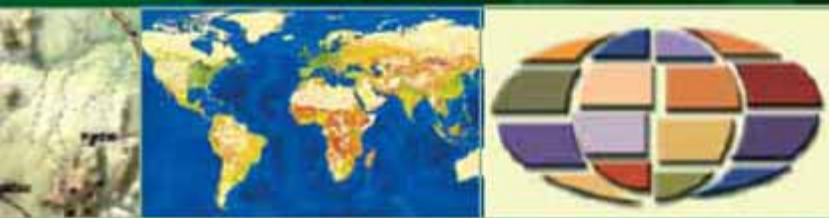


A geospatial framework for the analysis of poverty and environment links



**POVERTY
MAPPING**
MAPPAGE DE LA POVERTÉ
MAPPING DE LA POVERTÉ
MAPPAGE DE LA POVERTÉ







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FOREWORD

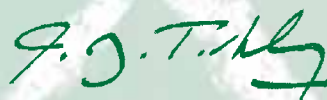
One of the core functions of FAO is to provide data and information. Geospatial information can be of particular value to audiences interested in the monitoring and assessment of progress towards achieving the Millennium Development Goals (MDGs) by 2015, and in analysing underlying causes of poverty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

A geospatial framework for the analysis of poverty and environment links

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

56 pages, 2 figures, 1 table, 10 maps

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Environment, food insecurity, FGGD, FIVIMS, geospatial, georeferenced information, GIS, GIS maps, Millennium Development Goals, MDGs, millennium indicators, Millennium Project, spatial data, spatial analysis, statistical maps, Summit decade, poverty, vulnerability.

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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 st Century
PMUR	Poverty Mapping Urban and Rural database
PPP	Purchasing Power Parity
PPP\$	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

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

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. Huddleston & 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 Velthuizen, B. Huddleston, G. Fischer, M. Salvatore, E. Ataman, F.O. Nachtergaele, M. Zanetti & M. Bloise. 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 Velthuizen, 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 50th 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 (PPP\$)). 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 21st 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 21st 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 54th 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 57th 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.

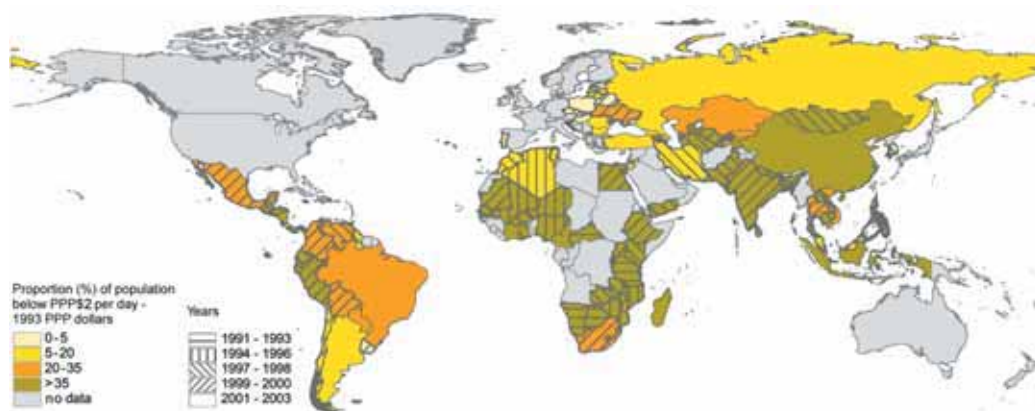
Also in 2002, the Committee for the Coordination of Statistical Activities (CCSA) was established. It brings together chief statisticians from the UN System agencies and from other international organizations active in the field of official statistics. Topics discussed by this committee have included, 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

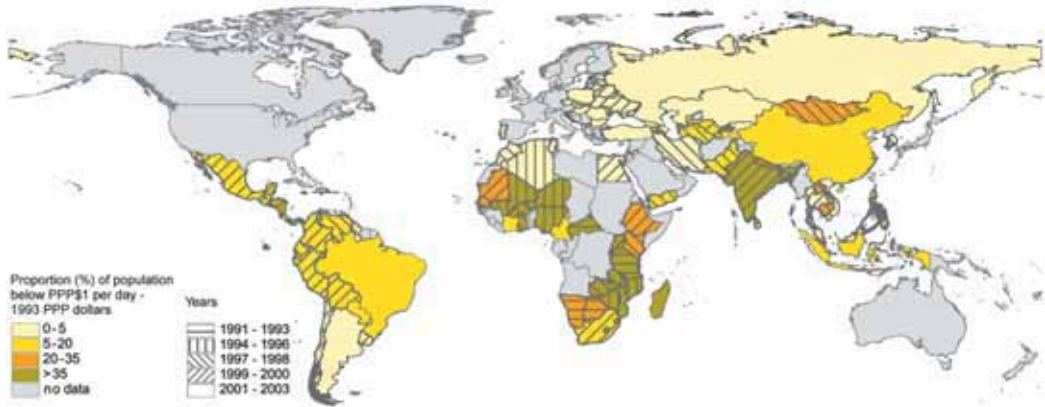
Share of population living in poverty, by country, varying years



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 (PRSPs) 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).

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

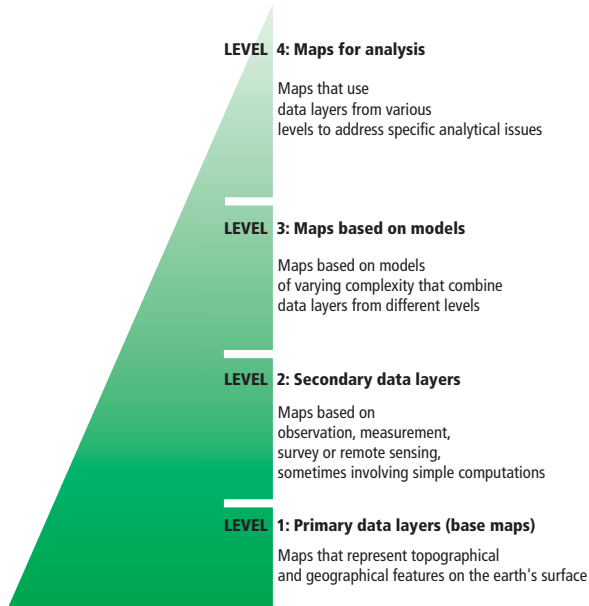


FIGURE 4.2

The hierarchy of GIS maps in the FGGD

