudan	2,463	890	145	-2,700	0	1	1,035		-193	8	
Sweden	523	-500	13	150	-1,010	23	-2,469	666,315	428	200	
Tanzania	3,206	90	18	-1,080	0	24	677	-3,893	-232	12	
Thailand	8,602	1,900	339	-6,795			669	-23,950	401	63	
USA	21,361	8,105	2,000	-2,746	680	11	-1,440	293,476	632	7,889	
Zaire	4,084	200	0	-2,800	-87	-24	-333	-6,111	8	5	

Table A5: Decennial Growth / Decline of Selected Indicators (absolute): 1971-1980

	Population (in 1000)	Arable Land (in 1000 Ha)	Irrigated Agriculture (in 1000 Ha)	Forest Wood Land (in 1000 Ha)	Permanent Pasture (in 1000 Ha)	Permanent Crops (in 1000 Ha)	Agric. Prod. Net Trade (in 100,000 $)	Forestry Prod. Net Trade (in 10,000 $)	Cereal Yields (in Tons / Ha)	Fertilizer Consumpt. (in 1000 Tons)	Tractors in Use (in 1000)
Australia	1,628	2,921	30	-31,816	-3,230	-18	61,663	-323,755	-209	94	583
Bangladesh	19,697	30	519	-37	0	33	-3,522	5,468	423	303	1,930
Brazil	23,071	11,532	750	-21,115	15,114	2,412	52,512	545,413	285	3,078	361,705
Burundi	576	92	21	8	200	24	204		44	0	86
Canada	2,462	1,924	159	15,900	4,893	0	16,470	7,082,612	-4	1,059	61,156
China	144,765	-2,452	6,281	-10,259	56,000	706	-39,706	-920,749	761	10,769	511,793
Ethiopia	7,418	380	5	-868	-440	0	1,843	-5,482	350	38	790
Finland	168	-105	40	791	14		-4,784	4,075,887	255	-17	52,000
France	2,629	416	140	371	-1,083	-212	33,474	-1,529,944	980	649	195,800
Gabon	285	100		0	-200	52	-847	119,649	333	0	450
India	121,148	4,602	7,378	3,560	-350	250	9,165	-133,545	214	2,876	239,869
Indonesia	27,715	1,200	928	-5,000	0	159	9,327	1,585,617	794	946	240
Ireland	423	-255		65	4	3	13,336	-264,490	558	181	55,200
Kenya	4,731	130	8	-180		0		4,098	-26	15	655
Malaysia	2,635	70	41	-2,279	0		21,922	1,525,050	367	282	2,333
Mexico	15,860	1,180	1,230	-5,430	-16,495	0	-18,392	-527,949	659	623	22,257
Nigeria	20,062	430	21	-2,700	0	0	-18,693	-222,961	397	165	4,800
Pakistan	17,823	880	1,694	130	5	16	2,167	-60,904	417		73,373
Philippines	9,742	-156	355	-3,418	0	88	9,702	154,256	345	125	3,321
Sudan	4,445	597	130	-2,702	-240	1	-999		-90	43	3,780
Sweden	212	-72	33	120	828	193	-10,592	3,481,032	-16	-41	-800
Tanzania	4,917	70	80	-1,082	0	1	815	-11,176	312	19	-6,898
Thailand	9,870	4,084	909	-4,973			22,663	-152,515	-83	147	64,187
USA	20,096	615	4,412	-7,200	680	10	227,328	690,525	46	5,900	-509,000
Zaire	5,907	240	7	-2,930	-331	-11	381	20,132	73	3	838

Table A6: Decennial Growth / Decline of Selected Indicators (absolute): 1981-1990

	Population (in 1000)	Arable Land (in 1000 Ha)	Irrigated Agriculture (in 1000 Ha)	Forest Wood Land (in 1000 Ha)	Permanent Pasture (in 1000 Ha)	Permanent Crops (in 1000 Ha)	Agric. Prod. Net Trade (in 100,000 $)	Forestry Prod. Net Trade (in 10,000 $)	Cereal Yields (in Tons / Ha)	Fertilizer Consumpt. (in 1000 Tons)	Tractors in Use (in 1000)
Australia	2,163	5,799	246	133	-21,714	21	14,813	-481,918	321	20	0
Bangladesh	24,890	-74	1,294	-332	0	32	-3,288	-36,178	554	533	700
Brazil	26,300	11,000	1,000	-22,770	11,500	-750	-9,997	551,447	144	395	151,000
Burundi	1,230	10	14	4	4	22	66		263	1	38
Canada	2,256	-172	235	16,500	-833	0	-8,215	6,457,632	282	128	122,394
China	130,594	-4,332	2,840	-7,650	59,000	-5	41,146	-1,836,047	1,219	11,924	30,652
Ethiopia	9,649	0	2	-900	-450	0	-2,477	4,885	90	66	-50
Finland	182	-104	4	-99	-39		-4,078	4,026,971	1,469	-16	26,000
France	2,238	463	240	217	-1,391	-131	61,694	-723,854	1,337	113	-19,600
Gabon	331	5		0	0	0	7	120,317	-167	-1	190
India	149,047	503	4,245	-721	-150	600	7,407	-143,697	498	6,476	570,301
Indonesia	30,139	1,750	2,182	-3,167	0	220	10,538	2,018,562	779	1,056	7,732
Ireland	60	-143		22	26	-7	19,092	-7,704	1,678	99	18,000
Kenya	6,747	100	14	-180		1		-12,090	58	33	3,501
Malaysia	3,780	20	12	-1,700	0		2,817	1,189,369	-260	552	4,091
Mexico	16,436	12	160	-4,840	1,093	1	-4,225	235,475	157	-2	26,922
Nigeria	27,539	1,915	40	-2,700	0	0	18,843	338,619	-410	187	2,700
Pakistan	34,267	304	1,200	560	-18	12	-8,997	-70,671	97		153,728
Philippines	12,811	70	291	-1,903	0	74	-12,864	-457,816	308	268	492
Sudan	5,925	440	110	-2,700	43	0	1,578		-299	6	-518
Sweden	246	-134	39	70	-487	265	-7,983	3,957,335	1,138	-157	-6,654
Tanzania	7,745	21	30	-1,080	0	3	-1,274	5,539	459	19	-2,700
Thailand	7,958	2,145	1,129	-1,993			4,033	-652,098	-117	731	68,798
USA	19,783	-874	-1,811	-2,900	450	20	-85,968	-1,270,346	497	-1,011	52,000
Zaire	8,571	152	3	-2,970	-339	-16	-153	-1,834	-62	-2	400

Table A7: Land Use, 1961-1990: World

Land Use (in 1000 Ha)

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961	13,076,529	4,540,543	1,255,921	74,793	3,209,928	139,703	4,252,877	4,312,547
1970	13,076,384	4,643,794	1,294,005	83,216	3,266,802	168,651	4,202,915	4,229,021
1980	13,079,017	4,750,366	1,325,910	91,150	3,333,306	210,975	4,100,255	4,228,396
1990	13,078,903	4,846,269	1,349,830	94,281	3,402,189	237,500	4,027,106	4,205,528

Land Use (in % of Total Land Area)

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961	100.00	34.72	9.60	0.57	24.55	1.07	32.52	32.98
1970	100.00	35.51	9.90	0.64	24.98	1.29	32.14	32.34
1980	100.00	36.32	10.14	0.70	25.49	1.61	31.35	32.33
1990	100.00	37.05	10.32	0.72	26.01	1.82	30.79	32.16

Land Use Changes (in 1000 Ha)

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961-1970	-145	103,251	38,084	8,423	56,874	28,948	-49,962	-83,526
1970-1980	2,633	106,572	31,905	7,934	66,504	42,324	-102,660	-625
1980-1990	-114	95,903	23,920	3,131	68,883	26,525	-73,149	-22,868
1961-1990	2,374	305,726	93,909	19,488	192,261	97,797	-225,771	-107,019

Land Use Changes in %

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961-1970	0.00	2.27	3.03	11.26	1.77	20.72	-1.17	-1.94
1970-1980	0.02	2.29	2.47	9.53	2.04	25.10	-2.44	-0.01
1980-1990	0.00	2.02	1.80	3.43	2.07	12.57	-1.78	-0.54
1961-1990	0.02	6.73	7.48	26.06	5.99	70.00	-5.31	-2.48

Land Use Changes in % of Total Land Area

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961-1970	0.00	0.79	0.29	0.06	0.43	0.22	-0.38	-0.64
1970-1980	0.02	0.81	0.24	0.06	0.51	0.32	-0.79	0.00
1980-1990	0.00	0.73	0.18	0.02	0.53	0.20	-0.56	-0.17
1961-1990	0.02	2.34	0.72	0.15	1.47	0.75	-1.73	-0.82

Source: FAO (1993): PC-AGROSTAT, 1993. Rome

Table A8: Land Use, 1961-1990: North America

Land Use (in 1000 Ha)

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961	1,835,726	509,659	223,750	1,959	283,950	14,350	629,971	696,096
1970	1,835,726	500,650	232,355	1,845	266,450	16,421	628,754	706,322
1980	1,838,745	501,713	234,375	1,949	265,389	21,178	637,300	699,732
1990	1,838,757	505,432	235,865	2,114	269,567	19,631	652,600	680,725

Land Use (in % of Total Land Area)

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961	100.00	27.76	12.19	0.11	15.47	0.78	34.32	37.92
1970	100.00	27.27	12.66	0.10	14.51	0.89	34.25	38.48
1980	100.00	27.29	12.75	0.11	14.43	1.15	34.66	38.05
1990	100.00	27.49	12.83	0.11	14.66	1.07	35.49	37.02

Land Use Changes (in 1000 Ha)

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961-1970	0	-9,009	8,605	-114	-17,500	2,071	-1,217	10,226
1970-1980	3,019	1,063	2,020	104	-1,061	4,757	8,546	-6,590
1980-1990	12	3,719	1,490	165	4,178	-1,547	15,300	-19,007
1961-1990	3,031	-4,227	12,115	155	-14,383	5,281	22,629	-15,371

Land Use Changes in %

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961-1970	0.00	-1.77	3.85	-5.82	-6.16	14.43	-0.19	1.47
1970-1980	0.16	0.21	0.87	5.64	-0.40	28.97	1.36	-0.93
1980-1990	0.00	0.74	0.64	8.47	1.57	-7.30	2.40	-2.72
1961-1990	0.17	-0.83	5.41	7.91	-5.07	36.80	3.59	-2.21

Land Use Changes in % of Total Land Area

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961-1970	0.00	-0.49	0.47	-0.01	-0.95	0.11	-0.07	0.56
1970-1980	0.16	0.06	0.11	0.01	-0.06	0.26	0.47	-0.36
1980-1990	0.00	0.20	0.08	0.01	0.23	-0.08	0.83	-1.03
1961-1990	0.17	-0.23	0.66	0.01	-0.78	0.29	1.23	-0.84

Source: FAO (1993): PC-AGROSTAT, 1993. Rome

Table A9: Land Use, 1961-1990: Europe

Land Use (in 1000 Ha)

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961	472,935	241,125	137,669	13,662	89,794	8,604	143,242	88,568
1970	472,949	234,341	131,285	14,422	88,863	10,723	150,747	87,307
1980	472,867	227,312	126,545	14,451	86,316	14,467	155,693	89,862
1990	472,740	221,800	124,721	14,005	83,105	17,116	157,332	93,608

Land Use (in % of Total Land Area)

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961	100.00	50.98	29.11	2.89	18.99	1.82	30.29	18.73
1970	100.00	49.55	27.76	3.05	18.79	2.27	31.87	18.46
1980	100.00	48.07	26.76	3.06	18.25	3.06	32.93	19.00
1990	100.00	46.92	26.38	2.96	17.58	3.62	33.28	19.80

Land Use Changes (in 1000 Ha)

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961-1970	14	-6,784	-6,384	760	-931	2,119	7,505	-1,261
1970-1980	-82	-7,029	-4,740	29	-2,547	3,744	4,946	2,555
1980-1990	-127	-5,512	-1,824	-446	-3,211	2,649	1,639	3,746
1961-1990	-195	-19,325	-12,948	343	-6,689	8,512	14,090	5,040

Land Use Changes in %

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961-1970	0.00	-2.81	-4.64	5.56	-1.04	24.63	5.24	-1.42
1970-1980	-0.02	-3.00	-3.61	0.20	-2.87	34.92	3.28	2.93
1980-1990	-0.03	-2.42	-1.44	-3.09	-3.72	18.31	1.05	4.17
1961-1990	-0.04	-8.01	-9.41	2.51	-7.45	98.93	9.84	5.69

Land Use Changes in % of Total Land Area

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961-1970	0.00	-1.43	-1.35	0.16	-0.20	0.45	1.59	-0.27
1970-1980	-0.02	-1.49	-1.00	0.01	-0.54	0.79	1.05	0.54
1980-1990	-0.03	-1.17	-0.39	-0.09	-0.68	0.56	0.35	0.79
1961-1990	-0.04	-4.09	-2.74	0.07	-1.41	1.80	2.98	1.07

Source: FAO (1993): PC-AGROSTAT, 1993. Rome

Table A10: Land Use, 1961-1990: Oceania (developed)

Land Use (in 1000 Ha)

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961	791,243	474,808	30,640	171	443,997	1,078	145,200	171,235
1970	791,243	495,048	42,179	187	452,682	1,587	144,900	151,295
1980	791,243	497,535	44,466	173	452,896	1,683	112,976	180,732
1990	791,243	480,749	49,204	199	431,346	2,180	113,350	197,144

Land Use (in % of Total Land Area)

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961	100.00	60.01	3.87	0.02	56.11	0.14	18.35	21.64
1970	100.00	62.57	5.33	0.02	57.21	0.20	18.31	19.12
1980	100.00	62.88	5.62	0.02	57.24	0.21	14.28	22.84
1990	100.00	60.76	6.22	0.03	54.51	0.28	14.33	24.92

Land Use Changes (in 1000 Ha)

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961-1970	0	20,240	11,539	16	8,685	509	-300	-19,940
1970-1980	0	2,487	2,287	-14	214	96	-31,924	29,437
1980-1990	0	-16,786	4,738	26	-21,550	497	374	16,412
1961-1990	0	5,941	18,564	28	-12,651	1,102	-31,850	25,909

Land Use Changes in %

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961-1970	0.00	4.26	37.66	9.36	1.96	47.22	-0.21	-11.64
1970-1980	0.00	0.50	5.42	-7.49	0.05	6.05	-22.03	19.46
1980-1990	0.00	-3.37	10.66	15.03	-4.76	29.53	0.33	9.08
1961-1990	0.00	1.25	60.59	16.37	-2.85	102.23	-21.94	15.13

Land Use Changes in % of Total Land Area

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961-1970	0.00	2.56	1.46	0.00	1.10	0.06	-0.04	-2.52
1970-1980	0.00	0.31	0.29	0.00	0.03	0.01	-4.03	3.72
1980-1990	0.00	-2.12	0.60	0.00	-2.72	0.06	0.05	2.07
1961-1990	0.00	0.75	2.35	0.00	-1.60	0.14	-4.03	3.27

Source: FAO (1993): PC-AGROSTAT, 1993. Rome

Table A11: Land Use, 1961-1990: Other Developed Countries

Land Use (in 1000 Ha)

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961	161,789	108,549	17,868	1,307	89,374	3,884	29,447	23,793
1970	161,789	102,503	17,605	1,526	83,372	4,587	29,302	29,984
1980	161,789	100,668	17,059	1,489	82,120	4,386	29,464	31,657
1990	161,789	100,378	16,832	1,375	82,171	4,181	29,464	31,657

Land Use (in % of Total Land Area)

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961	100.00	67.09	11.04	0.81	55.24	2.40	18.20	14.71
1970	100.00	63.36	10.88	0.94	51.53	2.84	18.11	18.53
1980	100.00	62.22	10.54	0.92	50.76	2.71	18.21	19.57
1990	100.00	62.04	10.40	0.85	50.79	2.58	18.21	19.57

Land Use Changes (in 1000 Ha)

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961-1970	0	-6,046	-263	219	-6,002	703	-145	6,191
1970-1980	0	-1,835	-546	-37	-1,252	-201	162	1,673
1980-1990	0	-290	-227	-114	51	-205	0	0
1961-1990	0	-8,171	-1,036	68	-7,203	297	17	7,864

Land Use Changes in %

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961-1970	0.00	-5.57	-1.47	16.76	-6.72	18.10	-0.49	26.02
1970-1980	0.00	-1.79	-3.10	-2.42	-1.50	-4.38	0.55	5.58
1980-1990	0.00	-0.29	-1.33	-7.66	0.06	-4.67	0.00	0.00
1961-1990	0.00	-7.53	-5.80	5.20	-8.06	7.65	0.06	33.05

Land Use Changes in % of Total Land Area

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961-1970	0.00	-3.74	-0.16	0.14	-3.71	0.43	-0.09	3.83
1970-1980	0.00	-1.13	-0.34	-0.02	-0.77	-0.12	0.10	1.03
1980-1990	0.00	-0.18	-0.14	-0.07	0.03	-0.13	0.00	0.00
1961-1990	0.00	-5.05	-0.64	0.04	-4.45	0.18	0.01	4.86

Source: FAO (1993): PC-AGROSTAT, 1993. Rome

Table A12: Land Use, 1961-1990: Former USSR

Land Use (in 1000 Ha)

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961	2,227,280	610,300	235,400	4,400	370,500	9,400	894,000	722,980
1970	2,227,280	607,000	227,800	5,200	374,000	11,100	912,000	708,280
1980	2,227,280	605,900	227,100	5,100	373,700	17,487	933,000	688,380
1990	2,227,280	598,820	225,100	4,520	369,200	21,215	947,000	681,460

Land Use (in % of Total Land Area)

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961	100.00	27.40	10.57	0.20	16.63	0.42	40.14	32.46
1970	100.00	27.25	10.23	0.23	16.79	0.50	40.95	31.80
1980	100.00	27.20	10.20	0.23	16.78	0.79	41.89	30.91
1990	100.00	26.89	10.11	0.20	16.58	0.95	42.52	30.60

Land Use Changes (in 1000 Ha)

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961-1970	0	-3,300	-7,600	800	3,500	1,700	18,000	-14,700
1970-1980	0	-1,100	-700	-100	-300	6,387	21,000	-19,900
1980-1990	0	-7,080	-2,000	-580	-4,500	3,728	14,000	-6,920
1961-1990	0	-11,480	-10,300	120	-1,300	11,815	53,000	-41,520

Land Use Changes in %

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961-1970	0.00	-0.54	-3.23	18.18	0.94	18.09	2.01	-2.03
1970-1980	0.00	-0.18	-0.31	-1.92	-0.08	57.54	2.30	-2.81
1980-1990	0.00	-1.17	-0.88	-11.37	-1.20	21.32	1.50	-1.01
1961-1990	0.00	-1.88	-4.38	2.73	-0.35	125.69	5.93	-5.74

Land Use Changes in % of Total Land Area

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961-1970	0.00	-0.15	-0.34	0.04	0.16	0.08	0.81	-0.66
1970-1980	0.00	-0.05	-0.03	0.00	-0.01	0.29	0.94	-0.89
1980-1990	0.00	-0.32	-0.09	-0.03	-0.20	0.17	0.63	-0.31
1961-1990	0.00	-0.52	-0.46	0.01	-0.06	0.53	2.38	-1.86

Source: FAO (1993): PC-AGROSTAT, 1993. Rome

Table A13: Land Use, 1961-1990: Less Developed Africa

Land Use (in 1000 Ha)

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961	2,329,062	826,868	111,106	12,967	702,795	2,818	702,528	799,414
1970	2,328,814	835,802	119,197	14,636	701,969	3,178	682,185	810,827
1980	2,328,730	845,117	126,866	16,288	701,963	4,431	659,412	824,201
1990	2,328,730	846,231	133,848	16,953	695,430	5,442	634,455	848,044

Land Use (in % of Total Land Area)

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961	100.00	35.50	4.77	0.56	30.18	0.12	30.16	34.32
1970	100.00	35.89	5.12	0.63	30.14	0.14	29.29	34.82
1980	100.00	36.29	5.45	0.70	30.14	0.19	28.32	35.39
1990	100.00	36.34	5.75	0.73	29.86	0.23	27.24	36.42

Land Use Changes (in 1000 Ha)

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961-1970	-248	8,934	8,091	1,669	-826	360	-20,343	11,413
1970-1980	-84	9,315	7,669	1,652	-6	1,253	-22,773	13,374
1980-1990	0	1,114	6,982	665	-6,533	1,011	-24,957	23,843
1961-1990	-332	19,363	22,742	3,986	-7,365	2,624	-68,073	48,630

Land Use Changes in %

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961-1970	-0.01	1.08	7.28	12.87	-0.12	12.78	-2.90	1.43
1970-1980	0.00	1.11	6.43	11.29	0.00	39.43	-3.34	1.65
1980-1990	0.00	0.13	5.50	4.08	-0.93	22.82	-3.78	2.89
1961-1990	-0.01	2.34	20.47	30.74	-1.05	93.12	-9.69	6.08

Land Use Changes in % of Total Land Area

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961-1970	-0.01	0.38	0.35	0.07	-0.04	0.02	-0.87	0.49
1970-1980	0.00	0.40	0.33	0.07	0.00	0.05	-0.98	0.57
1980-1990	0.00	0.05	0.30	0.03	-0.28	0.04	-1.07	1.02
1961-1990	-0.01	0.83	0.98	0.17	-0.32	0.11	-2.92	2.09

Source: FAO (1993): PC-AGROSTAT, 1993. Rome

Table A14: Land Use, 1961-1990: Latin America

Land Use (in 1000 Ha)

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961	2,017,650	607,848	86,663	15,816	505,414	8,189	1,033,209	376,598
1970	2,017,650	656,914	99,054	17,805	540,055	10,114	995,636	365,100
1980	2,017,651	704,628	117,486	21,135	566,007	13,711	946,213	366,810
1990	2,017,651	740,468	131,179	20,775	588,514	15,785	892,806	384,377

Land Use (in % of Total Land Area)

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961	100.00	30.13	4.30	0.78	25.05	0.41	51.21	18.67
1970	100.00	32.56	4.91	0.88	26.77	0.50	49.35	18.10
1980	100.00	34.92	5.82	1.05	28.05	0.68	46.90	18.18
1990	100.00	36.70	6.50	1.03	29.17	0.78	44.25	19.05

Land Use Changes (in 1000 Ha)

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961-1970	0	49,066	12,391	1,989	34,641	1,925	-37,573	-11,498
1970-1980	1	47,714	18,432	3,330	25,952	3,597	-49,423	1,710
1980-1990	0	35,840	13,693	-360	22,507	2,074	-53,407	17,567
1961-1990	1	132,620	44,516	4,959	83,100	7,596	-140,403	7,779

Land Use Changes in %

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961-1970	0.00	8.07	14.30	12.58	6.85	23.51	-3.64	-3.05
1970-1980	0.00	7.26	18.61	18.70	4.81	35.56	-4.96	0.47
1980-1990	0.00	5.09	11.66	-1.70	3.98	15.13	-5.64	4.79
1961-1990	0.00	21.82	51.37	31.35	16.44	92.76	-13.59	2.07

Land Use Changes in % of Total Land Area

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961-1970	0.00	2.43	0.61	0.10	1.72	0.10	-1.86	-0.57
1970-1980	0.00	2.36	0.91	0.17	1.29	0.18	-2.45	0.08
1980-1990	0.00	1.78	0.68	-0.02	1.12	0.10	-2.65	0.87
1961-1990	0.00	6.57	2.21	0.25	4.12	0.38	-6.96	0.39

Source: FAO (1993): PC-AGROSTAT, 1993. Rome

Table A15: Land Use, 1961-1990: Less Developed Far East

Land Use (in 1000 Ha)

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961	1,959,697	773,049	338,030	20,332	414,737	76,540	528,088	658,549
1970	1,959,686	818,521	346,314	22,319	449,888	94,216	515,207	625,958
1980	1,959,617	872,280	354,527	24,106	493,647	116,298	485,588	601,749
1990	1,959,631	944,417	356,251	27,172	560,994	131,593	462,033	553,181

Land Use (in % of Total Land Area)

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961	100.00	39.45	17.25	1.04	21.16	3.91	26.95	33.60
1970	100.00	41.77	17.67	1.14	22.96	4.81	26.29	31.94
1980	100.00	44.51	18.09	1.23	25.19	5.93	24.78	30.71
1990	100.00	48.19	18.18	1.39	28.63	6.72	23.58	28.23

Land Use Changes (in 1000 Ha)

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961-1970	-11	45,472	8,284	1,987	35,151	17,676	-12,881	-32,591
1970-1980	-69	53,759	8,213	1,787	43,759	22,082	-29,619	-24,209
1980-1990	14	72,137	1,724	3,066	67,347	15,295	-23,555	-48,568
1961-1990	-66	171,368	18,221	6,840	146,257	55,053	-66,055	-105,368

Land Use Changes in %

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961-1970	0.00	5.88	2.45	9.77	8.48	23.09	-2.44	-4.95
1970-1980	0.00	6.57	2.37	8.01	9.73	23.44	-5.75	-3.87
1980-1990	0.00	8.27	0.49	12.72	13.64	13.15	-4.85	-8.07
1961-1990	0.00	22.17	5.39	33.64	35.26	71.93	-12.51	-16.00

Land Use Changes in % of Total Land Area

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961-1970	0.00	2.32	0.42	0.10	1.79	0.90	-0.66	-1.66
1970-1980	0.00	2.74	0.42	0.09	2.23	1.13	-1.51	-1.24
1980-1990	0.00	3.68	0.09	0.16	3.44	0.78	-1.20	-2.48
1961-1990	0.00	8.74	0.93	0.35	7.46	2.81	-3.37	-5.38

Source: FAO (1993): PC-AGROSTAT, 1993. Rome

Table A16: Land Use, 1961-1990: Less Developed Near East

Land Use (in 1000 Ha)

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961	1,192,845	386,645	74,464	3,552	308,629	14,839	102,700	733,200
1970	1,192,945	391,214	77,870	4,575	308,769	16,724	102,700	733,200
1980	1,192,793	393,313	77,134	5,685	310,494	17,333	96,510	702,970
1990	1,192,780	406,005	78,566	6,360	321,079	20,356	93,861	692,914

Land Use (in % of Total Land Area)

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961	100.00	32.41	6.24	0.30	25.87	1.24	8.61	61.47
1970	100.00	32.79	6.53	0.38	25.88	1.40	8.61	61.46
1980	100.00	32.97	6.47	0.48	26.03	1.45	8.09	58.93
1990	100.00	34.04	6.59	0.53	26.92	1.71	7.87	58.09

Land Use Changes (in 1000 Ha)

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961-1970	100	4,569	3,406	1,023	140	1,885	0	0
1970-1980	-152	2,099	-736	1,110	1,725	609	-6,190	-30,230
1980-1990	-13	12,692	1,432	675	10,585	3,023	-2,649	-10,056
1961-1990	-65	19,360	4,102	2,808	12,450	5,517	-8,839	-40,286

Land Use Changes in %

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961-1970	0.01	1.18	4.57	28.80	0.05	12.70	0.00	0.00
1970-1980	-0.01	0.54	-0.95	24.26	0.56	3.64	-6.03	-4.12
1980-1990	0.00	3.23	1.86	11.87	3.41	17.44	-2.74	-1.43
1961-1990	-0.01	5.01	5.51	79.05	4.03	37.18	-8.61	-5.49

Land Use Changes in % of Total Land Area

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961-1970	0.01	0.38	0.29	0.09	0.01	0.16	0.00	0.00
1970-1980	-0.01	0.18	-0.06	0.09	0.14	0.05	-0.52	-2.53
1980-1990	0.00	1.06	0.12	0.06	0.89	0.25	-0.22	-0.84
1961-1990	-0.01	1.62	0.34	0.24	1.04	0.46	-0.74	-3.38

Source: FAO (1993): PC-AGROSTAT, 1993. Rome

Table A17: Land Use, 1961-1990: Other Less Developed Countries

Land Use (in 1000 Ha)

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961	88,302	1,692	331	627	738	1	44,492	42,114
1970	88,302	1,801	346	701	754	1	44,306	42,195
1980	88,302	1,900	352	774	774	1	44,306	42,195
1990	88,302	1,969	378	808	783	1	43,937	42,396

Land Use (in % of Total Land Area)

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961	100.00	1.92	0.37	0.71	0.84	0.00	50.39	47.69
1970	100.00	2.04	0.39	0.79	0.85	0.00	50.18	47.78
1980	100.00	2.15	0.40	0.88	0.88	0.00	50.18	47.78
1990	100.00	2.23	0.43	0.92	0.89	0.00	49.76	48.01

Land Use Changes (in 1000 Ha)

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961-1970	0	109	15	74	16	0	-186	81
1970-1980	0	99	6	73	20	0	0	0
1980-1990	0	69	26	34	9	0	-369	201
1961-1990	0	277	47	181	45	0	-555	282

Land Use Changes in %

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961-1970	0.00	6.44	4.53	11.80	2.17	0.00	-0.42	0.19
1970-1980	0.00	5.50	1.73	10.41	2.65	0.00	0.00	0.00
1980-1990	0.00	3.63	7.39	4.39	1.16	0.00	-0.83	0.48
1961-1990	0.00	16.37	14.20	28.87	6.10	0.00	-1.25	0.67

Land Use Changes in % of Total Land Area

	Land Area	Agricultural Area	Arable Land	Perm. Crops	Perm. Pasture	Irrigated Land	Forest Wood Land	Other Land
1961-1970	0.00	0.12	0.02	0.08	0.02	0.00	-0.21	0.09
1970-1980	0.00	0.11	0.01	0.08	0.02	0.00	0.00	0.00
1980-1990	0.00	0.08	0.03	0.04	0.01	0.00	-0.42	0.23
1961-1990	0.00	0.31	0.05	0.20	0.05	0.00	-0.63	0.32

Source: FAO (1993): PC-AGROSTAT, 1993. Rome