Introduction: The role of Geospatial Technology for ICZM

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Introduction

Geographic information systems are computer systems for the collection, storage, analysis and display of both spatial and temporal information. Spatial information is composed of sets of overlapping single-theme layers. Analysis allows the user to compare different situations over time. These information systems facilitate the analysis of rapidly changing and complex geographic reality in much more comprehensive way than traditional cartography (Scholten et al 2009).
A modern variant of GIS is the Geographical Information Infrastructure (GII), which offers even greater in-depth support to decision makers based on the fact that data and information are shared between the users (Hofstra et al 2008).
Integrated Coastal Zone Management also addresses complex natural and socio-economic issues in a specific geographic area. GIS and GII often and successfully support ICZM programmes.

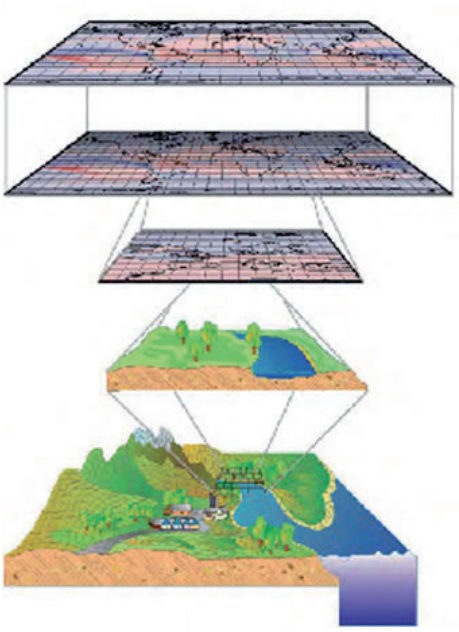

Figure 1: ***Geographic Information Systems (GIS)*** *facilitate spatial analysis of sets of single-theme layers coupled to temporal analysis of changes in time. (source: United Nations Economic Commission for Europe, 2009)*

(photo: //beeldbank.rws.nl, Rijkswaterstaat)

Geographic Information Infrastructure *(GII) offers real-time responsiveness and supports fast and effective decision-making during energencies.*

Geographical Information Infrastructure

In the coastal zone, decision makers often deal with special limitations, conflicting land use and involving many different sectors. Coastal management issues can be particularly complex as they often transgress political and physical boundaries, and incorporate a multitude of interconnected disciplines. The complex planning processes require interdisciplinary and integral data. GIS is a tool of choice to help understand, monitor, anticipate, plan, and to illustrate and communicate management options in the medium and long term.
Not all geographic information systems are able to deal with huge databases and models. A Geographical Information Infrastructure (GII), however incorporates meta databases, large spatial databases, visualisation techniques and tools, spatial models, spatial and temporal analyses, decision supporting systems, and evaluation methods. This range of tools improves the use of geographic information and is particularly valuable in coastal zone management.
The use of the GII evolved from a stand-alone PC, to a Local Area Network (LAN) and is now often web-based and can be accessed by mobile devices.

Two examples of Geographical Information Structures

Monitoring of the Dutch coast

Visualisation is an important part of any Geographical Information Infrastructure helping to present, explore and analysis geographical information (Romao et al 1999). These information systems are used during the processing of coastal monitoring data and result in coastline charts. Coastal monitoring is essential to assess the need for coastal defence measures, particularly of sandy beaches and dunes. Every year coastal measurements are carried out, along coastal profiles with a spacing of 200 to 250 metres. The results of these annual measurements are stored in the so-called JARKUS file. Analysis of these data provides an insight into coastline fluctuations. The sections of coastal accretion (sedimentation) and recession (erosion) are determined and displayed.

The Dutch 1990 dynamic preservation policy has as a reference point, the 1990 coastline, the so-called basal coastline. The position of the coastline is assessed annually. If the surveyed coastline moves from the basal coastline landwards over a wide coastal frontage then there may be a need for sand nourishment. Moreover, it is possible to calculate the trend in coastline movement and predict the year in which it will move from the basal coastline for a specific coastal section. These annual results are shown in the form of "coastline charts" (Figure 2, an example from 1999). This annual coastal atlas of the 350 km long Dutch coast is presented to the coastal managers of the Netherlands only a few months after the coastal survey.

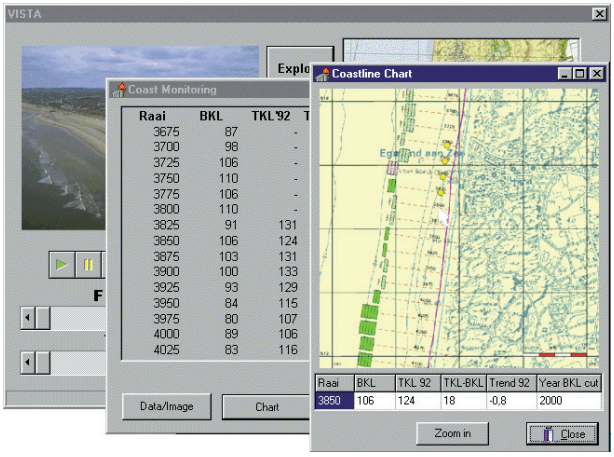

Figure 2: ***Monitoring the Netherlands' coastal zone including the GIS data processing*** *of the marine part and the terrestrial part (beach and dunes), results in the "coastline charts" comparing the surveyed coastline with the 'basal' coastline.*

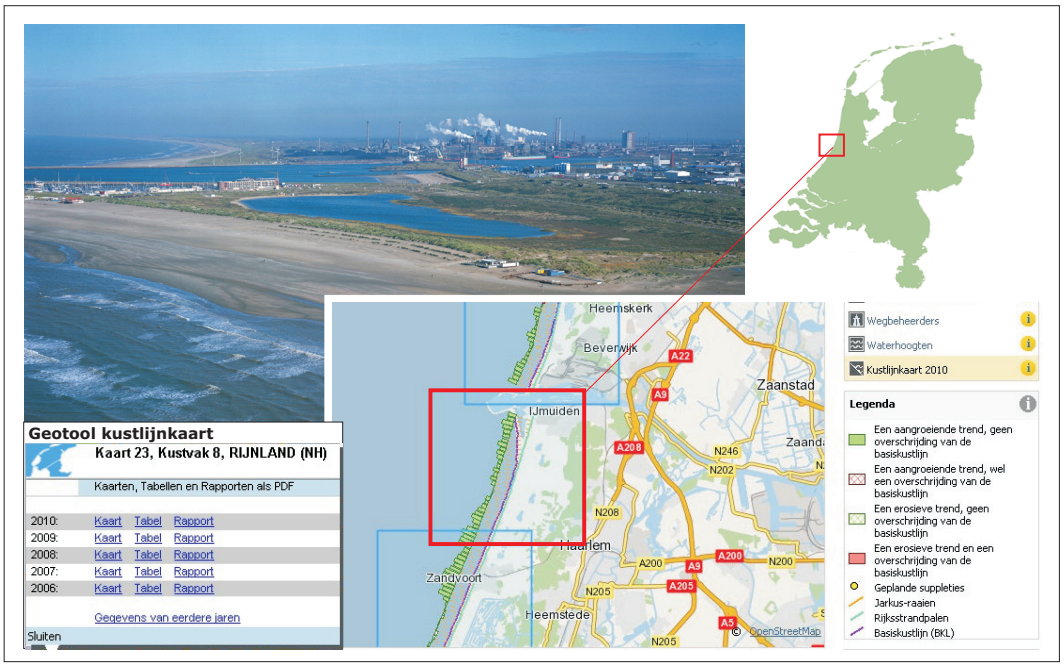

Figure 3: ***Coastline Charts on the web****, accessible for professionals and public. Screen shot of the Rijkswaterstaat GIS web application:*
Geotool: http://www.rws.nl/geotool/geotool_kustlijnkaart.aspx?cookieload=true

Recently, the Rijkswaterstaat (RWS)/Ministry of Transport, Public Works and Water Management has made the RWS Geotool website (in Dutch language) available. It contains information on the coast, waterways, roads and other infrastructure works. The coastal element of this web-based GIS encompasses information on all 50 coastal sections of the entire coast of the Netherlands. The coastline charts (Kustlijnkaart) from the last few years (Kaart), accompanied by oblique air-photographs, the coastal profile data (Tabel) and the results of the analysis (Report) of each of the coastal sections (kustvak) are displayed for the public (Figure 3).

Risk management: 'Eagle Suite'

A considerable amount of the information required for risk and emergency management, for example from flooding by rivers, is geographical in nature (Scholten et al 1998). Often this information does not reach the right people at the right time. For this reason the Ministry of Defense and Homeland Security, Vrije Universiteit, Geodan, ESRI and Microsoft developed a new concept in close cooperation with the Middle Gelderland Emergency Service Region (Figures 4,5,6). It consists of a suite of applications and services that allow multiple agencies to collaborate seamlessly in order to increase responsiveness and support fast and effective decision-making in a highly complex environment. Based on the experience of the emergency responders, a list of requirements was provided, which the system had to meet:

- Situation awareness: all organizations involved must be aware of the seriousness of any particular situation. All staff must have access to the same, geographic information, displayed in a standard way in a Geographic Information System (GIS);
- Real-time location awareness: when trying to manage a disaster, recording the real-time locations of staff, citizens, victims, volunteers or response teams is essential;
- Sharing data among different organisations: different organisations must work together and this requires management of communication and exchange of information.
- Large data flows: information has to be aggregated and responsive to the type and scale of the disaster, and the amount and type of organisations involved;
- Allow collaboration between (different) organisations: security restrictions such as firewalls impede the essential collaboration;
- Support strategic, tactical and operational levels: each level has specific requirements for the type and scope of information;
- Work under extreme conditions: a disaster management system must be flexible and able to deal with extreme conditions by ensuring alternative access to data. This requires a good data backup strategy.

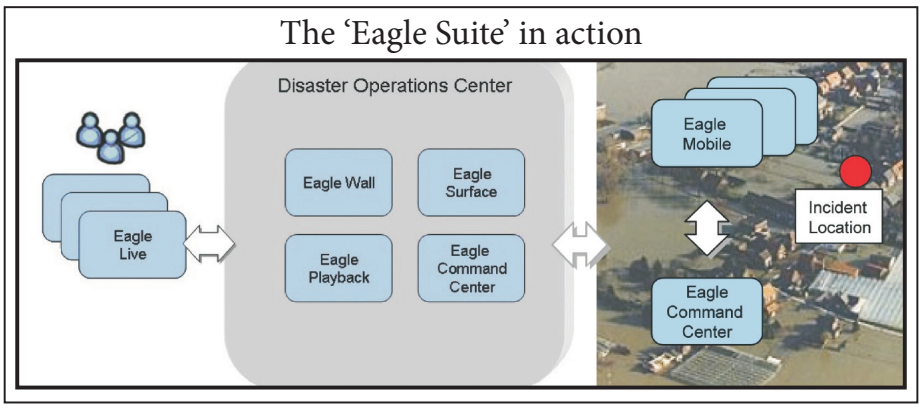

Figure 4: ***The 'Eagle Suite' in action***

To meet such a diverse set of requirements ''the Eagle Suite" was developed (Figure 4). This suite consists of the following components (see also Geodan Eagle Suite website):

- The Eagle Command Centre: the command centre staff can share, add and edit both geographical and textual data. This information is exchanged automatically between all users. The main entry point is a map, showing the current situation in the disaster area;
- Eagle Mobile gives ground staff, fighting the crisis in situ, the opportunity to add and edit geographical and textual data over a mobile data connection;

- With Eagle Surface Table tactical or strategic command can view the incident as a map on a Microsoft Surface table device, and is an easy-to-use conference tool;
- With Eagle Wall, a read-only view of the status of the incident is shown on wall-mounted displays in the command centre. It is updated automatically as changes in the status of the incident occur;
- Eagle Live is publicly available, as a read-only view. Since this is a website containing both spatial and textual information, it is visible to anyone online;
- Eagle Playback is a user-friendly playback tool for the command centre, with which the incident can be analysed and evaluated minute by minute.

'Eagle One' emergency drill

In March 2008, a special emergency drill took place in the Safety region Gelderland Midden in the Gelderland province in the east of the Netherlands (Figure 6). The exercise, focussed on the regional level. The idea behind this drill was to assess whether the use of geo-information in crises leads to better understanding and hence better decision-making. The Eagle Suite was applied and had a prominent role in the regional drill with the emergency services 'playing' four different emergency scenarios. The police, the fire brigade, medical services and municipalities had immediate and direct access to each other's information. Sharing information about the ongoing situation and providing access to national geo files were both tested successfully. It was concluded that the Eagle system contributed to both a common operational picture and a shared operational awareness. This was most obvious during the multidisciplinary meetings. Little time was needed to explain the situation, and the participants were able to begin planning their actions immediately.

Based on positive evaluations of the emergency drill, the 'Eagle – Geographic Information Infrastructure' has won the prominent Dutch Public Safety Award 2008 (Neuvel et al. 2010).

The flood disaster in Pakistan that started in August 2010 might be the largest disaster ever, in numbers of people involved, in recent history. The provincial government of Punjab responsible for the disaster management encounters many problems with the information infrastructure, like in all other large disasters has happened (e.g. Haiti). The government of Punjab has asked Geodan to implement Eagle for fighting this disaster (see www.eagle4pakistan.com).

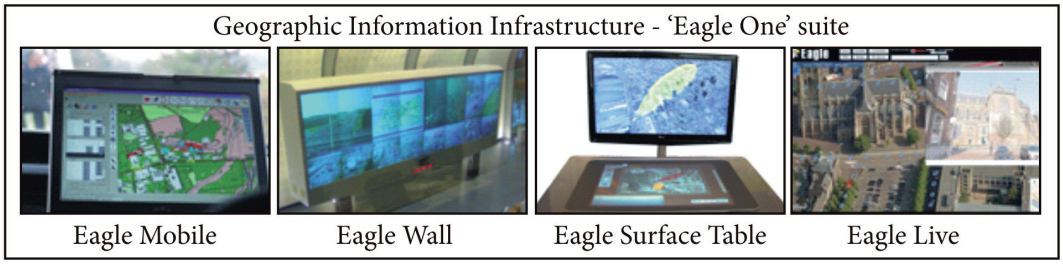

*Figure 5: **Geographic Information Infrastructure**: the main components of the 'Eagle One' suite.*

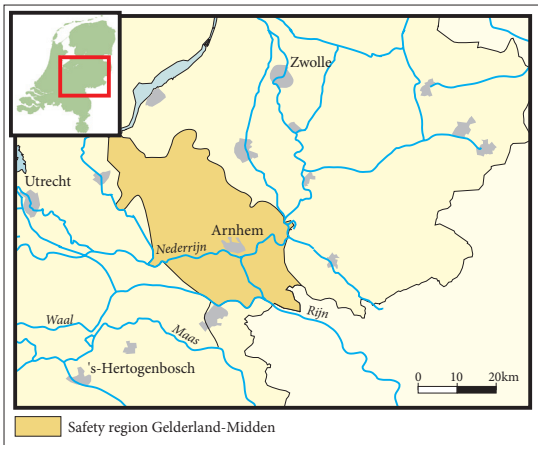

*Figure 6: **The 'Eagle One' emergency drill area:** Safety region in the province Gelderland - Midden, dissected by the rivers Rijn, Waal and IJssel*

(photo: Harry van Reeken)

Concluding remarks

Integrated Coastal Zone Management addresses complex natural and socio-economic issues in a specific geographic area.

A Geographical Information Infrastructure has much in common with ICZM: both are interdisciplinary and facilitate the interpretation and integration of data. The tool allows users to create interactive queries, analyse spatial information, edit data, maps, and present the results of all these operations. Such a system is applied to the processing of the yearly monitoring of the fluctuations of the Dutch coastline and assists coastal managers in answering the questions: When and where to apply sand nourishment?

A Geographical Information Infrastructure is also very suitable for risk and emergency management activities e.g. during critical river flooding situations. It is a tool for sharing of information during emergency plan preparation. Distributing geographic information through a network leads to improved communication, better and faster decision-making and a more effective emergency response.

GIS and GII often and successfully support ICZM programmes.

In the following chapters the developers of GIS tools introduce their use for ICZM planning and training. Demonstrations of the tools can be downloaded through the CCC website.

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