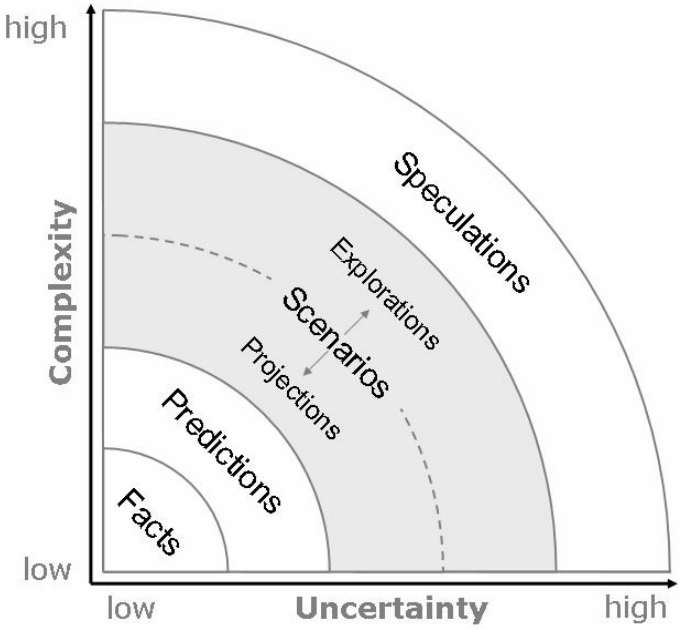


Figure 4.2.1 Which method is best suited for forward-looking assessments depends on both the complexity and the degree of uncertainty associated to an issue (Source: Zurek & Henrichs, 2007)

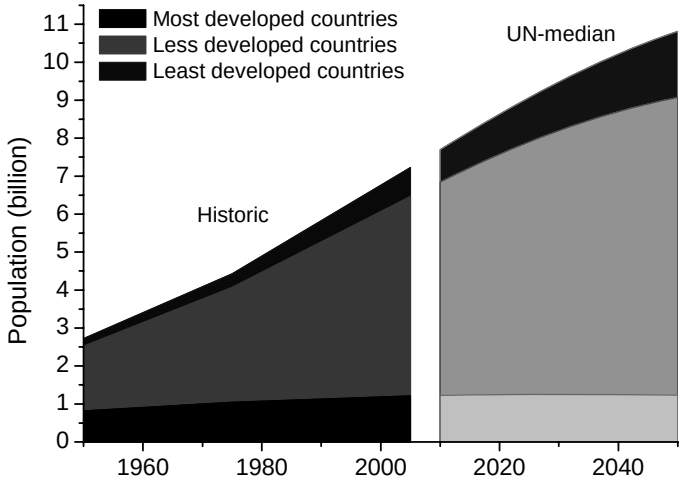


Figure 4.3.1.1 Development of population by aggregated region. Historic and according to the UN Medium scenario (UN, 2005)

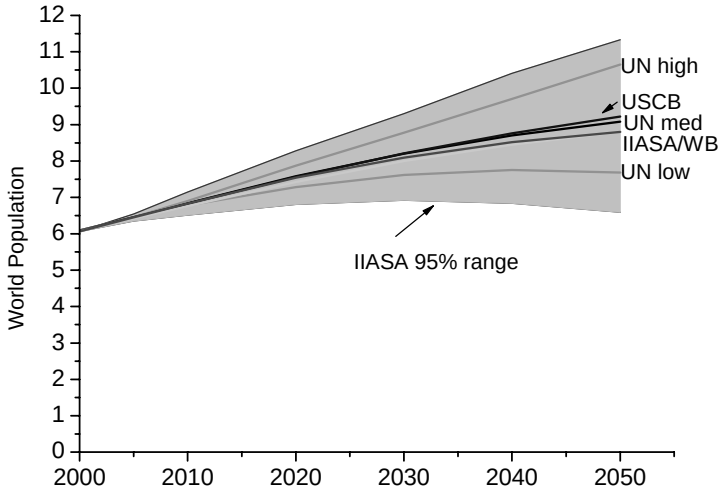


Figure 4.3.1.2 Future development og global population. According to different scenarios.

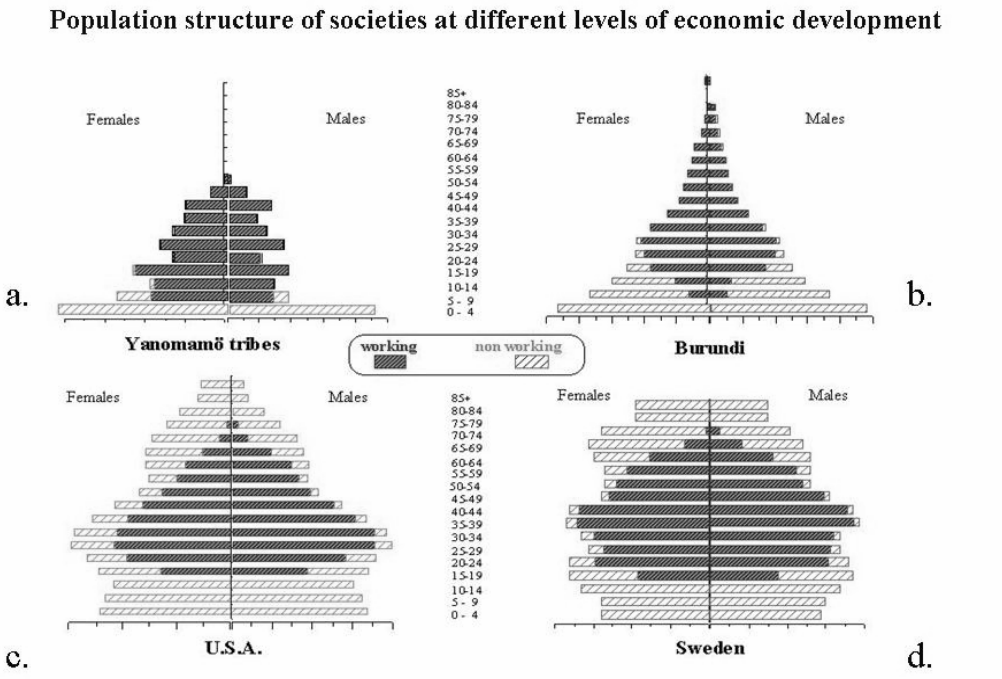


Figure 4.3.1.3: Population structure of societies at different levels of economic development

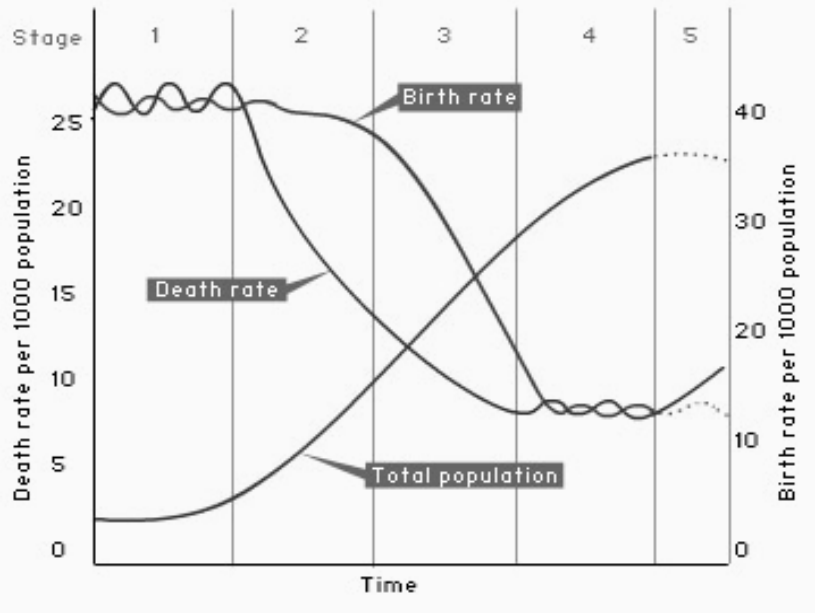


Figure 4.3.1.3: Diagram showing stages of Demographic Transition

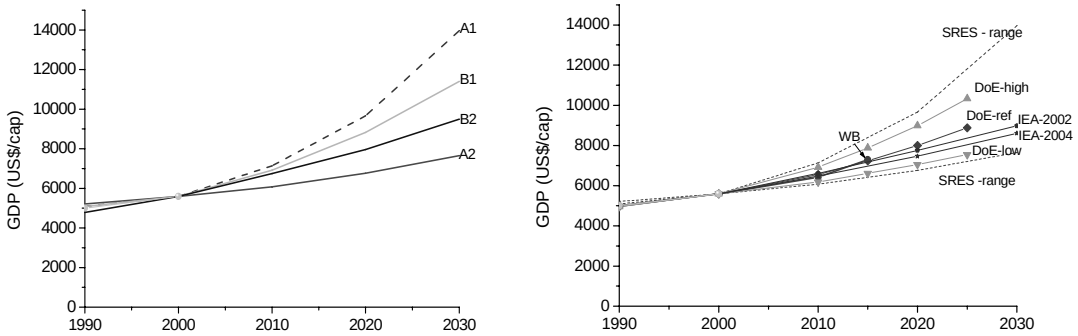


Figure 4.3.2-1: Comparison of global GDP growth in the SRES scenarios and more recent projections. *SRES = (Nakicenovic, 2000) using Scenarios A1, B1, B2, and A2; WB = World Bank (WorldBank, 2004), DoE = assumptions used by the United States Department of Energy (US.DoE, 2004a), IEA assumptions used by IEA (IEA, 2002;IEA, 2004)*.

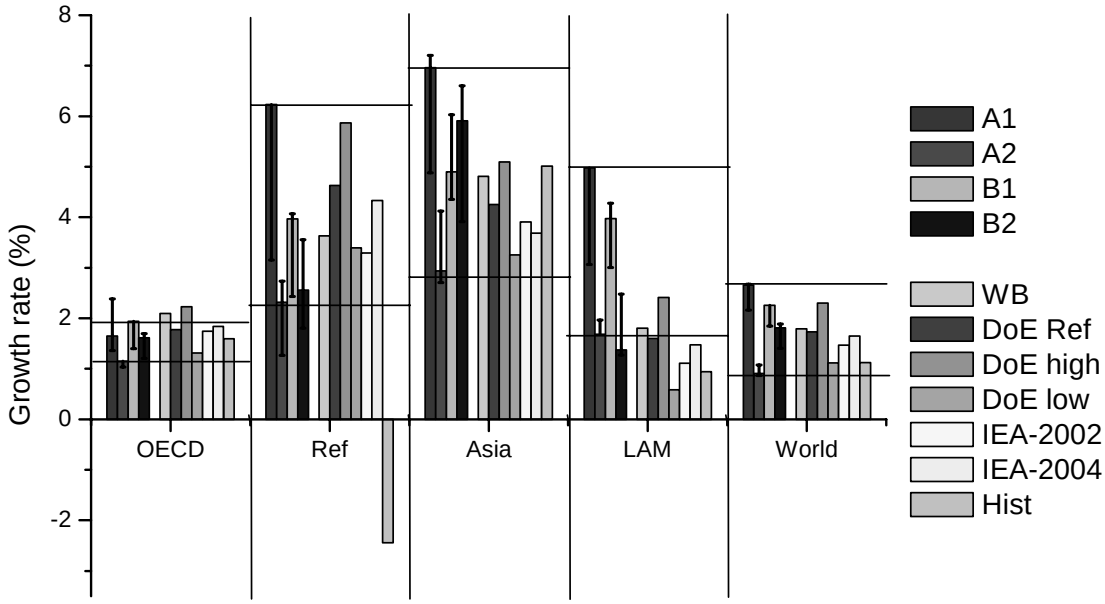


Figure 4.3.2- 2: Comparison of regional GDP annual average growth rate between 2000-2015 in the SRES scenarios and more recent studies. *WB = (World Bank, 2004), DoE = Reference, high and low scenario of US.DoE (2004a), IEA = International Energy Agency (IEA, 2002;IEA, 2004). Hist = Historic data from World Bank (2003).*

Note: The horizontal lines in the figure indicate the range of growth rates set out by the SRES marker scenarios. The vertical lines showing uncertainty bars for the SRES scenarios indicate the range of different outcomes of SRES scenarios within the same family (while the bars indicate the growth rates of the Marker scenarios). The historical rate represents the 1990-2000 period.

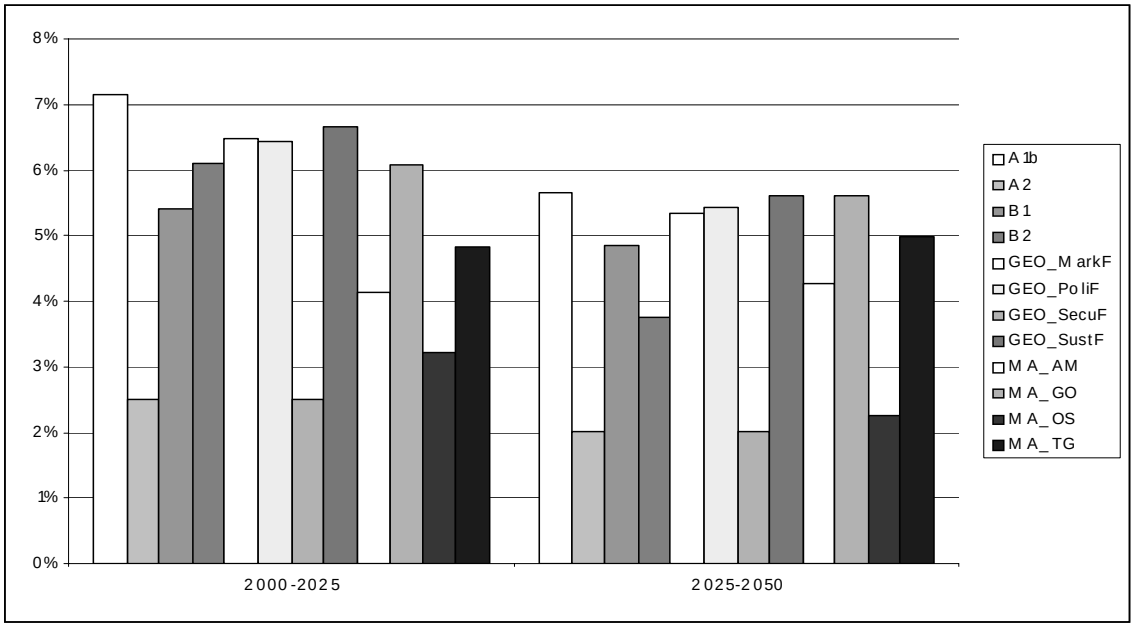


Figure 4.3.2-3: Growth of per capita GDP, 2000-2025 and 2025-2050, Asia

Notes: A1, A2, B1, and B2 refer to SRES scenarios, GEO-MarkF, GEO-PoliF, GEO-SecuF, and GEO_SustF refer to UNEP's GEO3 scenarios of Market First, Policy First, Security First, and Sustainability First, respectively, and MA_AM, MA_GO, MA_OS, and MA_TG refer to the Millennium Ecosystem Assessment Scenarios Adaptive Mosaic, Global Orchestration, Order from Strength, and TechnoGarden scenarios, respectively (MA 2005).

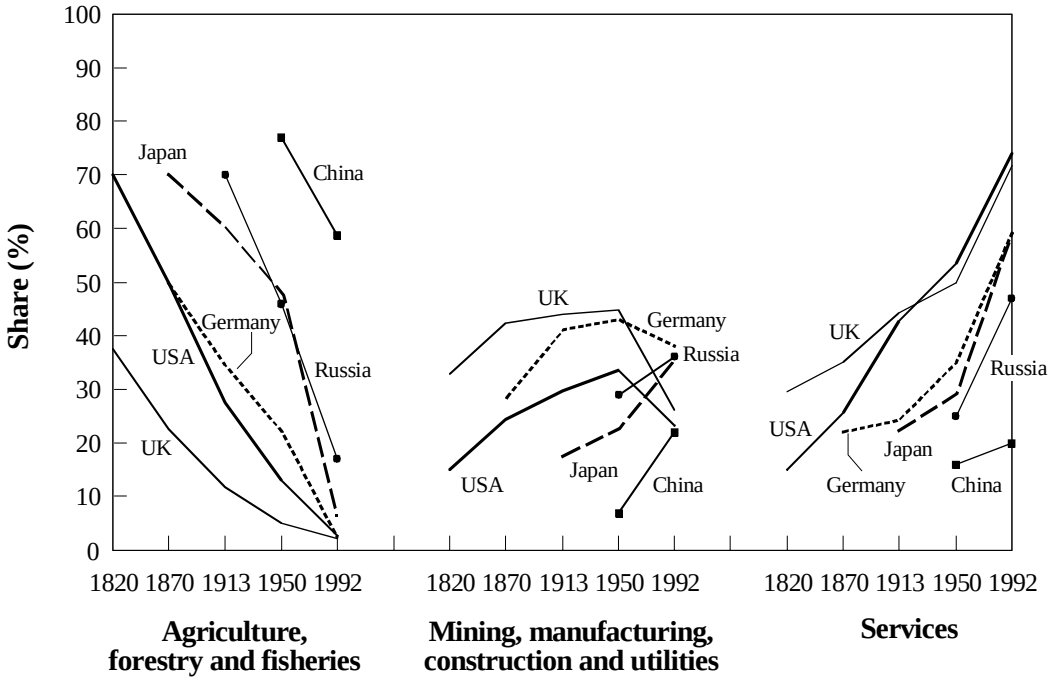
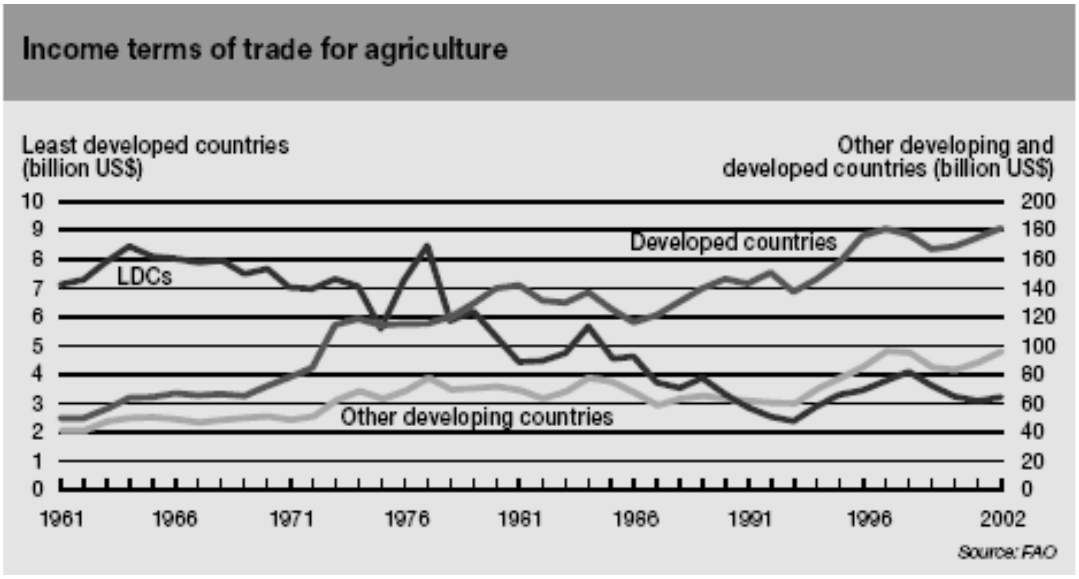
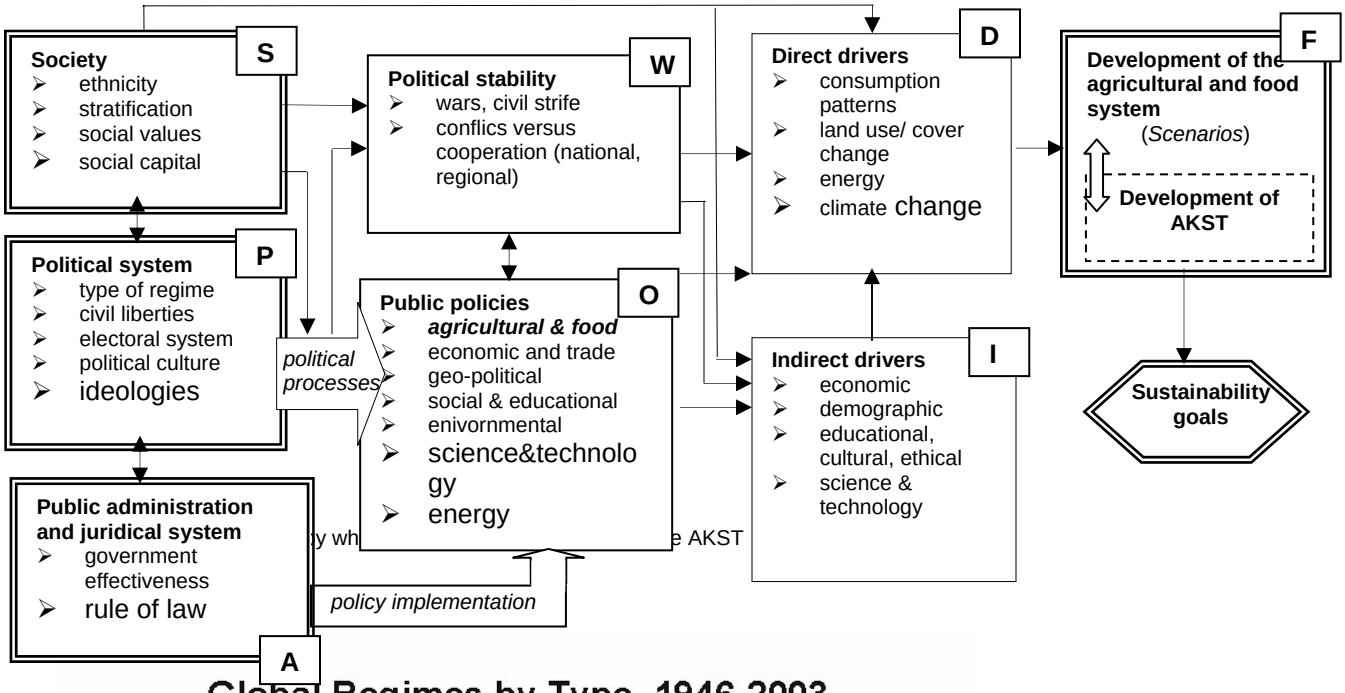


Figure 4.3.2-4. Changes in economic structure for selected countries. Source of figure: MA 2005.



Source: Taken from FAO. 2004. State of Agricultural Commodity Markets 2004. United Nations Food and Agricultural Organization

Figure 4.3.2-5: Income terms of trade for agriculture



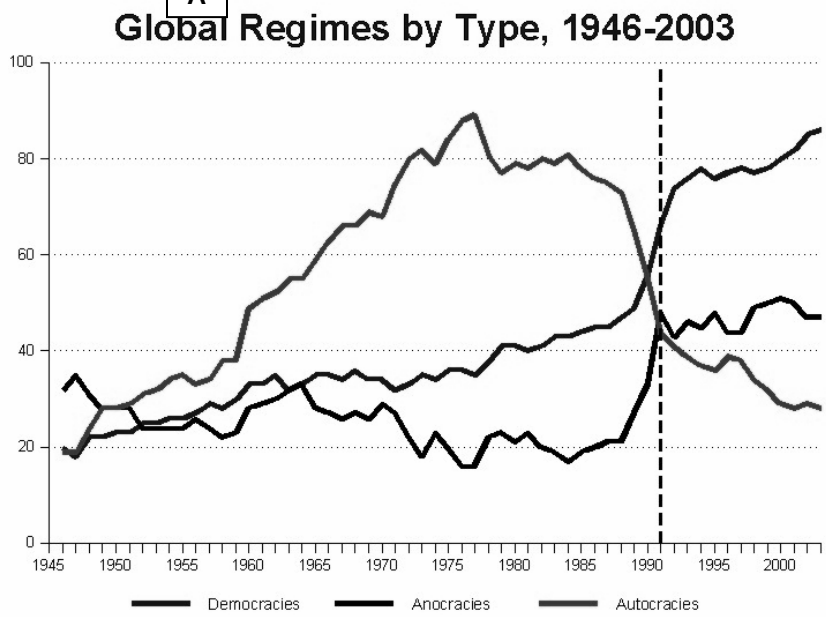


Figure 4.3.3-2: Global Regimes by Type, 1946-2006. Source: http://www.cidcm.umd.edu/inscr/polity/report.htm#ssaf

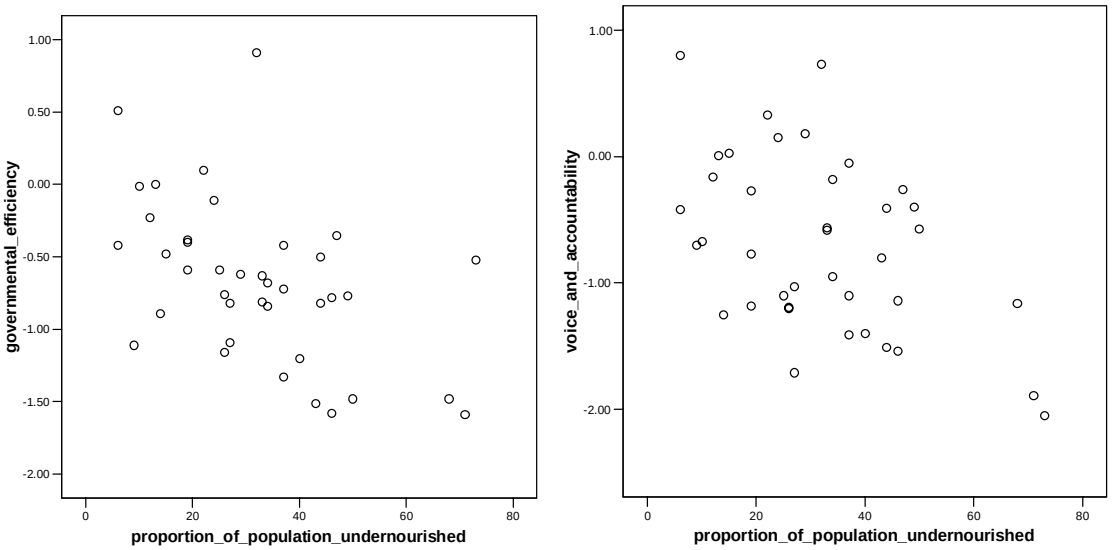


Figure 4.3.3-3: Relation between Governance and Food Security in Sub-Saharan Africa. Sources: Kaufman et al. 2003; FAO 2004.

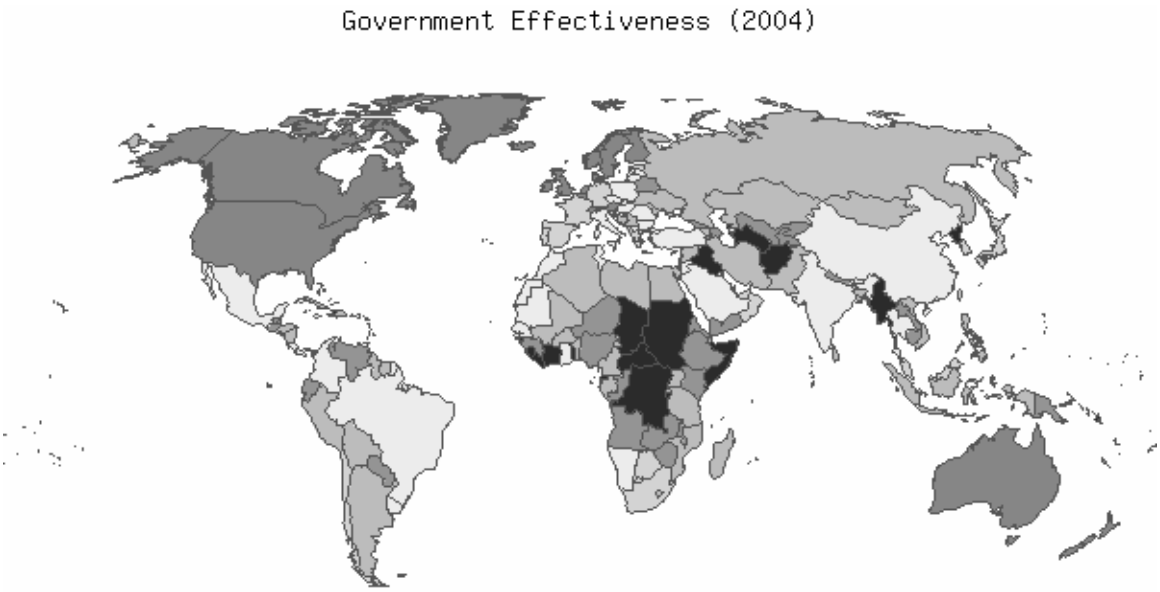


Figure 4.3.3-4: World Map of Government Effectiveness (2004). **Color Coding**: The above map depicts the percentile rank on the governance indicator, subject to a margin of error. Percentile rank indicates the percentage of countries worldwide that rate below the selected country. Each country color pattern follows a simple quartile distribution (for illustrative purposes): the best quartile (over 75th percentile) is in green (with top 10th colored in darker green), the second best quartile (over 50th) is in yellow, the third (over 25th) is in orange, and the fourth is in red (with bottom 10th in darker red). Source: Kaufmann et al. (2005)

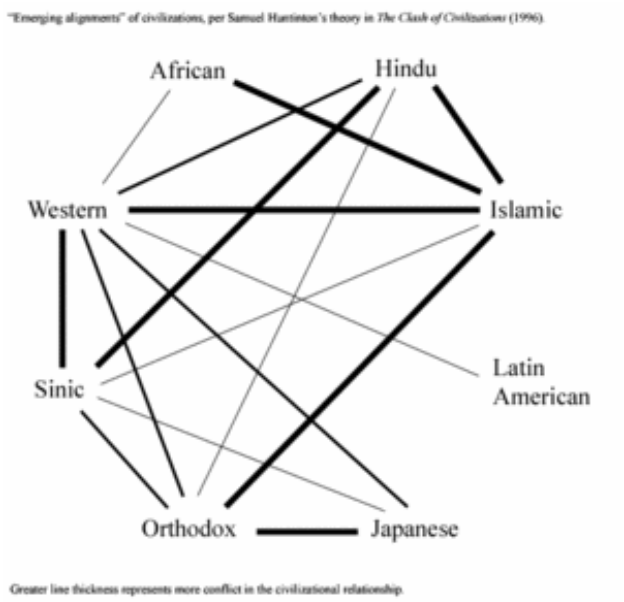


Figure 4.3.3-5: Emerging Alignments and Conflicts Among Civilizations predicted by Huntington in 1996. Note: Thicker lines represent more conflictual relationships

Source: Hungtington (1996).

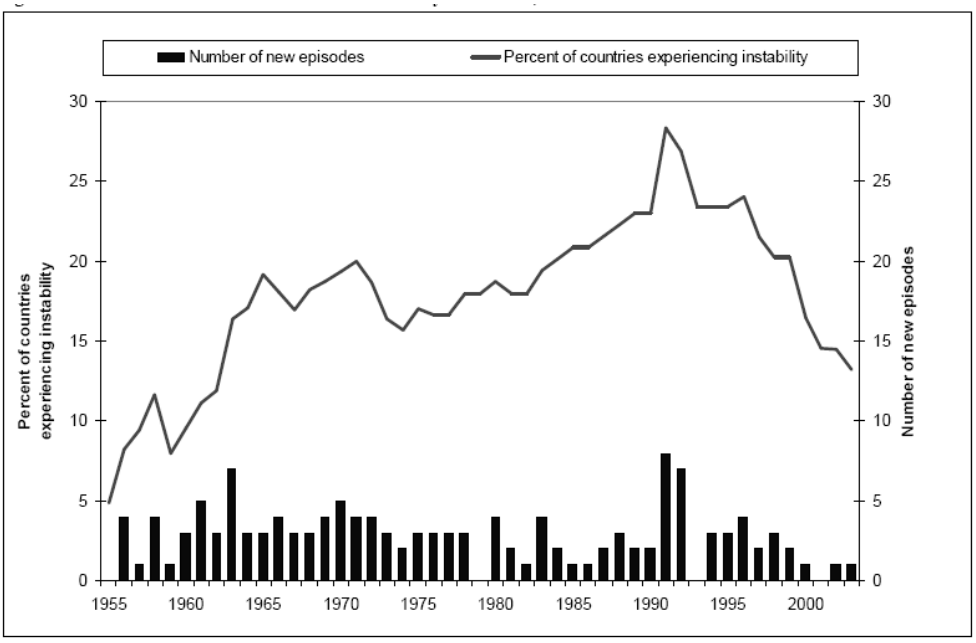


Figure 4.3.3-6: Incidence and Prevalence of Political Instability Worldwide, 1955-2003

Source: Goldstone et al. (2005).

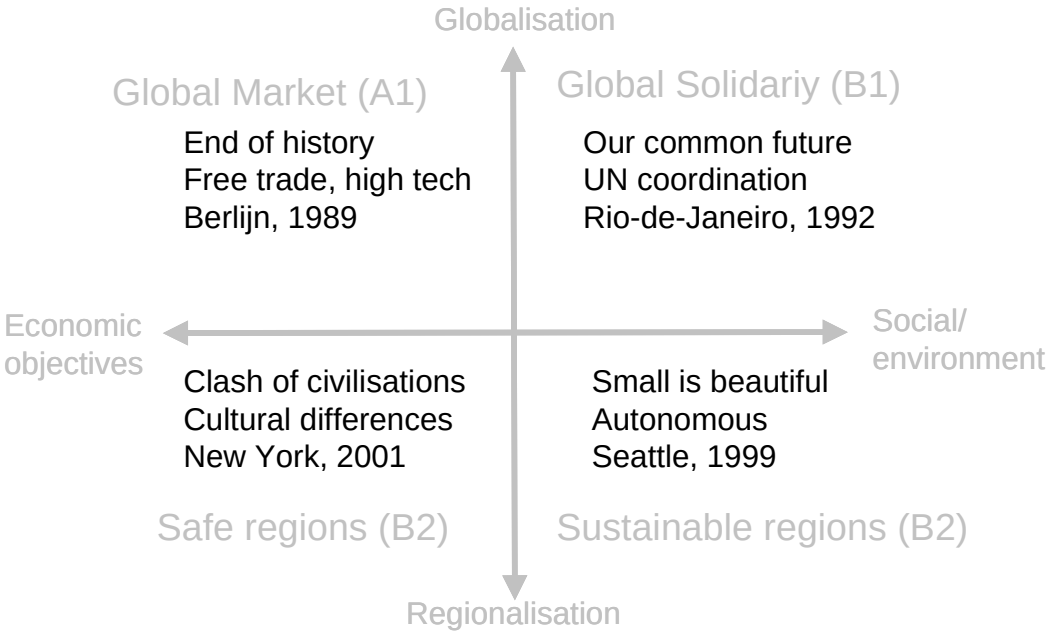
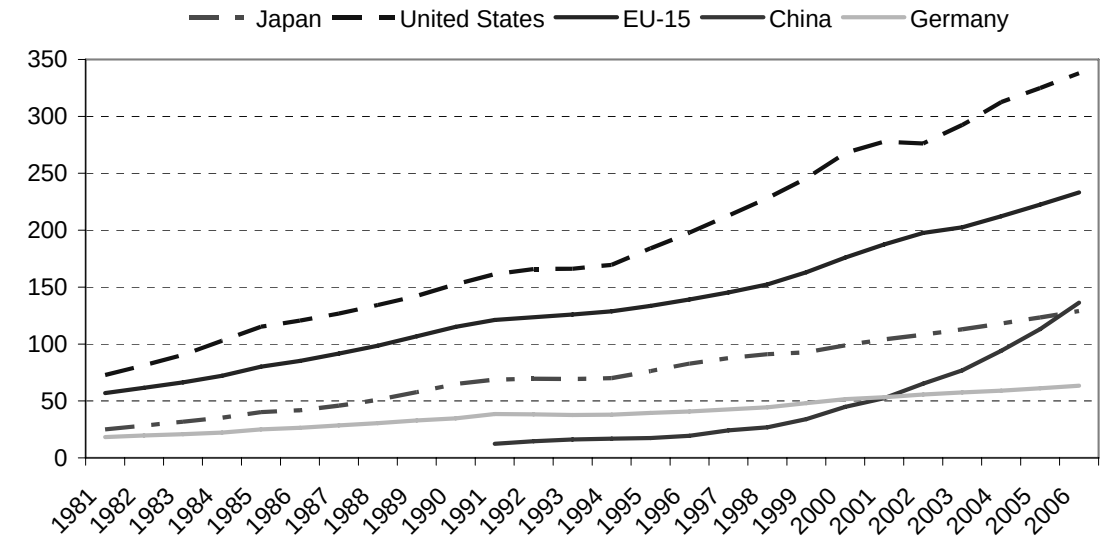
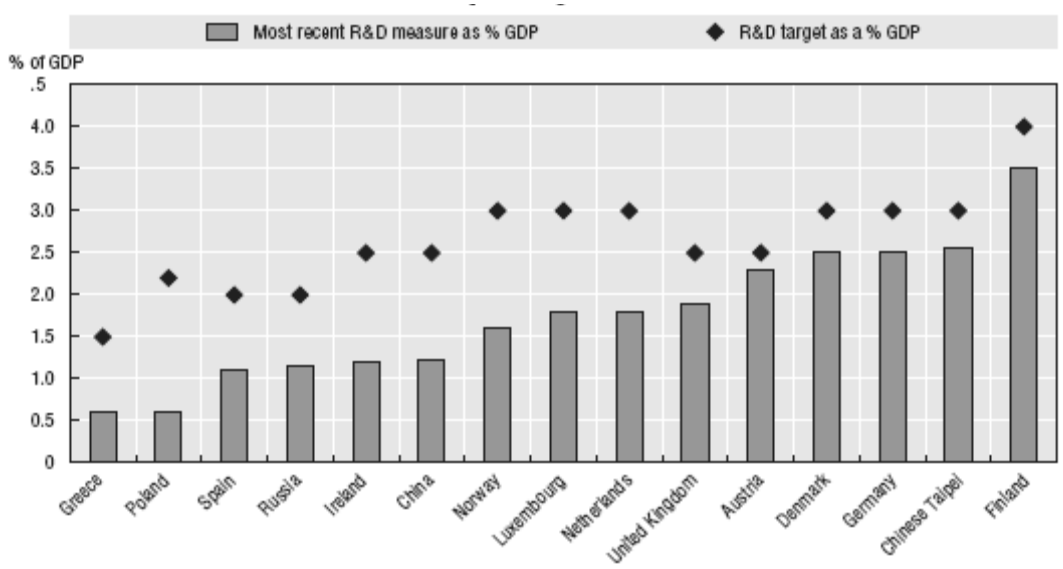


Figure 4.3.3-7: Socio-political drivers in IPCC-SRES as indicated in MNP, 2005.



Note: (1) Figures for 2005 and 2006 are projected on the assumption that growth of R&D expenditure in 2005 and 2006 will be same as average growth over 2000-2004.
Source: OECD, Main Science and Technology Indicators, 2006-I.

Figure 4.3.4-1: Gross domestic expenditure on R&D (billion current ppp$)



Note: R&D target dates range between 2005 and 2014.

Source: OECD, Country responses to STI policy questionnaire, 2006; Main Science and Technology Indicators database, June 2006.

Figure 4.3.4-2: Targets for R&D spending. OECD 2006

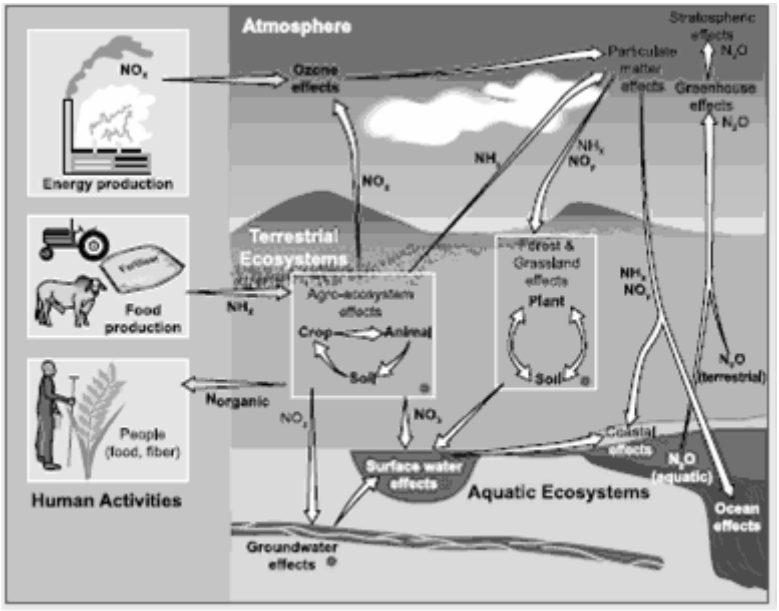


Figure 4.3.6.1: Elements of the biogeophysical system and their relationship with human activities, Source: IGBP (2006).

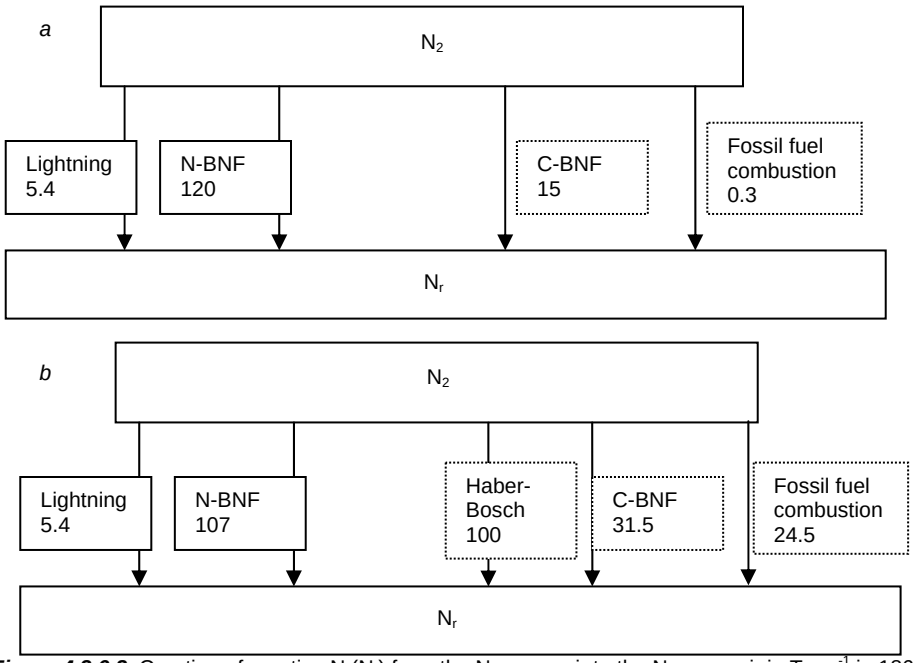


Figure 4.3.6.2. Creation of reactive N (N_r) from the N_2 reservoir to the N_r reservoir in Tg yr^{-1} in 1860 (*a*) and early 1990's (*b*). Anthropogenic processes are depicted by dotted boxes. Based on Galloway et al. (2004).

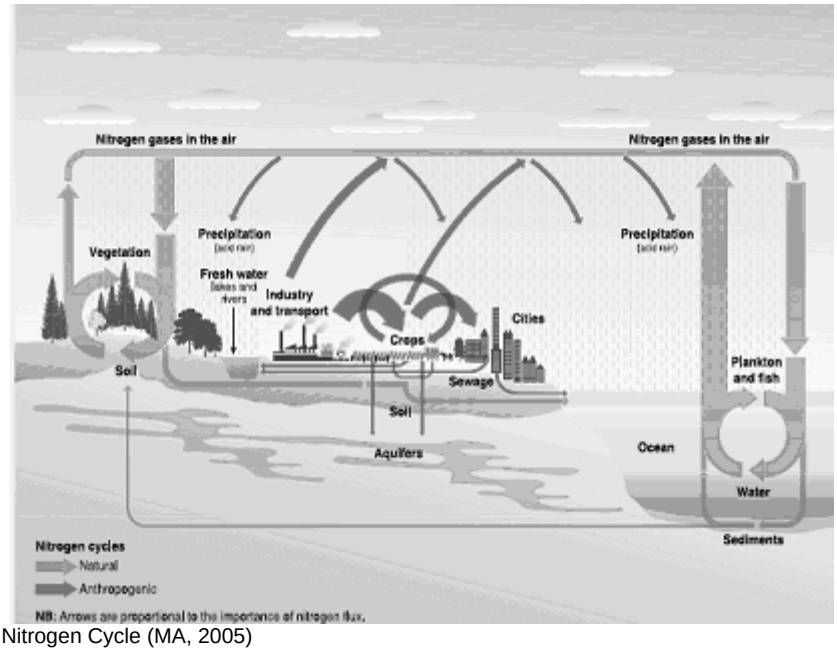


Figure 4.3.6.3: Nitrogen Cycle (MA, 2005)

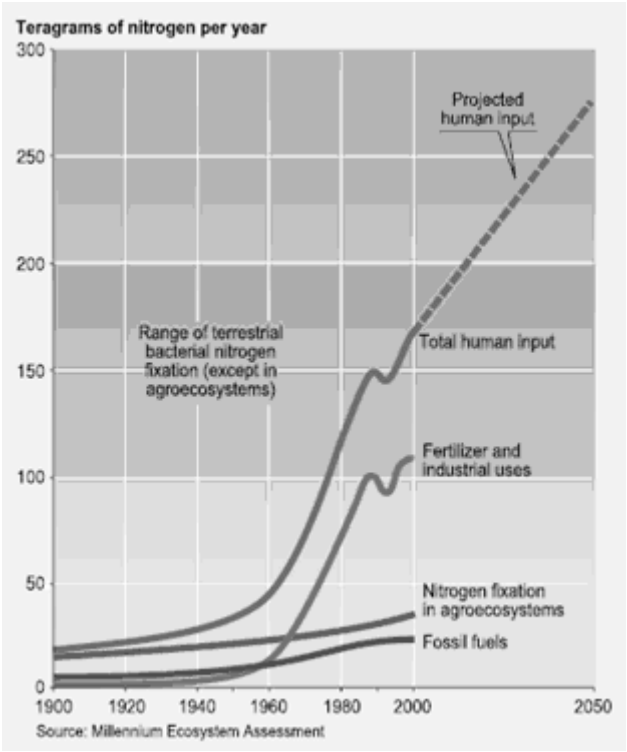


Figure 4.3.6.4: Global trends in and 2050 projections of the creation of reactive Nitrogen by anthropogenic activities (MA, 2005)

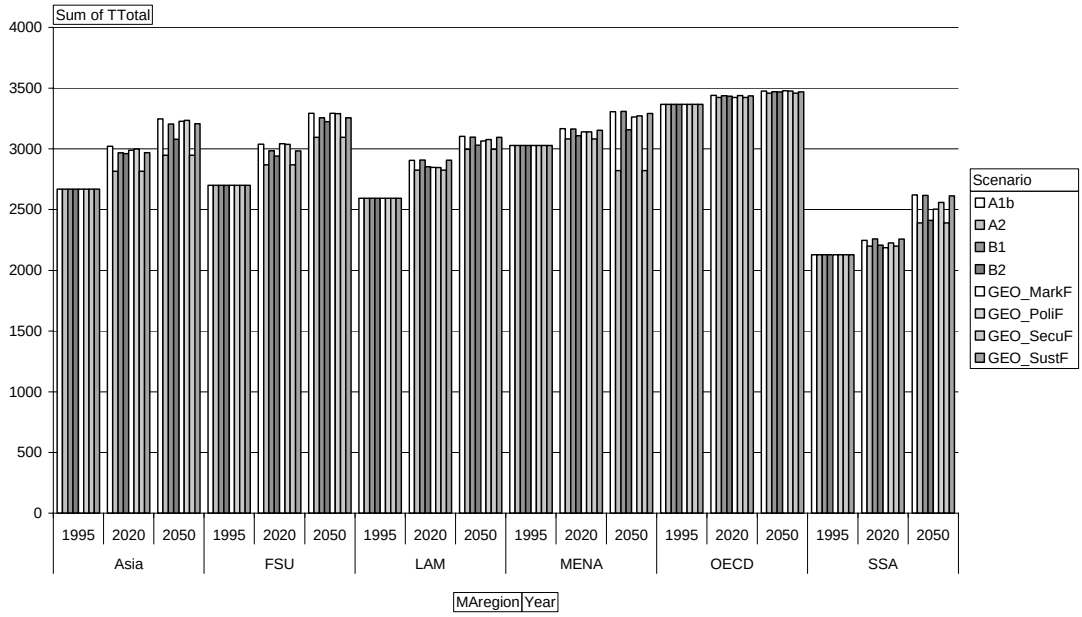


Figure 4.4.1.1 Kilocalorie availability per capita per day, 1995, and projected 2020 and 2050
Notes: A1, A2, B1, and B2 are storylines used in IPCC assessments. The results presented here are data underlying but not reported in the third IPCC Assessment Reports.
GEO_MarkF, GEO_PoliF, GEO_SecuF, and Geo_SustF relate to four storylines used in UNEP's GEO3 assessment: Markets First, Policy First, Security First, and Sustainability First, respectively. These data are not presented in the final GEO3 report.

Source: Westhoek (2005).

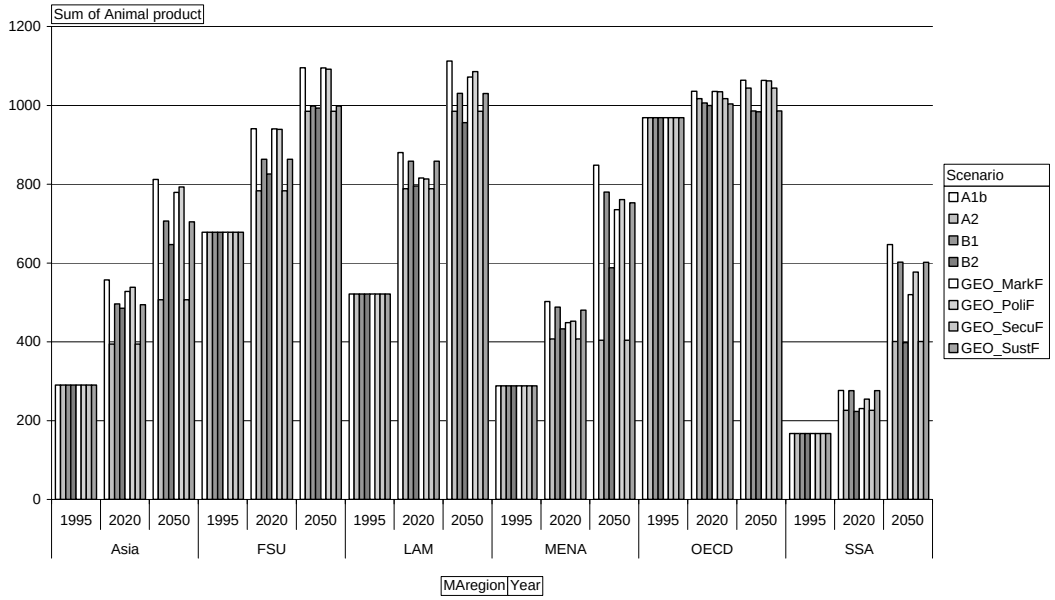


Figure 4.4.1.2 Kilocalorie availability per capita per day from livestock products only, 1995, and projected 2020 and 2050
Notes: A1, A2, B1, and B2 are storylines used in IPCC assessments. The results presented here are data underlying but not reported in the third IPCC Assessment Reports.
GEO_MarkF, GEO_PoliF, GEO_SecuF, and Geo_SustF relate to four storylines used in UNEP's GEO3 assessment: Markets First, Policy First, Security First, and Sustainability First, respectively. These data are not presented in the final GEO3 report.

Source: Westhoek (2005).

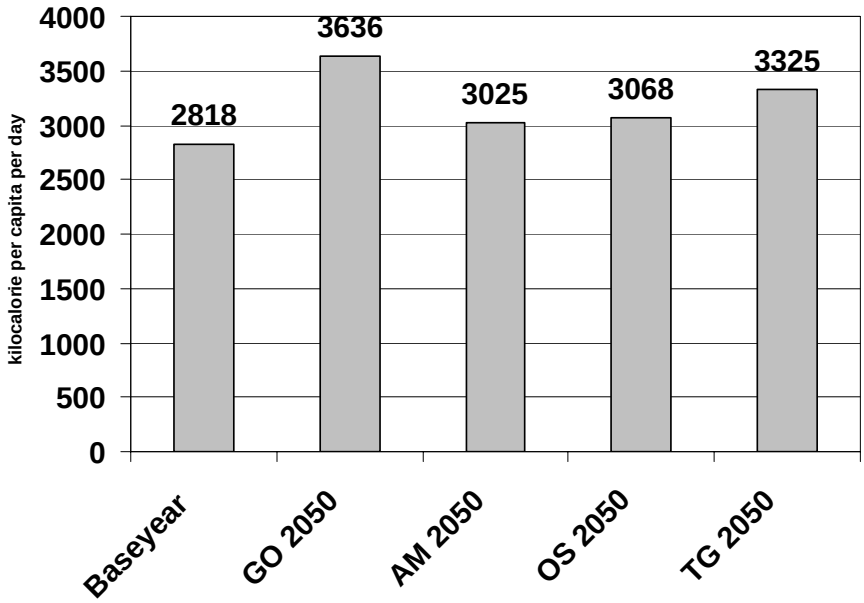


Figure 4.4.1.3 Average global kilocalorie availability per capita per day, Millennium Ecosystem Assessment Scenarios
Notes: GO, AM, OS and TG stand for the Global Orchestration, the Adapting Mosaic, Order from Strength, and TechnoGarden Scenarios, respectively.
Source: MA (2005).

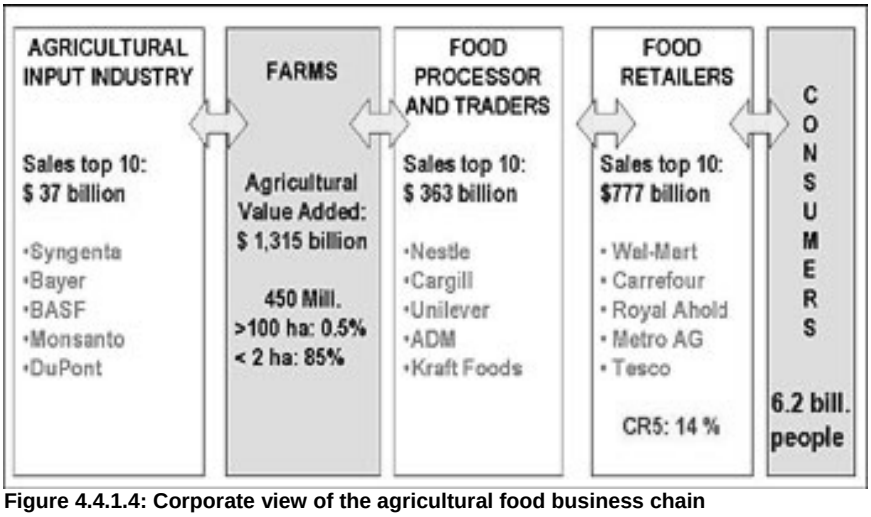


Figure 4.4.1.4: Corporate view of the agricultural food business chain
Note: CR5 represents the market share of the top five companies listed in the global retail industry.
Source: Based on stock market data, http://www.wsj.com and WDI 2005

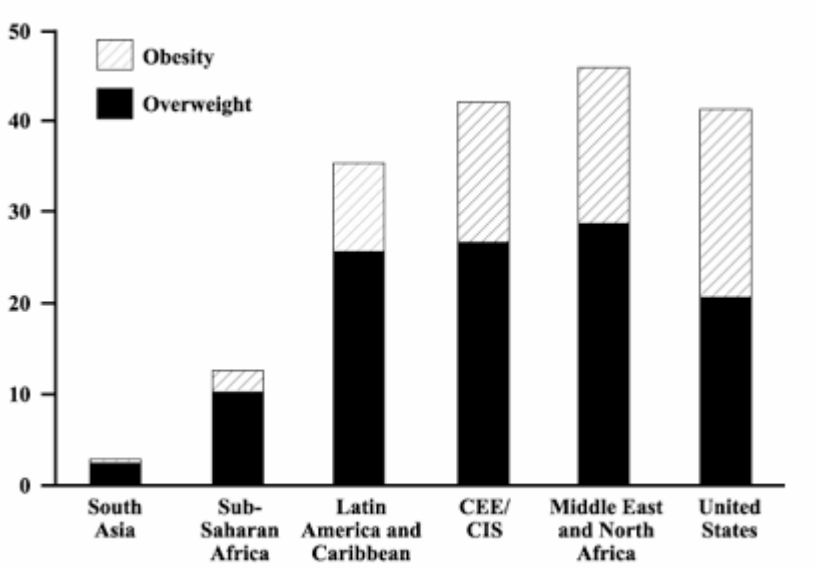
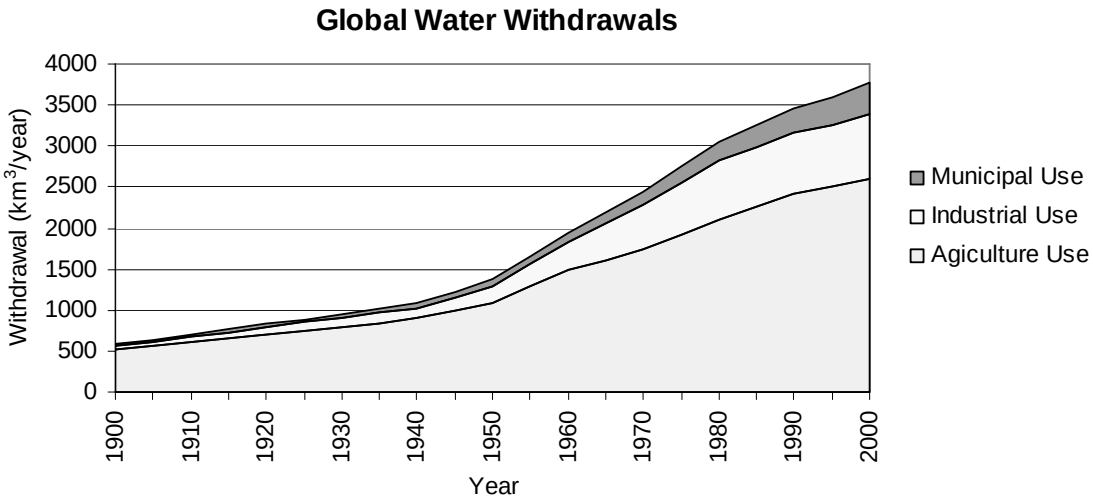
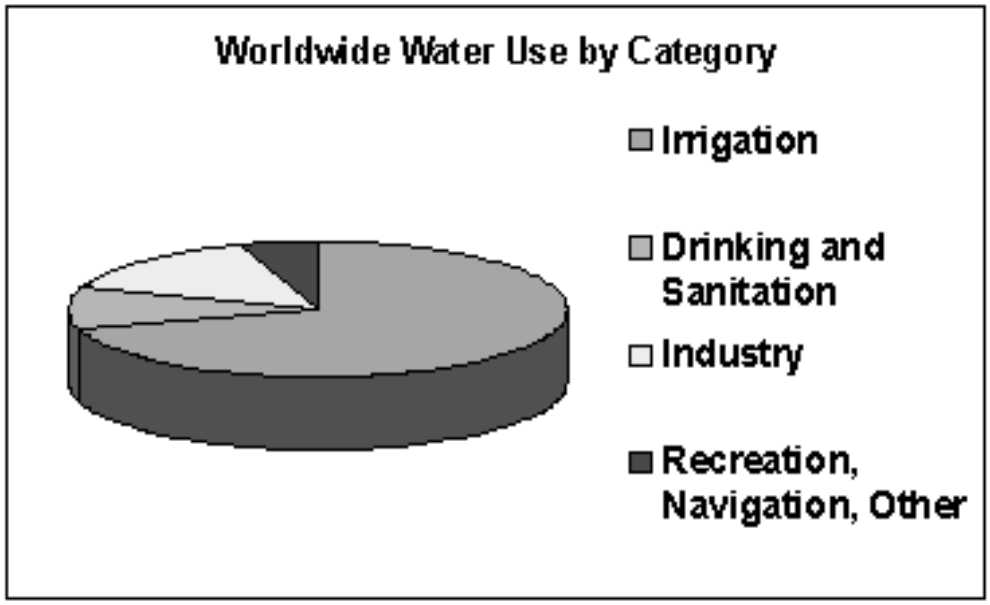


Figure 4.4.1.5: Overweight and Obesity in Women 15 to 49 Years Old in Selected Countries and Regions
Source: Martorell (2001).

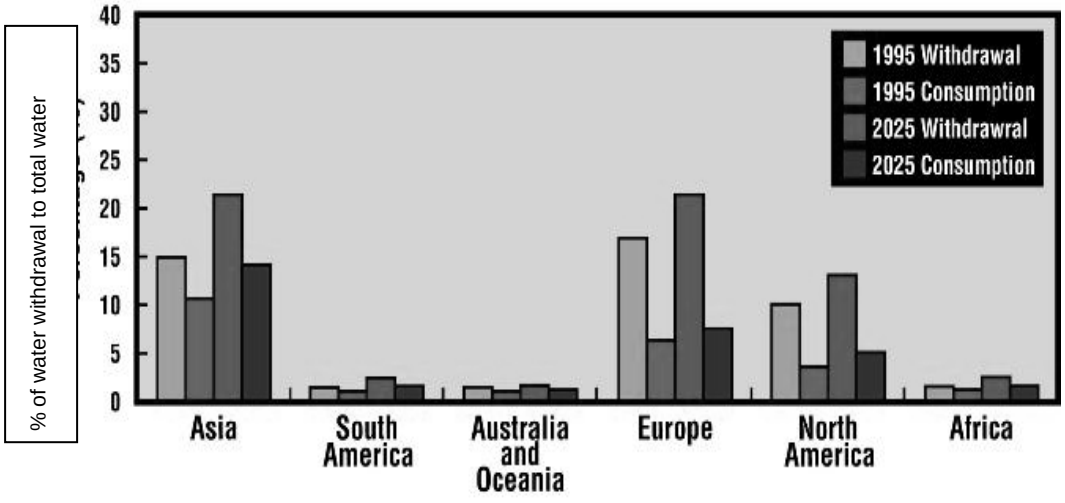


Source: I.A. Shiklomanov in IWRA, Water International, Vol. 25, No. 1, March 2000
Figure 4.4.2-1: Global water withdrawals



http://www.unesco.org/science/waterday2000/water use in the world.htm

Figure 4.4.2-2: Worldwide water use by category



Source: www.unesco.org/science/waterday2000/ water_use_in_the_world.htm

Figure 4.4.2-3: Regional water withdrawal patterns

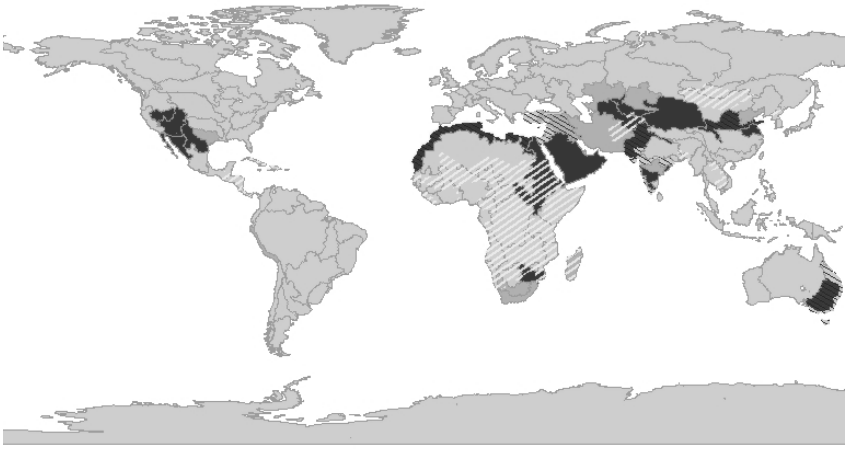


Figure 4.4.2-4: Water scarcity map 2000
Source: IWMI-CA 2006

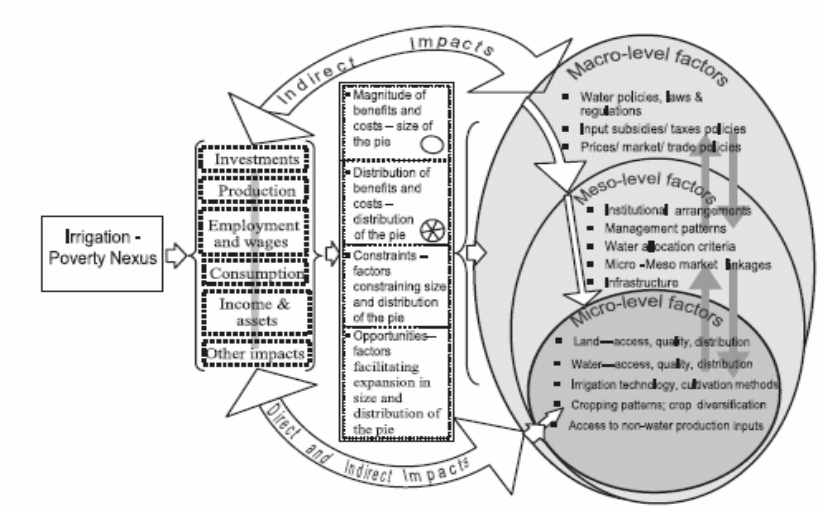


Figure 4.4.2-5 Irrigation-poverty alleviation linkages.

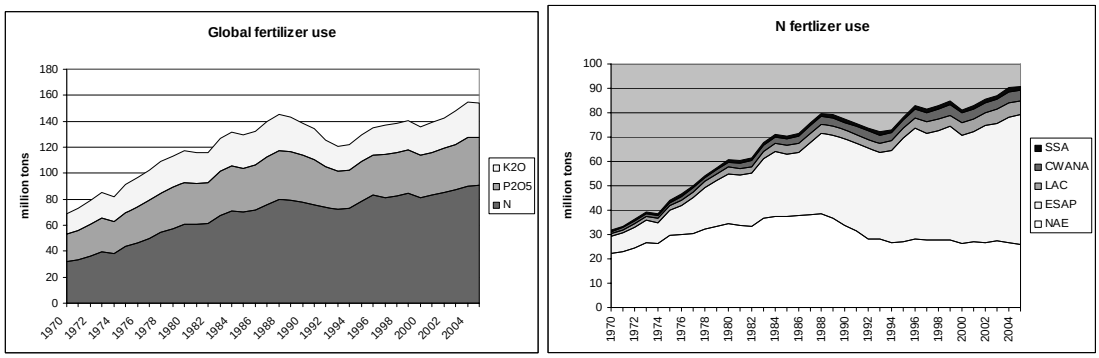


Figure 4.4.2.6 Global fertilizer use 1970-2005, divided over N, P2O5 and K2O and N fertilizer use per region. Source: IFA, 2006

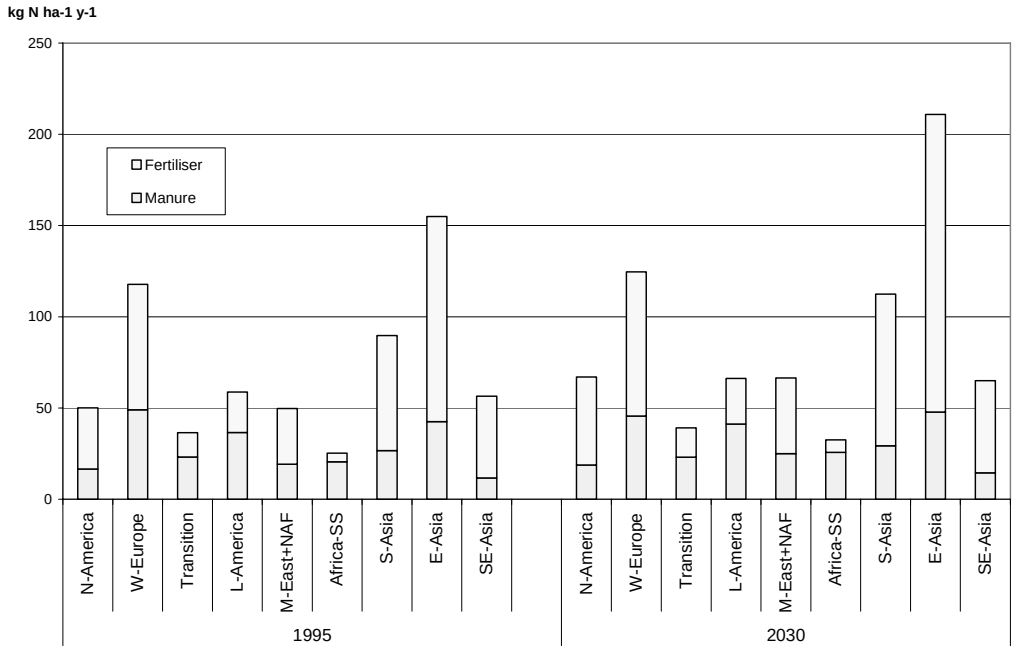


Figure 4.4.2.7 Projection of N-fertiliser use

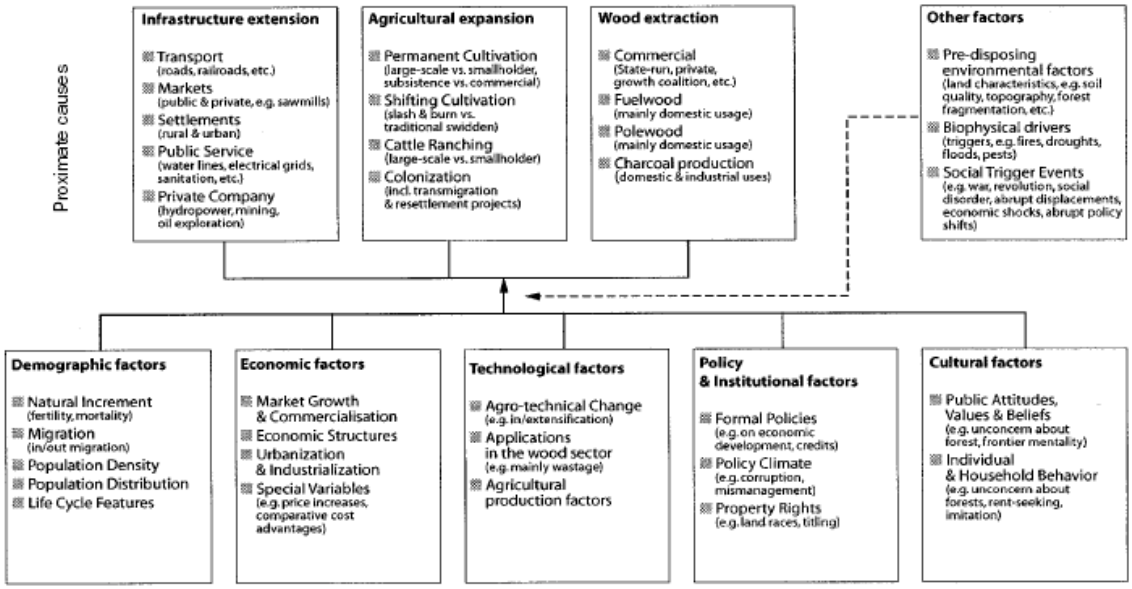


Figure 4.4.3-1. Clusters of indirect and direct drivers of land cover change
Source: Adapted from Figure 1 in Geist and Lambin (2004).

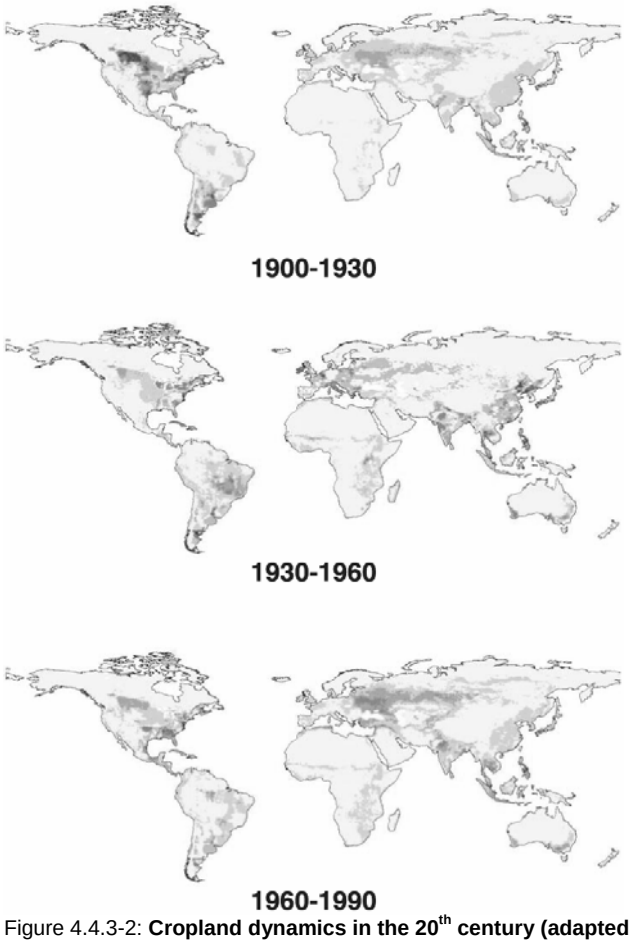


Figure 4.4.3-2: **Cropland dynamics in the 20th century (adapted from Ramankutty et al., 2002)**

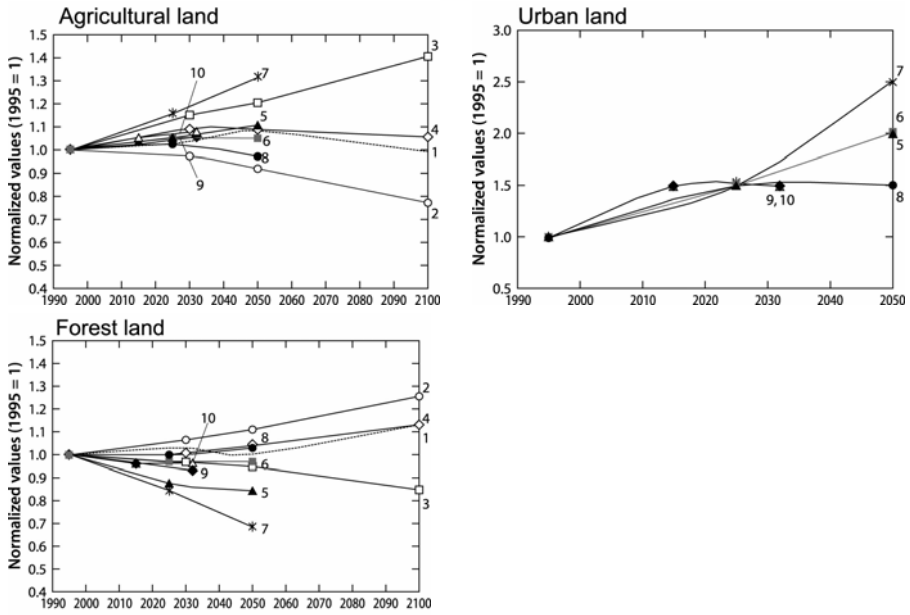


Figure 4.4.3-3: Projections of future land cover (1990 – 2050/2100)**.**
Redrawn with permission from Alcamo et al. (2006)

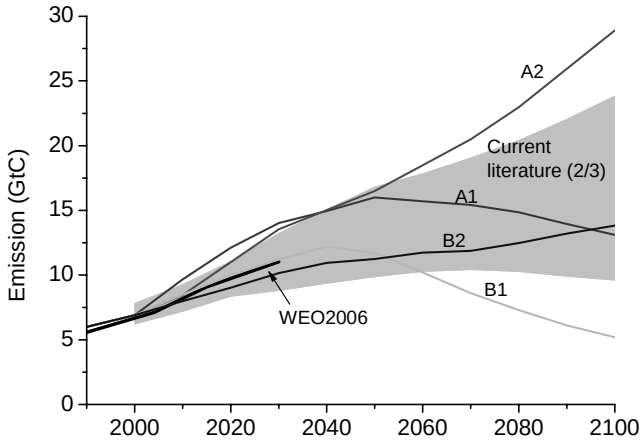


Figure 4.4.4.1: Comparison of current CO_2 emission scenarios (scenarios since IPCC's Third Assessment Report 2001; mean + std. deviation), IPCC-SRES and WEO2006.

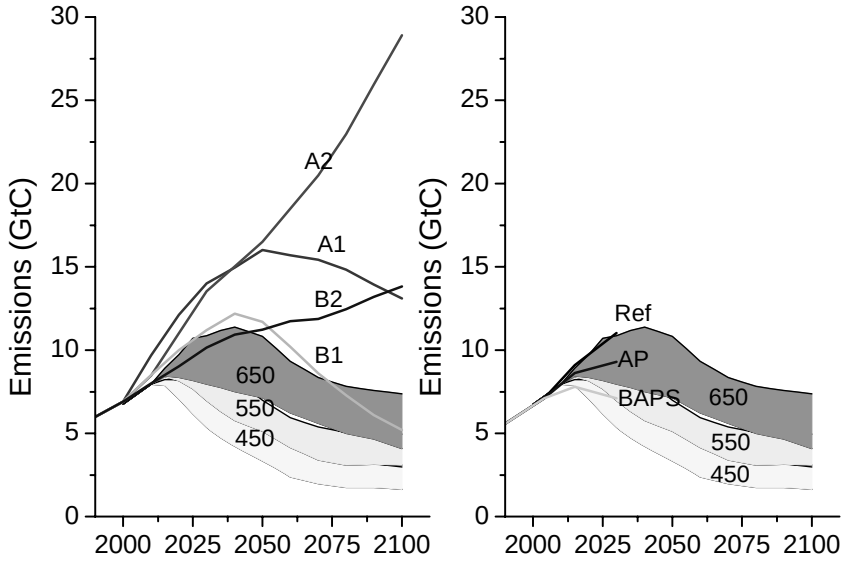


Figure 4.4.4.2: Comparison of emission pathways leading to 650, 550 and 450 ppm CO_2-eq. and the IPCC-SRES scenarios (left) and the WEO-2006 scenarios

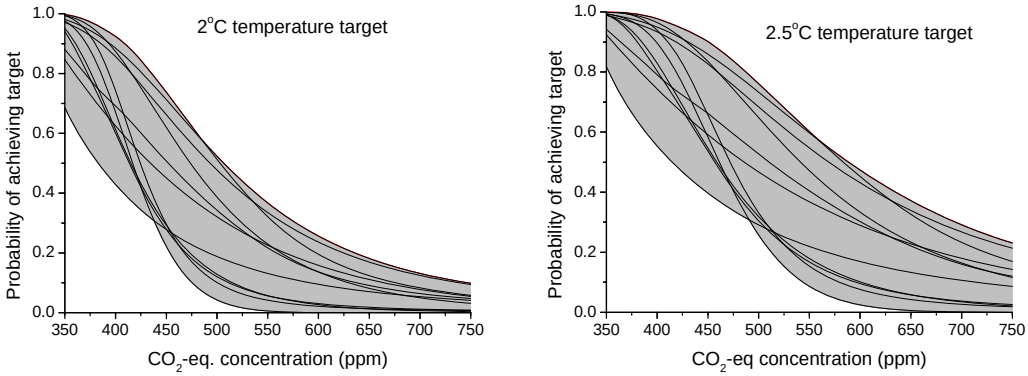


Figure 4.4.4.3: Probability of equilibrium temperature change staying within the 2°C or 2.5°C limit for compared to pre-industrial for different CO_2-eq. concentration levels compared to pre-industrial (following calculations of (Meinshausen, 2006). Note: The lines indicate the probability function as indicated in the individual studies quoted by (Meinshausen, 2006); the grey area indicates the total range between the highest and lowest study.

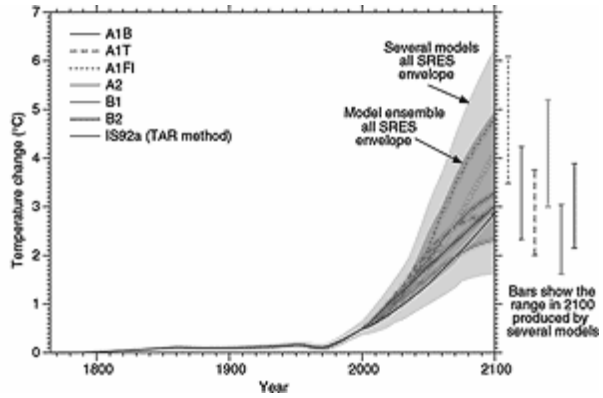


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Figure 4.4.4-4: Global mean temperature change under the different IPCC scenarios scenarios based on the uncertainty in emissions and the climate sensitivity (IPCC, 2001)

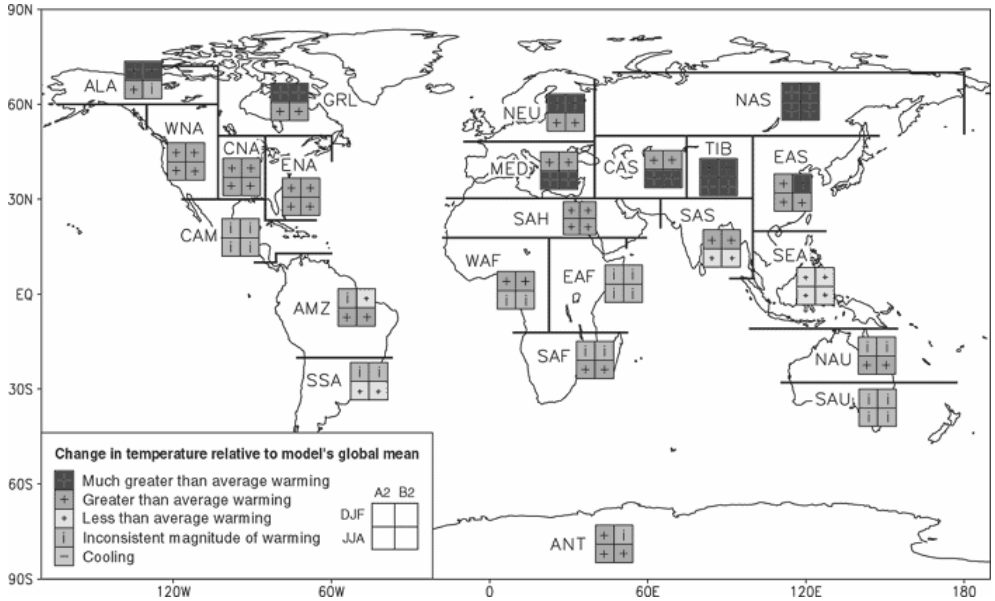

Figure 4.4.4-5: Change in temperature relative to global mean temperature change (IPCC, 2001).

Blue= with adaptation
Red= no adaptation

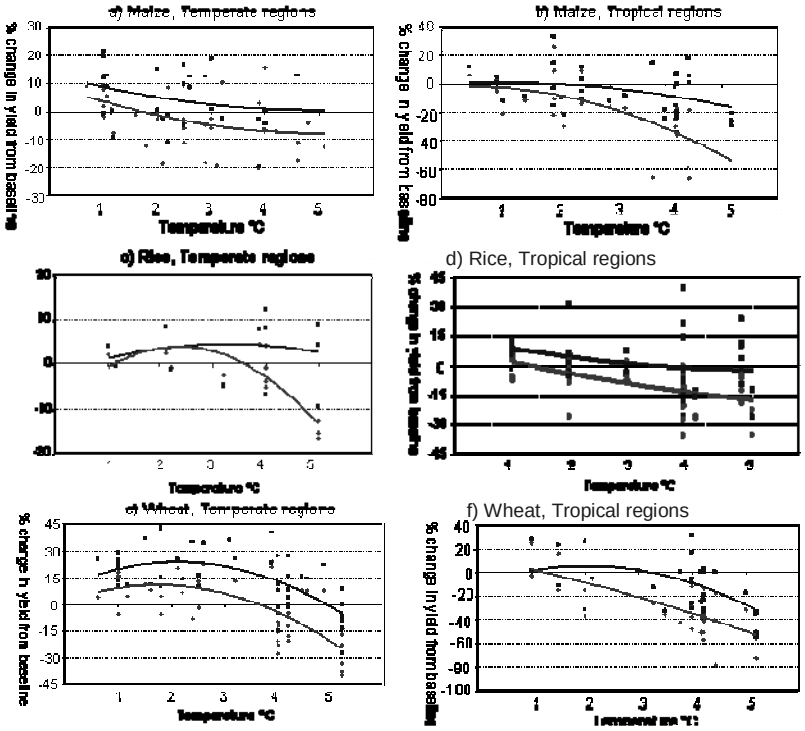

Figure 4.4.4-6: Yield sensitivity to climate change for major cereal crops, divided into temperate and tropical regions – from crop simulations with comparable climate scenarios.

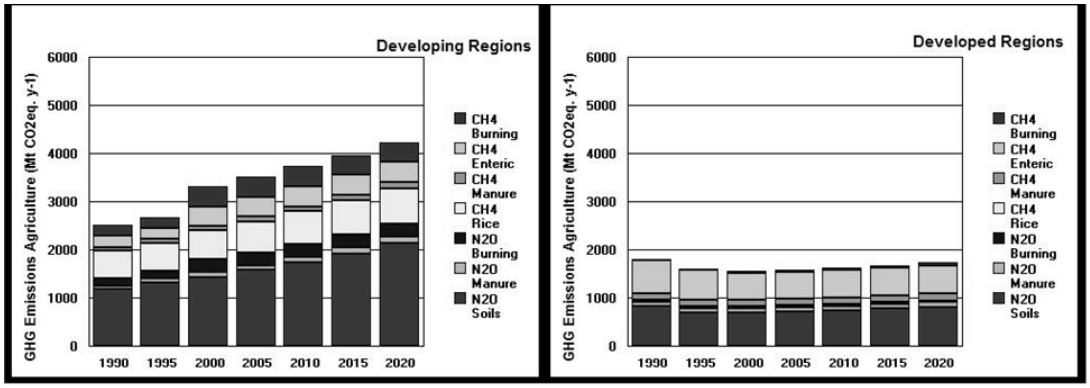

Figure 4.4.4.7: Estimated historical and projected N_2O and CH_4 emissions in the agricultural sector of the ten world regions during the period 1990-2020. Source: IPCC, 2007 (adapted from US-EPA, 2006a)

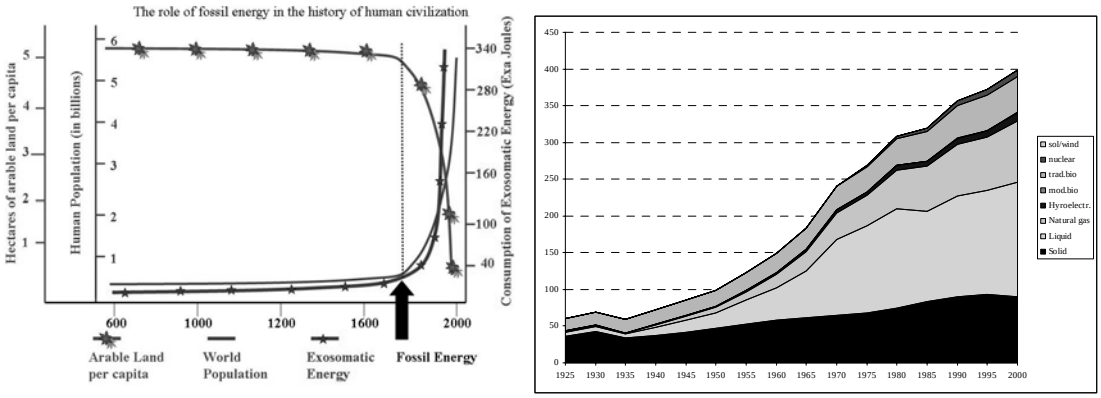

Figure 4.4.5.1: Energy and agriculture in historic context. Left trends in the 600-2000 period. Right, global energy use in the 1880-2000 period.

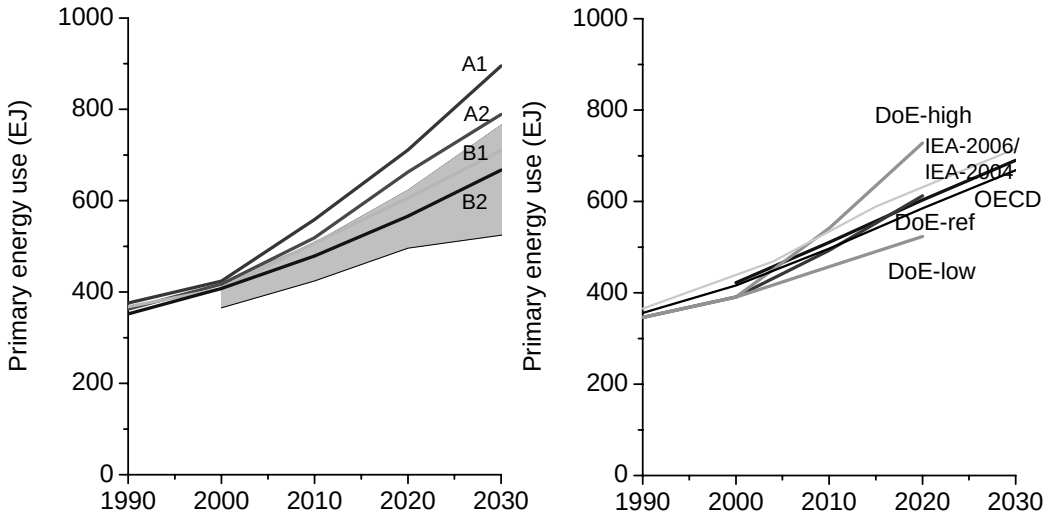

Figure 4.4.5-2: Trends in 21st century energy use. Comparison of trends in SRES total primary energy consumption and more recent studies by US.DoE and IEA. DoE = Projections from US. DoE (2004a), IEA-2004 = Projection from the International Energy Agency. (IEA, 2004). .

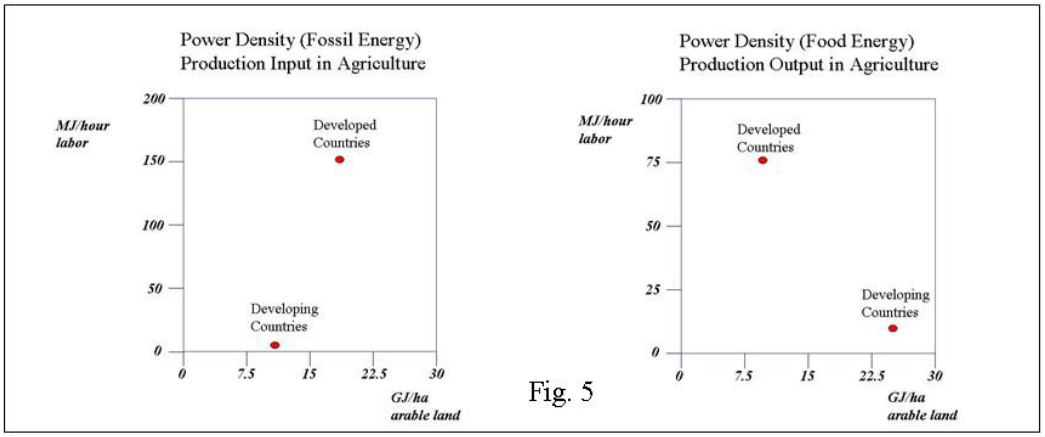

Fig. 5

Figure 4.4.5-3: Comparison of developing and developed countries with respect to different indicators

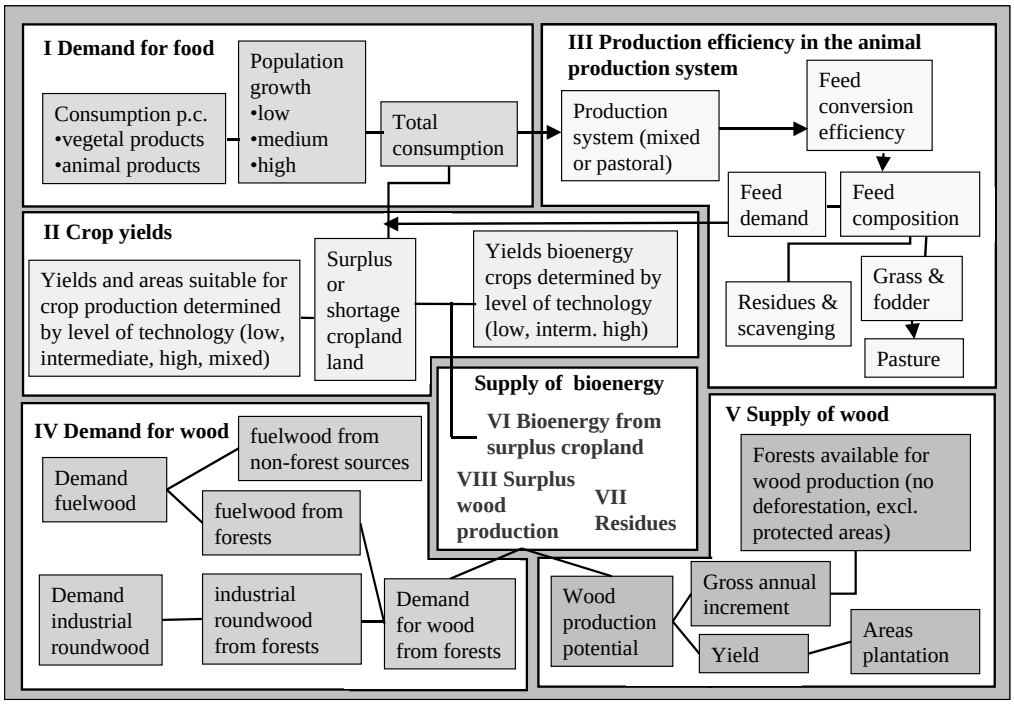

Figure 4.4.5.4: Key elements in the assessment of bio-energy potential

Figure 4.49. Cash flow per hour of work and the economic investment required per worker. (The graph on the right is shows (i) the spatial density of the cash flow and (ii) the available area of production system per household).

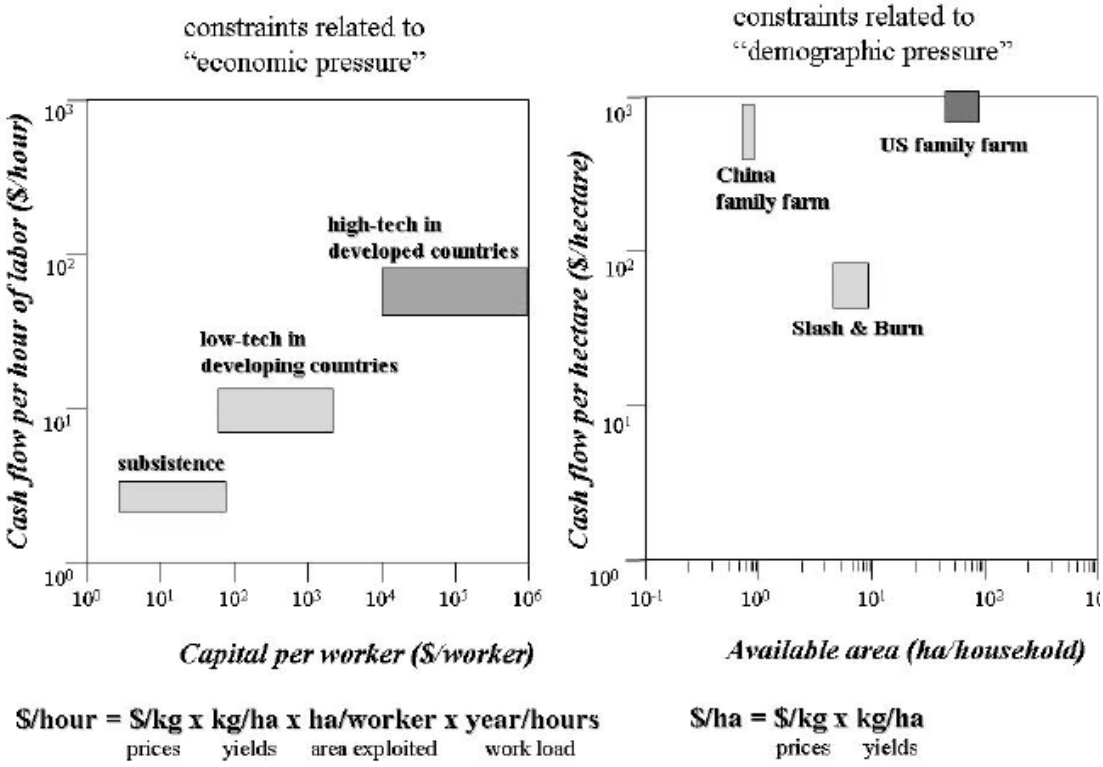

Figure 4.5.1. Global land use patterns in MA scenarios in 2050. Scenario names: GO: Global Orchestration; TG: Techno Garden; AM: Adapting Mosaic; OS: Order from Strength (figures produced by IMAGE 2.2). Source: Alcamo et al. (2005).

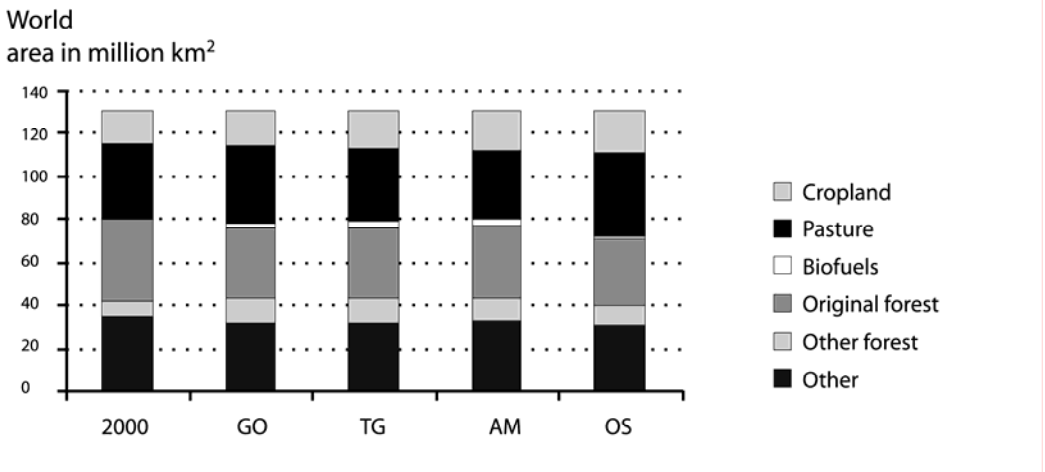

Figure 4.5.2 Global land use patterns in MA scenarios in 2050. Scenario names: GO: Global Orchestration; TG: Techno Garden; AM: Adapting Mosaic; OS: Order from Strength (figures produced by IMAGE 2.2). Source: Alcamo et al. (2005).

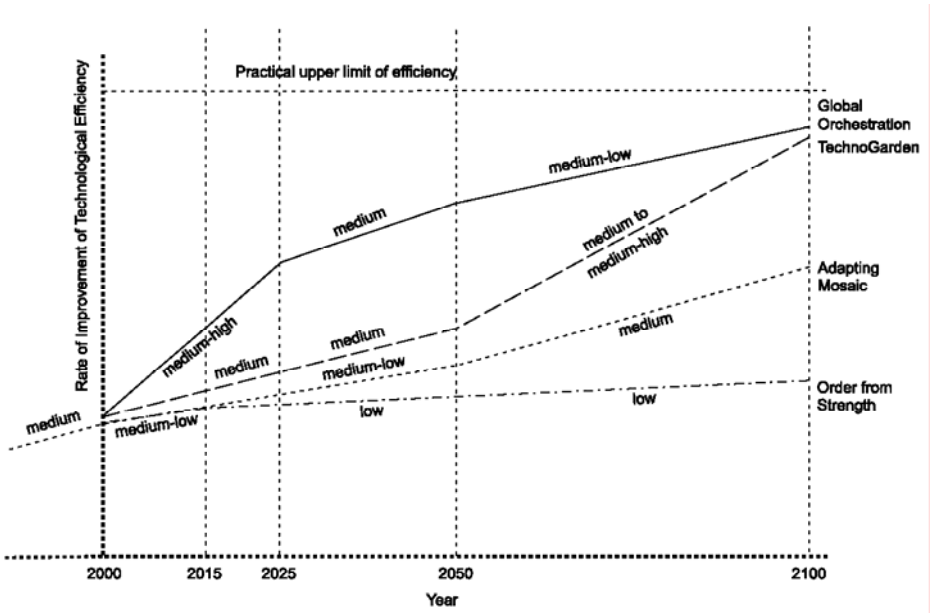

Figure 4.5.3. Global trends of technological efficiencies in MA scenarios. Technological Efficiency refers, for example, to the conversion efficiency of power plants, or the yield of all crops per hectare. Source: Alcamo et al. (2005).

Table 4.2-1: Overview of relevant global scenario studies

	Main focus	Character of assessment
GSG	Sustainable development	Strong focus on storyline, supported by quantitative accounting system
IPCC-SRES	Greenhouse gas emissions	Modelling supported by simple storylines. Multiple models elaborate the same storyline to map out uncertainties.
IPCC-TAR and AR4	Climate change, causes and impacts	Assessment of available literature and some calculations on the basis of IPCC-SRES
UNEP-GEO3/GEO4	Global environmental change	Storylines and modelling; modelling on the basis of linked models
MA	Changes in ecosystem services;	Storylines and modelling; modelling on the basis of linked models
FAO-AT2020	Changes in agriculture	Single projection, mostly based on expert judgement.
IFPRI	Changes in agriculture	Model-based projections
CA	Water and agriculture	Storylines and modelling; modelling on the basis of linked models

Table 4.2-2: Overview of existing assessment and their relationship to agriculture

	IPCC - SRES	UNEP - GEO-3	MA	GSG	IFPRI 2020	FAO 2030
Production	i.e. lucc					
Distribution		indirect	indirect	indirect	indirect	
Exchange		trade	trade	trade	trade	trade
Affordability						
Allocation		market	market		market	indirect
Preference						
Nutritional Value						
Social Value						
Food Safety						

Legend: Address food system qualitatively ( ) or quantitatively ( )

Table 4.2.3 Key assumptions in different scenario 'archetypes'

Economic optimism	Reformed Markets	Global SD	Regional competition	Regional SD	Business as Usual

Economic development	very rapid	rapid	ranging from slow to rapid	slow	ranging from mid to rapid	medium (globalisation)
Population growth	low	low	low	high	medium	medium
Technology development	rapid	rapid	ranging from mid to rapid	slow	ranging from slow to rapid	medium
Main objectives	economic growth	various goals	global sustainability	security	local sustainability	not defined
Environmental protection	reactive	both reactive and proactive	proactive	reactive	proactive	both reactive and proactive
Trade	globalisation	globalisation	globalisation	trade barriers	trade barriers	weak globalisation
Policies and institutions	policies create open markets	policies reduce market failures	strong global governance	strong national governments	local steering; local actors	mixed

Note: This table summarises key assumptions in very general terms. Where differences within a set of archetypes exist, broad ranges are indicated.

Table 4.2.4 Recent scenario-based assessments mapped against scenario 'archetypes'

	IPCC-SRES	**UNEP GEO-3**	**GSG**	**MA**	**IFPRI**	**FAO**
Conventional Markets	A1	Markets First	Conventional worlds		Optimistic scenario	
Reformed Markets		Policies First	*Policy reform*	*Global Orchestration*		
Global SD	*B1* (B1-450)	Sustainability First		TechnoGarden		
Regional Competion	A2	Security First	Barbarisation	Order from Strength	*Pesimistic scenario*	
Regional SD	*B2*		Great transitions	Adapting Mosaic		
Business as Usual	*B2*				Reference scenario	FAO AT2020

Note: Italics are used to indicate that scenarios are not completely consistent with the group in which it is categorised.

Table 4.3.1.1 Share of Population dependent on agriculture in total Population

	1989-91	1994-96	1998-00	
	(percent)			
World	46.4	44.4	42.8	
Developed countries	10.6	9.0	7.9	
Transition markets	20.1	17.6	15.8	
Developing countries	57.6	54.8	52.6	
Latin American Countries	26.3	23.3	21.1	
The Caribbean Countries	29.3	26.9	25.2	
Near East and North Africa	35.7	32.8	30.5	
Sub-Saharan Africa	69.7	66.9	64.7	
East and South East Asia and China	65.6	62.8	60.4	
South Asia	59.2	56.7	54.7	
Africa	60.8	58.1	56.1	
North and Central America	13.0	11.9	11.0	
South America	23.7	20.7	18.7	
Asia excluding (eight) Former USSR Republics	58.8	56.2	54.0	
Europe excluding (Seven) Former USSR Republics	10.2	8.4	7.2	

Table 4.3.1.2 Population projections in different assessments

	Projections
IPCC-SRES	4 scenarios ranging from 8.7-11.4 billion people in 2050
MA	4 scenarios ranging from 8.1-9.6 billion people in 2050
FAO, 2001	
IFPRI	
GEO4	
OECD outlook	1 scenario; UN-medium (9.1 billion)

Table 4.3.1.3: Percentage of migrants in different regions/countries from 1985 to 2005

Year	World	MDR	LDR	LDC	NA	OC	AF	AS	EU	LA
1985	2.3	4.6	1.6	2.0	8.2	17.0	2.6	1.3	4.8	1.6
1990	2.9	7.2	1.8	2.1	9.7	17.8	2.6	1.6	6.9	1.6
1995	2.9	8.1	1.6	2.0	11.2	17.5	2.5	1.4	7.6	1.3
2000	2.9	8.8	1.5	1.5	12.8	16.3	2.0	1.4	8.0	1.2
2005	3.0	9.5	1.4	1.4	13.5	15.2	1.9	1.4	8.8	1.2

Table 4.3.2-1. Per capita GDP growth rates for selected regions and time periods (percent per year).

	1870-1913	1913-1950	1950-1980	1980-1992	1992-2000*
Western Europe	1.3	0.9	3.5	1.7	1.7
Australia, Canada, New Zealand, U.S.	1.8	1.6	2.2	1.3	2.4
Eastern Europe	1.0	1.2	2.9	-2.4	2.4

Latin America	1.5	1.5	2.5	-0.6	-5.2
Asia	0.6	0.1	3.5	3.6	1.7
Africa	0.5	1.0	1.8	-0.8	2.7
World (sample of 199 countries)	1.3	0.9	2.5	1.1	1.9

Source: (Maddison 1995) (needs updated data to 2000)
**Calculated from WDI (2005) using $ 2000 PC GNP; Sample of 208 Countries as [(100/ 1993 GNP) *(2000 GNP – 1993 GNP)/9]*

Table 4.3.2.-2: Income Growth Assumptions, FAO 2030-2050 (preliminary results)

		GNI per Capita $		growth rates, percent per annum					
	World Bank Region*	WB Atlas 2002	PPP 2002	Total GDP at market prices 2000 -2030	Total GDP at market prices 2030 -2050	Per capita GDP at market prices 1980 -1990	Per capita GDP at market prices 1990 -2000	Per capita GDP at market prices 2000 -2030	Per capita GDP at market prices 2030 -2050
		1	2	3	4	5	6	7	8
World	World total	5121	7848	3.1	3.2	1.3	1.2	2.1	2.7
Developing countries		1077	3755	4.8	4.6			3.6	4.0
Sub-Saharan Africa	Sub Saharan Africa	450	1700	3.8	4.3	-1.1	-0.5	1.6	2.8
Near East/North Africa	Middle East and North Africa	2240	5670	4.1	4.1	-1.1	1.0	2.4	3.1
Latin America and the Caribbean	Latin America and the Caribbean	3280	6950	3.4	3.5	-0.9	1.6	2.3	3.1
South Asia	South Asia	460	2460	6.0	5.5	3.3	3.2	4.7	4.9
East Asia	East Asia and Pacific	960	4280	6.0	5.0	5.8	6.3	5.3	5.0
Industrial countries	High income countries	26490	28480	2.5	2.5	2.5	1.8	2.2	2.4
Transition countries	Europe and Central Asia	2160	6900	4.3	3.8	0.9	-1.8	4.5	4.3

Notes: *Cols 1, 2, from World Bank (2004).*
GNI=Gross National Income, formerly named Gross National Product (GNP);
Col. 3, based largely on World Bank projections to 2030 for World Bank (2005);
Col. 4, FAO assumptions.
Cols 5-6 from World Bank (2006): Table 1.2;
Cols 7-8, computed from Cols 1, 3, 4 and population projections in Table 2.4

*The country coverage of the World Bank groups is similar, though not identical to that in the FAO study, e.g. Turkey is included in the group (low and middle income) Europe and Central Asia, South Africa in sub-Saharan Africa, while Korea Rep., Hong Kong and Taiwan (Province of China) are in the High-Income Countries (World Bank classification from World Bank, 2005: Table A.51).

Source: Taken *from Prospects for food, nutrition, agriculture and major commodity groups: World Agriculture 2030-2050*, FAO 2006 http://www.fao.org/es/ESD/AT2050web.pdf

Table 4.3.2-3: Per capita income growth projections, Millennium Ecosystem Scenarios

Region	Historic	Global Orchestration		Techno Garden		Adapting Mosaic		Order from Strength	
	1971-2000	1995-2020	2020-2050	1995-2020	2020-2050	1995-2020	2020-2050	1995-2020	2020-2050
Former Soviet Union	0.4	3.5	4.91	2.94	4.49	2.6	4.03	2.24	2.64
Latin America	1.2	2.8	4.28	2.36	3.93	2.06	2.99	1.78	2.29
Middle East/North Africa	0.7	1.96	3.42	1.74	3.27	1.61	2.43	1.51	1.75
OECD	2.1	2.45	1.93	2.22	1.74	2	1.56	2.06	1.31
Asia	5	5.06	5.28	4.24	4.7	3.76	4.12	3.22	2.43
Sub-Saharan Africa	-0.4	1.69	3.97	1.44	3.8	1.21	2.85	1.02	2.12
World	1.4	2.38	3	1.9	2.46	1.46	1.91	1.39	1.04

Source: MA (2005).

Table 4.3.2-4. Global average GDP growth results (%, 2005-2030): Baseline World Growth

	2005-10	**2010-20**	**2020-30**	**2005-30**
OECD	2.8	2.2	2.0	2.2
- North America	3.5	2.5	2.3	3.1
--US & Canada	3.4	2.4	2.3	2.6
--Mexico	5.3	3.6	3.1	3.7
- Europe	2.5	2.1	1.8	2.1
- Pacific	1.6	1.8	1.3	1.6
--Asia	1.4	1.7	1.2	1.5
--Oceanía	3.5	2.5	2.2	2.6
Transition Economies	4.7	3.7	3.4	4.6
- Russia	4.7	3.9	3.6	3.9
- Other Transition economies	4.8	3.5	3.2	4.4
Developing countries	5.6	4.2	3.9	5.2
- China	7.2	4.9	4.1	5.0
- East Asia	5.3	4.3	3.7	4.3
--Indonesia	5.7	4.5	3.9	4.5
--Other East Asia	5.2	4.3	3.7	4.2
- South Asia	6.5	5.1	4.5	5.1
--India	6.5	5.2	4.5	5.2
--Other South Asia	6.5	4.8	4.4	5.0
- Middle East	4.6	3.6	3.9	3.9
- Africa	5.4	4.2	4.4	4.5
- Latin America	3.8	2.9	2.8	3.6
--Brazil	3.4	2.8	2.5	2.8
--Other Latin America	3.9	3	3	3.2
World	3.4	2.7	2.5	2.8

Table 4.3.2-5: World Primary commodity prices, 1999-2004 (% change over previous year)

	1999	2000	2001	2002	2003	2004
Tropical beverages	-21.3	-15.3	-21.0	12.7	5.6	6.4
Food	-16.9	2.0	3.0	-1.0	2.0	14.4
Oilseeds & oils	-26.5	-20.0	-6.0	24.5	17.1	13.1
Agricultural raw materials	-10.2	3.1	-4.0	-2.1	19.1	9.8

Table 4.3.2-6 : Investment in food security under the baseline scenario, 1997-2020

Region/Country	Irrigation	Rural Roads	Education	Clean Water	National Agricultural Research	Total Investments
			Billions of US Dollars			
Latin America	44.8	36.7	12.1	9.8	37	140.4
West Asia/North Africa	17.9	7.3	21.5	8.5	25.3	80.5
Sub-Saharan Africa	28.1	37.9	15.7	17.3	8	106.9
South Asia	61.3	27.4	14.5	27	18	148.2
India	42.5	23.5	10.5	18.4	15.6	110.5
Southeast Asia	18.6	3.9	6.8	9.4	14.1	52.6
China	3.2	6.8	2.4	14.4	14.6	41.4
Developing countries	174.6	120.3	75.9	86.5	121.7	578.9

Source: IFPRI IMPACT Projections, June 2001.

Table 4.3.2.7: CAADP areas of primary intervention

Areas of Primary Action	US$ billion
Extending the area under sustainable land management & reliable water control system	68
Improving rural infrastructure and trade-related capacities for market access	129
Increasing food supply and reducing hunger	49,5
Agricultural research, technology dissemination and adoption	4,6
Annual	

Source: NEPAD.

Table 4.3.3.1: Availabe indicators and data sources on historic trends in social and political drivers.

Data source	Description.
Polity IV:	Compiled by the Center for International Development and Conflict Management at the University of Maryland, College Park. Currently, the data set covers 161 countries for the time period from 1800 to 2003. Polity IV calculates a democracy and autocracy index, and a polity index which combines the two.
Freedom House	Freedom House has produced annually “Freedom in the World Ratings” since 1972. A combined score of a political rights and civil liberties index. Freedom House compiles these indices for 192 countries and 18 territories.
International Country Risk Guide (ICRG)	Covering 140 countries from 1980 to the present, the ICRG is a product of the Political Risk Services (PRS) Group that analyzes and forecasts risk for international investors. The ICRG contains 22 components that are grouped into three categories of risk: political, financial, and economic.

Aggregate Governance Indicators	This dataset developed by the World Bank Institute (Kaufmann et al., 2005), includes six indicators: voice and accountability, political stability, government effectiveness, regulatory quality, rule of law and control of corruption. The 2004 dataset covers 209 countries and territories, and the indicators are based on several hundred individual variables, drawn from data collected by 31 different organizations.
Other Governance Indicators	In total there are 130 different data sets of governance. However, many governance data sets are characterized by an "urban bias". An exception is the "rural investment climate" index compiled by the World Bank (2006), which assesses the investment climate for rural non-farm enterprises.
World Values Survey	The World Values Survey contains more information on socio-cultural drivers. This survey is carried out by a network of social scientists using nationally representative samples of the publics of more than 80 societies. A total of four waves have been conducted since 1981, making it possible to carry out global cross-cultural analyses and analysis of changes over time.

Table 4.3.4.1 Five Commonalities in Innovation Process (IPCC)

1.The process is fundamentally uncertain: outcomes cannot be predicted.
2.Innovation draws on underlying scientific or other knowledge.
3. Some kind of search or experimentation process is usually involved.
4. Many innovations depend on the exploitation of "tacit knowledge" obtained through "learning by doing" or experience.
5. Technological change is a cumulative process and depends on the history of the individual or organization involved."

Table 4.3.4.2: R&D share of gross domestic product, by country, 2000-2003, National Science Foundation 2006.

Country/economy	Share (%)	Country/economy	Share (%)
Total OECD (2002)	2.26	China (2002)	1.22
European Union-25 (2002)	1.86	New Zealand (2001)	1.16
Israel (2003)	4.90	Ireland (2001)	1.13
Sweden (2001)	4.27	Italy (2001)	1.11
Finland (2002)	3.46	Brazil (2000)	1.04
Japan (2002)	3.12	Spain (2002)	1.03
Iceland (2002)	3.09	Hungary (2003)	0.95
United States (2003)	2.67	Portugal (2002)	0.94
South Korea (2003)	2.64	Turkey (2002)	0.66
Switzerland (2000)	2.57	Greece (2001)	0.65
Denmark (2002)	2.52	Cuba (2002)	0.62
Germany (2003)	2.50	Poland (2002)	0.59
Belgium (2003)	2.33	Slovak Republic (2003)	0.59
Taiwan (2002)	2.30	Chile (2001)	0.57
France (2002)	2.26	Argentina (2003)	0.41
Austria (2003)	2.19	Panama (2001)	0.40
Singapore (2002)	2.15	Costa Rica (2000)	0.39
Netherlands (2001)	1.88	Mexico (2001)	0.39
Canada (2003)	1.87	Romania (2002)	0.38
United Kingdom (2002)	1.87	Bolivia (2002)	0.26
Luxembourg (2000)	1.71	Uruguay (2002)	0.22
Norway (2002)	1.67	Peru (2003)	0.11
Australia (2000)	1.54	Colombia (2002)	0.10
Slovenia (2002)	1.53	Trinidad and Tobago (2001)	0.10
Czech Republic (2003)	1.34	Nicaragua (2002)	0.07
Russian Federation (2003)	1.28		

OECD = Organisation for Economic Co-operation and Development

NOTES: Civilian R&D only for Israel and Taiwan. Data for latest available year in parentheses. The European Union-25 is comprised of the following countries: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, The Netherlands, and United Kingdom.

SOURCES: National Science Foundation, Division of Science Resources Statistics, National Patterns of R&D Resources (annual series); OECD, *Main Science and Technology Indicators* (2004); and Iberomerican Network of Science and Technology Indicators, http://www.ricyt.edu.ar, accessed 1 May 2005.

Table 4.3.5.1[A]. School-age population in WEI countries[B]

Statistical parameters	Change in population size between 1998 and (est.) 2015[C] (%)		
	ages 5-14	ages 15-19	ages 20-29
mean	7.2	17.6	31.7
± C.I.[D]	11.67	12.48	12.12

[A] Data was obtained from Table 2 in OECD-UNSECO (2003)
[B] Argentina, Brazil, Chile, China, Egypt, India, Indonesia, Jamaica, Jordan, Malaysia, Paraguay, Peru, Philippines, Russian Federation, Thailand, Tunisia, Uruguay and Zimbabwe
[C] Reference year is 2000
[D] Half the 0.95 confidence interval for the given mean

Table 4.4.1.1: Food expenditures and share of energy from staples, based on household expenditure surveys, selected African and Asian countries

Country	Year of household survey	Percent of expenditures on food	Expenditures on food, rural	Expenditures on food, urban	Share of energy from staples, rural	Share of energy from staples, urban
Burundi	1998	76.1	77.1	57.7	62.8	52.8

Ethiopia	1999	63.1	64.7	54.0	84.6	75.1
India	1999	58.7	61.0	52.5	69.8	57.5
Kenya	1997	74.8	78.7	59.0	63.9	53.3
Malaysia	1999	39.1	41.9	36.7	53.9	50.0
Pakistan	1998	50.9	52.9	45.8	58.3	50.9
Rwanda	2000	81.6	84.2	58.6	63.6	53.4
Senegal	2001	61.0	65.5	55.0	60.0	49.7

Source: For Asian countries: Smith and Subandoro (2005); for African countries: Smith, Alderman, and Aduayom (2005).

Table 4.4.1.2: Projections of food budget shares and share of expenditures on grains, selected countries

	Food budget shares		Share of expenditures on grains	
	1985	2020	1985	2020
Ethiopia	0.52	0.51	0.22	0.21
Senegal	0.41	0.37	0.13	0.11
United States	0.11	0.07	0.02	0.01

Source: Cranfield et al. (1998).

Table 4.4.1.3 Incorporation of changing food demand patterns in global assessment studies

No	Assessment Title	Publication Date	Projections timeframe	Food demand mentioned	Projections follow / adapted from
1	GEO-3 Assessment	2002	2032		FAO (2015/2030 outlook)
2	GEO-4 Assessment	Forthcoming 2007	2000-2050	Explicitly	IFPRI IMPACT
3	IPCC 3rd Assessment	2001	Various	Not explicitly	Various, IPCC-SRES
4	IPCC 4th Assessment	Mimeo	Various	Not explicitly	Various, IPCC-SRES
5	Millennium Ecosystem Assessment	2005	2000-2100	Explicitly	IFPRI IMPACT
6	Comprehensive Assessment of Water Management in Agriculture	Mimeo	2000-2050	Explicitly	Watersim, based on IFPRI IMPACT
7	OECD Outlook	Mimeo (2006 Draft)	2000-2030	Not explicitly	Partly FAO

8	World Energy Outlook	2006	2030	Not explicitly	-

Sources: 1) UNEP, Global Environmental Outlook, 2002 2) UNEP (mimeo), 3) IPCC (2001) 4) IPCC (Mimeo), 5) MA (2005), 6) de Fraiture and Wichelns (2006). 7), OECD (2006). 8) OECD/IEA (2006)

Table 4.4.1.4: Per Capita Food Consumption (kcal/person/day)

	1969/71	**1979/81**	**1989/91**	**1999/01**	**2015**	**2030**	**2050**
World	2411	2549	2704	2789	2950	3040	3130
Developing countries	2111	2308	2520	2654	2860	2960	3070
sub-Saharan Africa	2100	2078	2106	2194	2420	2600	2830
- excluding Nigeria	2073	2084	2032	2072	2285	2490	2740
Near East / North Africa	2382	2834	3011	2974	3080	3130	3190
Latin America and Caribbean	2465	2698	2689	2836	2990	3120	3200
South Asia	2066	2084	2329	2392	2660	2790	2980
East Asia	2012	2317	2625	2872	3110	3190	3230
Industrial countries	3046	3133	3292	3446	3480	3520	3540
Transition countries	3323	3389	3280	2900	3030	3150	3270

Source: FAO (2006).

Table 4.4.1.5 Changes in the commodity composition of food by major country groups in kg/person/year

World						
Cereals, food	148.7	160.1	171	165.4	165	162
Cereals, all uses	302.8	325	329.3	308.7	331	339
Roots and tubers	83.7	73.4	64.5	69.4	75	75
Sugar (raw sugar equiv.)	22.4	23.4	23.3	23.6	26	27
Pulses, dry	7.6	6.5	6.2	5.9	6	6
Vegetable oils, oilseeds and products (oil eq.)	6.8	8.3	10.3	12	16	17
Meat (carcass weight)	26.1	29.5	33	37.4	47	52
Milk and dairy, excl. butter (fresh milk eq.)	75.3	76.5	76.9	78.3	92	100
Other food (kcal/person/day)	216	224	241	289	325	340
Total food (kcal/person/day)	2411	2549	2704	2789	3040	3130
Developing countries						
Cereals, food	146.3	161.7	173.7	165.7	166	163
Cereals, all uses	191.8	219.1	238.6	238	268	279
Roots and tubers	78.8	69.6	60.1	67	75	77
(Developing minus China)	61.8	59	58.4	62.8	76	80
Sugar (raw sugar eq.)	14.7	17.5	19.2	20.7	25	26
Pulses, dry	9.2	7.8	7.3	6.7	7	7
Vegetable oils, oilseeds and products (oil eq.)	4.9	6.5	8.6	10.4	14	16
Meat (carcass weight)	10.7	13.7	18.2	26.7	38	44
(Developing minus China & Brazil)	10.7	12.5	13.6	15.9	26	32
Milk and dairy, excl. butter (fresh milk eq.)	28.6	34	38.1	45.2	67	78
Other food (kcal/person/day)	123	140	171	242	285	300
Total food (kcal/person/day)	2111	2308	2520	2654	2960	3070
Industrial countries						
Cereals, food	132.3	139.4	154.4	162.4	159	156
Cereals, all uses	531.1	542	543.7	591.8	641	665
Roots and tubers	74.2	67.1	69.4	66.7	61	57
Sugar (raw sugar eq.)	40.5	36.7	32.6	33.1	32	32
Pulses, dry	3.4	2.8	3.2	3.6	4	4
Vegetable oils, oilseeds and products (oil eq.)	13.2	15.7	18.5	21.5	24	24
Meat (carcass weight)	69.7	78.5	84.3	90.2	99	103
Milk and dairy, excl. butter (fresh milk eq.)	189.1	201	211.2	214	223	227
Other food (kcal/person/day)	486	500	521	525	565	580
Total food (kcal/person/day)	3046	3133	3292	3446	3520	3540
Transition countries						
Cereals, food	200.5	189.2	179.1	168.7	164	158
Cereals, all uses	653	777.6	767.8	499.1	618	688
Roots and tubers	140.2	118.4	97.1	103.3	99	94
Sugar (raw sugar eq.)	41.9	45.9	43.4	36.5	39	41
Pulses, dry	4.1	3.1	2.3	1.6	2	2
Vegetable oils, oilseeds and products (oil eq.)	7.4	9.2	10.2	10.1	15	18
Meat (carcass weight)	49.5	62.9	70.7	44.4	59	68
Milk and dairy, excl. butter (fresh milk eq.)	185.7	181.3	177.2	160.2	179	193
Other food (kcal/person/day)	331	372	333	317	365	390

Table 4.4.4.1: Greenhouse gas emission projections in the dffierent assessments

SRES	Emissions in 2050: 10-15 GtC; 2100 : 5-26 GtC
MA	Similar to SRES except for lower emissions as Technogarden includes climate policy.
GEO	Similar to SRES except for lower emissions as Sustainability First includes climate policy.
World Energy Outlook	2030 emissions of 10 GtC.
OECD-Environmental Outlok	Emissions similar to World Energy Outlook

Table 4.4.4.2: Proposed measures for mitigating greenhouse gas emissions from agricultural ecosystems, their apparent effects on reducing emissions of individual gases where adopted (mitigative effect), and an estimate of scientific confidence that the proposed practice can reduce overall net emissions at the site of adoption

		Mitigative effects[1]			**Net mitigation**[2] **(confidence)**	
Measure	**Examples**	**CO_2**	**CH_4**	**N_2O**	**Agree-ment**	**Evi-dence**
Cropland management	Agronomy	+		+/-	***	**
	Nutrient management	+		+	***	**
	Tillage/residue management	+		+/-	**	**
	Water management (irrigation, drainage)	+/-		+	*	*
	Rice management	+/-	+	+/-	**	**
	Agro-forestry	+		+/-	***	*
	Set-aside, land-use change	+	+	+	***	***
Grazing land management/ pasture improvement	Grazing intensity	+/-	+/-	+/-	*	*
	Increased productivity (e.g., fertilization)	+		+/-	**	*
	Nutrient management	+		+/-	**	**
	Fire management	+	+	+/-	*	*
	Species introduction (including legumes)	+		+/-	*	**
Management of organic soils	Avoid drainage of wetlands	+	-	+/-	**	**
Restoration of degraded lands	Erosion control, organic amendments, nutrient amendments	+		+/-	***	**
Livestock management	Improved feeding practices		+	+	***	***
	Specific agents and dietary additives		+		**	***
	Longer term structural and management changes and animal breeding		+	+	**	*
Manure/biosolid management	Improved storage and handling		+	+/-	***	**
	Anaerobic digestion		+	+/-	***	*
	More efficient use as nutrient source	+		+	***	**
Bio-energy	Energy crops, solid, liquid, biogas, residues	+	+/-	+/-	***	**

Notes:

[1] *+ denotes reduced emissions or enhanced removal (positive mitigative effect);*
- denotes increased emissions or suppressed removal (negative mitigative effect);
+/- denotes uncertain or variable response

[2] *A qualitative estimate of the confidence in describing the proposed practice as a measure for reducing net emissions of greenhouse gases, expressed as CO_2-eq*
Agreement refers to the relative degree of consensus in the literature (the more asterisks, the higher the agreement); Evidence refers to the relative amount of data in support of the proposed effect (the more asterisks, the more evidence).

Source: IPCC, 2007, adapted from Smith et al., 2007a.

Table 4.4.5-1: Comparison of developing and developed countries with respect to different indicators

Tab.1 – Useful indicators for studying trends of use in agriculture

	arable land per capita **ha**	Work Force in agriculture **%**	arable land per worker **ha**	fossil energy per worker **GJ/year**	fossil energy Fertil.+ Irrig arable land. **GJ/ha**	fossil energy Mach.+ Fuels. per worker **GJ/year**	Fossil energy consumption in agriculture **%**
World	0.24	50	1	16	6.3	3.2	6
Developed	0.49	10	12	273	4.9	70.0	5
Developing	0.17	60	1	6	7.4	0.8	8

Table 4.4.5-2: – Land Area Requirements for Energy Crop Production

Percentage of total global crude oil petroleum to be replaced by bioenergy	Energy Yield			
	1st generation biofuels		2nd generation biofuels	
	40 GJ/ha	60 GJ/ha	250 GJ/ha	700 GJ/ha
5 % ~ 1500 million barrels/year	230 million ha	153 million ha	37 million ha	13 million ha
10% ~ 3010 million barrels/year	460 million ha	307 million ha	74 million ha	26 million ha
20% ~ 6020 million barrels/year	921 million ha	614 million ha	147 million ha	53 million ha

Source: Avato (2006) based on petroleum data from BP (2006) and Monthly Energy Review (2005) and biofuel yields from GEF (2005), Hodes (2004) and Sheehan, et al.(1998)

Conversion factors: 1 GJ=0.948 million BTU; 1 barrel of oil ~ 5.8 million BTU

Table 4.4.5-3: Overview of the global potential bio-energy supply on the long term for a number of categories and the main pre-conditions and assumptions that determine these potentials. (Smeets and Faaij, 2004)

Biomass category	**Main assumptions and remarks**	**Potential bio-energy supply in 2050.**
Category I: Energy farming on current agricultural land	Potential land surplus: 0-4 Gha (more average: 1-2 Gha). A large surplus requires structural adaptation of HEI agricultural production systems. When this is not feasible, the bio-energy potential could be reduced to zero as well On average higher yields are likely because of better soil quality: 8-12 dry tonne/ha*yr is assumed. (*)	0 – 870 EJ (more average development: 140 – 430 EJ)
Category II: Biomass production on marginal lands.	On a global scale a maximum land surface of 1.7 Gha could be involved. Low productivity of 2-5 dry tonne/ha*yr. (*) The supply could be low or zero due to poor economics or competition with food production.	(0) 60 – 150 EJ
Category III: Bio-materials	Range of the land area required to meet the additional global demand for bio-materials: 0.2-0.8 Gha. (average productivity: 5 dry tonnes/ha*yr). This demand should be come from category I and II in case the world's forests are unable to meet the additional demand. If they are however, the claim on (agricultural) land could be zero.	**Minus** (0) 40 –150 EJ
Category IV: Residues from agriculture	Estimates from various studies. Potential depends on yield/product ratio's and the total agricultural land area as well as type of production system: LEI systems require re-use of residues for maintaining soil fertility. HEI systems allow for higher utilisation rates of residues.	Approx. 15 EJ
Category V: Forest residues	The (sustainable) energy potential of the world's forests is unclear. Part is natural forest (reserves). Range is based on literature data. Low value: figure for sustainable forest management. High value: technical potential.	(0) 14 – 110 EJ
Category VI:	Use of dried dung. Low estimate based on global current use. High estimate: technical	(0) 5 – 55 EJ

Dung	potential. Utilisation (collection) on longer term is uncertain.	
Category VII: Organic wastes	Estimate on basis of literature values. Strongly dependent on economic development, consumption and the use of bio-materials. Figures include the organic fraction of MSW and waste wood. Higher values possible by more intensive use of bio-materials.	5 – 50 (+) EJ (**)
Total	Most pessimistic scenario: no land available for energy farming; only utilisation of residues. Most optimistic scenario: intensive agriculture concentrated on the better quality soils. (between brackets: more average potential in a world aiming for large scale utilisation of bio-energy)	**40 – 1100 EJ (200 - 700 EJ)**

(*) Heating value: 19 GJ/tonne dry matter.

(**) The energy supply of bio-materials ending up as waste can vary between 20-55 EJ (or 1100-2900 Mtonne dry matter per year (see table 4; biomass lost during conversion, such as charcoal is logically excluded from this range). This range excludes cascading and does not take into account the time delay between production of the material and 'release' as (organic) waste.

Tables

Table 4.4.6.1: Regional Estimates of Employment in Agriculture (in percentage)

	1994	2000	2004
World	45.6	44.2	42.8
Developed Economies and European Union	5.3	4.3	3.9
Central and Eastern Europe (non-EU) and CIS	28.0	26.7	23.3
East Asia	57.7	57.8	57.7
South East Asia of the pacific	55.9	50.4	44.3
South Asia	64.5	64.0	62.2
Latin America and Caribbean	24.3	20.2	17.6
Middle South and North Africa	29.7	26.4	25.7
Sub-Saharan Africa	71.0	66.9	64.5

Source: 'Key indicators of the Labour market (KILM), 4th Edition, ILO, Geneva, 2005.

Table 4.4.6.2: Female Employment in Agriculture (in percentage)

	1994	2000	2004
World	46.7	45.1	43.2
Developed Economics and European Union	4.5	3.4	3.0
Central and Eastern Europe (non-EU) and CIS	27.0	26.8	23.2
East Asia	61.8	61.5	61.4
South East Asia and the pacific	56.0	50.0	41.9
South Asia	70.7	70.8	68.7
Latin America and Caribbean	14.2	11.0	8.4
Middle East and North Africa	32.1	30.1	28.1
Sub-Saharan Africa	74.7	69.5	66.5

Source: 'Key indicators of the Labour market (KILM), 4th Edition, ILO, Geneva, 2005.

Table 4.4.6.3: Gender distribution of the total, agricultural and non-agricultural labour force (FAO, 200) updated by FAOSTAT (2006)

Region or group of countries	Women's percentage share in:					
	Total labour force		Agricultural labour force		Non-agricultural labour force	
	1990	1997	1990	1997	1990	1997
Developed countries	43.4	44.2	38.4	36.7	44.0	44.9
Developing countries	38.8	39.3	42.9	43.6	32.3	33.7
African developing countries	40.0	40.5	46.6	47.3	27.5	29.5
- of which sub-Saharan Africa	42.4	42.5	46.9	47.3	31.4	32.7
Asian developing countries	39.4	39.8	43.5	44.0	31.7	33.1

Latin American and Caribbean developing countries	32.6	34.1	16.9	17.0	37.9	38.8
Oceanic developing countries	39.1	40.3	43.5	44.8	29.8	31.9
Low-income food-deficit countries	39.6	40.0	43.5	44.0	31.7	33.4
World	40.0	40.4	42.7	43.3	37.3	38.0

FAO, 2000. ***Gender and Food Security: The role of information.*** **FAO, Rome**

<<Table 4.5.1: Global Typology of Cultivated Systems—<WILL BE ADDED>>