CHAPTER 5

EVOLUTION IN THE USE OF GLOBAL GIS MAPS FOR POVERTY ANALYSIS

A GIS map is a digital database stored in a computer – in contrast to a GIS map image, or fixed map layout, which generally contains only a limited number of variables and classes to make it perceptible to the human eye. It is the digital map database, not the map image, that makes spatial analysis possible.

The use of maps to illustrate points being made in assessment reports is not new. However, prior to the advent of GIS, complex multi-layer spatial analysis was rarely undertaken. Section 5.1 discusses the early uses and limitations of maps based on statistical data for monitoring summit follow-up, while Section 5.2 discusses an influential early effort to use georeferenced data to evaluate how spatial factors may be affecting the distribution of poverty globally. Following the Millennium Summit in 2000, the UN Millennium Project carried out a major assessment, based on available data and information, that established priority needs and investments required if the MDGs were to be achieved.. This project, the uses made by the project team of the information available, and future challenges for GIS are presented in Section 5.3.

5.1 USES AND LIMITATIONS OF EARLY GLOBAL STATISTICAL MAPS

Many of the early maps generated to accompany summit follow-up monitoring processes classified countries based on national level data for a single variable in a given time period, and presented the results as picture images or map charts. Maps based on national-level statistical data were also used, amongst other things, to:

- highlight differences among countries for a specific indicator;
- display country-by-country differences in the degree of change from one time period to another for a specific indicator;
- show country-by-country associations among different indicators for the same time period.

Most such maps simply call attention to locations in the world where vulnerability, poverty and food insecurity appear to be particularly severe. They are commonly included in *State of the World* reports and other Summit follow-up publications targeted at informed lay audiences and generalists, and are often accompanied by statistical tables, graphs and charts that provide more detail about the data that is summarized in the map.

Large global map collections were produced by FAO in 1996 for the World Food Summit and the World Bank in 2000 for the Millennium Summit. The maps and graphics section of www.poverty.net includes a collection of 134 online global maps on the following themes:

- demographic indicators
- economy and markets
- education

- energy
- water and sanitation
- food security
- health
- poverty indicators
- urban areas

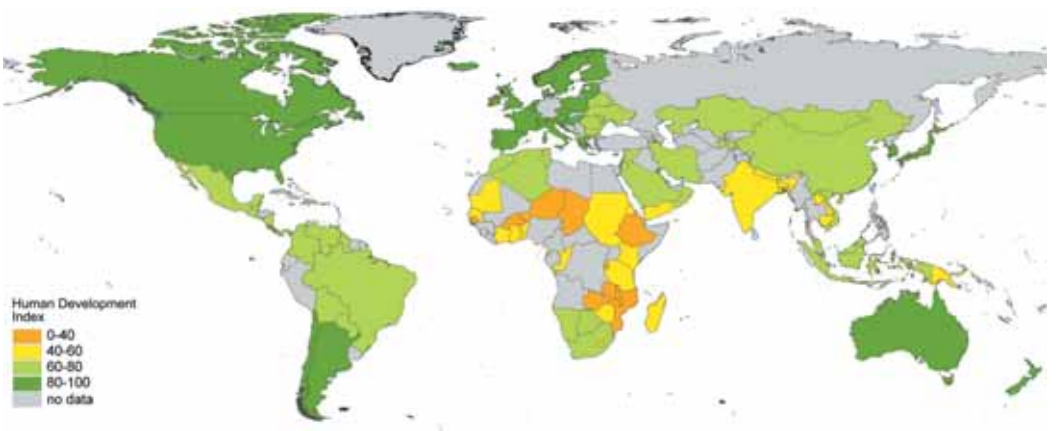
World Resources Institute also maintains an online collection of global maps (available at http://earthtrends.wri.org).

The collections cited represent only a few of the more pertinent. Most of the maps contained in these collections depict information derived from statistical data available at the national level (that is, one statistical value per country). Relatively few depict data at the subnational level and hardly any contain GIS-derived maps that show spatially-distributed data for other mapping units, such as agro-ecological zones, watersheds, farming system zones, mountain regions, coastal areas, and so forth.

The four examples shown below illustrate the utility of global maps that depict national statistical data. Map 5.1 highlights differences among countries with respect to the Human Development Index for 2000, while Map 5.2 does the same with respect to the prevalence of undernourishment in 2000–2002. Map 5.3 displays the magnitude and direction of change between 1990–1992 and 2000–2002 for the number of undernourished in developing countries, by country, while Map 5.4 shows the degree of association between adult illiteracy and undernourishment in 2000–2002 for developing countries for which data for both indicators were available. All of these maps call attention to the disparities in the human condition across the globe, and pinpoint locations where action is most desperately needed. However, for analysing underlying causes of poverty and food insecurity and guiding action, other approaches are more likely to yield results.

MAP 5.1

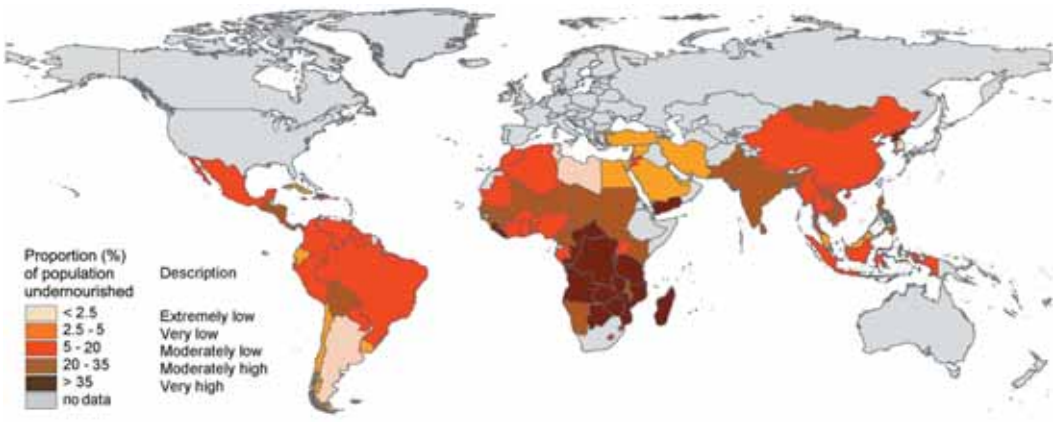
Degree of human development, by country, 2000



Source: FAO/SDRN, based on data published in UNDP, *Human Development Report 2003*.

MAP 5.2

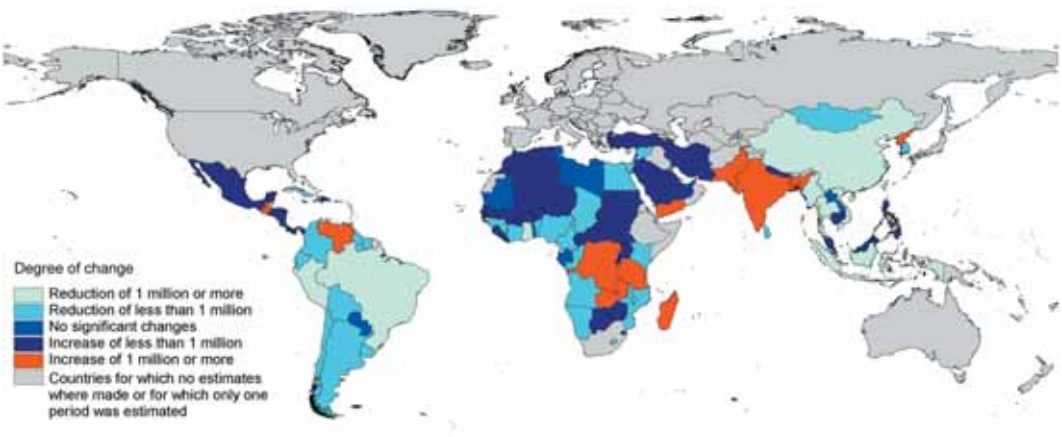
Share of population undernourished, by country, 2000-2002



Source: FAO/SDRN, based on data published in FAO, *The State of Food Insecurity in the World 2004*.

MAP 5.3

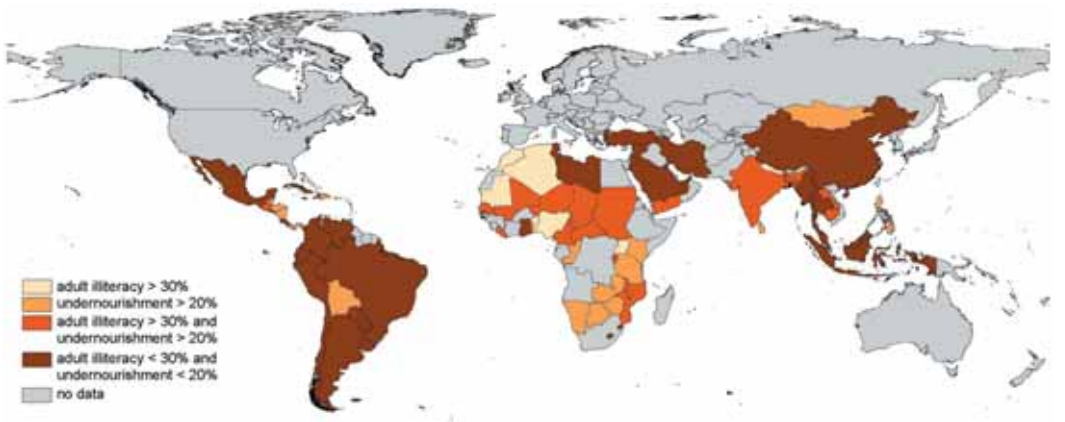
Changes in the number of undernourished, by country, between 1990-1992 and 2000-2002



Source: FAO/SDRN, based on data published in FAO, *The State of Food Insecurity in the World 2004*.

MAP 5.4

Countries with either high rates of adult illiteracy or high rates of undernourishment, or both, 2000-2002



Source: FAO/SDRN, based on literacy rates reported by UNESCO and downloaded from World Bank, *WDI Online*, and undernourishment rates published in FAO, *The State of Food Insecurity in the World 2004*.

5.2 EARLY APPLICATION OF A GLOBAL GIS-BASED APPROACH TO EVALUATE THE INFLUENCE OF GEOGRAPHY ON POVERTY AND MALNUTRITION

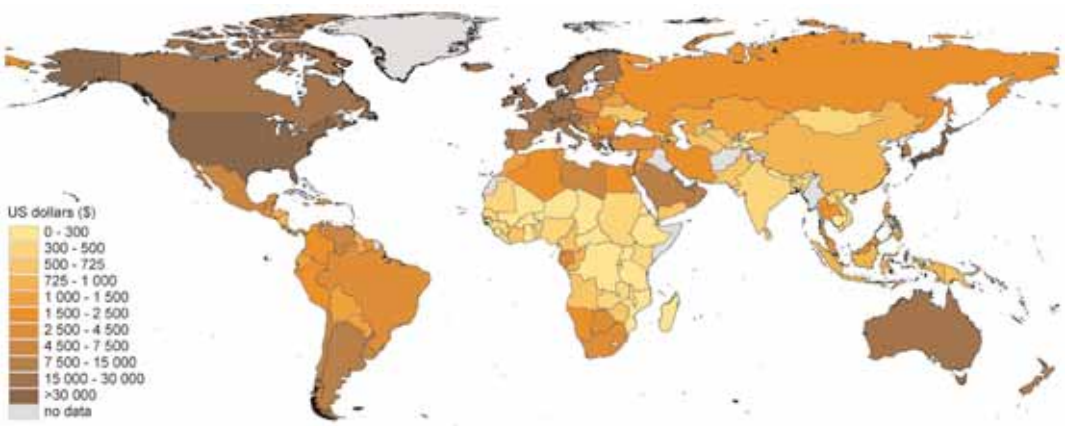
An early attempt to combine national GDP data with population data for subnational administrative units is contained in a CID Working Paper, *Geography and Economic Development*, published by John Gallup and Jeffrey Sachs, with Andrew Mellinger, in March 1999. The resulting map – GDP density – combined population counts and areas for lowest available subnational administrative units with average per capita GDP figures for 1995 (using PPP-adjusted estimates), by country. Because of the limitations of the data, the results are uniform for all pixels in each administrative unit, and do not capture inequalities in the distribution of wealth either across or within administrative units. Nevertheless, compared to earlier maps showing only average GDP per country, the new map represented a significant step forward.

The authors used the results of this mapping effort to probe the significance of geographical factors as explanations for the distribution of poverty across countries. They found that differences in physical geography have a large effect on economic development and recommended that empirical work should disentangle the forces of differential geography and self-organizing agglomeration economies.

FAO/SDRN has subsequently refined the approach using GDP density per square kilometre as a basis for comparison with GDP per capita per country. The difference in refinement of the visual information between a map based on national statistical data, and a map based on attribution of average per capita GDP figures according to the distribution of the population is clearly evident in Maps 5.5 and 5.6, which are based on data for the year 2000.

MAP 5.5

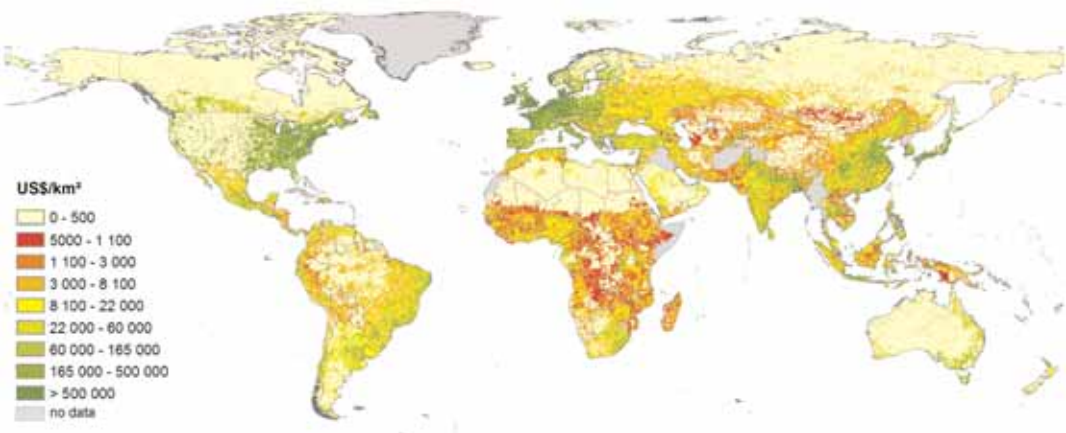
Average GDP per capita per country, 2000



Source: FAO/SDRN, using GDP data for 2000 from World Bank, *WDI online*, November 2005.

MAP 5.6

Density of GDP per square kilometre, 2000



Source: FAO/SDRN, using GDP data for 2000 from World Bank, *WDI online*, November 2005 and population data from Landscan 2002 adjusted to UN 2000 estimates, as described in FAO 2005c.

Also in 1999 Fujita, Krugman and Venables published a book entitled *The Spatial Economy*. This book drew attention to the dramatic increase in scientific interest in economic geography during recent years, and argued that a principal reason for this was the availability of new computer modelling tools that had removed crucial technical barriers, and transformed a once inhospitable field into fertile ground for theorists. In the words of the authors:

> We believe that the historical unwillingness of economists to address issues of economic geography was mainly due to the sense that these issues were technically intractable (...) The defining issue of economic geography is the need to explain concentrations of population and/or economic activity. Broadly speaking, it is clear that all these concentrations form and survive because of some form of agglomeration economies, in which spatial concentration itself creates the favourable economic environment that supports further or continued concentration. By modelling the sources of increasing returns to spatial concentration, we are able to learn something about how and when these returns may change – and then explore how the economy's behaviour will change with them.
>
> *Fujita* et al.*, 1999, Chapter 1: Introduction*

Recent developments in GIS technology are among the tools to which these authors refer, and the community of economic geographers constitutes one of the user communities to whom this report is addressed.

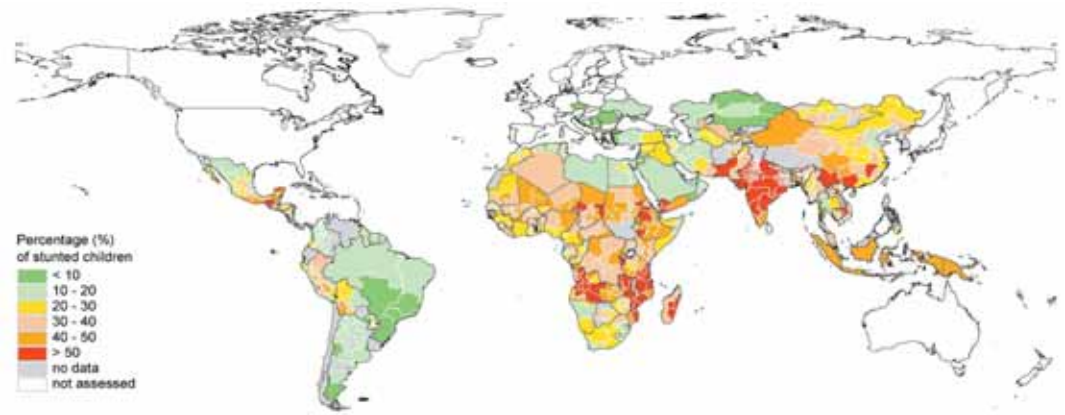
Prior to embarking on the development of the global GIS database introduced in this report, FAO/SDRN implemented a collaborative work programme with FAO/ESNA that led to the release of two new hunger maps depicting the distribution of stunted children under five by lowest subnational administrative unit for which recent data were available. Stunting, that is, low height for age, has been used in these maps as a proxy for chronic hunger because, unlike underweight, which can be the result of temporary reductions in food consumption, stunting in children only occurs as a result of insufficient food intake over an extended period of time.

By presenting a much more disaggregated picture of the parts of the world where hunger persists, as evidenced by the presence of undernourished children, these maps do for hunger what the GDP density maps did for poverty. Map 5.7 shows locations where the share of stunted children among the total population of children under five is high, while Map 5.8 shows locations where the absolute number of stunted children under five is largest. First released in December 2003, these maps have now become a standard feature in FAO's reporting on the prevalence of undernourishment in the world.

The ability to assemble and map data that is collected for subnational administrative units undoubtedly represents a significant advance and much useful work remains to be done. Like all similar maps that depict the distribution of statistical data by administrative unit, the results are not as refined as those that can be obtained from data that is distributed by pixel. Nevertheless, analysis of these maps together with high-resolution geospatial environmental databases contained in the FGGD can enable us to see relationships between locations where hungry people are concentrated and the environmental conditions in those locations.

MAP 5.7

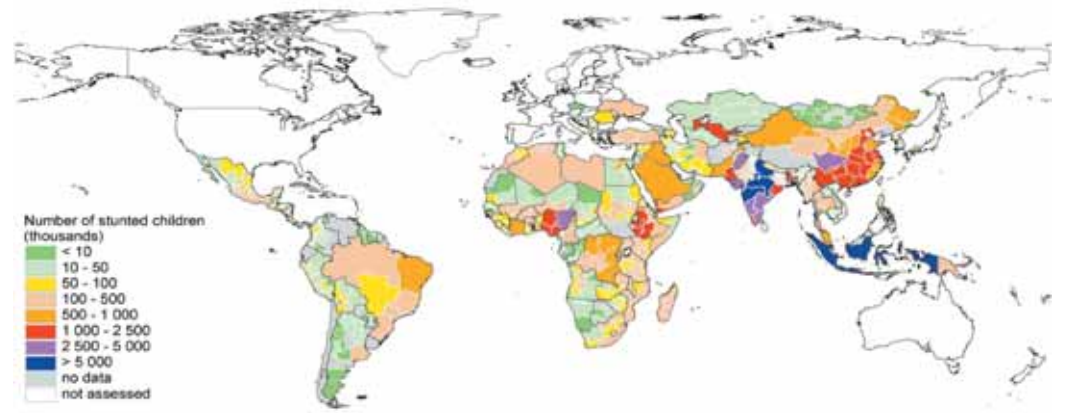
Prevalence of stunting among children under five, by lowest available subnational administrative unit, varying years



Source: FAO, 2003a.

MAP 5.8

Estimated number of stunted children under five, by lowest available subnational administrative unit, varying years



Source: FAO, 2003a.

5.3 THE MILLENNIUM PROJECT AND THE MILLENNIUM ASSESSMENT REPORT

The UN Millennium Project was commissioned by the United Nations Secretary General in 2002 to develop a concrete action plan for the world aimed at reversing the grinding poverty, hunger and disease affecting billions of people. It was organized as an independent advisory body and was given three years to conduct a series of sectoral needs assessments and prepare a consolidated report.

The premise that led to the establishment of the Millennium Project was that, although the world already has the technology and know-how to solve most of the problems faced in poor countries, to date these solutions have not been implemented at the required scale. The idea was that the project would work with developing countries to help quantify the investments needed to reach the MDG 2015 targets; for instance working out how many mothers need access to health clinics, how many children require immunizations, how many teachers should be in every district, how many roads need to be built, how many water pumps should be installed, and so on. It also set out to develop concrete recommendations for scaling-up successful approaches throughout the developing world, and to outline how donor countries' aid commitments can help achieve the MDGs.

The Millennium Project did not start work on a blank page. Many experts from different sectors had already been grappling with these problems, and documentation prepared for the Summit decade provided a rich resource for the Millennium Assessment working groups established by the Millennium Project.

In its *World Development Report 1990*, the World Bank had already outlined a generalized poverty reduction strategy that emphasized labour-intensive economic growth, based on the poor's labour as their most important asset, and investments in human capital in the form of improvements in health and education services, to enable the poor to use their labour asset more productively. This approach was later expanded to include social safety nets for the poorest and most vulnerable segments of society.

At the World Food Summit in 1996, the focus was on the magnitude of chronic hunger, and on mobilizing political will to combat it through increased investment in agriculture and rural development. FAO, the convenor of the WFS, argued that access of the majority of the poor to food depended on gains in agricultural productivity and growth in the rural economy.

At the same time, in collaboration with the World Food Programme (WFP), FAO had also been developing a parallel line of argument, documenting the economic costs of hunger in terms of lost productivity and income and showing that economic development and sustainable poverty reduction could not be achieved without providing immediate food relief for chronically hungry people that would reduce their vulnerability to disease and early death, increase the productivity of their labour, and improve the chances of young children to gain maximum benefit from primary school education. This provided a solid rationale for incorporating social safety net programmes into poverty reduction strategies, as a means to cushion transition and meet the immediate food needs of the poor, while they waited for the benefits of macroeconomic reform and longer-term development to reach them.

The FAO arguments were supported by another Rome-based food agency, the International Fund for Agricultural Development (IFAD). In its *Rural Poverty Report 2001 – The challenge of ending rural poverty*, IFAD noted that three quarters of the world's 1.2 billion extremely poor people lived and worked in rural areas, many of whom depended on agriculture as their main source of income.

The convergence of these various arguments led FAO to propose a twin-track approach at the World Food Summit: *five year later*, held in Rome in June 2002. This approach was articulated in the form of an Anti-Hunger Programme that called for simultaneous attacks on the causes and consequences of extreme poverty and hunger. The first track of the Anti-Hunger Programme proposes an average 20 percent increase in the budgets of developing countries and a doubling of external concessional funding for agriculture and rural

development. The second track proposes to reduce the number of hungry people in a rapid and sustainable manner by providing immediate access to relief food for an estimated 200 million of the most desperately hungry people among the 800 million estimated to be chronically food insecure.

The Millennium Project established eight Millennium Assessment Task Forces, including one on hunger, which drew heavily on the documentation cited above in developing its analysis and making its recommendations. All eight task forces had completed their work by mid-2004 and the Millennium Project team published its final report, *Investing in development: A practical plan to achieve the Millennium Development Goals*, in January 2005. This report synthesized the evidence generated by the eight task forces and recommended specific actions aimed at making the millennium targets a reality by 2015.

Interestingly, however, although ample evidence was collected to support the recommendations for immediate action, the report did not make systematic use of the 48 agreed millennium indicators. Nor did it include any disaggregated spatial analysis of those indicators it did include.

The Millennium Assessment Report contains 14 maps, each of which presents national data (or subnational data, in the case of child malnutrition) about a relevant variable. The mapped indicators presented in the 2005 report include:

Millennium indicators:

- Absolute poverty: Infant mortality rate per 1 000 live births and percentage of children underweight, combined
- Disease: Child mortality (under-five mortality rate per 1 000 live births)
- Disease: Maternal mortality rate per 100 000 live births
- Environment: Share of urban population living in slums

Action indicators:

- Physicians per 1 000 people (most recent available year)
- Antiretroviral drug coverage
- Fertilizer consumption (metric tonnes per million persons)
- MDG financing gap

Indexes generated specifically for the report:

- Human vulnerability (agriculture risk, transport risk, malaria risk)

GIS maps:

- Global map of malaria stability index, based on regionally dominant vector mosquitoes and a 5 arc-minute temperature and precipitation data set
- Areas at highest natural disaster-related mortality risk

Subnational data for pockets of extreme poverty:

- Per capita incomes in provinces of Mainland China
- Literacy rates for girls compared to boys in India
- Infant mortality rates in Latin America and Caribbean

Despite the remarkable improvements in information technology that have occurred during the past decade, the fact that the Millennium Project team was unable to make systematic use of data for the agreed indicators confirms that there are still significant gaps in the availability of timely and reliable data to feed modern, high-tech information systems, and that the creative use of these systems for analysing whatever data is available is not yet widespread.

CHAPTER 6

POSSIBLE APPLICATIONS OF THE FGGD

The Food Insecurity, Poverty and Environment Global GIS Database (FGGD) introduced in this report offers an exciting new tool for using global GIS maps to probe poverty and environment links.

A unique feature of geographic information systems of particular relevance for poverty analysis is their ability to generate and manage data that refer to spatial areas other than those defined by political boundaries. The higher the resolution of the data, the more valuable this quality becomes. The GIS maps included in the FGGD have been developed from sources that report data according to their actual or estimated geographic locations rather than by administrative units. The feature of this approach that makes it so attractive for poverty analysis is the ability to associate socio-economic and environmental variables with population distribution, at the level of the pixel. This makes it possible to analyse relationships amongst these variables that is not possible with data reported only by administrative unit.

The FGGD can be used to quantify and map analytical issues such as the extent to which the rural poor are located in zones that are only marginally suitable for rainfed agriculture or the interrelations between poverty, agro-energy shortages and environmental degradation.

Spatially-related questions that may be addressed by future work include:

- Are most of the poor in a country or region rural or urban?
- What is the distribution of the rural population by agro-ecological zone? By farming system? By suitability of the land for rainfed agriculture?
- Are most of the rural poor living in favourable or marginal rural areas?
- Are there differences in the commodities and farming systems found in favourable versus marginal rural areas in a country?
- What has been the recent agricultural production performance in different agro-ecological zones, compared to their agricultural potential?
- What has been the total and per capita value of recent agricultural production in different agro-ecological zones or farming systems?
- What has been the total and per capita value of recent agricultural production in different agro-ecological zones or farming systems?
- What is the estimated agricultural income of the rural poor, by country, in total, and by commodity?
- What is the relationship between estimated per capita agricultural income of the rural poor and access to roads and markets?
- What is the relationship between estimated per capita agricultural income of the rural poor and vulnerability to natural disasters or disasters caused by human activities?
- What is the relationship between estimated per capita agricultural income of the rural poor and the prevalence of malnutrition? Malaria? Infectious disease?
- What is the physical, economic and environmental accessibility of forest biomass for energy use?

- What is needed to break the vicious circle of fuelwood shortages, poverty and environment degradation in agro-energy deficit areas?
- Where are the main energy crops (such as maize, soya, sugar cane) currently being grown?
- Where could the main energy crops (maize, soya, sugar cane, and so on) potentially be grown? Which agro-ecological zones are more or less favourable to various energy crops?
- Where are the main agro-energy consumers currently located?
- Is the competition with other crops (or land and water uses) a true constraint in the expansion of agro-energy systems?

The above list is already long and could be longer. What it highlights is that, by making greater use of GIS technologies, many important questions for which there are currently no good answers can now be probed and analysed. Further, in many instances global GIS maps with high utility can be developed at relatively low cost compared to other options, for generating the information needed to programme new investments, in order to achieve the targets and goals agreed by the World Food Summit, the Millennium Summit and the World Summit on Sustainable Development.

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ANNEX 1

PROPOSED FIVIMS-RELATED INDICATORS FOR WFS MONITORING COMPARED WITH OTHER UN SYSTEM LISTS

The table shown in this Annex has been reprinted from Committee on World Food Security, 26th Session, 18–21 September 2000. *Suggested core indicators for monitoring food security status*, CFS: 2000/2 – Sup.1. FAO, Rome.

Indicator[1]	FIVIMS-related indicators			UN-system lists		Data availability[2] (incl. main institutional source)
	IAWG	FAO-Secretariat	ANDI	OECD	UN/CCA	
FOOD SECURITY AND NUTRITION OUTCOMES						
Food Consumption Status						
Average per person dietary energy supply (DES)	X	X	X			1999 (FAO)
Cereals, roots and tubers as % of DES		X				1999 (FAO)
Percentage of population undernourished	X	X	X		X	1996/98 (FAO)
Health Status						
Life expectancy at birth		X		X		1998 (UN)
Maternal mortality rate (%)		X		X	X	1998 (WHO)
Under-5 mortality rate (%)	X	X		X	X	1998 (UN)
Infant mortality rate (%)		X		X		1998 (UN)
Prevalence of anaemia		X				1999 (WHO)
Prevalence of cholera		X				1999 (WHO)
Prevalence of acute respiratory infections			X			1999 (WHO)
Prevalence of diarrhoea			X			1999 (WHO)
Prevalence of HIV		X				1999 (WHO)
Prevalence of malaria		X				1999 (WHO)
Prevalence of tuberculosis		X				1999 (WHO)
Nutritional Status						
Percentage of adults with low BMI		X	X			varying years (WHO)[3]
Percentage of children under 0-3 months exclusively breastfed			X			1990-99 (UNICEF)
Percentage of children under 5 that are underweight	X	X	X	X	X	varying years (WHO)[3]
Percentage of children under 5 affected by night blindness		X				varying years (WHO)
Percentage of households consuming iodised salt			X			varying years (UNICEF)[3]
Percentage of newborns with low birth weight		X				1997 (WHO/UNICEF)
Percentage of population affected by goitre		X				varying years (WHO)

Indicator[1]	FIVIMS-related indicators			UN-system lists		Data availability[2] (incl. main institutional source)
	IAWG	FAO-Secretariat	ANDI	OECD	UN/CCA	
OUTCOME INDICATORS FOR VULNERABILITY FACTORS						
Demographic conditions						
Fertility rate		X	X	X		1998 (UN)
Percentage of population in different age groups			X			varying years (UN)
Population growth rate		X	X			1999 (UN)
Urban/rural population shares		X	X			1999 (UN)
Environmental Conditions						
Arable land per person		X			X	1998 (FAO)
Average annual rate of deforestation		X				varying years (WRI)[3]
Carbon Dioxide emissions per person				X	X	1996 (WB)
Carrying capacity of land		X				2000 (FAO/IIASA)
Countries with environmental strategies (%)				X		1997 (WRI)
Energy use in agriculture		X				(*)
Forest area as % of total land area				X		1995 (WB)
GDP per unit of energy use				X	X	(*)
Land area protected as % of total arable land				X		1996 (WB/FAO)
Mangrove areas				X	X	(*)
Percentage of change in km^2 of forest land in past ten years					X	1999 (FAO)
Severely degraded land as % of total area		X				FAO
Tree density outside forest		X				(*)
Total human induced soil degradation		X				varying years (UNEP,ISRIG,FAO)
Urban air pollution				X		1995 (WB)
Economic Conditions						
Cropped area as % of total area		X				1997 (FAO)
Employment of population of working age ratio (%)					X	varying years (ILO)[3]
GDP/GNP per person		X	X	X		1999 (WB)
Growth in cereal yields		X				1999 (FAO)
Growth in GDP		X				1999 (WB)
Growth in staple food yields, by commodity		X				1999 (FAO)
Informal sector employment as % of total employment					X	varying years (ILO)
Share of agriculture in GDP		X			X	1998 (WB)
Wages, by economic activity (real $ per year)		X				1998 (ILO)
Yields per hectare for major cereals		X				1999 (FAO)
Political Conditions						
Number of countries facing a conflict-related emergency		X				2000 (CRED)
Socio-Cultural Conditions						
Adult literacy/illiteracy rate		X		X	X	1998 (UNESCO)
Female illiteracy rate			X			varying years (UNSD)[3]
Girl net enrolment rate in primary school			X			1997 (UNESCO)
Literacy rate of 15-24 year-olds				X	X	1998 (WB)
Net primary enrolment or attendance rate (%)			X	X	X	1999 (UNESCO)
Percentage of population with access to primary health care		X				varying years (WHO)[3]
Percentage of pupils starting grade 1 who reach grade 5				X	X	1996 (WB)

Indicator[1]	FIVIMS-related indicators			UN-system lists		Data availability[2] (incl. main institutional source)
	IAWG	FAO-Secretariat	ANDI	OECD	UN/CCA	
OUTCOME INDICATORS FOR VULNERABILITY FACTORS						
Risks, Hazards, Shocks						
National monthly rainfall index		X				varying years (FAO)
Intensity of freshwater use from renewable internal sources		X		X		varying years (FAO)
Land use change		X				1997 (WB)
Percentage of population affected by droughts and natural disasters		X				varying years (CRED)
Percentage of land with erosion risk		X				varying years (USGS)
Percentage or rate of deforestation		X				varying years (FAO)
Food Availability						
Animal protein supply per person			X			1999 (FAO)
Cereals supply per person			X			1999 (FAO)
Dietary fat supply per person			X			1999 (FAO)
Dietary protein supply per person			X			1999 (FAO)
Food production index		X				1999 (FAO)
Food Access						
Consumer prices index		X				varying years (WB)[3]
Food prices index		X				varying years (WB)[3]
Gini-index of income distribution		X				varying years (WB)[3]
GDP/GNP per person	X	X				1999 (WB)
Market density (number of markets per unit area)		X				(*)
Paved roads as % of total road mileage		X				1998 (WB)
People living below national poverty line (%)		X			X	varying years (WB)[3]
People living on less than $1 a day (%)				X	X	varying years (WB)[3]
% of household income spent on food for the poorest quintile				X	(*)	
Percentage of income spent on food	X	X				1985 (UNDP)
Poorest fifth share of national consumption				X	X	(*)
Poverty gap ratio		X		X	X	varying years (WB)[3]
Road density (kilometres of road per unit area)		X				(*)
Share of national income by percentile of population		X				varying years (WB)[3]
Stability of Food Supplies and Access						
Cereal import dependency ratio		X				1999 (FAO)
Frequency of published or broadcast market information		X				(*)
Index of variability of food production		X	X			1999 (FAO)
Months of cereal self-provisioning capacity		X				(*)
Variability of food prices		X				1999 (FAO)
Household Characteristics						
Average household income (only urban)		X				1993 (WB)
Average household size		X				(UN)
Number of persons per room, or average floor area per person					X	(UN)
Ratio of dependants to wage-earners in average households	X				(UN/ILO)	

Indicator[1]	FIVIMS-related indicators			UN-system lists		Data availability[2] (incl. main institutional source)
	IAWG	FAO-Secretariat	ANDI	OECD	UN/CCA	
OUTCOME INDICATORS FOR VULNERABILITY FACTORS						
Health and Sanitation						
Contraceptive prevalence rate (%)				X	X	varying years (UNDP)[3]
Estimated HIV adult prevalence rate (%)					X	varying years (WHO)
HIV prevalence in pregnant women under 25 years of age (%)				X	X	(*)
Percentage of 1 year old children immunised against measles			X		X	varying years (UNDP)[3]
Percentage of population with access to adequate sanitation		X			X	1996 (WHO)
Percentage of population with access to primary health care services					X	varying years (WHO)
Percentage of population with access to safe water	X	X		X	X	1996 (WHO)
Care and Feeding Practices						
Number of meals eaten in a day		X				(*)
Percentage of births attended by skilled health personnel				X	X	1996/98 (WHO)
Percentage of children under 15 in the labour force					X	varying years (ILO)[3]
Weaning age		X				varying years (WHO)[3]

1. Gender indicators are included in the modules to which they relate.
2. Acronyms: CRED: Centre for Research on the Epidemiology of Disasters; IIASA: International Institute of Applied Systems Analysis; ILO: International Labour Organization; ISRIC: International Soils Reference and Information Centre; UNESCO: United Nations Educational, Scientific and Cultural Organization; UNEP: United Nations Environment Programme; UNICEF: United Nations Children's Fund; UNDP: United Nations Development Programme; UNSD: United Nations Statistical Division; USGS: United States Geological Survey; WB: World Bank; WHO: World Health Organization; WRI: World Resources Indicators. * indicates no international database holder identified.
3. According to latest survey data available in each country.

Source: Column One: Report of the Fourth Meeting of the IAWG-FIVIMS Subgroup on Indicators, Assessment and Mapping, October 1999.
Column Two: *Assessment of the World Food Security Situation* (CFS:99/2); *Assessment of the World Food Security Situation* (CFS:2000/2), *The State of Food Insecurity in the World* (FAO 1999), *The State of Food Insecurity in the World* (draft, FAO 2000); draft FAO-Secretariat lists for developing food access and vulnerability indices and for monitoring Agenda 21 (FAO 2000).
Column Three: *African Nutrition Database Initiative*, http://www.africanutrition.net/.
Column Four: *OECD 2000: Measuring Development*; United Nations 2000
Column Five: *Guidelines for Common Country Assessment (CCA)*, United Nations 1999.

ANNEX 2

CONTENT OF THE FGGD AND DIGITAL ATLAS FOR THE YEAR 2000[1]

FGGD MODULES		DATALAYERS WITH FGGD ATLAS MAPS		SOURCES
No.	Name	No.	Title	Reference documents
One	Boundaries and topography	1.1	Coastal and country boundaries of the world	**FAO & UNESCO.** 1991
		1.2	Inland water bodies	**FAO & UNESCO.** 1991
Two	Population	2.1	Rural population distribution (persons per pixel), 2000	**FAO.** 2005c
		2.2	Rural population density (persons per square kilometre), 2000	**FAO.** 2005c
		2.3	Global population density estimates, 2015	**FAO.** 2005a
Three	Socio-economic and nutrition indicators	3.1	Degree of human development, by country, 2000	**UNDP.** 2000
		3.2	Share of population living in poverty, by country, varying years	FAO/SDRN, based on **World Bank, Online.** WDI April 2005
		3.3	Share of population living in extreme poverty, by country, varying years	FAO/SDRN, based on **World Bank Online.** WDI April 2005
		3.4	Share of population undernourished, by country, 2000-2002	FAO/SDRN, based on **FAO.** 2004b
		3.5	Changes in the number of undernourished, by country, between 1990-1992 and 2000-2002.	FAO/SDRN, based on **FAO.** 2004b
		3.6	Prevalence of stunting among children under five, by lowest available subnational administrative unit, varying years	**FAO.** 2003a
		3.7	Estimated number of stunted children under five, by lowest available subnational administrative unit, varying years	**FAO.** 2003a
Four	Environmental conditions	4.1	Thermal climate zones of the world	**FAO & IIASA.** 2006
		4.2	Length of growing period (LGP) zones of the world	**FAO & IIASA.** 2006
		4.3	Coefficient of variation (CV) of length of growing period (LGP), 1901-1996	**FAO & IIASA.** 2006
		4.4	Climatic zones of the world, based on length of growing period (LGP)	**FAO & IIASA.** 2006
		4.5	Major soil groups of the world	**FAO& UNESCO.** 1992
		4.6	Terrain slope classes of the world	**FAO & IIASA.** 2006
		4.7	Global land area with climate constraints	**FAO & IIASA.** 2006
		4.8	Global land area with soil constraints	**FAO & IIASA.** 2006
		4.9	Global land area with terrain slope constraints	**FAO & IIASA.** 2006
		4.10	Hierarchical distribution of severe environmental constraints	**FAO & IIASA.** 2006
Five	Land use patterns and land cover	5.1	Occurrence of barren and sparsely vegetated land	**FAO & IIASA.** 2006
		5.2	Occurrence of forest	**FAO & IIASA.** 2006
		5.3	Occurrence of cropland	**FAO & IIASA.** 2006
		5.4	Occurrence of pasture and shrubs	**FAO & IIASA.** 2006
		5.5	Irrigated areas	**FAO & IIASA.** 2006
		5.6	Protected areas	**UNEP-WCMC Online**
		5.7	Global land cover distribution, by dominant land cover type	**FAO & IIASA.** 2006
		5.8	Irrigated area and land not currently available for reined agriculture, by land cover type	**FAO & IIASA.** 2006
		5.9	Irrigated area and land not currently available for rainfed agriculture, total	**FAO & IIASA.** 2006
		5.10	Farming system classes in developing and transition countries, 2000	**FAO & World Bank.** 2001

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1. FAO. 2006. *Food Insecurity, Poverty and Environment Global GIS Database (FGGD) and Digital Atlas for the Year 2000*, by E. Ataman, M. Salvatore, B. Huddleston, M. Zanetti, M. Bloise, J.F. Dooley, H. van Velthuizen, G. Fischer & F.O. Nachtergaele. Environmental and Natural Resources Working Paper No. 26. Rome.

FGGD MODULES		DATALAYERS WITH FGGD ATLAS MAPS		SOURCES
No.	Name	No.	Title	Reference documents
Six	Land productivity potential		For cereals	
		6.1	Suitability of global land area for rainfed production of cereals (low level of inputs)	**FAO & IIASA.** 2006
		6.2	Suitability of global land area for rainfed production of cereals (intermediate level of inputs)	**FAO & IIASA.** 2006
		6.3	Suitability of global land area for rainfed production of cereals (high level of inputs)	**FAO & IIASA.** 2006
		6.4	Suitability of currently available land for rainfed production of cereals (low level of inputs)	**FAO & IIASA.** 2006
		6.5	Suitability of currently available land for rainfed production of cereals (intermediate level of inputs)	**FAO & IIASA.** 2006
		6.6	Suitability of currently available land for rainfed production of cereals (high level of inputs)	**FAO & IIASA.** 2006
		6.7	Variability of rainfed cereal production potential, by country, 1961-1990	**FAO & IIASA.** 2006
			For fibres	
		6.8	Suitability of global land area for rainfed production of fibres (low level of inputs)	**FAO & IIASA.** 2006
		6.9	Suitability of global land area for rainfed production of fibres (intermediate level of inputs)	**FAO & IIASA.** 2006
		6.10	Suitability of global land area for rainfed production of fibres (high level of inputs)	**FAO & IIASA.** 2006
		6.11	Suitability of currently available land for rainfed production of fibres (low level of inputs)	**FAO & IIASA.** 2006
		6.12	Suitability of currently available land for rainfed production of fibres (intermediate level of inputs)	**FAO & IIASA.** 2006
		6.13	Suitability of currently available land for rainfed production of fibres (high level of inputs)	**FAO & IIASA.** 2006
			For oil crops	
		6.14	Suitability of global land area for rainfed production of oil crops (low level of inputs)	**FAO & IIASA.** 2006
		6.15	Suitability of global land area for rainfed production of oil crops (intermediate level of inputs)	**FAO & IIASA.** 2006
		6.16	Suitability of global land area for rainfed production of oil crops (high level of inputs)	**FAO & IIASA.** 2006
		6.17	Suitability of currently available land for rainfed production of oil crops (low level of inputs)	**FAO & IIASA.** 2006
		6.18	Suitability of currently available land for rainfed production of oil crops (intermediate level of inputs)	**FAO & IIASA.** 2006
		6.19	Suitability of currently available land for rainfed production of oil crops (high level of inputs)	**FAO & IIASA.** 2006
			For pulses	
		6.20	Suitability of global land area for rainfed production of pulses (low level of inputs)	**FAO & IIASA.** 2006
		6.21	Suitability of global land area for rainfed production of pulses (intermediate level of inputs)	**FAO & IIASA.** 2006
		6.22	Suitability of global land area for rainfed production of pulses (high level of inputs)	**FAO & IIASA.** 2006
		6.23	Suitability of currently available land for rainfed production of pulses (low level of inputs)	**FAO & IIASA.** 2006
		6.24	Suitability of currently available land for rainfed production of pulses (intermediate level of inputs)	**FAO & IIASA.** 2006
		6.25	Suitability of currently available land for rainfed production of pulses (high level of inputs)	**FAO & IIASA.** 2006
			For roots and tubers	
		6.26	Suitability of global land area for rainfed production of roots and tubers (low level of inputs)	**FAO & IIASA.** 2006
		6.27	Suitability of global land area for rainfed production of roots and tubers (intermediate level of inputs)	**FAO & IIASA.** 2006
		6.28	Suitability of global land area for rainfed production of roots and tubers (high level of inputs)	**FAO & IIASA.** 2006
		6.29	Suitability of currently available land for rainfed production of roots and tubers (low level of inputs)	**FAO & IIASA.** 2006
		6.30	Suitability of currently available land for rainfed production of roots and tubers (intermediate level of inputs)	**FAO & IIASA.** 2006
		6.31	Suitability of currently available land for rainfed production of roots and tubers (high level of inputs)	**FAO & IIASA.** 2006

FGGD MODULES		DATALAYERS WITH FGGD ATLAS MAPS		SOURCES
No.	Name	No.	Title	Reference documents
			For stimulants	
		6.32	Suitability of global land area for rainfed production of stimulants (low level of inputs)	**FAO & IIASA.** 2006
		6.33	Suitability of global land area for rainfed production of stimulants (intermediate level of inputs)	**FAO & IIASA.** 2006
		6.34	Suitability of global land area for rainfed production of stimulants (high level of inputs)	**FAO & IIASA.** 2006
		6.35	Suitability of currently available land for rainfed production of stimulants (low level of inputs)	**FAO & IIASA.** 2006
		6.36	Suitability of currently available land for rainfed production of stimulants (intermediate level of inputs)	**FAO & IIASA.** 2006
		6.37	Suitability of currently available land for rainfed production of stimulants (high level of inputs)	**FAO & IIASA.** 2006
			For sugar crops	
		6.38	Suitability of global land area for rainfed production of sugar crops (low level of inputs)	**FAO & IIASA.** 2006
		6.39	Suitability of global land area for rainfed production of sugar crops (intermediate level of inputs)	**FAO & IIASA.** 2006
		6.40	Suitability of global land area for rainfed production of sugar crops (high level of inputs)	**FAO & IIASA.** 2006
		6.41	Suitability of currently available land for rainfed production of sugar crops (low level of inputs)	**FAO & IIASA.** 2006
		6.42	Suitability of currently available land for rainfed production of sugar crops (intermediate level of inputs)	**FAO & IIASA.** 2006
		6.43	Suitability of currently available land for rainfed production of sugar crops (high level of inputs)	**FAO & IIASA.** 2006
			For tree fruits (includes only banana/plantain and citrus in tropics and subtropics)	
		6.44	Suitability of global land area for rainfed production of tree fruits (low level of inputs)	**FAO & IIASA.** 2006
		6.45	Suitability of global land area for rainfed production of tree fruits (intermediate level of inputs)	**FAO & IIASA.** 2006
		6.46	Suitability of global land area for rainfed production of tree fruits (high level of inputs)	**FAO & IIASA.** 2006
		6.47	Suitability of currently available land for rainfed production of tree fruits (low level of inputs)	**FAO & IIASA.** 2006
		6.48	Suitability of currently available land for rainfed production of tree fruits (intermediate level of inputs)	**FAO & IIASA.** 2006
		6.49	Suitability of currently available land for rainfed production of tree fruits (high level of inputs)	**FAO & IIASA.** 2006
			For vegetables (includes only cabbage, onion and tomato)	
		6.50	Suitability of global land area for rainfed production of vegetables (low level of inputs)	**FAO & IIASA.** 2006
		6.51	Suitability of global land area for rainfed production of vegetables (intermediate level of inputs)	**FAO & IIASA.** 2006
		6.52	Suitability of global land area for rainfed production of vegetables (high level of inputs)	**FAO & IIASA.** 2006
		6.53	Suitability of currently available land for rainfed production of vegetables (low level of inputs)	**FAO & IIASA.** 2006
		6.54	Suitability of currently available land for rainfed production of vegetables (intermediate level of inputs)	**FAO & IIASA.** 2006
		6.55	Suitability of currently available land for rainfed production of vegetables (high level of inputs)	**FAO & IIASA.** 2006
			For pasture	
		6.56	Suitability of global land area for pasture	**FAO & IIASA.** 2006
		6.57	Suitability of currently available land for pasture	**FAO & IIASA.** 2006
			Combined suitabilities	
		6.58	Multiple cropping zones under rainfed conditions, global land area	**FAO & IIASA.** 2006
		6.59	Multiple cropping zones under rainfed conditions, currently available land	**FAO & IIASA.** 2006
		6.60	Suitability of global land area for rainfed crops, using maximising crop and technology mix	**FAO & IIASA.** 2006
		6.61	Suitability of currently available land for rainfed crops, using maximising crop and technology mix	**FAO & IIASA.** 2006

see next page

FGGD MODULES		DATALAYERS WITH FGGD ATLAS MAPS		SOURCES
No.	Name	No.	Title	Reference documents
		6.62	Combined suitability of global land area for pasture and rainfed crops (low input level)	**FAO & IIASA.** 2006
		6.63	Combined suitability of global land area for pasture and rainfed crops (intermediate input level)	**FAO & IIASA.** 2006
		6.64	Combined suitability of global land area for pasture and rainfed crops (high input level)	**FAO & IIASA.** 2006
		6.65	Combined suitability of currently available land for pasture and rainfed crops (low input level)	**FAO & IIASA.** 2006
		6.66	Combined suitability of currently available land for pasture and rainfed crops (intermediate input level)	**FAO & IIASA.** 2006
		6.67	Combined suitability of currently available land for pasture and rainfed crops (high input level)	**FAO & IIASA.** 2006

FGGD MODULES		DATALAYERS WITH NO FGGD ATLAS MAPS[2]	SOURCES
No.	Name	Title	Reference documents
One	Boundaries and topography	Elevation	**U.S.** Geological Survey. 1993
		Urban area boundaries based on urban/rural population thresholds, 2000	**FAO.** 2005c
Two	Population	Rural population distribution (persons per pixel), 2000 (high resolution layer)	**FAO.** 2005c
		Rural population density (persons per square kilometre), 2000 (high resolution layer)	**FAO.** 2005c
		Urban population distribution (persons per pixel), 2000 (high resolution layer)	**FAO.** 2005c
		Urban population density (persons per square kilometre), 2000 (high resolution layer)	**FAO.** 2005c
		Population distribution of rural settlements (persons per pixels), 2000 (high resolution layer)	**FAO.** 2005c
		Population density of rural settlements (persons per square kilometre), 2000 (high resolution layer)	**FAO.** 2005c
Three	Socio-economic and nutrition indicators	Accessibility to roads, straight-line distance to nearest road	FAO/SDRN, based on DCW (**ESRI**. 1992)
		Accessibility to markets, straight-line distance to nearest urban area	FAO/SDRN, based on PMUR in **FAO.** 2005c

2. No FGGD Atlas maps are given for these datalayers, which where created at a higher resolution (30-arc seconds). They are provided on DVD II for higher-resolution GIS analysis.

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The last decade of the twentieth century witnessed the convening of numerous international conferences and summits that raised interest in the use of georeferenced poverty and hunger maps to target action. At the Millennium Summit in 2000, world leaders reached a consensus on goals and targets for economic and social development in the 21st century. However, there were many gaps in the information available to guide action. Mapping of statistical indicators helps to monitor progress within administrative units, usually countries, or provinces and districts within countries. While useful, such mapping products tell just part of the story. A GIS map is a digital database stored in a computer – in contrast to a GIS map image, or fixed map layout, which generally contains only a limited number of variables and classes to make it perceptible to the human eye. It is the digital map database, not the map image, that makes spatial analysis possible. The Food Insecurity, Poverty and Environment Global GIS Database (FGGD) introduced in this report offers an exciting new tool for using global GIS maps to probe poverty and environment links.

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