

SATELLITE DATA-BASED NATURAL HAZARD STUDIE IN IRAN

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1. INTRODUCTION

The revolution caused by placing earth observation satellites into orbit and data acquired, has provided a new opportunity to geoscientists to access to a series of precise and complementary tools with a significant impact on their understanding of earth phenomena and features. Development of new sensors multiplied by increased temporal, spectral and spatial resolution have made these data as an ideal means not only to monitor different surfacial and environmental phenomena but also tom define the parameters involved, to delineate the areas affected and finally to extract information for requoied planning and management.

This report represents the results obtained from investigation made on some of the existing natural disasters of the country and their respective impavts which are carried out on the base of application of data acquired by space platforms and their subsequent integration through the use of geographic information systems.

2. DATA USED

Space taken data which are used for the projects under investigations includes:

- a. Manned spacecrafts (Gemini and Appolo)**
- b. Landsat imageries (MSS ,TM, ETM+)**
- c. NOAA images (AVHRR)**
- d. SPOT data (HRV, XS)**
- e. Terra and Aqua Data (ASTER. MODIS)**
- f. ENVISAT Data (ASAR)**
- g. Space Stations (Astronauts Photographs)**

Complementary data such as topographic and thematic maps at different scales ,aerial photographs at available scales, ground observation data etc, are also used not only to carry out these projects but to be used in establishment of a GIS-based databank as well.

3. PROJECTS

3.1. Drought Impacts Studies

From 1998 to 2002, the country was facing with a drought period . To assess the impact of these dry years NOAA data and NDVI method were used to detect the change in vegetative cover of the whole country which was forwarded to related authorities for their information and possible use in their decision making process.

Second impact of such a drought period were observed in many wetlands of the country ,Figure1and 2 .These wetlands and marshlands which were covered with a considerable amount of waters were completely dried with a very important effects not only on the life of the people living in their peripheral areas but also associated with a very significant environmental, social, and economic changes in their near by areas. The most largest of these wetland are two vast marshlands in IRAN—IRAQ southeastern border which studied by UNDP.

To carry out these studies we are using Landsat series satellite data including MSS,TM and ETM+ imageries both in pictorial and digital forms. These multi-temporal data ,are assisting us to collect a series of valuable information on different parameters involved and to extract information required to establish a GIS-based databank . Preparation of DEM through the integration of data collected, are part of the approach used which is shown in Fig 3 (as an example).

3.2. Duststorm Studies

High temporal resolution Terra and Aqua satellites data, taken by MODIS sensor and multi-visions provided have given us a unique opportunity to monitor heavy sandstorms blowing over 2/3rd of the country. Actually for the first time now we are able to understand not only the parameters involved (i.e. source, direction and channels of transportation, relative densities, areal extent etc) but also to delineate their depositional areas and their relationship with the geomorphological features present Fig 4. It should be emphasized that, gathered information are extremely important to evaluate their impacts on execution of infrastructural development plans which are planned or going to be planned to be performed in the vast areas of the country under the influence of this phenomena (i.e. construction of airports, ports, agricultural production etc) in addition to through understanding and analysis of the phenomena itself .

3.3 Flood Monitoring and Mapping

While almost most of the areas close to large and long rivers of the country are treated by flooding and floods, Khuzestan Plain with its long and major rivers (i.e. Karun, Dez , Marun , Hendijan, Zohreh, Karkheh) located in southwest of the country ,Fig 5 and 6, are supposed to be the most flood-prone areas with a numerous infrastructural plans which includes; industrial, agricultural , oil and

gas ,urban development projects. In this regard ,we have used multi-temporal Landsat data to extract and gather a considerable amount of information on the parameters required and try to delineate flood-prone areas and their respective use for preparation of flood plain zonation map .

A new sets of data acquired by Terra satellite and its MODIS sensor Fig 6, has added new and valuable amount of information to our existing knowledge about flooding in the above =mentioned region and also its nearby areas making us able to complete the picture . With availability of existing very high resolution satellite data such as those taken by IKONOS and Quickbird ,we now are very hopeful to be able to delineate the areas affected by floods and being able to assess precisely damages occurred for their subsequent use in preparation of rehabilitation plans and crisis management.

3.4. Water Fluctuation Studies

water fluctuation in two famous Iranian lakes located partly or as a whole, within the boundaries of the country ,called Caspian Sea and Urumieh respectively, as a natural disaster and their impacts on peripheral areas is the subject of an investigation presently under execution .

To achive the objective defined we are using multi-temporal Landsat data and data taken by SPOT (HRV in XS mode), ASTER and MODIS sensors on board of Terra/Aqua satellites as well as those taken by astronauts orbiting the earth by Space Station ,Fig 8. While Landsat data are used to define and delineate coastal areas under the invasion of progressive waters in 1997-2000 period resulting from water level rise in Caspian Sea , Fig 7, other mentioned types of satellite data are used to monitor the shrinkage in Urumieh Lake due to regression of water level in this unique water body which is recognized by UN as a registered international protected zone.

In this regard, SPOT data were used to define sedimentation pattern change within the lake due to construction of highway right in the middle part of this water body ,Barzegar & Sadighian 1991, 1992.In addition to such a study , Landsat-7 ETM+ data were also utilized for phytoplankton mapping(Barzegar & Khodaei, 2002) and structural analysis of faults involved in the formation of the Urumieh Lake (Mehr-alizadeh & Barzegar ,2002).

3.5. Landslide Mapping

Space taken remotely sensed data due to its repetitive coverage is used effectively as an ideal tool to delineate landslides, of course based on extent of land displaced and type and spatial resolution of data accessible. To evaluate such an application for recognition and mapping of landslides occurring in different geological and morphological environments, Landsat data were effectively used to map such a natural hazard in two different areas in northern Alboz Ranges and southwestern famous oil bearing Zagros Ranges as well ,Fig 9 .

In both cases existing resolutions, both in PAN and ETM+ data were quite effective and lead us not to define and map the mass moed bot also to understand its impacts on the areas of slided debries. Even these data helped us to recognize the paleo – landslides (11000 years in age) through the analysis

approach which is based on conventional interpretation methodology and factors involved.

Understanding of related parameters such as source areas, debris flowing routes, areas covered by mud or debris flows etc are other types of information which will be used to model the phenomena when integrated by other additional data which are essential for such an investigation.

3.6. Monitoring of Volcanoes

High multi-temporal resolution coupled by high spectral resolution provided by data acquired by ASTER on board of TERRA satellite has provided a unique opportunity for geoscientists to achieve a comprehensive understanding of volcanoes characteristics and being able to prevent the resulting disastrous hazard.

Studies made by different specialists around the world now has proven that, these data could effectively be used to access the information required from different phases of volcanoes activities starting from its heating up phase down to evaluation and mapping of affected regions.

Due to existence of such a potential source of natural hazards and being fortunate (for the time being at least) not to have eruptions from even active quaternary volcanoes of the country, we are trying to establish a GIS-based databank for potential volcanoes of the country. In this regard, while we are using Landsat images to create a DEM from these volcanoes (Fig 9) and through its integration with other sources of data for its respective use in morphological analysis and establishment of a GIS-based databank.

To reach our goals, we are now trying to monitor and gather information related to: (1) vegetative cover changes, (2) existing hot springs and their temperature changes based on the data gathered through field measurements, (3) dominant wind directions, (4) existing villages, (5) reconnaissance of evacuation routes and other parameters involved.

It is hoped that such a databank could be used not only to predict the time of eruption but also to be used for crisis management and preparation of a rehabilitation plan.

3.7. Earthquake Impact Studies

Earthquakes is the most destructive natural hazard with a vast environmental, economic, social, cultural impact which still can not be predicted. Regardless of on-going activities by numerous seismologists around the world, presently main concentration of those involved in this subject, is to prevent the event through different approaches.

One of the basic steps in this regard, is based on mapping of active faults and use the maps prepared to define seismic prone areas and their zonation which itself are used by seismic engineers to calculate the coefficients required for seismic calculations and designing of the structures to reduce the probable casualties and financial impacts. Based on this effective approach, we have used different spaceborne data, including photos taken by astronauts on board of GEMINI, APOLLO spacecrafts and also those acquired by Landsat series of satellites (both MSS and TM) to map basement and unknown faults to be added to previously mapped faults and to update the existing information.

Such a information extracted by conventional interpretation technique , was associated with a huge amount of new findings which were presented in the form of Seismic-Faulting Risk Map (Barzegar et al, 1997) . This map itself were later used for production Seismic Risk Map of Iran to be utilized in National Spatial Plan of the country.

In the recent years , after launching of ERS ,Terra and Envisat satellites in to the earth orbit, we are using InSar, ASTER and ASAR data on board of these space platforms and new interpretation techniques developed (such as Interferometric Analysis) to complete our knowledge and find a better understanding about these features and the mechanism involved.

In addition to these sets of data, very high resolution satellite data taken by IKONOS and to some extent Quickbird can also be used for damage assessments with regards to preparation of large scale damage map of the areas under destruction impacts as well.