A DISASTER HAZARD AND VULNERABILITY ATLAS FOR SA

Web-enabled GIS in Disaster Management

Increasingly frequent disasters with attendant damage have heightened climate change related environmental and social vulnerability, emphasising the need for tools to support disaster management. In South Africa a National Disaster Hazard and Vulnerability Atlas has been developed using Web-enabled GIS as the primary user interface.

The disaster, hazard and vulnerability â€˜Atlasâ€™ which is operational today in South Africa is a virtual book consisting of various chapters, such as drought, flood, cyclones, storms, severe weather, and fires. The Atlas enables users:

- to search and select data, images, maps and graphs
- to perform calculations
- to run models on the fly
- to copy-paste results to the local computer
- to print their own page of the Atlas.

The main aims of the Atlas project are:

- to carry out research on factors contributing to disaster hazard and vulnerability and measures to alleviate this vulnerability
- to develop methodologies for the analysis of disaster related hazard and vulnerability indicators, and to improve disaster management
- to disseminate the research results and methodologies
- to act as a core of the national early warning system.

The text box gives an overview of key Atlas elements.

Key Atlas Elements

- Development of national disaster-related hazard, vulnerability and risk assessment tools to enable periodic reporting on national exposure to natural hazards, patterns and trends or changes in the exposure and to guide priorities in natural disaster vulnerability-reduction efforts.
- Development of an integrated national disaster hazard and vulnerability information network to provide tools needed by national, provincial and local governments the private sector and the general public.
- Augmentation of comprehensive, hazard-specific programmes.
- Development of a comprehensive database to identify hazard, vulnerability and risk-prone areas.
- To enhance the understanding and addressing of risk.
- Information assimilation and dissemination.

Disaster Management Act
Intensive implementation of integrated information technology in disaster management in South Africa began in 1998, the â€˜El Nino yearâ€™. The weather pattern that year was unusual. The Ministry of the Department of Water Affairs and Forestry instructed experts from the Strategic Planning Directorate to initiate implementation of information technology as a tool for the management of rainfall, river flow, and flood. The National Disaster Management Centre (NDMC) of South Africa (at that time Y2K Centre) implemented the technology. The main idea was to monitor and register as early as possible potential hazards and to increase lead warning time. This is one of the main activities at the NDMC main observation room, where there is continuous monitoring of various hazards worldwide. In January 2003 the President of South Africa signed the South African Disaster Management Act, a backbone of national disaster management legislation. The main focus is on prevention, which represents a 180-degree turn from historically inherited post-disaster management activity; the Act

highlights the role of information as the most significant driver.

GIS Set-up
GIS systems play an important role in the set-up of the system at NDMC. The structure and set-up is based on ten years experience on the part of the South African Department of Water Affairs and Forestry (DWAF) Water Management Information System. Awareness of the importance of visual information led to GIS being considered a very significant component for interactive communication. The NDMC server room contains four interconnected servers: a main web, server, a database server, a GIS server and a mathematical server. The GIS serves interactive visual information (maps) using ESRI Arc-IMS version 4 and Arc SDE.

Co-ordination
The main disaster management activity at national and provincial levels is co-ordination, which has, in general, two equally important components: temporal and spatial. The temporal component assumes co-ordination as a continuous activity. Improvement in the co-ordination of hazard, vulnerability and risk-related activities requires improved understanding of complex mechanisms and interaction between â€˜mother natureâ€™, society and technology. This takes time, in a continuous sense. The spatial component has three main directions of co-ordination: horizontal, vertical and thematic.
Horizontally, co-ordination as part of the national framework and activities involves bringing together national, provincial and district institutions and organisations that run programmes in support of disaster reduction. These include:

- government Departments of Water Affairs and Forestry, Agriculture, Environmental Affairs and Tourism
- South African Weather Services
- South African Police Service
- National Defence Force
- Non-Governmental Organisations (NGOs)
- public and private institutions
- businesses and educational institutions.

Vertically, co-ordination occurs between the province, the district, metropolis and municipality. The spatial and temporal distribution of hazards differs around the globe. Twelve hazards are listed at the Atlas website but not all of these are equally present over South African territory. The most dominant natural hazards are floods and droughts; for both of these the common input variable is rainfall. Therefore Atlas emphasises continuous integrated spatial and temporal rainfall monitoring and evaluation.

Rainfall Watch
Since the mid-1980s there has been an increase in the frequency of tropical cyclones above the Indian Ocean between Australia and Madagascar. During the rainfall season between October and April, eight to twelve tropical cyclones are born and head towards Africa. One of the workstations at the NDMC observation room continuously monitors the University of Hawaii website, which refreshes on a daily basis the map of the Indian Ocean. Memories remain of the year 2000; sixteen tropical cyclones were born in that region. Two, Gloria and Elaine, were strong enough to walk all over the African continent, leading to heavy rainfall and floods in Mozambique and South Africa. Sub-Saharan Africa is a region of sudden heavy rain: 70 â€“ 150mm in a 24-hour period. The impact of heavy rainfall on informal settlements (informal housing, rural communities) is disastrous. NDMC puts much effort into having this kind of information available as early as possible.
One useful website is the NOAA satellite four-days-in-advance 24-hours rainfall estimation. The South African National Weather Services is the biggest national rainfall data collector. Apart from ground-based gauging rainfall measurement they operate a network of eleven ground radar systems. For disaster management, information is very important concerning real-time storm development and 30-minute estimation, and accumulated hourly rainfall estimation.
In 2000 NDMC and the WITS University Johannesburg began working with NASA and the University of Virginia on the â€˜SAFARI 2000â€™ project. One outcome of this was distribution of the historical global monthly rainfall data and its inclusion in â€˜Atlasâ€™. Users can select a country and station via a GIS (ArcIMS) enabled browser interface. The South African Weather Services provides six-hourly SYNOP files according to World Meteorological Organization (WMO) standards. NDMC receives a copy of these files and automatically extracts relevant rainfall data and stores it in a relational database. Internet and intranet users can easily manipulate SYNOP data, in the form of accumulated daily rainfall, using a ArcIMS-based user interface. Apart from the SYNOP stations, additional layers such as national and provincial boundaries, primary road network, river network, catchment boundaries, water management areas, and urban areas are available.

Drought Analysis
Drought should not be viewed as merely a physical phenomenon or natural event. The impacts it has on society result from the interplay between a natural event (less precipitation than expected, as a result of natural climatic variability) and the demand people place on water supply. Human activity often exacerbates the impact of drought. Recent droughts in both developing and developed countries and the resulting economic and environmental impacts and personal hardships have underscored the vulnerability of all societies to this â€˜naturalâ€™ hazard. The basis for drought analysis is the Standardized Precipitation Index (SPI) developed to provide a better representation of wetness and dryness. At the NDMC, the SPI is calculated on a monthly basis. Historical spatial and temporal SPI distribution is calculated on-the-fly utilising integrated, database-driven, web-enabled technology. Spatial units are quaternary catchment (polygon entity) and gauging stations (point entity). Spatial SPI distribution, as a result of complex time-series analysis, is also GIS-enabled in the form of simple, â€˜semaphoreâ€™-like, coloured drought levels.

Cholera Outbreak
At the beginning of 2001 NDMC was approached by the National Department of Health to help in the development of a database-driven, web-enabled application for cholera-outbreak monitoring and management. Cholera data was transferred via ftp to the NDMC database server and stored in a relational database. After selecting a province the user is able to include other spatial information, such as local councils and hospitals. Zooming further a user is able to include schools and their water and sanitation-related information.

Hot Spots
Five common post-accident questions asked by rescue services include:

- Where is place of accident/incident?
- Are there people there?
- How many people are there?
- What is the capacity of the nearest airport (if any)?
- What is the status of the road network in the area?

To answer these questions the NDMC uses GIS as described above, along with alphanumeric tools. Since the beginning of this year this application has been further extended, enabling users to utilise a GIS-web version of 1:250,000 topographic maps. Using web browser, a user can zoom in, select an appropriate section and use the selected map.

Further Reading

- Peter van Oosterom, Siyka Zlatanova and Elfriede M. Fendel (Editors): 'Geo-information for Disaster Management', Springer-Verlag, Berlin Heidelberg, 1434p, ISBN 3-540-24988-5, 2005.

https://www.gim-international.com/content/article/web-enabled-gis-in-disaster-management