

# A geospatial framework for the analysis of poverty and environment links



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# A geospatial framework for the analysis of poverty and environment links

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## FOREWORD

One of the core functions of FAO is to provide data and information. Geospatial information can be of particular value to audiences interested in the monitoring and assessment of progress towards achieving the Millennium Development Goals (MDGs) by 2015, and in analysing underlying causes of poverty and hunger.

During and immediately after the World Food Summit (WFS) in 1996, FAO's GIS unit received numerous requests for global Geographic Information System (GIS) maps that depict relationships between environmental and social drivers of poverty. Fortuitously, this coincided with the Government of Norway's decision to support a project entitled *Improving methods for poverty and food insecurity mapping and its use at country level*, which was implemented from September 2000 to November 2004.

The activities were led by FAO in collaboration with UNEP/GRID-Arendal and some of the centres of the Consultative Group for International Agricultural Research (CGIAR). The collaborating CGIAR Centres tested innovative methods for mapping poverty at national and subnational level, while UNEP/GRID-Arendal promoted dissemination of results and encouraged information exchange and dialogue for the growing community of poverty-mappers worldwide. FAO developed an integrated georeferenced global database and a modeling framework entitled the Food Insecurity, Poverty and Environment Global GIS Database.

This report introduces the database to analysts and statisticians responsible for monitoring and assessment activities in the context of WFS follow-up and the MDGs. Two companion reports describe in more detail how the databases relating to land productivity potential and population have been constructed. Also a DVD and a hardcopy atlas called *Food Insecurity, Poverty and Environment Global GIS Database (FGGD) and Digital Atlas for the Year 2000* is being released simultaneously with this report. This DVD contains GIS databases for all the datalayers completed and provides specific technical information needed by GIS experts to use the databases.

It is the sincere hope of the Environment and Natural Resources Service that the database and the accompanying reports will extend and facilitate analysis of the poverty-environment linkages.



Jeffrey B. Tschirley  
Chief, Environment and Natural Resources Service, FAO



## ABSTRACT

This report begins with a review of the demand for better information that emerged during the Summit decade, culminating with the Millennium Summit in 2000. It explains how georeferenced information can be used to bring greater precision to the understanding of spatially-related factors underlying poverty and food insecurity and discusses the role of the Food Insecurity and Vulnerability Information and Mapping System (FIVIMS) in promoting greater use of geospatial information. A new georeferenced database for analysing poverty and environment links – the Food Insecurity, Poverty and Environment Global GIS Database (FGGD) – is introduced and early efforts to make greater use of map products for monitoring poverty and food insecurity indicators are reviewed. The report concludes with a brief summary of opportunities for using the FGGD for the spatial analysis of links between poverty and environment, and applying the results to current policy issues.

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by Barbara Huddleston, Ergin Ataman, Mirella Salvatore and Mario Bloise

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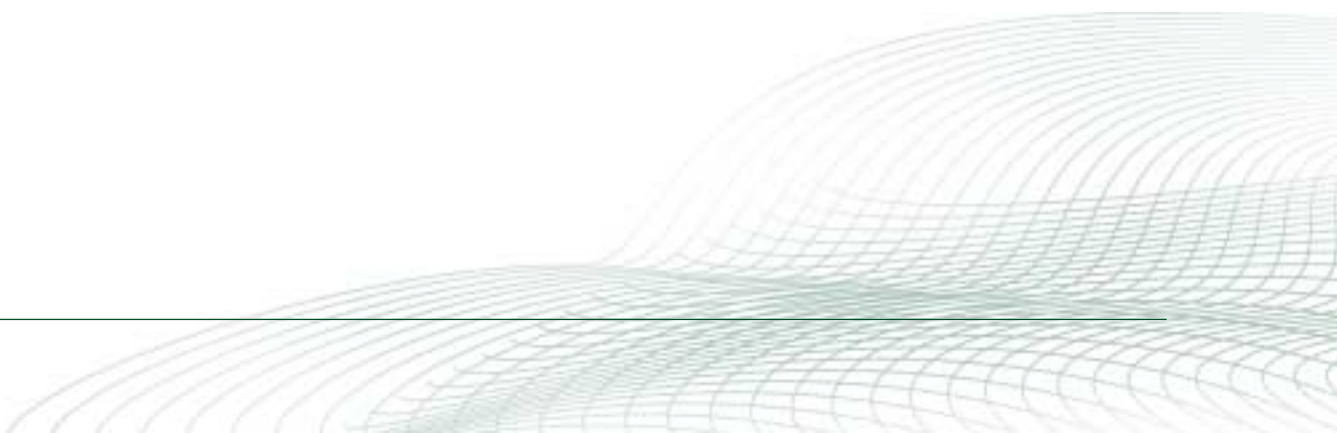
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## ACRONYMS

CCAs	Common Country Assessments
CCSA	Committee for the Coordination of Statistical Activities
CDF	Comprehensive Development Framework
ECOSOC	Economic and Social Council
ESRI	Environmental Systems Research Institute
FAO	Food and Agricultural Organization of the United Nations
FGGD	Food Insecurity, Poverty and Environment Global GIS Database
FIVIMS	Food Insecurity and Vulnerability Information and Mapping Systems
GDP	Gross Domestic Product
GIS	Geographic Information System
GNI	Gross National Income
GNP	Gross National Product
GRID-Arendal	Global Resource Information Database (Arendal, Norway)
Habitat	United Nations Human Settlements Programme
HDI	Human Development Index
HIPC	Heavily-Indebted Poor Countries
HIV/AIDS	Human Immunodeficiency Virus/ Acquired Immune Deficiency Syndrome
IAWG	Inter-Agency Working Group
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IIASA	International Institute for Applied Systems Analysis
ILO	International Labour Office
IMF	International Monetary Fund
IPU	Inter-Parliamentary Union
ITU	International Telecommunication Union
LDCs	Least Developed Countries
LGP	Length of Growing Period
MDGs	Millennium Development Goals
ODA	Official Development Assistance
OECD	Organisation for Economic Co-operation and Development
OECD/DAC	Organisation for Economic Co-operation and Development/Development Assistance Committee
PARIS21	Partnership in Statistics for Development in the 21 <sup>st</sup> Century
PMUR	Poverty Mapping Urban and Rural database
PPP	Purchasing Power Parity
PPPs	Purchasing Power Parity dollars
PRSPs	Poverty Reduction Strategy Papers
SDRN	Environment and Natural Resources Service (FAO)
UN	United Nations
UNAIDS	Joint United Nations Programme on HIV/AIDS

<b>UNCTAD</b>	<b>United Nations Conference on Trade and Development</b>
<b>UNDAFs</b>	<b>United Nation Development Assistance Frameworks</b>
<b>UNDESA</b>	<b>United Nations Department of Economic and Social Affairs</b>
<b>UNDGO</b>	<b>United Nations Development Group Office</b>
<b>UNDP</b>	<b>United Nation Development Programme</b>
<b>UNEP</b>	<b>United Nations Environment Programme</b>
<b>UNESCO</b>	<b>United Nations Educational, Scientific and Cultural Organization</b>
<b>UNFCCC</b>	<b>United Nations Framework Convention on Climate Change</b>
<b>UNICEF</b>	<b>United Nations Children’s Fund</b>
<b>UNSD</b>	<b>United Nations Statistics Division</b>
<b>WCMC</b>	<b>World Conservation Monitoring Centre</b>
<b>WDI</b>	<b>World Development Indicators</b>
<b>WFP</b>	<b>World Food Programme</b>
<b>WFS</b>	<b>World Food Summit</b>
<b>WHO</b>	<b>World Health Organization</b>
<b>WTO</b>	<b>World Trade Organization</b>



The convening by FAO of the World Food Summit (WFS) in 1996 heightened international interest in the use of georeferenced data for analysing factors underlying poverty and food insecurity. Policy-makers wanted to know exactly where the 800 million hungry people lived. And they wanted better subnational information that would enable them to evaluate poverty and hunger in relation to location-specific environmental and socio-economic variables such as agro-ecological zones, farming systems and access to roads. Their response was to mandate the establishment of FIVIMS – Food Insecurity and Vulnerability Information and Mapping Systems – as an interagency initiative to make better use of disaggregated spatial information at both global and national levels.

The timing of the WFS coincided with a more general shift toward poverty reduction as a priority focus for development assistance. Even before the introduction of Poverty Reduction Strategy Papers (PRSPs) by the World Bank and IMF in September 1999, Bank staff and other collaborators had been investing in developing methodologies for mapping poverty with greater precision. While global poverty maps already existed that classified countries according to the prevalence of poverty, based on human development or per capita income criteria, maps that classified subnational units within countries according to these and other related criteria were seldom available. The new work therefore concentrated on developing methodologies for using subnational data to map poverty within countries.

One method employed statistical data to develop country-specific poverty indices that could be estimated for each district in the country. Another method used georeferenced household data obtained from national censuses to determine the distribution of variables relevant for poverty analysis within and across districts. Both of these methods focused primarily on locating the poor according to the administrative units in which they were most concentrated. While such information is essential for targeting aid, more complex forms of spatial analysis are required to investigate causality and identify priority action areas for decision-makers. These analyses can help to find out where the poor and the hungry are in relation to factors such as:

- agroecological zones
- marginal and productive lands
- major crop and livestock production systems
- market access
- access to social services
- livelihood systems

In order to meet the needs for such analyses, a geospatial database called the Food Insecurity, Poverty and Environment Global GIS Database (FGGD) has been developed. Six modules have so far been completed, using 2000 as the reference year. The methods used to develop the data layers included in each FGGD module, and preliminary results obtained by overlaying gridded population data with other selected data layers, are described in two companion reports. They are:

- FAO. 2005. *Mapping global urban and rural population distributions*, by M. Salvatore, F. Pozzi, E. Ataman, B. Huddlestone & M. Bloise. Environment and Natural Resources Working Paper No. 24. Rome.

- **FAO & IIASA. 2006.** *Mapping biophysical factors that influence agricultural production and rural vulnerability*, by H. van Velthuis, B. Huddleston, G. Fischer, M. Salvatore, E. Ataman & F. Nachtergaele. Environment and Natural Resources Series No. 11. Rome.

The FGGD and digital atlas, together with a user manual, are being released simultaneously as:

- **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 Velthuis, G. Fischer & F. Nachtergaele. Environment and Natural Resources Working Paper No. 26. Rome.

This report begins with a general introduction to the global anti-poverty agenda and Millennium Development Goals (MDGs), and the resulting demand for improved information to monitor and assess progress toward 2015 targets (Chapters 2 and 3). It then explains the nature of georeferenced databases and GIS maps and their utility for mapping and analysing poverty and environment links, describes the intended contribution of the FIVIMS initiative to this work, and describes the structure and content of the FGGD (Chapter 4). Finally, it summarizes recent developments in the use of global maps for poverty analysis and identifies several promising areas for future work (Chapters 5 and 6).

The authors assume that the report's readers will not have expert knowledge of GIS technologies but have an interest in applying these technologies to greater effect in their own day-to-day work. More detailed technical information about the FGGD is available in the accompanying DVD.

# THE DEMAND FOR BETTER INFORMATION

*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.*

During the last decade of the twentieth century, numerous world summits, other international conferences, and follow-up meetings were convened to call attention to conditions threatening quality of life and obstructing sustainable development for the six billion inhabitants of planet earth. These led to a global recognition that, to deliver minimum standards of human wellbeing for all without destroying the natural resource base for future generations, not only did more need to be done, it needed to be done differently. As the decade proceeded, it became increasingly obvious that the changes required would be difficult to achieve without first changing the nature and quality of the information being provided to guide policies and investments.

Section 2.1 reviews the events that took place during the Summit decade and discusses the emergence of a global anti-poverty agenda for development assistance, Section 2.2 describes various global initiatives to monitor and assess progress and comments on the information gaps that hampered these initiatives and Section 2.3 explains the efforts made to identify and provide for the monitoring of a core list of indicators to fill the most urgent of these information gaps. A comparison of three early indicator lists that emerged from these efforts is given in Annex 1.

## 2.1 THE SUMMIT DECADE AND THE EMERGENCE OF A GLOBAL ANTI-POVERTY AGENDA

In 1990 the United Nations convened a World Conference on Education for All in Jomtien (Thailand) and a World Summit for Children in New York (USA). However, the true beginning of the Summit decade is generally considered to have been the United Nations Conference on Environment and Development (UNCED), which was attended by 152 world leaders in Rio de Janeiro in 1992. Known as the Earth Summit, it focused on environmental challenges that, if not addressed, threatened to undermine the sustainability of livelihood systems for rich and poor alike.

Subsequent summits and conferences during the first half of the 1990s gave vivid testimony to the specific conditions preventing millions of people in developing countries from attaining minimum standards of human well-being. The most prominent were those held between 1993 and 1996 in Vienna, Cairo, Copenhagen, Beijing, Istanbul and Rome, focusing respectively on Human Rights, Population, Social Development, Women, Human Settlements and Food. Each of these world conferences or summits produced its own declaration and action plan. These plans all addressed essentially the same set of issues, but from different sectoral perspectives.

To give impetus to the various Declarations and Plans of Action that had been adopted, in December 1995 the 50<sup>th</sup> session of the UN General Assembly proclaimed 1997–2006 as the First United Nations Decade for

the Eradication of Poverty. Responding to recommendations of the Secretary-General and ECOSOC, in July 1996 the General Assembly also mandated ECOSOC to provide a coordinated follow-up to the outcome of major international conferences in the economic, social and related fields. These decisions established a UN system framework for a new drive to end poverty and promote social and human development worldwide.

Between 1995 and 2000, several parallel efforts were made to integrate the emerging global anti-poverty agenda into development work at national level. These efforts were led by the Development Assistance Committee of the Organisation for Economic Co-operation and Development (OECD/DAC) and the Office of the UN Development Group (UNDGO) in UNDP, as well as by the Bretton Woods institutions.

In May 1996, OECD/DAC published a review of lessons learned from a half-century of development assistance. Top among the findings of this review was the conclusion that, although the efforts of countries and societies to help themselves constitute the main ingredient for success, development assistance is often an essential complementary factor. Based on its findings, OECD/DAC concluded that in order to hold public authorities accountable for the effective use of public money, a limited number of targets needed to be agreed, and a similarly limited number of indicators selected, by means of which the success of development efforts could be judged. To this end, OECD/DAC proposed the following targets for the year 2015:

- the reduction by half of the proportion of people in extreme poverty;
- universal primary education;
- elimination of gender disparity in primary and secondary education;
- two-thirds reduction in infant and child mortality;
- three-quarters reduction in maternal mortality;
- access to reproductive services;
- all countries to have national strategies for sustainable development under implementation by 2005, so as to ensure reversal of current negative trends in the condition of the environment by 2015.

*OECD/DAC, 1996*

At around the same time, UNDGO decided to develop a process for carrying out Common Country Assessments (CCAs). These assessments were intended to address the lack of a tool for integrating follow-up to international summits at national level and provide a basis for the preparation of United Nations Development Assistance Frameworks (UNDAFs). Guidelines for the conduct of CCAs were issued in April 1999.

At their annual meetings in September 1996, the World Bank and the International Monetary Fund (IMF) jointly launched the Initiative for the Heavily-Indebted Poor Countries (HIPC). The HIPC Initiative provided for the reduction of the external debt burdens of all eligible countries to sustainable levels, on condition that they carried out strong programmes of macroeconomic adjustment and structural reform.

Like UNDP, the World Bank also recognized the importance of helping countries to integrate recommendations coming at them from many different directions into a holistic long-term strategy, with the country in the lead and the World Bank and other partners each defining their support through their respective business plans. In 1999, the World Bank thus introduced its own Comprehensive Development Framework (CDF) planning process for use at national level. The CDF provided space for all development partners, both national and international, and private as well as public, to participate. UNDAFs were not superseded, but instead featured as business plans for the UN system agencies contributing to the CDF.

In October 1999, the Bretton Woods institutions revised the modalities of the HIPC Initiative in light of increased emphasis on poverty reduction in World Bank and IMF-supported lending programmes, and included the preparation of poverty reduction strategy papers (PRSPs) as a new condition for eligibility. In low-income countries, the PRSPs were meant to become the instrument for making CDFs operational. Since then, the PRSP process has been institutionalized in some 40 countries; for many it has become a driving force for economic reform and good governance.

## 2.2 GLOBAL MONITORING AND ASSESSMENT PRODUCTS

Until 1990, the most commonly used measures of socio-economic progress had simply been gross national product (GNP) or gross domestic product (GDP) per capita. In that year, UNDP launched its Human Development Report series and introduced the Human Development Index (HDI). The new index was the work of a pioneering development thinker at UNDP, Mehbub ul Haq.

The HDI was comprised of three basic indicators – life expectancy, adult literacy, and basic purchasing power (measured in terms of GDP per capita in purchasing power parity dollars (PPPS)). Besides measuring the standard of living, based on income, it also measured quality of life as indicated by longevity and knowledge. Thus the HDI was considered to give a better picture of the degree of human well-being, country-by-country, than per capita GNP or per capita GDP alone.

The Human Development Report 1990 drew attention to the fact that the distribution of quality of life was not the same as the distribution of income across countries, and emphasized that people and their lives should be the ultimate criteria for assessing the development of a country, not economic growth. It asked policy-makers to consider how two countries with the same level of income per capita could have very different levels of human development, whereas two countries with very different per capita income levels could have the same HDI. The striking contrasts highlighted by the report provoked debate in many countries about the adequacy of social policies and the level of their public sector investments in health and education. During the 1990s, UNDP introduced several improvements in its indexing methods. Today, it publishes four indices in its annual human development reports, each with a different perspective on the nature and prevalence of poverty in the world.

In 1990 the World Bank also introduced a new measure for poverty. Using the proportion of a country's population living on less than PPP\$ 370 per year to represent poverty, and the proportion living on less than PPP\$ 270 per year to represent extreme poverty, the World Bank estimated that, in 1985, 1 116 million people in developing countries were poor, of which 633 million were extremely poor. The theoretical underpinning for this method was developed and articulated by Martin Ravallion, a senior World Bank staff member who argued that income is the best proxy for measuring poverty and that economic growth is the most effective means of reducing poverty. Subsequently, the thresholds were redefined as PPP\$ 2 per capita per day for poverty and PPP\$ 1 per capita per day for extreme poverty. With only a few other minor refinements, this method is still used by World Bank staff to generate estimates of income poverty, although the thinking about the nature of the interventions needed to reduce and eventually eradicate poverty has evolved.

Several of the early Summits also led to the introduction of, or improvements in, State of the World reports for various global issues. Examples include: *The State of the World's Children* (UNICEF), *The State of the World's Cities* (Habitat), *The State of Food Insecurity in the World* (FAO) and *The World Social Situation* (UNDESA). In each case, the agency responsible sought to incorporate formats for the regular monitoring of progress toward Summit goals and targets, as well as continuing their past practice of assessing and analysing current data and trends.

In preparation for the end of the millennium in 2000, UNDP and the World Bank each prepared new reports on poverty, and IFAD issued its first report on rural poverty. The International Food Policy Research Institute (IFPRI) also launched a 2020 vision initiative for which a large number of background papers were prepared, culminating in an international conference on the subject of *Sustainable Food Security for All by 2020*, held in Bonn in 2001.

The numerous assessment reports generated during this period were highly successful in their advocacy mission, but none succeeded in gaining acceptance for any standard formats or procedures that could be used for the regular monitoring and assessment of progress towards already agreed goals and targets. A fundamental reason was the inadequacy of available information sources.

### 2.3 THE SEARCH FOR INDICATORS

Experts charged with devising procedures for monitoring summit follow-up were first concerned to select appropriate indicators to track progress towards achieving the various goals and targets established by the summits. The World Bank had been publishing world development indicators (WDI) as an Annex to its annual World Development Reports since 1978. However, as these depended on the data collection procedures of individual countries, there were significant gaps in the coverage, and the time periods for which data were available were not standard.

Initially, each agency responsible for monitoring follow-up to one of the Summits attempted to develop its own list of indicators. However, it soon became evident that all were drawing on essentially the same pool of indicators, and all faced the same problems of lack of reliable data. Thus the focus shifted to rationalizing and streamlining the list of indicators to be monitored, and ensuring that national statistical services had the capacity and were equipped to monitor the selected indicators.

During the second half of the 1990s, a consensus began to emerge about what indicators to monitor but data constraints and analytical lacunae still remained. In 1999, a CCA indicator framework was released for national use, as part of the Common Country Assessment guidelines. This framework represented an international consensus on a list of 29 indicators designed to capture the many dimensions of poverty within a country. Its primary purposes were:

- to focus on national and international development goals;
- to provide a quantitative focus for measuring results in achieving the major development goals and objectives of United Nations conferences, summits and conventions;
- to flag key development issues covered by United Nations agency mandates;
- to help identify data gaps and constraints in the capacity of national statistical systems.

*UN Statistics Division, 1999*

In the meantime, OECD/DAC had also been working to develop a shorter list of priority indicators for global monitoring. Its list, containing 26 indicators, was released by the United Nations in 2000.

In September 2000, the twenty-sixth session of the Committee on World Food Security reviewed a document that compared the CCA and OECD/DAC indicator lists with an indicator list that had been proposed by FIVIMS for monitoring World Food Summit follow-up. This comparison revealed the extent of the difficulties encountered in arriving at an agreed list of manageable length and the problems that lay ahead in trying to obtain timely, reliable data with global coverage for all of the listed indicators (see Annex 1).

To improve the coverage and regularity of data collection at national level, a consortium comprised of the OECD, World Bank, United Nations, IMF and EC founded the Partnership in Statistics for Development in the 21<sup>st</sup> Century (PARIS21). This partnership was created in November 1999 in response to a UN Economic and Social Council resolution on the goals of the UN Conference on Development. Since then, PARIS21 has evolved into a worldwide partnership of policy-makers, analysts and statisticians that promotes work on high-quality statistics, on making these data meaningful, and on encouraging their use in policy design.



# THE MILLENNIUM CONSENSUS

*At the Millennium Summit in 2000, world leaders reached a consensus on goals and targets for economic and social development in the 21<sup>st</sup> century. However, there were many gaps in the information available to guide action.*

International consensus on an integrated course of action for tackling interrelated problems of poverty, hunger and environmental degradation in the twenty-first century emerged at the Millennium Summit, convened by the United Nations in New York, in September 2000. This consensus was subsequently articulated in the form of eight Millennium Development Goals (MDGs) and eighteen 2015 targets. These established a set of priorities for action that reflected the main findings and recommendations of the preceding summits and international conferences on economic and social development. Section 3.1 describes the process that produced this consensus while Section 3.2 discusses steps taken to track progress towards the agreed goals and targets.

## 3.1 THE MILLENNIUM GOALS AND TARGETS

Three months before the Millennium Summit, on the opening day of the UN General Assembly Special Session on Social Development in Geneva, 26 June 2000, the Secretary-General of the UN launched the report *A Better World for All*. The report had been developed by a unique partnership involving the United Nations Development Group and the OECD, as well as the IMF and the World Bank. It listed seven international development goals for the year 2015 that were essentially the same as those recommended by OECD/DAC in its 1996 report referred to above.

The section of the Secretary-General's report introducing these goals argues for them in the following terms:

The goals for international development address that most compelling of human desires—a world free of poverty and free of the misery that poverty breeds. The goals have been set in quantitative terms, so part of the story is told in words and pictures, but most of it is in numbers and charts.

The goals come from the agreements and resolutions of the world conferences organised by the United Nations in the first half of the 1990s. These conferences provided an opportunity for the international community to agree on steps needed to reduce poverty and achieve sustainable development. Each of the seven goals addresses an aspect of poverty. They should be viewed together because they are mutually reinforcing. Higher school enrolments, especially for girls, reduce poverty and mortality. Better basic health care increases enrolment and reduces poverty. Many poor people earn their living from the environment. So progress is needed on each of the seven goals.

*UN/OECD/IMF/World Bank, 2000*

The United Nations Millennium Summit was held in New York during the 54<sup>th</sup> session of the General Assembly, just two-and-a-half months after the release of this report. It had a much broader remit than the economic and social focus of the international development goals. In fact, at the conclusion of the Summit on 8 September 2000, the General Assembly adopted a Millennium Declaration that contained a wide range of commitments in the following areas:

- I. Values and principles
- II. Peace, security and disarmament
- III. Development and poverty eradication
- IV. Protecting our common environment
- V. Human rights, democracy and good governance
- VI. Protecting the vulnerable
- VII. Meeting the special needs of Africa
- VIII. Strengthening the United Nations

The so-called Millennium Development Goals were not actually tabled as such during the Millennium Summit itself, although much of their content was incorporated in Commitment III. To give concrete meaning to this commitment and harmonize it with other undertakings and commitments reached at the global conferences of the Summit decade, the UN Secretariat initiated a process of consultations with representatives of the IMF, OECD and World Bank following the Millennium Summit. Eight MDGs with accompanying 2015 targets and indicators were agreed upon by this group, and submitted by the Secretary-General to the General Assembly for information in September 2001.

The eight MDGs reflect a consensus that had already been emerging within the Bretton Woods institutions and OECD, to the effect that development aid needed to be better coordinated and more focused on investment in basic social services and human capital. To take account of commitments made in 1996 at the Habitat and World Food Summits after the OECD/DAC report had been released, targets related to reducing hunger (goal 1) and improving the lives of urban slum dwellers (goal 7) were added. Goal 6 was also revised to refer to combating HIV/AIDS, malaria and other diseases rather than ensuring access to reproductive services. Otherwise, the first seven MDGs were the same as the international development goals that had been proposed to the Special Session on Social Development a year earlier. Goal 8 pertaining to strengthening of the global partnership for development had also been foreseen by OECD/DAC, which recognized that if the 2015 targets were to be met, there needed to be a stronger network of effective partnerships.

### 3.2 THE MILLENNIUM INDICATORS

One of the first tasks of the expert group on Millennium Summit follow-up, convened by the Secretary-General in 2001, was to decide on a list of indicators that all partners could agree to use in monitoring progress toward achieving the MDGs. The CCA indicator framework, along with the OECD/DAC list, became important sources for the list of millennium indicators subsequently developed by this group. Table 3.1 lists the eight MDGs and 2015 targets, together with the 48 agreed indicators currently being monitored as a means of measuring progress towards achieving these goals and targets.

The hope was that, by obtaining a UN consensus on the indicators to be monitored, countries would be encouraged to invest in building the capacity of their statistical services to collect the information required.

Several promising beginnings have been made by UN- and World Bank-sponsored initiatives, as well as by the PARIS21 consortium, but much remains to be done.

During its 57<sup>th</sup> session in 2002/2003, the UN General Assembly established an open-ended working group to produce concrete recommendations on all aspects of the integrated and coordinated follow-up of the United Nations conferences and summits, in the economic, social and related fields. The group was established by GA Resolution 57/270 A in December 2002 and completed its work in June 2003. Included in its recommendations were a number of measures to improve national and international statistics for monitoring purposes.

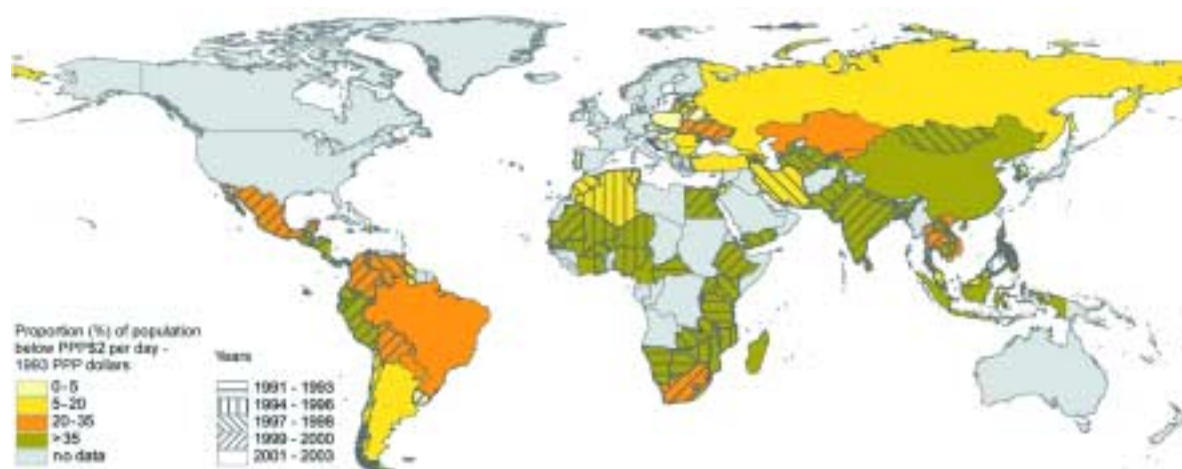
Also in 2002, the Committee for the Coordination of Statistical Activities (CCSA) was established. It brings together chief statisticians from the UN System agencies and from other international organizations active in the field of official statistics. Topics discussed by this committee have included, for example, aggregation of national data to regional and global estimates, harmonization of base years for index numbers, development of international guidelines for the presentation of statistical data and metadata, and improving the quality of data used as indicators for the Millennium Development Goals and targets.

The United Nations Statistics Division recently launched a project to prepare a publication on statistical concepts, methods and best practice for poverty statistics. The division's Web site presents work in progress on the project. The Division also maintains the Millennium Indicators Database, which is updated regularly from the databases maintained by contributing agencies, namely FAO, HABITAT, ILO, IMF, IPU, ITU, OECD, UN Population Division, UNAIDS, UNCTAD, UNEP, UNESCO, UNFCCC, UNICEF, UNSD, WCMC, WHO, WTO and World Bank.

For most indicators there is global coverage for at least one recent year since 2000. However, there are some notable exceptions, the most significant being the lack of comparable data across countries for the poverty indicator. The lack of comparability across countries for this indicator is evident in Maps 3.1 and 3.2. These maps have been constructed by the FAO/SDRN GIS unit from the most recent data available in the World Bank's World Development Indicators Database – the data source for monitoring this MDG indicator.

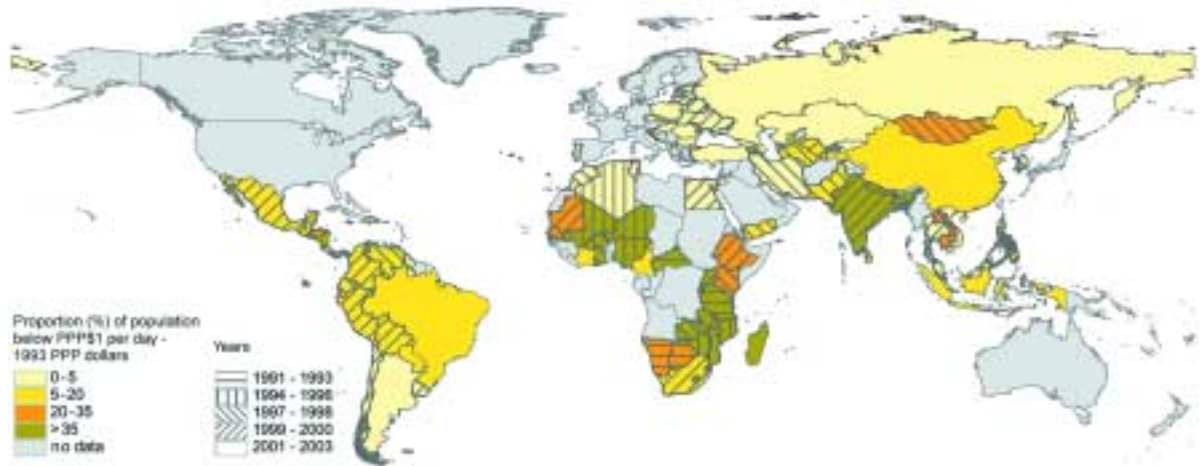
MAP 3.1

### Share of population living in poverty, by country, varying years



Source: FAO/SDRN, based on data reported in World Bank, *WDI Online*, as of April 2005.

MAP 3.2

**Share of population living in extreme poverty, by country, varying years**

Source: FAO/SDRN, based on data reported in World Bank, *WDI Online*, as of April 2005.

Since 2000, HIPC countries have been supported in establishing national poverty monitoring systems designed to keep development outcomes at the centre of attention and ensure better practical success in reducing poverty. However, many countries are still not equipped to monitor all of the indicators included in the millennium indicators list on a regular basis. In 2003, the World Bank reported that:

On the whole, countries' monitoring of progress toward the MDGs as adapted through the Poverty Reduction Strategies (PRSs) needs more attention. Despite the increased emphasis on quantitative targets, few PRSPs follow through with monitoring and evaluation programs. Only a few countries have systems that monitor MDG indicators. Attention to the monitoring and evaluation of outcomes remains largely insufficient and is mostly directed to projects funded by external partners.

*World Bank, 2003*

Owing to the lack of good data for regularly monitoring income poverty and other MDG indicators, most monitoring efforts until now have had to rely on proxy methods using other, more up-to-date and reliable, types of data. Geographic Information Systems that combine remote sensed data about the physical environment and the distribution of population, with statistical data for variables that are regularly monitored, are one such source.

TABLE 3.1

**Millennium Development Goals (MDGs) and 2015 targets, with their monitoring indicators**

	Goal	2015 targets	Monitoring indicators (as of January 2006)
MDG 1	Eradicate extreme poverty and hunger	Target 1. Halve, between 1990 and 2015, the proportion of people whose income is less than one dollar a day	1. Proportion of population below \$1 (1993 PPP) per day 2. Poverty gap ratio (incidence x depth of poverty) 3. Share of poorest quintile in national consumption
		Target 2. Halve, between 1990 and 2015, the proportion of people who suffer from hunger	4. Prevalence of underweight children under five years of age 5. Proportion of population below minimum level of dietary energy consumption
MDG 2	Achieve universal primary education	Target 3. Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling	6. Net enrolment ratio in primary education 7. Proportion of pupils starting grade 1 who reach grade 5 8. Literacy rate of 15–24 year-olds
MDG 3	Promote gender equality and empower women	Target 4. Eliminate gender disparity in primary and secondary education, preferably by 2005, and in all levels of education no later than 2015	9. Ratio of girls to boys in primary, secondary and tertiary education 10. Ratio of literate women to men, 15–24 years old 11. Share of women in wage employment in the non-agricultural sector 12. Proportion of seats held by women in national parliament
MDG 4	Reduce child mortality	Target 5. Reduce by two-thirds, between 1990 and 2015, the under-five mortality rate	13. Under-five mortality rate 14. Infant mortality rate 15. Proportion of 1 year-old children immunized against measles
MDG 5	Improve maternal health	Target 6. Reduce by three-quarters, between 1990 and 2015, the maternal mortality ratio	16. Maternal mortality ratio 17. Proportion of births attended by skilled health personnel
MDG 6	Combat HIV/AIDS, malaria and other diseases	Target 7. Have halted by 2015 and begun to reverse the spread of HIV/AIDS	18. HIV prevalence among pregnant women aged 15–24 years 19. Condom use rate of the contraceptive prevalence rate 20. Ratio of school attendance of orphans to school attendance of non-orphans aged 10–14 years
		Target 8. Have halted by 2015 and begun to reverse the incidence of malaria and other major diseases	21. Prevalence and death rates associated with malaria 22. Proportion of population in malaria-risk areas using effective malaria prevention and treatment measures 23. Prevalence and death rates associated with tuberculosis 24. Proportion of tuberculosis cases detected and cured under directly observed treatment short course (DOTS)
MDG 7	Ensure environmental sustainability	Target 9. Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources	25. Proportion of land area covered by forest 26. Ratio of area protected to maintain biological diversity to surface area 27. Energy use (kg oil equivalent) per \$1 000 GDP (PPP) 28. Carbon dioxide emissions per capita and consumption of ozone-depletion CFCs (ODP tons) 29. Proportion of population using solid fuels
		Target 10. Halve by 2015 the proportion of people without sustainable access to safe drinking water and sanitation	30. Proportion of population with sustainable access to an improved water source, urban and rural 31. Proportion of population with access to improved sanitation, urban and rural
		Target 11. By 2020, to have achieved a significant improvement in the lives of at least 100 million slum dwellers	32. Proportion of households with access to secure tenure

see next page 

	Goal	2015 Targets	Monitoring indicators (as of January 2006)
MDG 8	Develop a Global Partnership for Development <i>(Some of the listed indicators will be monitored separately for the least developed countries (LDCs), Africa, landlocked developing countries (LLDCs) and small island developing States (SIDS))</i>	<p>Target 12. Develop further an open, rule-based, predictable, non-discriminatory trading and financial system <i>(Includes a commitment to good governance, development and poverty reduction – both nationally and internationally)</i></p> <p>Target 13. Address the special needs of the least developed countries <i>(Includes tariff and quota free access for least developed countries' exports; enhanced programme of debt relief for heavily indebted poor countries (HIPC) and cancellation of official bilateral debt; and more generous ODA for countries committed to poverty reduction)</i></p> <p>Target 14. Address the special needs of landlocked developing countries and small-island developing States <i>(through the Programme of Action for the Sustainable Development of Small Island Developing States and the outcome of the twenty-second special session of the General Assembly)</i></p> <p>Target 15. Deal comprehensively with the debt problems of developing countries through national and international measures in order to make debt sustainable in the long term</p>	<p><i>Official development assistance (ODA)</i></p> <p>33. Net ODA, total and to LDCs, as percentage of OECD/DAC donors' gross national income (GNI)</p> <p>34. Proportion of total bilateral, sector-allocable ODA of OECD/DAC donors to basic social services (basic education, primary health care, nutrition, safe water and sanitation)</p> <p>35. Proportion of bilateral ODA of OECD/DAC donors that is untied</p> <p>36. ODA received in landlocked developing countries as a proportion of their GNIs</p> <p>37. ODA received in small island developing States as a proportion of their GNIs</p> <p><i>Market access</i></p> <p>38. Proportion of total developed country imports (by value and excluding arms) from developing countries and from LDCs admitted free of duty</p> <p>39. Average tariffs imposed by developed countries on agricultural products and textiles and clothing from developing countries</p> <p>40. Agricultural support estimates for OECD countries as percentage of their GDP</p> <p>41. Proportion of ODA provided to help build trade capacity</p> <p><i>Debt sustainability</i></p> <p>42. Total number of countries that have reached their HIPC decision points and number that have reached their HIPC completion points (cumulative)</p> <p>43. Debt relief committed under HIPC initiative</p> <p>44. Debt service as a percentage of exports of goods and services</p>
		Target 16. In cooperation with developing countries, develop and implement strategies for decent and productive work for youth	45. Unemployment rate of young people aged 15–24-years, each sex and total
		Target 17. In cooperation with pharmaceutical companies, provide access to affordable essential drugs in developing countries	46. Proportion of population with access to affordable essential drugs on a sustainable basis
		Target 18. In cooperation with the private sector, make available the benefits of new technologies, especially information and communications	47. Telephone lines and cellular subscribers per 100 population 48. Personal computers in use per 100 population

# THE ADDED VALUE OF GEOREFERENCED INFORMATION

*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.*

Map products have been used by a number of UN agencies, research institutes and other organizations to support Summit follow-up monitoring processes. Many early poverty and environment maps were gross visual summaries of statistical data that had not been georeferenced. They made an important contribution to raising awareness and stirring the world's conscience. However, they were not sufficiently detailed to address questions about location-specific causality that were beginning to matter more and more to the development community.

Map databases generated by Geographic Information System (GIS) provide a promising alternative. A GIS stores cross-sectoral spatial and statistical data, and the software needed for analysis. An advanced GIS can integrate data layers for a very large array of variables in the same format, structure and map projection, and run statistical programmes and process complex models. This capacity of GIS technology constitutes a powerful tool for investigating relationships between poverty, hunger and environment.

Section 4.1 looks at the utility of GIS mapping technology for analysing links between poverty and environment, Section 4.2 provides background information about FIVIMS, and Section 4.3 explains the background and approach used to create the FGGD and accompanying DVD and Atlas, and summarizes their content. Annex 2 lists the titles and sources for each of the data layers included in the FGGD.

## 4.1 GEOGRAPHIC INFORMATION SYSTEMS (GIS) AND THEIR USES

Computer technology has long made it possible to manipulate and analyse statistical information. But technology that can convert maps into a computer-usable digital format and allow the simultaneous manipulation of geographic spatial data and related attribute data is relatively recent. In fact, it is only since the mid-1990s that geographic information systems have come into widespread use, following advances in computer technology that made high-speed processing of very large quantities of data and the production of high-resolution global maps feasible (see Box 4.1).

Today it is possible to analyse and map the global spatial distribution of variables that contribute to rural poverty and hunger in various ways, for instance:

- within areas bounded by geographical rather than political characteristics;
- at various scales, from as small as one field to as large as all land suitable for agriculture;
- through overlays that combine the spatial distribution of rural population with the distribution of other variables of interest and permit the estimation of per capita occurrence of these variables.

What makes GIS unique is that spatial data and attribute data can always be linked and processed jointly. This makes it possible for decision-makers to compare and combine selected information from different maps in order to answer a specific question.

The ultimate utility of a GIS lies in its capability for modelling: constructing models of the real world from digital databases, and using these models to simulate the effect of a specific process over time and in space for a given scenario. Modelling is especially useful for analysing trends and identifying factors that affect them, or for displaying the possible consequences of planning decisions or projects that affect resource use and management. Examples include mapping suitability of land for various types or intensities of use, and projecting future production scenarios for each suitability class.

#### BOX 4.1

##### **KEY CONCEPTS OF GIS**

This box presents a few key concepts of GIS for readers who are not GIS experts, but who have an interest in using GIS products, and want to acquire a basic understanding of what the technology is and how it works. More detailed explanations of these concepts are given in FAO/SDRN, *Geographic Information Systems in Sustainable Development*, 2004 (available at [www.fao.org/sd/eidirect/gis/Elgis000.htm](http://www.fao.org/sd/eidirect/gis/Elgis000.htm)).

A GIS, or Geographic Information System, is a computerized database management system that is specifically designed for simultaneous storing and processing of spatial and related attribute data. A GIS database is a digital database stored in a Geographic Information System. It includes two components: i) a spatial component with precise geographic coordinates, linked to points, lines, or polygons in vector maps and to pixels or grid cells in raster maps; ii) tabular data, which are always linked to the spatial components and represent their attributes, expressed in the form of either numeric or textual data, or both. The database usually contains many GIS maps, or data layers, each representing the geospatial distribution of a single variable. In some instances, the variable will come directly from a primary data source; in other instances, several data layers may be overlaid and manipulated in order to create the new single variable.

A GIS map image is a visual impression of a GIS map that can be viewed on the computer screen or plotted and produced as a paper map. This map image is generated by grouping the attribute data in a small number of classes to make them perceptible to the human eye, and then projecting the results on to a two-dimensional space that can be printed on paper or displayed on a computer screen.

GIS provides a means of taking many different kinds of georeferenced information, processing it into compatible datasets, combining it, querying it and analysing it. In addition to displaying the results of spatial analysis in the form of map images, tables and charts are often used to provide more detailed, complementary information. A global GIS database can store and manipulate very high-resolution georeferenced data that can be used for spatial analysis, even when the results cannot be represented meaningfully on a global GIS map image.

## 4.2 THE FIVIMS INITIATIVE

To meet the need for more detailed subnational and spatially distributed information, world leaders who gathered at the World Food Summit in 1996 mandated the establishment of Food Insecurity and Vulnerability Information and Mapping Systems (FIVIMS), at both national and global levels. In their words:

It is necessary to target those people and areas suffering most from hunger and malnutrition and identify causes and take remedial action to improve the situation. A more complete, user-friendly source of information at all levels would enable this.

*World Food Summit Plan of Action, 1996, paragraph 4*

In response, an Inter-Agency Working Group (IAWG), whose membership currently includes representatives from 31 agencies and organizations, launched the FIVIMS initiative in 1998 and requested FAO to host its permanent secretariat.

The idea behind FIVIMS is that improved information can be actively used to produce better results in efforts to reduce undernourishment by half by 2015. The acronym FIVIMS does not refer to any one particular system or network of systems; rather, it is a framework within which a wide range of activities may be carried out at national and international levels in support of improved information to achieve World Food Summit goals. Any system that assembles, analyses and disseminates information about who the food insecure are, where they are located, and why they are food insecure, nutritionally vulnerable or at risk can be part of the FIVIMS initiative. At the international level, FIVIMS is implemented through a diverse programme of activities that aims to support national FIVIMS and establish a common international database and information exchange network, referred to as global FIVIMS.

Much of the innovative mapping work promoted by FIVIMS has been done at, or for, the national level. Prior to the establishment of FIVIMS, national-level data for poverty-monitoring indicators had usually been obtained from national surveys. Sometimes data that had been collected for other purposes by subnational administrative units was aggregated to obtain a national figure, but this practice was not common. Today, more and more countries are introducing survey methods that sample at subnational rather than national level and are systematically recording data provided by subnational collection points before creating the national aggregates. This allows survey data to be used for analysis at subnational as well as national level, and marks an important step forward for national statistical services that have adopted this approach.

The FIVIMS initiative has strongly promoted the more systematic use of subnational sampling methods for national surveys. Since 1998, the FIVIMS secretariat, supported by technical and financial contributions from IAWG members, has also:

- provided technical guidance for national FIVIMS in requesting countries
- carried out a review of how FIVIMS might support CCA and PRSP formulation processes
- created an online inventory of subnational food insecurity and vulnerability maps
- promoted methods research for subnational mapping within countries

*FIVIMS Coordinator, Personal communication, 2005*

The online FIVIMS Mapping Products Inventory contains a collection of maps obtained from various sources that show aspects of food insecurity, vulnerability and poverty in different countries and regions.

Information is given on the variables used to create the maps, and on how these maps have been or could be used by policy-makers.

The inventory contains many maps that depict poverty data at subnational level. However, although all of these maps contain statistical data that have been attributed to subnational administrative units, none depicts distribution of the data spatially within subnational units. Therefore there is considerable synergy between the activities of FIVIMS and the FAO GIS unit, for making GIS technologies and better mapping products more widely available to the decision makers and information system managers.

#### 4.3 THE FOOD INSECURITY, POVERTY AND ENVIRONMENT GLOBAL GIS DATABASE (FGGD)

The poverty mapping website created by UNEP/GRID-Arendal (<http://povertymap.net>) contains a quite comprehensive inventory of map products related to poverty. A review of this inventory shows that the mapping of poverty monitoring indicators at subnational level has so far been attempted mainly by national poverty monitoring systems; few global maps exist that depict the prevalence of poverty-related variables at subnational level, let alone by pixel. The purpose of the Food Insecurity, Poverty and Environment Global GIS Database (FGGD) is to help fill this information gap as well as to contribute to the common international database.

In developing the FGGD, FAO/SDRN has considered its primary users to be experts concerned with monitoring follow-up to the Millennium Summit, the World Summit on Sustainable Development and the World Food Summit: *five years later*. Documents produced by these summits, together with guidance from the FIVIMS secretariat, have served as sources for defining user needs.

The relationship of the data layers in any GIS database is hierarchical. Figure 4.1 depicts a generic form of this hierarchy. The characteristics of each level are summarized below.

- Level 1 contains base maps and other maps with raw data. These maps are referred to as primary data layers. They contain information about:
  - topographical features such as coastlines, contour lines (elevation), mountains;
  - hydrological features such as rivers, inland water bodies;
  - geographical features that are the consequence of human activity, such as human settlements, boundaries of political and administrative units, physical infrastructure (roads, railroads, dams, power stations, telecommunication lines).
- Level 2 maps cover a wide variety of variables for which georeferenced information can be obtained through observation, measurement, survey or remote sensing; some computations such as interpolations may also be required in their construction. These maps are referred to as secondary data layers. Typical secondary data layers contain:
  - information for any statistical variable that can be assigned to administrative units for which boundaries have been established in the base layer, such as demographic or socio-economic data;
  - information about the properties of soil, terrain and climate;
  - information about land use patterns obtained from direct observation or survey.
- Level 3 maps contain information based on models. Some of the models are not very complex; many simply create new maps by standardizing and combining several different data layers from various levels. Others are quite complex, introducing assumptions and manipulating multiple datasets so as to generate new, previously unavailable, georeferenced information.
- Level 4 maps provide georeferenced information relevant for a specific analytical project. These maps are generated from data layers contained in the lower levels.

The FGGD contains a large number of data layers that relate to the theme of food insecurity and livelihood vulnerability. These are capable of being combined in various ways to answer questions relevant to monitoring progress towards achievement of the WFS target and MDGs. The FGGD's purpose is to make standardized global GIS databases more widely available at resolutions that permit the use of spatial analysis for evaluating poverty and environment links.

The FGGD has been developed using existing digital GIS databases in FAO or the public domain as well as through the creation of new data layers made using remote sensed data, conversion of statistical datasets to geospatial data layers, and GIS modelling capabilities. All the data layers have been converted into a uniform GIS format and spatially integrated to minimize errors in multilayer overlays. This allows data from different sectors to be combined to create various geophysical, biophysical, demographic and socio-economic maps. Documentation has been prepared for all the map data layers, and is contained in the *Food Insecurity, Poverty and Environment Global GIS Database (FGGD)* and *Digital Atlas for the Year 2000* (see Annex 2 for contents).

The FGGD currently comprises six modules:

1. Boundaries and topography
2. Population
3. Socio-economic and nutrition indicators
4. Environmental conditions
5. Land use patterns and land cover
6. Land productivity potential

Each module contains data layers that have been generated at different levels of complexity. The data layers included in each module have been generated from various primary data sources, in accordance with a standard set of FGGD specifications.

In some instances, the steps involved to move from the primary source to the FGGD data layer have been quite straightforward. In other instances, data layers have been developed from quite complex models that involve several procedural steps and the application of mathematical formulae. For several modules, a fairly complex product or set of products is generated as the outcome of a sequence of mapping procedures. The hierarchy of GIS maps contained in the FGGD is displayed in Figure 4.2, along with references to some other additional modules which are planned, e.g. estimates for agricultural performance and economic value of agricultural production by pixel.

FIGURE 4.1

**A generic hierarchy of GIS maps**

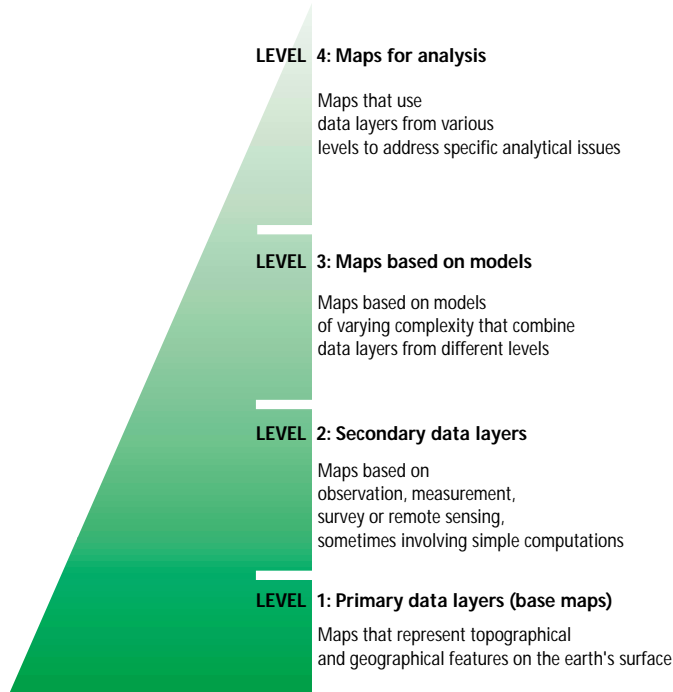
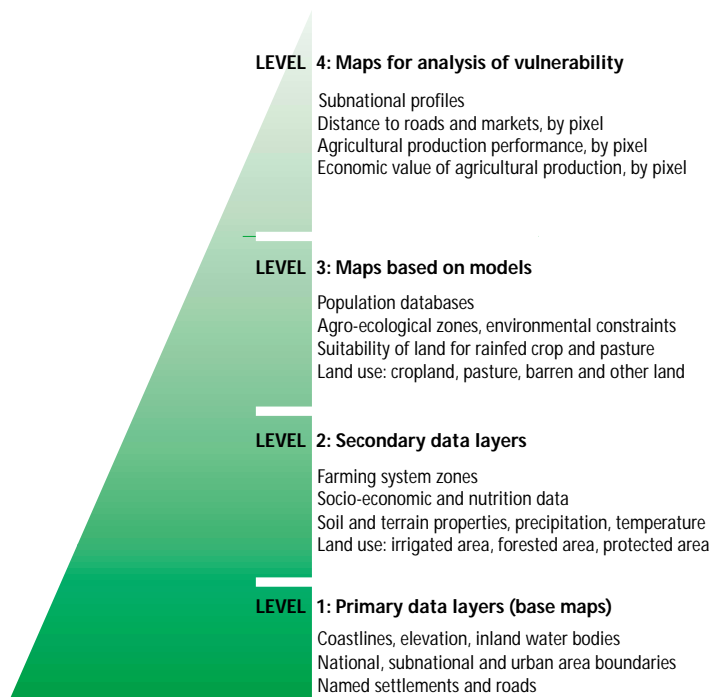


FIGURE 4.2

**The hierarchy of GIS maps in the FGGD**



# 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](http://www.poverty.net) includes a collection of 134 online global maps on the following themes:

- demographic indicators
- economy and markets
- education

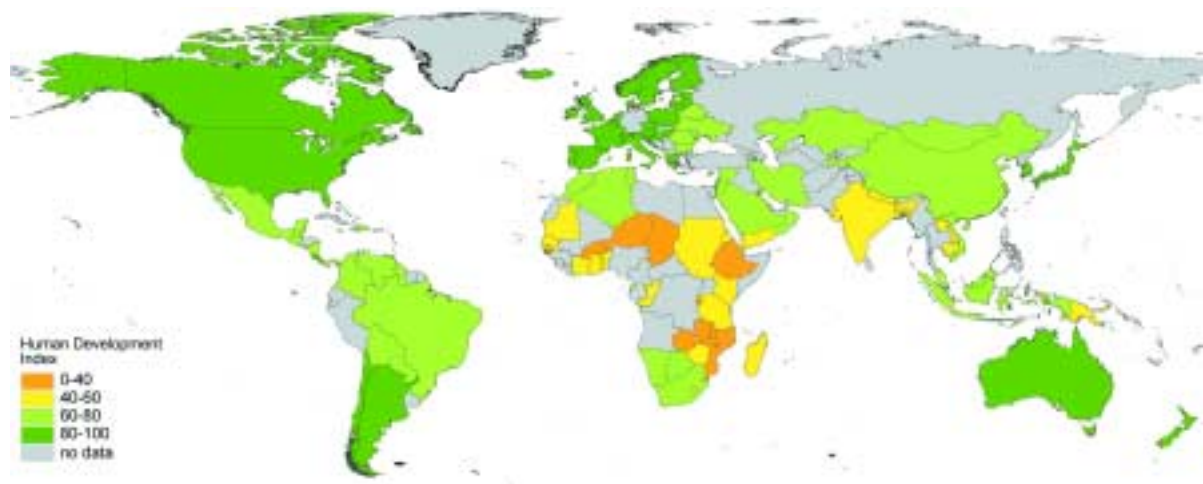
- energy
- water and sanitation
- food security
- health
- poverty indicators
- urban areas

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.

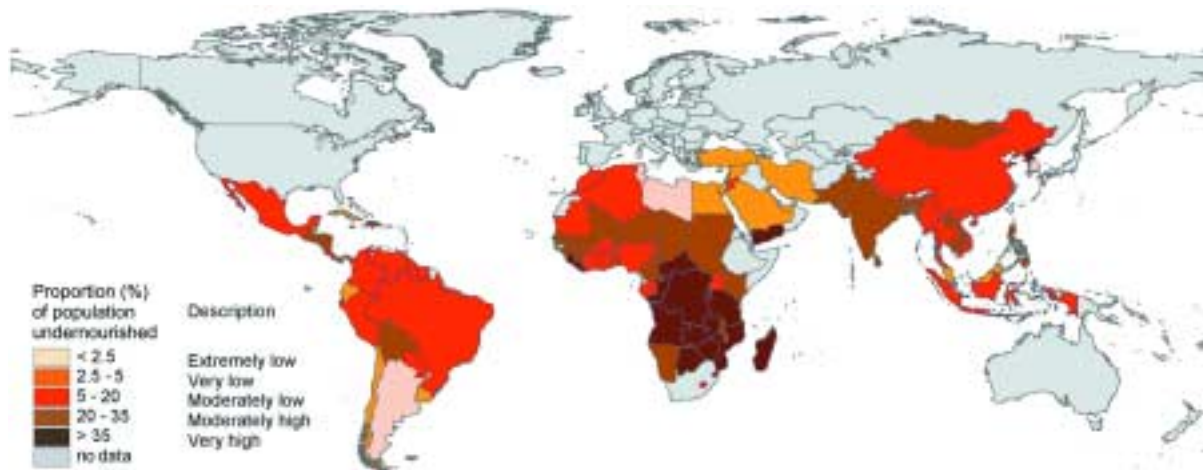
The four examples shown below illustrate the utility of global maps that depict national statistical data. Map 5.1 highlights differences among countries with respect to the Human Development Index for 2000, while Map 5.2 does the same with respect to the prevalence of undernourishment in 2000–2002. 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



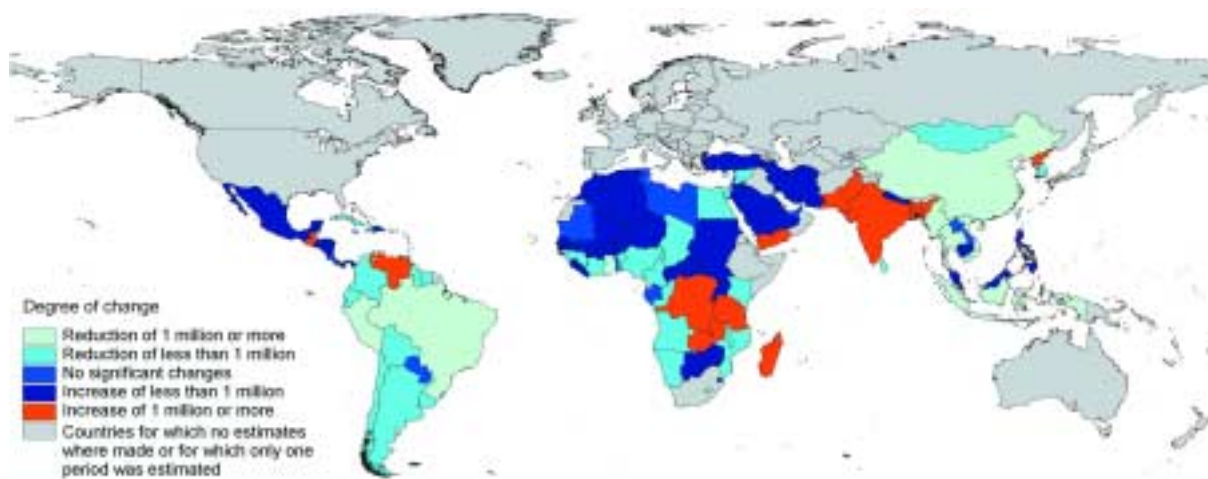
Source: FAO/SDRN, based on data published in UNDP, *Human Development Report 2003*.

MAP 5.2

**Share of population undernourished, by country, 2000-2002**

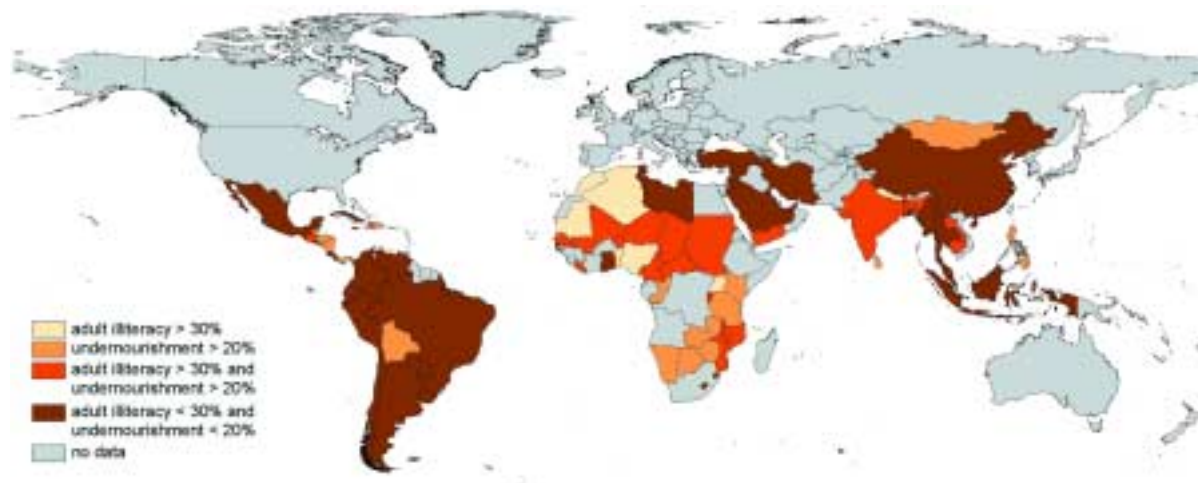
Source: FAO/SDRN, based on data published in FAO, *The State of Food Insecurity in the World 2004*.

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*.

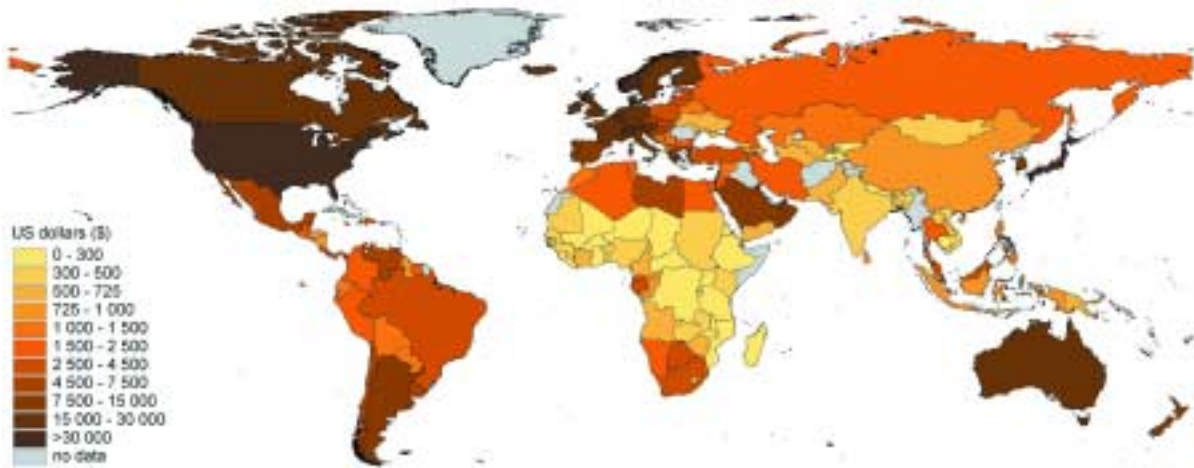
## 5.2 EARLY APPLICATION OF A GLOBAL GIS-BASED APPROACH TO EVALUATE THE INFLUENCE OF GEOGRAPHY ON POVERTY AND MALNUTRITION

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.

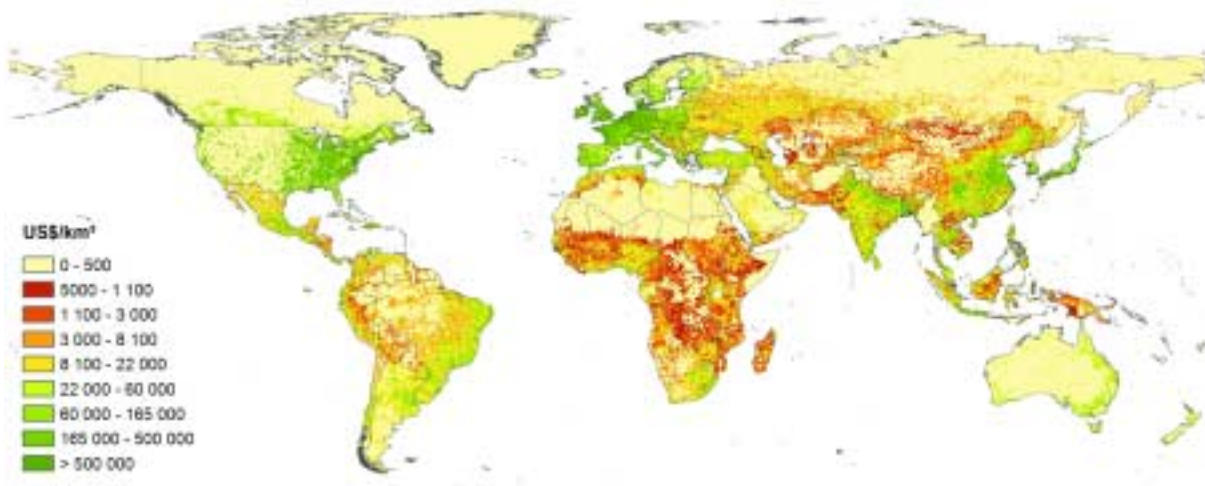
FAO/SDRN has subsequently refined the approach using GDP density per square kilometre as a basis for comparison with GDP per capita per country. The difference in refinement of the visual information between a map based on national statistical data, and a map based on attribution of average per capita 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.

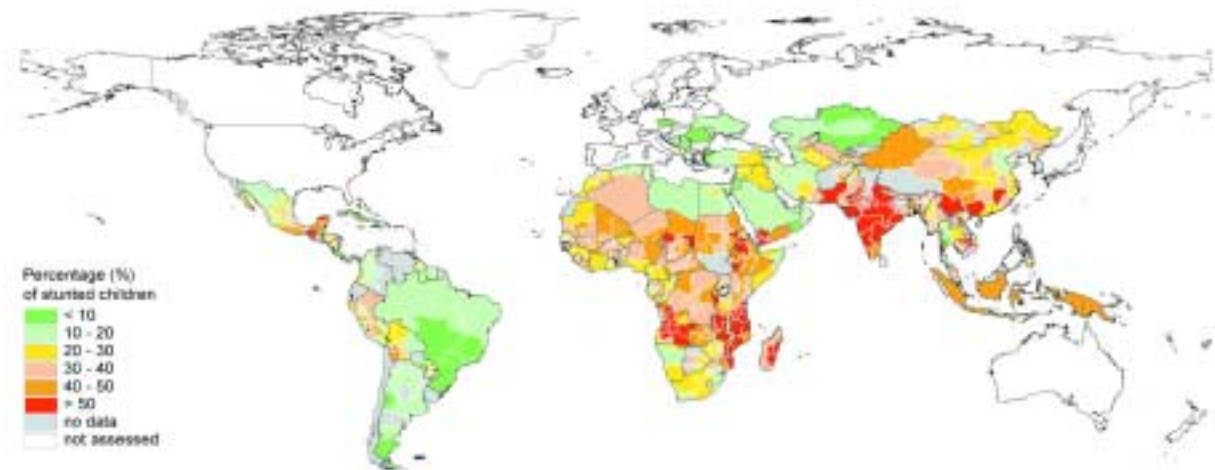
Prior to embarking on the development of the global GIS database introduced in this report, FAO/SDRN implemented a collaborative work programme with FAO/ESNA that led to the release of two new hunger maps depicting the distribution of stunted children under five by lowest subnational administrative unit 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

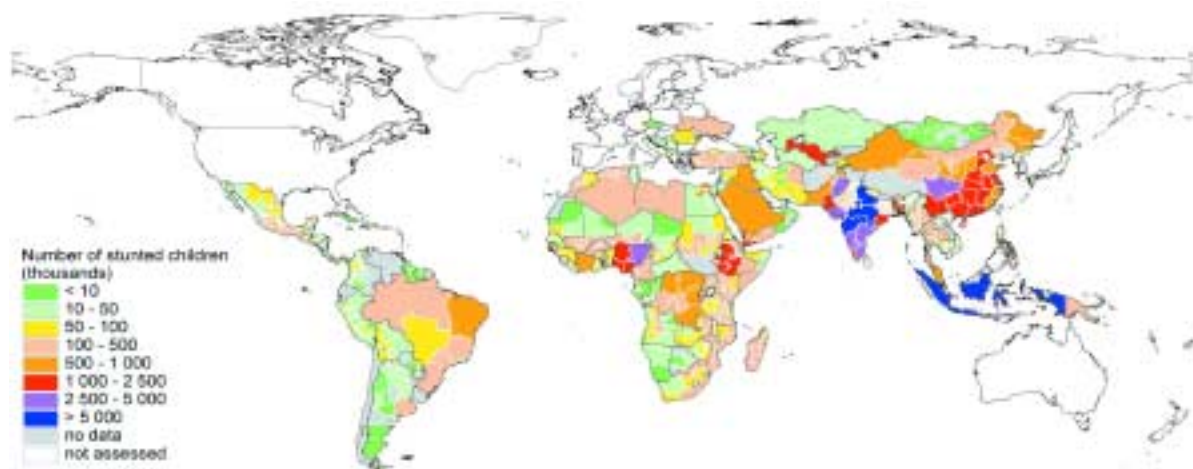
**Prevalence of stunting among children under five, by lowest available subnational administrative unit, varying years**



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.



## 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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# 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, 26<sup>th</sup> Session, 18–21 September 2000. *Suggested core indicators for monitoring food security status, CFS: 2000/2 – Sup.1.* FAO, Rome.

Indicator <sup>1</sup>	FIVIMS-related indicators			UN-system lists		Data availability <sup>2</sup> (incl. main institutional source)
	IAWG	FAO-Secretariat	ANDI	OECD	UN/CCA	
<b>FOOD SECURITY AND NUTRITION OUTCOMES</b>						
<b>Food Consumption Status</b>						
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)
<b>Health Status</b>						
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)
<b>Nutritional Status</b>						
Percentage of adults with low BMI		X	X			varying years (WHO) <sup>3</sup>
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) <sup>3</sup>
Percentage of children under 5 affected by night blindness		X				varying years (WHO)
Percentage of households consuming iodised salt			X			varying years (UNICEF) <sup>3</sup>
Percentage of newborns with low birth weight		X				1997 (WHO/UNICEF)
Percentage of population affected by goitre		X				varying years (WHO)

Indicator <sup>1</sup>	FIVIMS-related indicators			UN-system lists		Data availability <sup>2</sup> (incl. main institutional source)
	IAWG	FAO-Secretariat	ANDI	OECD	UN/CCA	
<b>OUTCOME INDICATORS FOR VULNERABILITY FACTORS</b>						
<b>Demographic conditions</b>						
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)
<b>Environmental Conditions</b>						
Arable land per person		X			X	1998 (FAO)
Average annual rate of deforestation		X				varying years (WRI) <sup>3</sup>
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 <sup>2</sup> 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)
<b>Economic Conditions</b>						
Cropped area as % of total area		X				1997 (FAO)
Employment of population of working age ratio (%)					X	varying years (ILO) <sup>3</sup>
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)
<b>Political Conditions</b>						
Number of countries facing a conflict-related emergency		X				2000 (CRED)
<b>Socio-Cultural Conditions</b>						
Adult literacy/illiteracy rate		X		X	X	1998 (UNESCO)
Female illiteracy rate			X			varying years (UNSD) <sup>3</sup>
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) <sup>3</sup>
Percentage of pupils starting grade 1 who reach grade 5				X	X	1996 (WB)

Indicator <sup>1</sup>	FIVIMS-related indicators			UN-system lists		Data availability <sup>2</sup> (incl. main institutional source)
	IAWG	FAO-Secretariat	ANDI	OECD	UN/CCA	
<b>OUTCOME INDICATORS FOR VULNERABILITY FACTORS</b>						
<b>Risks, Hazards, Shocks</b>						
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)
<b>Food Availability</b>						
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)
<b>Food Access</b>						
Consumer prices index		X				varying years (WB) <sup>3</sup>
Food prices index		X				varying years (WB) <sup>3</sup>
Gini-index of income distribution		X				varying years (WB) <sup>3</sup>
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) <sup>3</sup>
People living on less than \$1 a day (%)				X	X	varying years (WB) <sup>3</sup>
% 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) <sup>3</sup>
Road density (kilometres of road per unit area)		X				(*)
Share of national income by percentile of population		X				varying years (WB) <sup>3</sup>
<b>Stability of Food Supplies and Access</b>						
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)
<b>Household Characteristics</b>						
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 <sup>1</sup>	FIVIMS-related indicators			UN-system lists		Data availability <sup>2</sup> (incl. main institutional source)
	IAWG	FAO-Secretariat	ANDI	OECD	UN/CCA	
<b>OUTCOME INDICATORS FOR VULNERABILITY FACTORS</b>						
<b>Health and Sanitation</b>						
Contraceptive prevalence rate (%)				X	X	varying years (UNDP) <sup>3</sup>
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) <sup>3</sup>
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)
<b>Care and Feeding Practices</b>						
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) <sup>3</sup>
Weaning age		X				varying years (WHO) <sup>3</sup>

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.

# CONTENT OF THE FGDD AND DIGITAL ATLAS FOR THE YEAR 2000<sup>1</sup>

FGGD MODULES		DATA LAYERS WITH FGDD ATLAS MAPS		SOURCES
No.	Name	No.	Title	Reference documents
One	Boundaries and topography	1.1	Coastal and country boundaries of the world	FAO & UNESCO. 1992
		1.2	Inland water bodies	FAO & UNESCO. 1992
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. 2004
		3.5	Changes in the number of undernourished, by country, between 1990-1992 and 2000-2002.	FAO/SDRN, based on FAO. 2004
		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 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	Median 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	Land not currently available for rainfed crop production, by land cover type	FAO & IIASA. 2006
		5.9	Land not currently available for rainfed crop production, total	FAO & IIASA. 2006
		5.10	Farming system classes in developing and transition countries, 2000	FAO & World Bank. 2001

see next page ➡

1. FAO. 2006. *Food Insecurity, Poverty and Environment Global GIS Database (FGDD) 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. Nachtergaele. Environmental and Natural Resources Working Paper No. 26. Rome.

FGGD MODULES		DATA LAYERS 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, global land area, 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		

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FGGD MODULES		DATA LAYERS 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

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

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

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<b>C</b> Chinese	<b>P</b> Portuguese	* Out of print
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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 21<sup>st</sup> 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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