GIS in fighting the effects of the frequent floods over the Romanian counties

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1 THE SITUATION

1.1 Geo-spatial situation

The geographical situation consists mainly in a dense hydrographic network, with a low developing level, thus with many overflowing risks when it rains too much. Also we have all kinds of earth surfaces, from plains, to hills and mountains, and irregular forests. From a demographic point of view, the rural and suburban regions are populated mostly with poor people, surviving with temporary jobs and with the goods from their own small around-houses farms.

When rains intensely fall, the running waters flowing from forested versants can easily break the farms assets and even small buildings (including houses). Here it must be said that in several regions the forests have been illegally and abusively cut, and as a result the danger of terrain-sliding raises and the soil absorption capacity is reduced.

At the end of winter, due to the rapid environmental temperature rise, there are also possible floods on rivers across the country (caused by snow thawing and ice-bridges melting).

Another potential danger consists in the subterranean caves resulting from previous salt-exploitation which, because they have remained hollow after the mining stopped, the mine plafond can fall in case of intense/long rains (at Ocnele-Mari, a locality from the Vâlcea district, somewhere in the center of the country, where there are several unsecured mine ceilings). Such terrain sliding/falling happened in a couple of times (2001, 2004), and many houses and farms located over/near the mine excavation were destroyed (by sliding/falling earth or by the salted-water overflowing from underground).

The "cartographic" situation of Romania: the country is divided in forty districts, totaling an area of 238427 km2, each of them having a local administration (council), a capital-city, and containing several tens of localities. Also we have a water administration office and an environmental guard (which are governmental institutions/organizations) in each district.

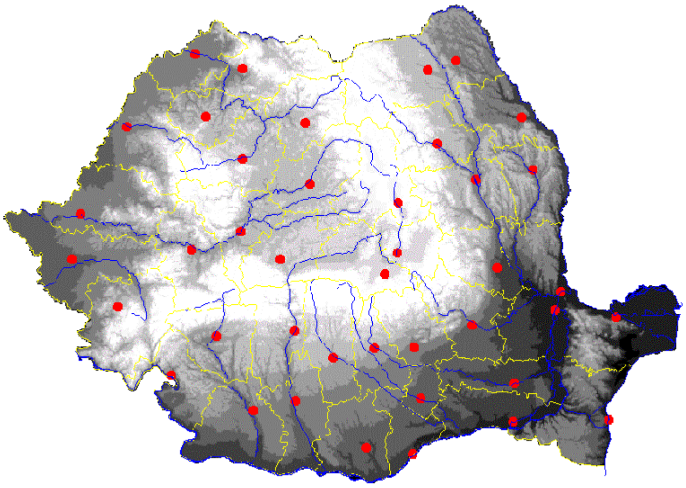

Figure 1 - A map of Romania

A GIS project/application for managing such natural-disasters has to a priori represent (mainly as thematic layers) and deal with:

water networks (rivers, lakes, canals), with a comprehensive symbology, including the capability to reveal particular sectors/branches of waters (showing the types of river-guide-banks, water alarming levels, water flow discharges);

transportation infrastructure and accessing ways (roads, paths, railways, highways, bridges, tunnels, passages, etc);

terrains and residential areas (buildings, parcels, land-use);

utilities infrastructure (electrical networks, gas pipes, drinking-water networks, sewerages). [Here we can identify a bidirectional matter concerning this kind of natural disaster: the utilities which can be affected by floods, and – on the other hand – the utilities which can be used/employed in crisis management.];

institutions (e.g. public institutions, hospitals, schools, local govern);

terrain conditions (critical soils; slopes); etc.

The classic GIS analysis function (from finding locations on digital map and from spatial entities directly querying, to complex/mixed scenarios simulations) must be, needless to say, supported.

Of course, a GIS designed for dealing with such disasters must hold trustful data (fresh, coherent and complete), and even to be able to up-date the on-the-field information in real-time. This up-dating feature is advisable for dynamically modeling the situation (river overflown basins, flood levels, affected terrains, particular risks). If the GIS application has 3D facilities, then a three-dimensional model of potential dangerous areas-zones can be deployed (flood simulating/modeling). The "buffer" simulation of the flood (which is a bi-dimensional analysis tool/function) supplies good information only in a symmetrical terrain situation, thus sometimes (especially when the river banks are asymmetrical) a 3D flood modeling can bring better information. A representation of the flood inundation areas can be based on many elevation models (2D″, DTM, shaded raster, isolines/hypsolines).

Also, it is advisable that the regional/zonal analysis engages aerial/satellitar photography/imagery (and the ideal GIS supports spatial raster-based queries).

In order to support the mobile teams, a modern GIS can participate with LBS functions (support for dynamical geo-location): stating objectives toward which the assisted team should go; tracking moving object(ive)s; real-time guidance; traffic control; etc.

1.2 Weather situation

We commonly known that springtime brings a lot of precipitations. But the global climate changes from recent years also make this happen in summer, autumn and winter.

When the rains fall too intensely, often exceeding 25 l/m2/h [liters per square meter per hour] (thus a water quantity which overpasses the combined absorbing capacity of the soil and of the sewages; in the Vrancea district in the summer of 2004 an amount of 138 liters on squared-meter in 80 minutes was recorded), overflowing appears on many rivers and the resulted floods affect people's lives, mostly in rural regions, where the residences are not systematized, and sometimes where there are very few sewage canals. Many people’s assets are then destroyed (including houses and cars), and even human deaths occur (mainly children, women and aged). Similar flooding situations happen in springtime when, after a rich winter, the snow is thawing.

Figure 2 - Overflowing effects

The summer precipitations of 2004 affected many districts from Romania (Arges, Bacău, Buzău, Cluj, Gorj, Hunedoara, Neamț, Sibiu, Suceava, Vâlcea, Vrancea, etc), and seemed to be some of the worst floods from the last 30-40 years.

These floods affect not only the human habitats, but also the whole environment.

The abundant rains have destroyed bridges, roads and railways, thus many farms became isolated, and these families were then supplied with foods (drinking/mineral water, bread, conserved meet, other foods) through extraordinary means (temporary bridges, boats, helicopters, etc).

The running waters – instantly developed by torrential rains what came after long, hot sun, dry days, with thunder-lightning and strong wind, sometime becoming hailstorms – provoke deep despondency to the agriculture people: many crops across the country were destroyed (vegetables, pot herbs, wine-yards, grain cultures, corn fields, etc – sometimes in a proportion between 50 and 100%).

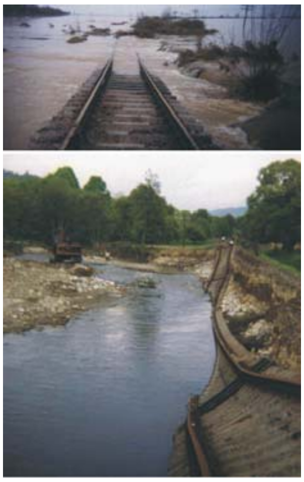

Figure 3 - Railway destroyed by flood

From another perspective, such weather angrily combining day-after-day torrential rains (exceeding 60 liters/m2), hailed precipitations, wind and thunder-lightning, could interrupt or dangerously delay the summer agricultural works. And this, in the rural regions, can negatively affect people’s life.

Sometimes, hailstorms (bringing egg-sized stones) have destroyed roofs of hundreds of houses. Overflowing rivers took away barns, stables and mews, often killing farm animals.

Thunderstorms and/or floods have affected occasionally the electrical power network (by destroying stations, breaking lines, plants), and this outages affect both residential and commercial/industrial consumers.

Floods have inundated roads and even stopped trains.

The same rains, affecting the Ocnele-Mari area by terrain-sliding and by salt-water overflowing from mining cavities, not only have destroyed many farms and houses, but have also affected the environment by salt debouching into the Olt river (one of the largest rivers from Romania). The neighboring chemical companies which currently use the water from this river have been affected too.

Figure 4 - Terrain-sliding at Ocnele Mari

In this summer the river overflowings and the terrain-slidings have destroyed thousands of houses, tens of bridges, hundreds of kilometers of forest roads, tens of cars, many water pipes, electrical power lines, columns/pillars and electrical transformation stations, hundreds of hectares of agricultural terrain, kilometers of banks, hundreds of fountains, kilometers of railway, many water-stations, shop houses, stores, etc.

GI in weather monitoring:

GIS functions for monitoring, recording and analysing weather information (at national and local scale/level);

Internet published weather forecasts (having GIS servers as core for web-based forecasting services);

subscription-based periodical communication about weather conditions and forecasts from weather institutions (national, local).

2 POSSIBLE AND PRACTICAL SOLUTIONS

2.1 Proactive solutions

Of course, the most practical measure for preventing and minimizing flood negative effects is to build guide banks for rivers and brooks. The presence of a safety embankment or/and of a longitudinal dike is very advisable on sides of almost all flowing waters (from big rivers to creeks), especially where the natural banks are not high enough, but such stream harnessing costs. (I presume that in the poor- and developing-countries not all the flowing waters have a proper basin development.)

Another prime solution consists in the extension and/or rehabilitation of the water duct networks (first the waste-waters sewages, but also the potable-water adductions).

This kind of works needs proper designs, which will be well served by GIS and CAD software (from the incipient phases – strategical design –, to the concrete constructive and detailed design, and also to the exploitation and maintenance).

As it might be expected, weather statistical analyses (showing the most "rainy" month of the year, and particularities of the rain-falls), combined with a dynamic connection at the regional/national/local weather forecasts services/information, can play a leading role in forestalling flood effects.

Beyond the main purpose of real-time monitoring of the river levels along the hydrographic basin of the potentially dangerous rivers, the adjustment of the former alarming levels (possibly in correlation with majors factors which previously have not appeared) can become useful, and so can develop statistical research/studies over the levels database to find behavioral patterns.

Another basic key in preventing the crisis consists in increasing the reaction speed of the emergency services: rescuing, ambulance, hospitals, police, fire-brigade, gendarmerie, et cetera.

Similarly, with or without previous/practical experience, communities need plans for fighting against disasters. They have to define crisis-management strategies, to know about able-to-be-involved resources, methodologies, and responsibilities, to be ready to apply such knowledge (because by acting ad-hoc, only on the spur of the moment (under the moment's inspiration), decisions can be compromised by not-knowing all the aspects and even by human emotions). In the "Information Technology" perspective, this need of planning and monitoring actions in case of necessity is served by the CMS applications (Crisis Management Systems), from those for communities (generally serving people) to those for particular enterprises (including utilities and infrastructures).

Before seeing effective use of the GIS in emergency management, let us shortly remember why we use geographic information when we deal with crisis:

» a better understanding of the real facts and of the situation;

» a better, sharper and faster decision making.

GIS for proactive disaster management:

it is vital to have a geo-spatial database representing the district, with people's residences, infrastructures, buildings, and water networks, supporting major editing and querying functions;

is also advisable to possess GIS functions for revealing geo-risks situations;

floodplain simulation analysis (2D vector, 3D, DTM, raster based or mixed);

engage specific queries, from distance measurements to proximity analysis.

Also as a preventive measure the dispatchers/headquarters of emergency public services (ambulance, police, fire-brigade) must have GI application (or GIS function in their phone-call CRM application) for controlling the district and for tracking and assisting their mobile teams/equipages.

On-the-field disaster simulation alarming exercises (with the GIS off-line or on-line support) help the responsible people with regard to: managing resources; starting and deploying actions; monitoring reaction times; watching simulation results (as time-frames, costs); revealing weaknesses; analysing and proposing alternatives. It is an operative way to find solutions for disasters mitigation.

2.2 Reactive solutions

In the summer of 2004 many efforts were engaged for helping people affected by floods (mostly from national and local administration, and with a "political will" catalysed by the fact that it was an election year).

One top measure was leveraging the emergency services: rescue, ambulance, hospitals, police, fire brigade, etc.

Figure 5 – Roads restoration

Whenever most of these situations happened, the local-government (the public administration) constituted crisis management teams, having the task to initiate/control several back-up measures for people from the affected regions:

A. Immediate actions:

homing the people who can not anymore use their houses (in hospitals, schools, other public facilities);

assuring live-support for affected people (health-care, foods, utilities);

identifying dangerous areas in case of other consequent overflowing occurrences;

(local/national) government operative group (non-stop, or continuous shifts) as call-center for situations monitoring, for receiving signals and calls from citizens, and also for humanitarian help calls.

B. Long-term actions:

epidemiological monitoring, diseases controlling, vaccination campaigns;

identifying lands for people relocating and for house building;

assuring building materials (cement, lumbers, steel, BCA bricks, glass, etc) bought from the state's strategical reserve; etc.

Relocating people (by building houses for them to replace those broken) presume several key aspects:

» assuring their lives (life support) for a relatively long period (hosting; feeding; health support), until the new houses and/or farms are ready;

» giving financial and/or material aids;

» finding vacant/disposable terrain areas (mostly from the public domain patrimony) - this is the most suitable for being effectively served by GIS/GI applications;

» quickly contracting and deploying building yards [construction/project sites];

» providing social assistance (social services), and sometimes legal consultation (e.g. due to the many aspects concerning the property); etc.

The Ministry of Health has solicited the districtual health offices to intensify their activities in the flood-affected areas: information broadcasting for citizens; surveying the quality of drinking water; watching for pest holes and epidemic diseases signs; vaccine campaigns.

Because many people from stricken hard-hit regions left without drinking water sources, the local administration and the Red Cross distributed thousands of mineral-water bottles and many potable-water auto-cisterns, and they put banners signaling the disease potential of affected fountains. People must know that drinking water from affected subterranean sources (affected by clogging, silting or aggradation) can provoke severe diseases, like "A hepatitis".

Also, many cargoes with foods for farm-animals were distributed (grains, flour, brans). Beyond these material aids, the administration deployed many financial aids.

The govern approved, in fast mode, several statements concerning the systematizations and developments of hazardous rivers banks.

A particular and dangerous local situation is that assets insurances in Romania only reach a low level. There are governmental and non-governmental efforts to stimulate and to encourage the Romanian people to use the insurance systems, but the legislation is still perfectible in this direction. Because of the many facets of the floods, it is obviously advisable to engage not only life- and house-insurances, but also those which cover agricultural risk assessment, therefore insuring crops (including hail damage) and livestocks.

GIS and IT&C for reactive disaster management:

the GIS solution must allow the operators (from dispatching center, or even from field) to quickly introduce and edit those entities that model the flow affected areas, in various aspects (as polygons, lines, points, raster, annotations, etc).

portable/mobile GIS application (for notebooks, PDA with GIS essential functions; GPS pocket-receivers; other mobile devices combining geo-spatial information and telecommunications: GIS, LBS, GSM, etc) connected with the central GIS (databases and applications from team headquarter);

easiness of installing and supporting dispatching centers for crisis management (an opened GIS environment based on LAN, VPN and Internet/intranet, able to disseminate geo-spatial data to thick- and thin-clients: from full-featured PC stations to web browsers and mobile devices);

seamless communication between crisis management team members (by mobile telephony, paging, instant messaging, e-mail, fax, etc);

Internet publishing for information dissemination (web portals for disaster management; media/press communication);

green phone call lines (for affected citizens, also for people who need to report new situations and changes, and for citizens who want to help others).

Other important requirements for the geographic information systems/application involved in crisis management:

_ a high level of reliability (guaranteed by using quality stuff: hardware, software, human resources; back-up solutions; uninterruptible power supplies, redundancy of critical hardware/software components; hot-swappable devices; etc)

_ fast map-producing (for printing on paper, for publishing through Internet, or for accessing through wire-less connections), dedicated to a larger audience (than those “IT familiarized”);

_ data interoperability/interchange with other information systems/applications (including GIS, CMS) from other involved organizations (the local administration, civil defense, police, ambulance, public health offices, environment guards, and committable private organizations);

_ connections and conformance with local/national SDI portals (Spatial Data Infrastructure).

But, above all these administrative and technical issues, the human spirit rules: from knowing and thinking, to helping one another.

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