Application of High resolution Stereo satellite imagery for finding vulnerability to flood and Land Slide

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Key words

Remote Sensing, Satellite Imagery, Digital Elevation Model (DEM)

Abstract

Sri Lanka is a country affected frequently by floods and Landslides in some areas while the drought is experienced in other areas. Flood control and disaster mitigation are will certainly help the task of sustainable development of the society and its economy. Recent developments in Information and communication technology in the form of GPRS and Internet, GPS, High Resolution Satellite Imagery and real time data transfer can immensely facilitate the processes of planning and implementation of hazard reduction measures.

1. Introduction

It is a fact that natural disasters strikes countries, both developed and developing, causing enormous material destruction and suffering to mankind, creating thereby heavy negative impacts on national economies. Due to diverse geo-climatic conditions prevalent in different parts of the globe, different types of natural disasters like floods, droughts, earthquakes, cyclones, landslides, etc. strike according to the vulnerability of the location. When compared to many other countries of the world that are more disaster-prone, Sri Lanka is fortunate to experience a lesser number of disasters. However, it has witnessed several natural disasters like droughts, floods, and landslides, etc. in recent past.

2. Natural Disasters in Sri Lanka

Sri Lanka is an Island with maximum length of 435 km in the North –South direction and a maximum width of 240 km in the East West direction. Out of the total land area of 65,525 square kilometers, approximately 30,000 falls within the range of 0-100 meters altitude, and about another 20,000 in between 100 m-500 m contours. The remaining areas vary beyond 500 m and up to 2524 m which is the height of the Piduruthalagala peak. Among all the natural disasters that country faces, river floods are the most frequent and often devastating. The decrease in rainfall causes drought or near-drought situations in various parts of the country. It is often observed that drought situation prevail in some areas while some other areas are under floods. During heavy rain falls in the central hills, landslides occur very often resulting in losses of human life and damages to property. The country has faced several sea erosions that have caused widespread damages to the environment along the coast line.

3. GIS and Satellite Imagery

Geographical locations integrated with other information forms a Geographical Information System (GIS). GIS provides a tool for effective and efficient storage, and processing of remotely sensed data together with other spatial and aspatial data types for both scientific management and policy oriented information analysis. This can be used to facilitate measurement, mapping, monitoring and modeling of variety of

data types related to natural phenomenon. The location data used in GIS for analysis should be accurate and current if the intended applications are proper planning and correct decision making.

Observation satellites remotely sense the objects from a distance without coming into physical contact. Remote sensing techniques can gather data much faster than those of ground based observation, and can cover larger a area at a time to give a synoptic view. Recently developed High resolution, 50 centimeters, Satellite Remote Sensors with stereo imaging capability can generate a digital elevation model with an accuracy of 1 meter in respect of the details on it. Reliefs and drainages, slopes of hills, flood prone areas, sea erosions can be identified accurately using digital elevation model; and a DEM can help integration of natural hazard assessments into development planning studies. Some applications of GIS and Remote Sensing in various disaster situations are briefly stated below.

3.1 Floods

Satellite data can be effectively used for mapping and monitoring the inundated areas, flood damage assessment, flood hazard zoning and post-flood survey of river configuration, and protection works.(DEM prepared using WV-1 stereo images of Colombo area is taken for the study. Simulations can be done to study the flood levels using 'ERDAS virtual GIS' software with the stereo images.)

3.2 Landslides

Available Landslide zonation maps depicting the stretches or areas of varying degree of anticipated slope stability or instability can be updated using an accurate DEM prepared at 1 meter accuracy. The map has an inbuilt element of forecasting and hence is of probabilistic nature. Depending upon the methodology adopted and the comprehensiveness of the input data used, a landslide hazard zonation map is able to provide help concerning location, extent of the slop area likely to be affected, and rate of mass movement of the slope mass. The direct water collections from the roofs discharge to earth surface of upland ridges can be calculated and new preventive drainage can be planned using high resolution satellites images. (Deniyaya forest reserve and houses build on the ridges using Quick Bird Image)

3.3 Drought

GIS and Remote Sensing can be used in drought relief management programmes such as early warnings of drought conditions, and this will help plan out the strategies to organize relief work. Satellite data may be used to target potential ground water sources for executing well-digging programs. Satellite data provides valuable tools for identifying areas vulnerable to droughts.

Further studies can be done to inter-connect rivers. Flooding in one area and drought in another area is a common scenario in Sri Lanka. The advantage of one contour running throughout the separation line of hill and valley (between and 100m 500m) has to be considered.

Quote

"In surface configuration Sri Lanka comprises, a high land massif, situated in the south-centre, which is surrounded more or less by an intermediate zone of upland ridges and valleys at a lower elevation. These two set of topographical features are in many places separated by well marked scarps, so that when a stream descends from one to another there is a water fall. There are over fifty such waterfalls in the island."

Unquote

(Page 2 of Arjuna's Atlas of Sri Lanka, Published by Vidyanidhi T. Somasekaram-former Surveyor General of Sri Lanka)

3.4 Sea Erosion

Predicting the effects of storm surge and tsunamis requires a detailed understanding of the near-shore environment. With photogrammetric techniques, the entire coast line can be mapped simultaneously above and below the water, providing unprecedented continuity and critical insights.

Launching of 'World view-2' satellite on 8th October 2009, with 50 cm high resolution and 8 spectral bands , specially with ocean blue , analysts will be able to distinguish features more accurately and increase the scope of remote sensing applications. Thanks to WorldView-2's ability to collect large volumes of stereo imagery, new photogrammetric techniques for calculating ocean depth are finally possible. Current, accurate depth measurements will provide increased navigational security, and support detailed mapping and modeling applications.

(Data sheet of Digital globe)

3.5 Human settlement

The selecting hazard zone areas using satellite images are possible with high resolution satellite images. Combining with SAR images for further study of underground data such as soil types can determine the best possible area for human settlements.

4. Conclusions

In recent times, after the Tsunami, large floods with typhoons and earth quakes, nations are preparing for disaster mitigations using most modern technologies to obtain real time data, method of data management and information to the victimized areas. It may be observed that advancement in Information Technology in the form of Internet, GIS, Remote Sensing, Satellite communication, etc. can help a great deal in planning and implementation of hazards reduction. GIS can improve the quality and power of analysis of natural hazards assessments, guide development activities and assist planners in the selection of mitigation measures and in the implementation of emergency preparedness and response action. Remote Sensing, on the other hand, as a tool can very effectively contribute towards identification of hazardous areas, monitor the planet for its changes on a real time basis and give early warning to many impending disasters. Communication satellites have become vital for providing emergency communication and timely relief measures. Integration of space technology inputs into natural disaster monitoring and mitigation mechanisms is critical for hazard reduction. It is absolutely necessary to create awareness amongst the public as well as decision makers for allocating resources for appropriate investments in information technology. Awareness and training in Information technology in a much greater measure is required to develop human resources, particularly in the developing countries, who chronically suffer from natural disasters.

Computer presentations live

a) DEM prepared using 1:250,000 data from Survey Department.:

b) Map of relief and drainage (Arjuna's Atlas)

c) DEM and satellite imagery overlaid.

d) DEM of Colombo using WV-1 stereo images

e) Simulations using ERDAS Virtual GIS using the DEM

f) Coastal line and Bathymetry on ERDAS Virtual GIS

g) Bathymetry application data sheet of WV-2

h) Deniyaya forest DEM

5. References

1) Arjuna's Atlas of Sri Lanka for relief and drainage map of Sri Lanka

2) Paper published on "Information Technology and Natural Disaster Management in India" by Dr. Alok Gupta

3) Digital Globe's WV-1 stereo imagery of Colombo