FAO Spatial Information Infrastructure

United Nations GeoNetwork

The Food and Agriculture Organization of the United Nations FAO has a wide-ranging mandate including such diverse activities as agricultural development policy and planning, food security, forestry, fisheries and rural poverty alleviation. These, and other undertakings in the area of sustainable development, make use of GIS technologies supporting spatial data collection, analysis and decision making. Spatial data (also referred to as geographic information, geospatial data and geo-information) is defined as data concerning location, shape and relationships among geographic features. Most of the data collected, analysed and used by FAO and other UN agencies (e.g. satellite imagery, census, social and economic statistics and national or regional environmental reports) is linked to a location and will, in many circumstances, benefit from being presented in map context.

By Jelle U. Hielkema and Jeroen Ticheler, FAO, Italy

Identifying the spatial component of phenomena such as food insecurity and rural poverty is critical in both the design and implementation of short-term interventions and long-term aid strategies. The plan explicitly recognises relevance of the spatial components of the information collected by FAO to its core mission. In fact, the Organisation has established two Priority Areas for Interdisciplinary Action (PAIA) to address these matters. The PAIA on 'Spatial Information Management and Decision Support Tools' is concerned with standardising and facilitating access to spatial information coming from a variety of sources and the PAIA on 'Definition, Norms Methodologies and Quality of Information' deals with consistency and quality of basic data. A challenge for both FAO and the whole development community is to make spatial information more accessible to technicians, decision-makers and scholars managing and studying various aspects of sustainable development.

***Figure 1**, FAO GeoNetwork homepage*

GeoNetwork

Since late 2001 the FAO, through its Environment and Natural Resources Service (SDRN), has taken on this challenge through concentrated efforts to improve dynamic and standardised access to both its own geospatial data holdings and those generated by and located at a variety of complementary organisations and institutions worldwide. This effort has been realised in the establishment of GeoNetwork, a spatial information management infrastructure the manifold objective of which is to provide the means to identify, access, search, retrieve and combine geo-information such as spatial datasets, thematic maps and satellite imagery (Figure 1). These may originate from a variety of sources and are accessed by browsing through servers connected to the network. GeoNetwork combines the following four complementary and integrated functionalities:

- Global library for geospatial data
- Metadata catalogue describing geospatial data and thus enabling users to assess suitability to their analysis needs
- System for searching, editing and publishing geospatial information
- Service that allows the integration of geospatial data from various sources

GeoNetwork Features

The descriptive information used to identify geographic data and information is called metadata. GeoNetwork metadata include those elements related to the content of the resource (e.g. location: Mozambique; keyword: floodplains, title; date; geographic location, latitude, longitude). These elements describe also the methods used to represent spatial information (e.g. vector, raster, imagery, etc.) and elements related to the intellectual property of the resource (e.g. the organisation or the individual responsible for map content, information about license rights and ownership, permission to access, use, etc.) Further, elements related to the geographic nature of the resource (e.g. spatial, temporal, spectral resolution for satellite data, geodetic information for maps, reference system information, etc.) and, last but not least, elements related to the quality of the data. These include information about completeness, positional accuracy, internal consistency, etc. (Figure 2).

Metadata Standards and Protocols

For each dataset, the GeoNetwork metadata catalogue contains a standardised description of its thematic content (vegetation, roads, etc.), geographic location (geographic area covered), information about ownership and other parameters. All are based on the metadata standard set by the International Standards Organization (ISO), the leading institution in the development of international standards and specifications. ISO Technical Committee 211 (ISO TC 211) has proposed the ISO 19115 as one defining a protocol for describing geographic datasets using a comprehensive set of metadata parameters. This standard is now being extended with the ISO 19139 standard which aims at controlling the implementation of ISO 19115.

Search Functions

GeoNetwork features two search functions: a local one which allows data search and retrieval on the local GeoNetwork server and a remote one that allows data searches on remote servers (Figure 3). Both search functions are based on the use of standardised metadata. Spatial information of interest to a user is often distributed over multiple locations, for example, in multiple servers housed in different institutions. In many circumstances users may want to generate a new map by integrating datasets available in different online electronic repositories. Exploiting the rich connectivity of the internet, GeoNetwork users are able to retrieve data from different servers and analyse it on their own computer.

InterMap Viewer

A dedicated capability that embodies and highlights the integrating potential of GeoNetwork is its InterMap viewer function (Figure 4). Developed jointly by FAO-SDRN and the Vulnerability Assessment and Mapping (VAM) Unit of the World Food Programme (WFP), InterMap allows users to digitally overlay various map layers coming from one or more servers to compose a new customised map. Typically, each layer contains one or more variables, e.g. biophysical (vegetation density, soil quality, rivers, etc), demographic (population density), economic (GNP/capita, poverty measures), infrastructure (administrative boundaries, human settlements, roads, water reservoirs) and human capital resources (health facilities, food distribution points) etc. By overlaying layers with different thematic content, InterMap can function as a valuable exploratory tool to illustrate spatial relationship existing between a pair or series of variables. For example, it may suggest to what extent a poor transport infrastructure may be preventing a region blessed with a rich agricultural endowment from realising its own potential.

Information System Interoperability

GeoNetwork, being one of the key components of the PAIA on 'Spatial Information and Decision Support Tools', was developed with the objective of standardising and enhancing FAO capabilities in serving, sharing and exchanging spatial data for a variety of applications. In other words, GeoNetwork was not intended to be yet another information management project predestined to operate in isolation from other geographic software applications. The system was designed to fit seamlessly with existent software applications. Seamless integration was achieved by complying with the specifications set by the international Open Geospatial Consortium OGC. GeoNetwork exploits interoperability mainly in two of its features: the remote search and the InterMap function. In the former, interoperability is made possible by adoption of Z39.50 communication protocol, widely used for the remote querying of bibliographical and geographic databases. In the case of InterMap, interoperability is guaranteed by the use of the Open Geospatial Consortium Web Map Service (WMS) specification for sharing data layers. InterMap is also able to natively connect to ArcIMS Web

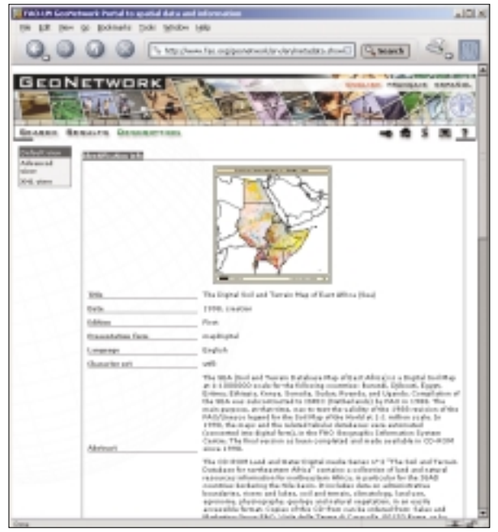

***Figure 2**, One metadata description page*

***Figure 3**, A search results page*

In early 2004 the GeoNetwork catalogue contains:
- 1,000 metadata records
- 600 downloadable geographic data files
- Metadata for 5,000 hardcopy maps
- 200 Dynamic Map Services

Map Services, developed by the Environment Systems Research Institute (ESRI).

GeoNetwork Functionality

GeoNetwork plays a critical role in FAO efforts to collect, analyse and disseminate geographic information. Clearly, the effectiveness of any initiative delivering geospatial information services tailored to the needs of developing countries must be measured against an FAO ability to ensure equitable access to these services. Many of the communities and organisations which stand to benefit the most from a geospatial information infrastructure such as GeoNetwork live and operate in countries with limited financial resources and often limited internet access. Clearly, the use of proprietary software in the development of GeoNetwork would have carried the risk of increasing the 'digital divide', the gap existing between countries with widely differing opportunities to access information and communication technologies, rather than reducing north-south inequalities.

Avoiding the 'Digital Divide'

To avoid reinforcing the 'digital divide' and to facilitate its effective use in developing countries, Geo-Network employs an independent and open-source platform, i.e. license-free software. This means that users of GeoNetwork are able to use, modify and redistribute system source code software without restriction and thus do not risk becoming dependent on foreign suppliers. Open Source versions of both GeoNetwork and InterMap are available from the world's largest Open Source software development website, SourceForge.net (see websites). GeoNetwork users may increasingly request datasets coming from different sources; the success of the project therefore crucially depends on the metadata required for the description of maps and other geospatial data conforming to a set of international standards and protocols. Only a high degree of interoperability – the ability to combine information from different systems – will ensure that geospatial data generated on one server employing application software A may be read with ease on another server using application software B and also by another user using application software C.

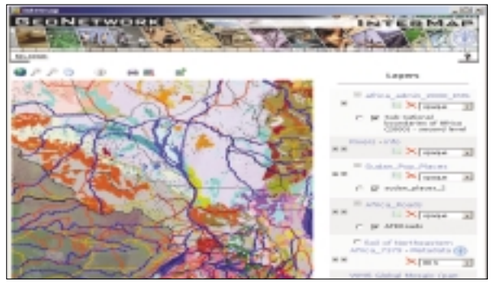

Figure 4, A sample interactive map on Africa (Sudan), combining OpenGIS WMS map services and ESRI ArcIMS map services from four different sources

Advantages

The idea of a global spatial information infrastructure designed to facilitate efficient search, networking and use of geographic data is not exclusive to GeoNetwork. Similar initiatives have been developed over the past five years with a wide range of objectives. However, GeoNetwork can claim two unique distinctions:
- It is exclusively targeted to exploit geo-referenced thematic information and related knowledge to serve developing countries and assist them in their spatial information management capacity development
- Thanks to its deployment of free and open source software, it minimises costs to all its current and prospective stakeholders

Sharing with Other UN Agencies

A major thrust of GeoNetwork activity is to increase the opportunities to share geographic information between UN agencies and research institutes active in the fields of agriculture, environment assessment and natural resource management, food security and emergency operations. FAO is an active and leading partner in various activities of the UN Geographic Information Working Group (UNGIWG) and is establishing partnerships with various institutions working in development and international agricultural research. FAO recently initiated a joint development plan with the United Nations Environment Programme (UNEP) that will consolidate and further expand GeoNetwork capacity and performance by making its architecture more flexible and therefore able to manage a broader spectrum of both meta-data and spatial data holdings. Similar partnering discussions are ongoing between GeoNetwork and the Center for International Earth Science Information Network (CIESIN) at Columbia University in New York. GeoNetwork capacities are also used by other UN agencies, such as the World Health Organization (WHO) in the implementation of the Second Administrative Level Boundaries (SALB) project in the context of UNGIWG activities, in Health Mapping and, as mentioned earlier, in close collaboration with the World Food Programme (WFP).

Websites

www.fao.org
www.fao.org/geonetwork
http://metart.fao.org
http://sourceforge.net/projects/geonetwork
www.opengeospatial.org
www.isotc211.org◆

Biography of the Authors

Jelle Hielkema studied Soil Science at the Agricultural University of Wageningen in The Netherlands with a specialisation in Remote Sensing at ITC. Upon graduation in 1975, he joined FAO where he has held various positions of increasing responsibility in first the FAO Remote Sensing Centre and currently the Environment and Natural Resources Service (SDRN).

Jeroen Ticheler studied Tropical Forestry at the Agricultural University of Wageningen with specialisation in GIS and Remote Sensing. Upon graduation in 1997 he worked on Participatory Soil Fertility Management in Africa at the Royal Institute for the Tropics of The Netherlands until he joined FAO in 1999 in support of the ARTEMIS system and later initiated the GeoNetwork project.

Dr Jelle U. Hielkema, Senior Remote Sensing Officer (Environmental Monitoring) and Jeroen Ticheler, Environment and Natural Resources Service, SDRN, Sustainable Development Department, FAO, Room F-818, Rome, Italy, e-mail: jelle.hielkema@fao.org and jeroen.ticheler@ fao.org