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Geospatial Technologies to Reach the Millennium Development Goals*

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Geospatial Technologies to Reach the Millennium Development Goals

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ABSTRACT

There are serious threats to the population of planet Earth, many from physical phenomena brought about by changes to the environment caused by human activities. A list of these would include threats from weather, natural disasters (although some of these, such as earthquakes, are not new threats, or brought about by human activity), disease and loss of adequate water of food supplies. These threats have not escaped the notice of governments, and although there is discussion over who is responsible and what should be done, many governments have policies to tackle these problems.

For a human living on this planet is to think about the future of his/her environment. This is currently the most important issue for scientists, whether or not he or she is working on an area close to the subjects such as "Environmental Monitoring", "Climate Change" or "Global Warming".

We should be in the actions of "Powering a Sustainable Future: Policies and measures to make it happen". We should investigate how we can contribute to reach the "Millennium Development Goals".

The paper introduces current intergovernmental and governmental initiatives to utilise the resources of Earth Observation to solve societal problems such as disasters, health and climate change. The areas recognised by the Group on Earth Observations (GEO) are presented and some examples given of how geo spatial data from a whole range of sources is being used to tackle these. Finally the role which international organisations, such as ISPRS and AARS, us discussed.

Introduction

Nobody doubts that there are serious threats to the population of planet Earth, many from physical phenomena brought about by changes to the environment caused by human activities. A list of these would include threats from weather, natural disasters (although some of these, such as earthquakes, are not new threats, or brought about by human activity), disease and loss of adequate water of food supplies. These threats have not escaped the notice of governments, and although there is discussion over who is responsible and what should be (GEO) established by the first Earth Observation Summit in July 2003 which declared the need for "timely, quality, long-term, global information as a basis for sound decision making". The second Earth Observation Summit in April 2004 agreed to a Framework which established the basic principles for preparing an Implementation Plan for a Global Earth Observation System of Systems (GEOSS). The plan also calls for support to countries, particularly developing countries, in their national efforts to collect data, use satellite and remote-sensing technologies for data collection and to access, explore and use geographic information. All of these intergovernmental initiatives come on top of the on-going activities of the United Nations, CEOS and IGOS, (The Integrated Global Observing Strategy) and ICSU and the efforts of international societies such as ISPRS, ICA, FIG.

The paper sets out to review some of these activities and to address the issue of how organizations such as ISPRS can contribute to them. Such discussion must go alongside the technological developments which have occurred in the past 10 years or so. We have seen much more Earth observation data become available and the convergence of the nature and application of satellite data with airborne data, so that either could be used in the generation of digital elevation models, (DEMs), for example, or for mapping. The advances in Geographical Information Science (GIS) and associated GIS software, and of Global

Navigation Satellite Systems (GNSS), have helped to make geo spatial information a major source of data for government, commerce and industry.

The problems

The GEOSS 10 Year Implementation Plan recognizes different areas of Societal Benefit from Earth Observation. These are listed in table 1.

Area	Task Short Title
Agriculture	Data Utilization in Agriculture Forest Mapping and Change Monitoring Training Modules for Agriculture Improving Measurements of Biomass Agricultural Risk Management Operational Agricultural Monitoring System
Biodiversity	Biodiversity Requirements in Earth Observation Capturing Historical Biodiversity Data Biodiversity Observation and Monitoring Network Invasive Species Monitoring System
Climate	Sustained Reprocessing and Reanalysis Efforts Key Climate Data from Satellite Systems Key Terrestrial Observations for Climate GEOSS IPY Contribution Global Ocean Observation System Seamless Weather and Climate Prediction System
Disasters	Seismographic Networks Improvement and Coordination Integration of InSAR Technology Implementation of a Tsunami Early Warning System at Global Level Multi-hazard Zonation and Maps Multi-hazard Approach Definition and Progressive Implementation Use of Satellites for Risk Management Implementation of a Fire Warning System at Global Level Risk Management for Floods
Ecosystems	Integrated Global Carbon Observation (IGCO) Ecosystem Classification Regional Networks for Ecosystems Global Ecosystem Observation and Monitoring Network
Energy	Using New Observation Systems for Energy Management of Energy Sources Energy Environmental Impact Monitoring Energy Policy Planning
Health	Forecast Health Hazards Strengthen Observation and Information Systems for Health Environment and Health Monitoring and Modeling Integrated Atmospheric Pollution Monitoring, Modeling and Forecasting
User	Identify Priorities and Synergies between SBAs Pilot Communities of Practice Nowcasting and Forecasting User Applications Millennium Development Goals Environmental Risk Management

Water	Forecast Models for Drought and Water Resource Management In-situ Water Cycle Monitoring Capacity Building Program for Water Resource Management Global Water Quality Monitoring Satellite Water Quantity Measurements and Integration with In-situ Data
Weather	Surface-based Global Observing System for Weather Space-based Global Observing System for Weather THORPEX Interactive Global Grand Ensemble (TIGGE) Numerical Weather-Prediction Capacity Building Data Assimilation for Operational Use Weather Demonstration Project for the Beijing 2008 Olympic Games

Table 1.

This is a comprehensive summary of potential benefits and this table provides a useful basis for discussion of the problems and the ways in which organizations can contribute. The use of the data listed in the table can be roughly divided into two types: that which can be used immediately by scientists, and professionals on the ground, for solving problems in an operational way, and those which are input to research into the causes and solutions of the problems, which includes the very important field of modeling applied to climate research and tectonic modeling, for example.

The next section will summarize some of the important international initiatives involved in the process some examples of how EO data can be used in now on the ground.

Some examples

Three of the areas set out in table 1 will now be illustrated to demonstrate the importance of all areas of remote sensing and photogrammetry to the solution of these problems.

<u>AGRICULTURE</u>

GEOSS Agriculture Strategic Plan	Initiate the creation of a 5- to 10-year strategic plan: define specific objectives for 2007 and create a plan of action for GEO in agriculture.
Data Utilization in Agriculture	Consult with scientists and experts from the fisheries, aquaculture, coastal zone management and Earth observation communities at international and regional levels to identify opportunities for enhanced utilization of Earth observations in fisheries and aquaculture.
Forest Mapping and Change Monitoring	Initiate an international assessment effort on forests and forest changes utilizing ongoing land cover mapping projects (e.g. GLOBCOVER). Ensure application of standardized classifications and harmonization of existing datasets.
Training Modules for Agriculture	Initiate the design of training modules to demonstrate the usage of Earth observation data and products for the agricultural sectors in Africa, Asia, Latin America, Central and Eastern Europe, and in Small Island States.
Improving Measurements of Biomass	Explore the utility of current Earth observations within the agricultural, fishery stock and aquaculture sectors, especially in developing countries with an emphasis on improving classification and quantification of biomass.
Agricultural Risk Management	Develop and improve analytical tools and methods for agriculture risk assessment, particularly for

	crop failure, and establish common standards and formats.
Operational Agricultural Monitoring System	Development of an Operational Agricultural Monitoring System comprising global databases regularly updated with satellite and in-situ data.

<u>CLIMATE</u>

Sustained Reprocessing and Reanalysis Efforts	Ensure the development of international mechanisms to coordinate and maintain sustained climate data reprocessing and reanalysis efforts. With regard to the reprocessing of historical datasets (to obtain consistent long-time series of satellite records), make relevant synergies with Task CL-06-02.
Key Climate Data from Satellite Systems	Establish actions securing the provision of key data for climate studies and forecasting from satellite systems. Make relevant synergies with Tasks DI-06-13, CL-06-01, WA-07-02, AG-06-04, AG-07-01, AR-06-09, DA-07-01, DA-07-02, and AR-07-03 ("Virtual Constellations") in particular.
Key Terrestrial Observations for Climate	Develop intergovernmental mechanisms for coordinating terrestrial observations needed for climate studies and forecasting. Develop a framework for the preparation of guidance materials, standards, and reporting guidelines for terrestrial (including land-coast interface) observing systems for climate and associated data, metadata, and products to expand the comprehensiveness of current networks and facilitate exchange of data. This Task will build on the outcome of Task CL-06-02.
GEOSS IPY Contribution	Coordinate with the International Polar Year (IPY) to enhance the utilization of Earth observations in all appropriate realms (including, but not limited to, sea and land ice, permafrost, coastal erosion, marine and terrestrial ecosystem change, biodiversity monitoring and impacts of increased resource exploitation and marine transport).
Global Ocean Observation System	Enhance and improve coordination of coastal and marine climate observations in support of a global ocean observation system.
Seamless Weather and Climate Prediction System	Support the development of a THORPEX/WCRP initiative on "International Weather, Climate and Earth-system Science", to better address uncertainties associated with climate variability and change, and related societal impacts. Related activities will include: Promote international multi-disciplinary (physics-biology-chemistry) collaboration on the development of a high-resolution seamless weather/climate global prediction system - including coupled atmosphere-ocean data assimilation. Support the development of an international framework for the design and implementation of a unified approach toward weather, climate, Earth system, and societal-economic research.

<u>DISASTERS</u>

Seismographic Networks Improvement and Coordination	Facilitate improvement of capabilities for global seismographic networks such as GSN, FDSN, DAPHNE, GNSS networks and new ocean bottom networks such as VENUS and NEPTUNE and sharing of data and event products among GEO members.
Integration of InSAR Technology	Support the improved integration of InSAR (Interferometric Synthetic Aperture Radar) technology for disaster warning and prediction.
Implementation of a Tsunami Early Warning System at Global Level	Support the IOC Implementation Plan, through (i) promotion and facilitation of free and unrestricted exchange of all Earth observation data relevant to Tsunami Early Warning Systems (ii) contribution in terms of GEO developed operational capabilities (iii) definition and implementation of standards
Multi-hazard Zonation and Maps	Conduct an inventory of existing geologic and all-hazard zonation maps, identify gaps and needs for digitization and progressively develop related products
Multi-hazard Approach Definition and Progressive Implementation	Promote the cooperation of national and international agencies towards the definition and implementation of a multi-hazard approach to systematically address all risks
Use of Satellites for Risk Management	With reference to a multi-hazard approach, define and facilitate implementation of a virtual constellation for risk management
Implementation of a Fire Warning System at Global Level	Initiate a globally coordinated early warning system for vegetation fires (wildland fires), including the development of improved information products and risk assessment models.
Risk Management for Floods	Definition of best practices, here including decision support systems, with the goal to identify minimum required observations and associated networks (in-situ, remote sensing) and models to deal with flood management at different geographical scales. It will include definition and implementation of a pilot project, centred on the development and demonstration of a Flood risk management system for the South-Central American Regions.

A very basic but essential requirement for tacking the problems is information on where the problem is located, what is there and how to get there. Existing mapping is frequently out of date, especially in less developed areas, but satellite images can provide up to date information. There are a number of initiatives in place to provide such data such as International Charter "Space and Major Disasters under which the space agencies provide data to the disaster management authorities; and the ESA ICEDS (Integrated CEOS European Data Server) with the aims to:

1. use Open Geospatial Consortium (OGC) technologies for map and data serving;
2. serve datasets for Europe and Africa, particularly Landsat TM and Shuttle Radar Topography Mission (SRTM) digital elevation model (DEM) data;
3. provide a website giving access to the served data;
4. provide software scripts, etc., and a document reporting the data processing and software set-up methods developed during the project.

One of the major components of the latter is the Shuttle Radar Topography Mission data which includes a DEM with 90m spacing, of the landmass of the globe between 56°N and 60°S. This is a very valuable, homogeneous data set.

In developed countries up to date data might exist and national mapping organizations can provide this. In United Kingdom, for example, the Ordnance Survey has a 24 hour emergency response capability to government requests for data. Disasters can give an impetus to technology; again drawing an example from UK, the foot and mouth crisis in 2001 Demonstrated to government how useful GIS can be and the uptake of this in government departments has greatly increased since that crisis.

The provision of weather information is also critical in predicting hurricane and floods for example and we are now all familiar with satellite images of hurricanes determinedly heading for SE USA.

DISASTER MANAGEMENT

The use of geospatial information for managing disasters is a key area in which earth observation already plays an important role, and in which we can also see the use of many different types of geospatial data.

Earth observation satellites have demonstrated their utility in providing data for a wide range of applications in disaster risk management. Pre-disaster uses include risk analysis and mapping; disaster warning, such as cyclone tracking, drought monitoring, the extent of damage due to volcanic eruptions, oil spills, forest fires and the spread of desertification; and disaster assessment, including flood monitoring and assessment, estimation of crop and forestry damages, and monitoring of land use/change in the aftermath of disasters. Remotely sensed data also provide a historical database from which hazard maps can be compiled, indicating which areas are potentially vulnerable. Information from satellites is often combined with other relevant data in geographic information systems (GIS) in order to carry out risk analysis and assessment. GIS can be used to model various hazard and risk scenarios for the future planning and the development of an area.

A proposed concept of a geo-space system for prediction and monitoring earthquakes and other natural and man-made catastrophes, which is based on a system capable of monitoring precursors of earthquakes in the ionosphere and magnetosphere of the Earth and using these precursors to make short-term forecast of earthquakes. Investigations on the interaction between ionosphere's F layer variations and different variations occurring in circumterrestrial environment (atmosphere, ionosphere and magnetosphere) associated with seismic activity, and detected by means of ground base and satellite monitoring. This method and others like GPS measurements for long distances are providing useful parameters for earthquake forecasting.

Realizing the fact that the remotely sensed data can help very much for the disaster risk management, at its forty-fourth session, the Committee on the Peaceful Uses of Outer Space agreed to establish action teams composed of interested Member States in order to implement the recommendations of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III). One of the action teams focused on studying and recommending the implementation of an integrated operational global system, especially through international cooperation, to manage natural disaster mitigation, relief and prevention efforts through Earth observation, communications and other space-related services, making maximum use of existing capabilities and filling gaps in worldwide coverage. Several UN Member States expressed their support for the work being carried out by the action team, emphasizing the importance of creating an entity (United Nations Platform for Space-based Information for Disaster Management and Emergency Response **(UN SPIDER**)) in that it could promote more effectively the **application of space technology in disaster reduction and management** at the global level, and in developing countries in particular, and their preference of setting up such an entity under the umbrella of the United Nations in order to guarantee universal access.

Another area of disaster management is flooding. Environmental protection agencies and insurance companies are collecting and using high resolution DEMs for this purpose. Airborne interferometric SAR (IfSAR) is particularly suitable for this purpose, giving an economic data source to cover large areas, and is often complemented by airborne LiDAR data to give more detail in critical areas. To take again an example from the UK, Intermap has covered the Britain with an IfSAR DEM with 1m vertical accuracy and the Environment Agency has collected LiDAR data over large a area which complements the IfSAR. Satellite data is widely used for monitoring flooding after it has taken place and can also be used to predict flooding by providing data to input to hydrological models.

A very important area is to pre-determine the natural disaster potential. It must be evaluated by geological and hydrological research. Beside the determination of the potential earthquake centers, the path of the wave-energy must be modeled. In case of an earthquake, the geological structure transports the various waves. In the event of a tsunami, the bathymetric conditions, the vertical water column and the run-up-path are of interest. Geological and hydrological data build the basic layers in a geo-database. Remotely sensed data can assist to detect significant changes from the air or the orbit. Radar data can monitor even very small changes in the terrain that indicate stress in the geological structures. Hyper spectral sensors can assist to detect anomalies in the environment, e.g. the emission of thermal heat, gas or other indicators. This information can also be part of an early warning system. For modeling tsunamis, terrain models of the seafloor, the shore and the coastline must be established. Beside classical hydrological methods e.g. via echo sounder, LIDAR technologies, using water penetrating laser, assist in the off-shore areas for bathymetric measurements. DTM (digital terrain models) and DSM (Digital Surface Models) which include artificial structures are important to compute reliable hydrodynamic run-up Simulations. This is very important for tsunami Modeling. Aerial surveys use airborne cameras and/or airborne LIDAR sensors and are able to deliver a high dense DTM and DSM. In combination with land use data, risk estimations and generalization of the city into certain risk-levels can be done. Tsunamis cannot be compared with "normal" waves since their energy is extremely high even the amplitude might be small from beginning. On the open sea you might not recognize them but their energy shows up when approaching the beach. Typical indicator for a tsunami is the sudden and sustainable falling of the water level where a high front of the Tsunami follows. Water can transport material that is then used as "weapons" and increases the destructive force of the wave. Run-up simulation becomes complex when objects or the terrain presses the water into specific directions.

The role of societies

It can be seen from the above discussion that space agencies and governments are taking the lead in establishing structures to make the optimum use of Earth observation data for the benefit of mankind. As members of international and regional scientific societies we need to ask whether we are playing a role and whether we should be doing more. We also need to ask whether our members want us to devote resources to this type of activity and whether the right people are already involved. ISPRS is represented on COPUOS, CEOS and ICSU and makes a contribution through discussions at meetings and through the advice of experts nominated by ISPRS. This has been done in the area of education and data policy for example. We are very limited by the resources available; in the past we have been generally unable to support experts to attend meetings. Currently ISPRS is part of the ICSU GeoUnions group which has identified a number of areas which the unions related to earth science of various types. We are seeking to demonstrate that interdisciplinary science can be harnessed to solve problems. The areas identified are hazards, health, groundwater, desertification and cities and mega-cities. These are clearly important topics, which fit well with the GEOSS themes, and experts from the Unions could have a significant impact, but before anything can be done funding is needed, and like ISPRS, the other unions have only limited resources, as does ICSU at the moment. The question then has to be asked: should ISPRS funds be invested in a scientific project to support research into this cross cutting themes.

Conclusions

It can be concluded from this brief review that inter government activity support Earth Observation and that there are many examples to show that EO can help solve some of the problems which face the people of our planet. The outstanding question is what international societies can contribute, and where funding can come from, if they wish to participate in these activities.

References

Gérard Brachet, Delphine Fontannaz, Gérard Begni, Yves Tourre, Antonio Guell, Nicolas Poirot, Hervé Jeanjean, 2002. Future EO Systems Supporting Sustainable Development Contributions From Europe and France: an Example of EO-Based Applied System: Telemedicine & Epidemics. Paper presented to ISPRS Commission IV Symposium, Hyderabad. 3 - 6th December 2002.

Orhan ALTAN et al; The Contribution of the Surveying Profession to Disaster Risk Management, A publication of FIG Working Group 8.4, 2006