Some Observations about the Use of Remote Sensing and GIS in Catastrophic Events Mitigation

Gottfried KONECNY
Emeritus Professor, Leibniz University Hannover, Germany

1. Introduction

Catastrophic Events are unexpected disasters threatening the environment and human beings dependant on their living space. Imaging systems from the air and from space have traditionally been able to record such events quickly, so that it became possible to offer relief from the effects of the disaster. While aerial imaging using conventional optical systems requires suitable flight conditions in cloud-free daylight conditions, optical sensors can be supplemented by thermal and microwave systems operating at night or through clouds in special cases.

Aerial sensors suffer from the inability to cover large areas on a worldwide scale. Present satellite offers a suitable possibility to image remote disaster areas quickly.

Meteorological satellites at 1km resolution permit to image cloud free global scenes at half hour intervals, while 1m or 0.5m high resolution satellites need to be targeted to cover limited specific areas, permitting to cover a particular disaster site only.

Depending upon the type of disaster different image resolutions are required:

- Cyclones may already be monitored with coarse resolutions of 1 to 10km, and so are areas affected by drought.
- Floods can be monitored with 10m resolution images, while effects of earthquakes and human caused disasters require images by high resolution satellites.

2. International Charter “Space and Major Disaster”

The Space Agencies of Europe, France, Canada, India, the USA and of Argentina have offered their imaging capabilities to the United Nations, if a disaster is officially declared. This entails targeted image acquisition and processing of the imagery for the use in disaster mitigation. This includes the entire technical processes of sensor calibration, georeferencing, modelling, analysis archival and delivery of data during the process to transform raw data into information.

This data delivery system has proved to be very effective. In te case of the Sumatra tsunami the German Space Center DLR has provided 40 analysis products and maps of the tsunami affected areas within two weeks alone for the mitigation of post event effects.

Other German agencies, like the Geo Research Center in Potsdam has concentrated on developing an integrated system for the early warning of Tsunamis after an earthquake consisting of seismometers, tidal stations, pressure gauges, GPS buoys working in real time networks for the rapid determination of risk areas and evacuation plans. It is clear that such a system can only work within an established infrastructure to be internationally established with the mutual consent and the concerned nations.

3. Past Natural Disasters in Historic Times

Past historical records, shown here as incomplete examples, demonstrate that almost all continents have suffered from severe disasters:

- the Yellow River Flood 1967 in China, which killed 1 million people
- the tidal wave of 1737 in the Bay of Bengal with 300 000 dead
- the Galveston tidal wave 1899 in Galveston, Texas, which killed 60 000 people
- the Lisbon Tsunami of 1755, which resulted in the loss of 10 000 lives
- the Indian Ocean Tsunami of 2004 with a death toll of 100 000
- the Etna Volcanic Eruption of 1669, killing 100 000 people
- the Martinique volcanic eruption killing 30 000 humans.
- even Central Europe suffered severe earthquake damages in the 15th century in the City of Basel.

4. Causes and Effects of Natural Hazards

A number of statistical studies have been internationally made identifying the impacts of the nature of catastrophic events with respect to:

damage:

- 32% caused by floods
- 30% caused by tropical storms
- 22% caused by drought

number of persons affected:

- 33% caused by drought
- 32% caused by flood
- 30% caused by tropical storms

Number of deaths:

- 26% caused by floods
- 19% caused by tropical storms
- 17% by epidemics
- 13% by earthquakes (as seen recently in Turkey, Pakistan, China and Haiti).

5. Studies by EMERCOM in the Russian Federation

In the Russian Federation the Ministry EMERCOM has been very effective in providing materials for disaster mitigation and in analyzing the causes of disasters within the territory of the Russian Federation:

According to these studies the causes for natural disasters in Russia are as follows:

- Floods 35%
- storms 19%
- torrents 14%
- earthquakes 8%
- landslides 5%
- snowfalls 5%
- frosts 3%
- avalanches 2.5%
- droughts 2%
- thunderstorms 1%

With respect to the natural disasters, not to be ignored are the human caused technical disasters, which amount to a total of about 50% of the damages caused.

The number of human caused disasters per year in the Russian Federation in the late 1990´s was:

- building accidents 277
- industrial accidents 244
- big truck accidents 104
- life support infrastructure 83
- explosions in populated areas 60
- pipeline accidents 80
- chemical accidents 80
- air crashes 26
- ship accidents 20
- railway accidents 22

Human induced hazards refer particularly to:

- nuclear power plants
- chemical hazards
- industrial fires
- pipelines
- transport
- dam breaks
- municipal construction

- energy and water supply
- subsidence by water, oil or gas extraction

It is evident, that all mentioned hazards are particular for a certain region.
In this respect danger zone maps have been prepared (e.g. for seismic dangers).

With regard to seismic dangers the most advanced monitoring system using permanent GPS receivers 10 km apart and seismic stations has been established in Japan.

EMERCOM´s strategy in disaster mitigation is remarkable with respect to that of other countries:

- it makes use of the existing map material
- it enhances the existing digital map data in form of a GIS with other thematic data (e.g. population distribution, evacuation routes, building stability)
- it is like directly to the armed forces, which have a centralized decision and implementation structure, which is lacking in developing countries.

6. Conclusion

Emercom posseses the desired Disaster Mitigation Infrastructure:
It has:

- a central emergency decision center
- real time satellite imagery reception facilities
- sensor networks
- GIS information of all endangered regions based on
  - digital topographic maps
  - population distribution maps
  - evacuation routes
  - building material maps
- a fire, contamination or accident reporting system
- computer enhanced analysis capabilities.

In the international context we must conclude:
Technology, which we all have throughout the world, is easy, but Organization is difficult in most countries with very few exceptions.