MOBILE CLIENT - APPLICATION CASE: MOZAMBIQUE

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ABSTRACT:

The major rivers in Mozambique were affected in the last years by very large floods. These natural and humanitarian hazards led to the intervention of international help organizations. During the practical application of the rescue actions, it was proved that often maps and geographical information was not up-to-date or just not available in the moment that they were needed. The objective of this project is to study and evaluate the possibility of using satellite and GIS data to provide up-to-date and precise information about the situation in near real time to the people by means of the newest communication and remote sensing technologies. The first step was to produce a basic geographic information system using GIS layers provided by the University of Salzburg (Austria) and Dinageca (Mozambique) with geographic, demographic and infrastructure information updated with the help of remote sensing data (DLR). The second step was to create a system to send the information to the places where it is necessary. For this point a central data bank using ORACLE with an extension for Arc/View was selected. The transmission of the actual information to the relief workers in the field is realized using the so called "mobile client". It is a laptop, with a preprogrammed software, that integrates a local ORACLE data bank with a Java program to visualize and receive the information (via Internet, satellite link or mobile phone), with a user friendly interface for visualization and analysis. The third step is the preparation of up-todate information. In case of a flood emergency it is possible to use satellites like MODIS, to achieve a quick overview of the situation in a large area, RADARSAT (with the advantage to penetrate clouds) and SPOT to produce high-resolution imagery. These images must be quickly processed and the results (preferably vector data) has to be sent to the mobile clients in the field. This way the people in field or in the help organizations can have an really up-to-date information about the current situation to take the right decisions. The whole process must be ready and the information sent to the mobile clients in few days or even hours.

1. INTRODUCTION

In several crisis situations it was demonstrated that the need of up-todate information (especially in the place where the major problems were located) can be mandatory for the decision makers in order to save human lives. This problematic inspired the idea to create a system capable to receive satellite data, process them quickly (in a research or processing centre) and send the information to the field of operations. In the field the system must be easy to use, user friendly, and able to be updated with the newest information. In order to implement that, a mobile client was conceived. The systems works with a central data bank, using remote sensing and GIS systems, that obtains information from these data and integrates it in a geographical data bank and sends it to the mobile clients. These laptops or notebooks have also a local geographical data bank with the basis information previously installed from the server and can be updated with new information downloaded from the server or acquired in the field (like GPS points or actual status of the roads, bridges, etc). The processing centre must provide information in vector format or a compacted format to be transmitted to the mobile clients. In a crisis situation or after a natural disaster the normal communication systems are often destroyed or damaged and the data transfer must be realised by mobile or satellite phones. This implies lower transfer rates and higher costs, for these reasons the information transmitted should not be redundant and have a low data amount. Under this concept the mobile client study was developed.

2. DESCRIPTION

The mobile client system consist of two parts, a server where all the data are gathered, the information is extracted and processed, as well as one or more laptops, with essential information to be used in the field and with the capability to update its own information in both directions, from and to the server (see Figure 1).

On the server side, located in this case at DLR, but with the possibility to be installed in any other place where the data can be processed and sent to the application fields, there must be the possibility to quickly process the satellite imagery and convert them into relevant information. In order to set up the whole processing chain and provide usable information several aspects were taken into account:

- Satellite imagery
- Geographical information
- Extraction of valuable information from the data
- Integration in a data bank
- Transmission and update between both data banks (Server and mobile client)

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For the first point, it must be known, which satellites are acquiring images of the affected area or which of them can be quickly reprogrammed to obtain images of the area. In the Mozambique case MODIS and NOAA data can be used. They cover a wide area, don't implies extra costs and the temporal resolution is very high, but on the other hand the ground resolution is low, and if there is clouds cover, they are almost unusable. The MODIS data with 250 m pixel resolution are a good alternative to evaluate the flood extension and its evolution, but due to the high temporal demand of this kind of data, the actualization delays of the acquired images in the web is unacceptable for a crisis situation at the moment. Efficient information links must be activated to the responsible organization to obtain the data in near real time.

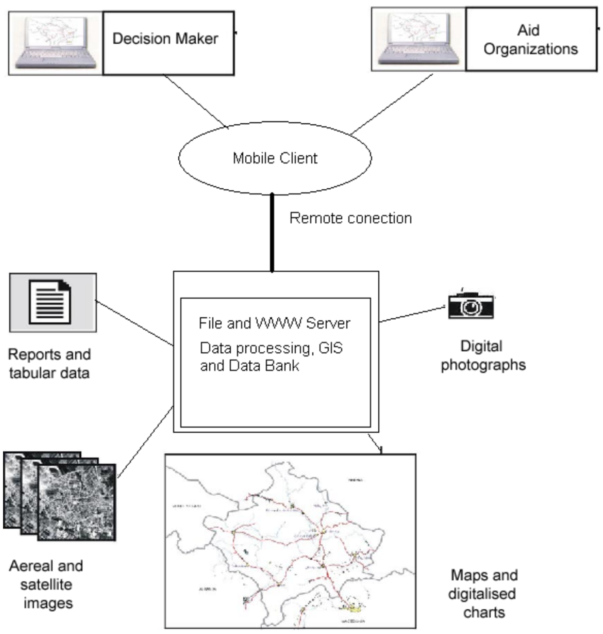

Figure 1. Structure of the system. A central data bank resides on a server where the information is processed and distributed plus one or more mobile clients, where the information is used and updated

The satellite SPOT can be programmed to obtain a scene in few hours to days. It has a high ground resolution, but is optical, expensive and covers a relative small area. A good alternative is RADARSAT, it has also a good ground resolution and the images can be obtained in some cases in a few hours to days, it is independent of cloud cover and sun illumination. The covered area is variable, but also limited. The only disadvantage, is that high trained personnel is needed to interpret the images.

Both satellites, RADARSAT and SPOT (and in the future IRS) are possible to be programmed and their images can be obtained gratis if the so called Charter is activated. The International Charter 'Space and Major Disasters' is the first initiative of its kind in which various space fairing nations and international organizations formally participate to task their space and ground resources for delivering data in situations of emergency. The European Space Agency (ESA) the French Centre National d'Études Spatiales (CNES) and the Canadian Space Agency decided to establish a Charter of cooperation for a unified response to natural and technological disasters. NOAA and ISRO have also joined the Charter recently, increasing the Charter membership to five agencies. The Charter can be activated by Authorized Users (AUs), which are "institutions or services responsible for rescue and civil protection, defence and security under the authority of a State whose jurisdiction covers an agency or operator that is a party to the Charter.

The AU request is received by a centralized 24 hours/day call-receiving unit entitled 'On Duty Operator' (ODO). After initial application of the acceptance criteria for the request, the ODO refers the request to the next functional unit called 'emergency On-Call Officer' (ECO), which is accessible 24 hours a day. The ECO carries out in-depth verification of the request by interaction with the requester and using his own means of information on the reported disaster event, before the request is finally accepted. The ECO prepares an elaborate record of the request, and determines the data source (archive or new acquisition) and space sensor(s) most appropriate to cover the disaster. The ECO then checks the availability of the sensor (s), and suggests, whenever possible after discussions with the relevant space agency or its designate, a draft plan to the concerned agency (ies) for execution. Next, the ECO transfers the entire file on the disaster occurrence, called a 'Dossier' to a 'Project Manager (PM). The PM ensures the management of the project related to the coverage of the disaster with regard to data processing and data delivery. The PM through interaction with the requester complements the information needs of the requester and initiates, if needed, any special data product generation and value-adding on behalf of the concerned agency and beyond the agency's obligations under the Charter. The PM also provides a project closeout report to the Charter Executive Secretariat, recording its experience and user feedback.. In Germany one AU is the foreign ministry. For this study MODIS, RADARSAT, SPOT and LANDSAT images were used to obtain water masks in different periods of the floods of the Zambezi river in the years 2000 and 2001.

The second point: the geographical information, is one of the most difficult to obtain. For the construction of an CIS (Crisis Information System) the basic geo-information is essential, because for the extraction of information from the satellite data it is necessary to have vector information, such as: the communication network, the localization of health posts, villages, bridges and general infrastructure, the ethnic distribution of the population in some cases and other important data. This information can be partially extracted from high-resolution satellite imagery (SPOT or IKONOS), but they are not always available, cover only small areas and are very expensive.

In cases where no up-todate geographical information is available it is possible to utilize the DCW (Digital Chart of the World). Taking into account that the scale is 1:1.000.000 and the precision of the results will be not very exact. Another possibility is to use the TCP (Tactical Pilotage Charts) with a 1:500.000 scale or the ONC (Operational Navigational Chart) with a scale of 1:1.000.000, that not always are in digital format to be quickly processed. The best alternative is to obtain digital layers from the local authorities or institutions, because they have normally the best resolution. In the present study, through the cooperation between DLR, ZGIS and the local Mozambican institutions, the following vector and databases were available:

- CIDDI GIS (Centro da Investigacao e Documentacao para Desenvolvimiento Integral), Mozambique: vector layers from central and North Mozambique.

- ZGIS (Zentrum für Geographische Informationsverarbeitung), Austria: vector layers, tabular data and Landsat Images.
- DINAGECA (Direcao Nacional de Geografía e Cadastro), Mozambique: detailed vector layers and tabular data of North and central Mozambique.
- DCW (Digital Chart of the World).
- USAID (The United States Agency for International Development) ,USA: vector layers and tabular data of whole Mozambique.
- DLR (German Aerospace Agency), Germany: Satellite imagery.

All these layers were integrated in a GIS and corrected. To be processed, the projection and coordinates system had to be adjusted, the different scales and covered areas of the data had to be integrated. After the geometrical correction, they were used to reference the satellite images.

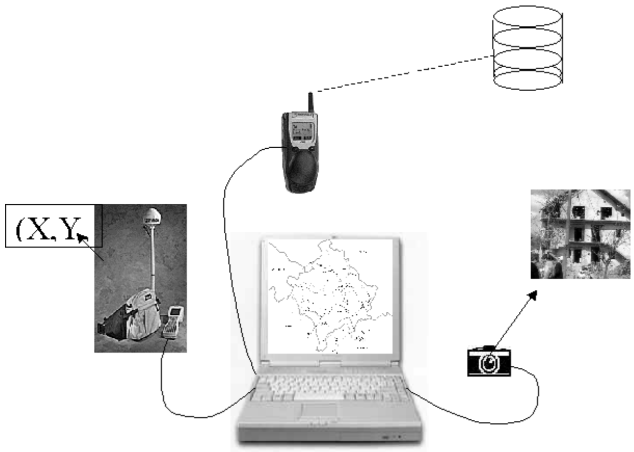

Figure 2. Mobile client (laptop) with a digital camera, GPS and its own data bank to acquire data in situ. All the information can be up/downloaded from/ to the server

The third point, the extraction of valuable information from the data, consist mainly - in this application case - in recognizing roads and bridges and to generate an up-todate water-mask (see Figure 3). For this purpose different classification assessment were applied to obtain water masks from MODIS, RADARSAT, LANDSAT and SPOT data. The results must be converted into vector layers, integrated in the server and sent to the mobile clients. The water-mask must be compared with the vector sets available to obtain information about which roads are usable, what is the extent of the flood, how many people are affected and where these people can be relocated, taking into account the health posts and supply with fresh water and food.

The fourth point is the integration into the data bank, which is a simple process in the case of vector or raster layers but a complex pre-selection work when the tabular data must be integrated. These data must be processed in a way that they will be usable for the end user. Normally each institution uses different nomenclature and not all the data have the same extension. In many cases they must be adapted, completed, filtered or translated before they can be uploaded in the central data bank. For this case an ORACLE data bank with the corresponding graphic and geographical extensions was used.

The last point is the actualization of both data banks. An synchronizing tool was developed in order to up and download the new layers or the changes in the existent layers. This interchange of information can take place one time a day or whenever it should be necessary. From the server side whenever new vector information extracted from acquired satellite data and from the mobile client side, whenever new information obtained in situ (see Figure 2).

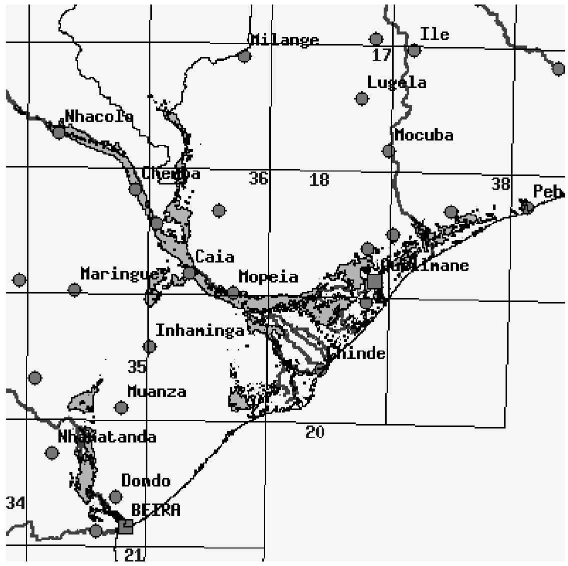

Figure 3. Example of a water mask obtained from MODIS data with information about the principal cities in the affected area

3. PROCESSING DATA

In a crisis situation, the usual communication system are often not functioning with their whole capacity. Therefore the systems have normally only a low bandwidth available. For this reason the volume of information transmitted to the field must be kept as low as possible. In other words, the information must be processed in a centre before it can be sent to the mobile clients. Like previously described, there are three important requisites to be taken into account for a crisis information system:

- A basis information system (with GIS and ancillary data)
- The possibility to update the information very quickly
- The transfer of this information where it is needed

For the implementation of the first point a server has been established at the DLR. For this server a Linux operating system was chosen, just due to economical reasons.

The GIS information was processed using Arc/View to make compatible the different formats and projection systems of the data, the available data were above described. In this case the data set was very good, but not always such good are data available. The mobile client can read and import shape files, a standard format of Arc/View, a very diffused and not expensive software in many countries.

The image processing was made using ERDAS Imagine. For MODIS data a previous conversion had to be carried out, because the different standard of HDF formats. In the selection of MODIS data our experience says, it is better to use the channels of the surface reflectance mode with 250 m resolution and processing level 2 G. SPOT and LANDSAT where processed using ERDAS to generate the water masks. In case of use RADARSAT images, there are several different modes. If a wide area is desired the ground resolution is lower and in this case a lower incidence angle is recommended. If a more detailed analysis is needed, for example to identify if the bridges are under water or if they still exist, a standard or fine mode are the best solutions. Processing radar imagery is a complex task and requires highly trained personal to obtain water mask from these kind of data. For the mobile client itself, a notebook with Windows was chosen. Here a ORACLE data bank was also installed. This data bank contains the necessary information pre-processed in the server to be used in field.

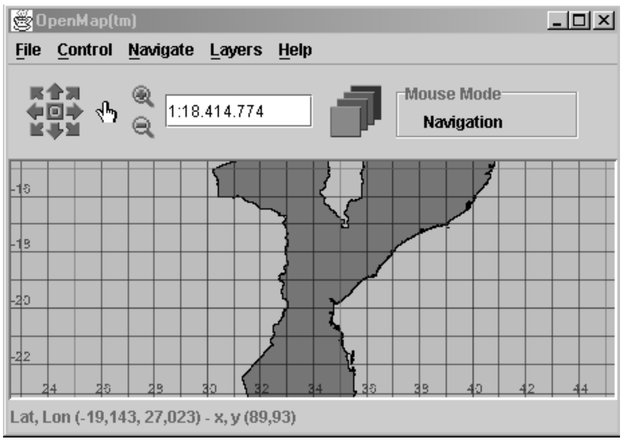

Figure 4. Start-up screen of the mobile client with a map of Mozambique and the cursor co-ordinates

The communication between the server and the client is made by using a mobile phone or a standard Internet connection. Both computers use a ORACLE data bank with a similar structure. On the mobile client side, a software programmed in Java must be installed having as basis the OPEN MAP shell. On the server side are running ORACLE, a GIS and a image processing software.

4. MOBILE CLIENT

The mobile client is not a GIS for itself, it is a system to display geographical and tabular information in a crisis situation where the communication with a processing centre is difficult. It serves to update the information in the field in order to help the decision makers in a quick and precise manner. The idea is to have available actual, wide covering and precise information in a crisis situation. It is not an on-line service or an Internet application. For this reason it has its own data bank, in order to work off-line. When new information is available it can be updated mobile and quickly.

In order to display the information in a user-friendly format, several programs were written in Java and Java scripts based on the OPEN MAP libraries. The user can display the information from different sources and make simple query just by clicking on the desired points. The standard functions zoom in and out, and pan are integrated. The scale and cursor co-ordinates are always displayed. It is also possible to change the cursor in a information or distance modes. With the first one is possible to click on the desired feature and obtain information from the associated data bank. With the second mode is possible to measure distances between two points or along a road, for example.

For the mobile client the concept is to have a set of data predefined in field. In the moment when the catastrophe is known, the mobile client is charged with the actual information and send to the field and the information can be actualised direct in field or from the server, always to support the decision making process.

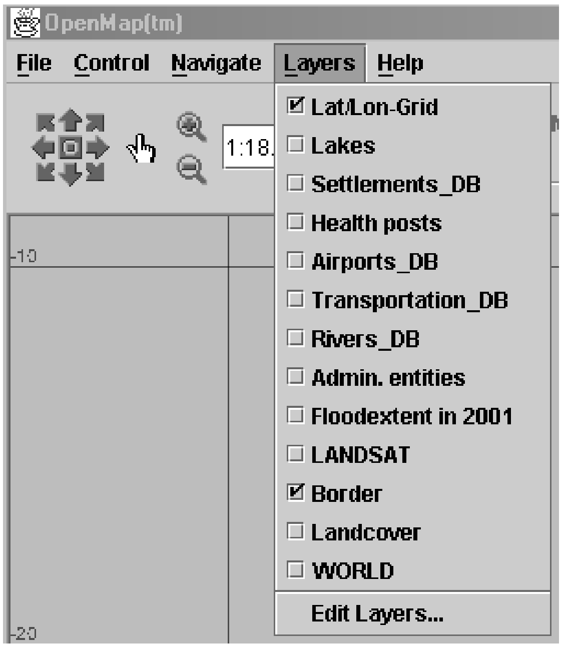

Figure 5a. Example of the available layers and cursor modes

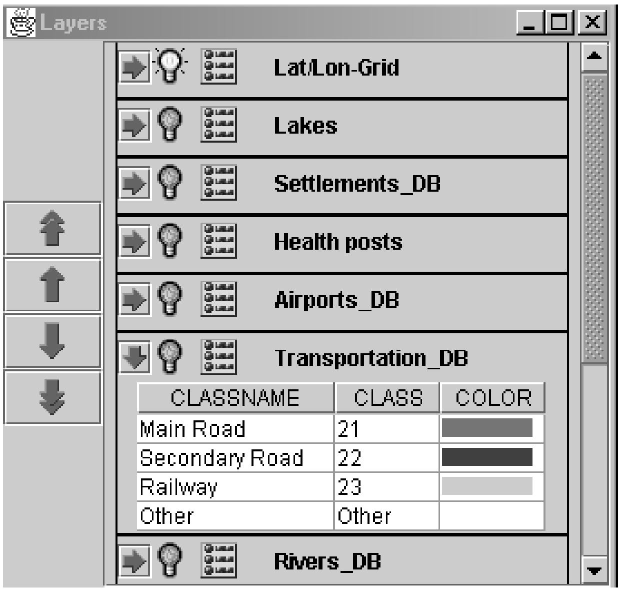

Figure 5b. Example of the available layers, their legends and display order

Figures 4 and 5 shows the layout of the mobile client. The different information layers can be displayed or hidden, and their order can also be modified. For each layer the corresponding legend will be shown and the data bank can be asked. It must to be pointed out, that these queries are user friendly designed, to make the operation possible by people that are not familiar with GIS environments.

5. CONCLUSION

A crisis information system was developed and tested with a central data bank and processing facilities located at the DLR. The whole processing chain was tested, from the acquisition of the images, their processing, extraction of information to the conversion into vector information in a very quickly way, demonstrating that it is possible to create a semi-operational system, depending of course on the priority in the programming of the satellites orbits and acquisition schedules. A mobile client software was developed in order to display geographical and tabular information in a easy way for the end user. The actualisation mechanism was also developed and tested in both direction using a mobile phone. It was a study case and more time and effort must be invested to create a prototype able to communicate with more servers or other mobile clients and a user interface further adapted to the needs of the relief organisations. Additionally a WWW server with a similar structure has also been created, it can be consulted at www.dfd.dlr.de.

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