

Data integration for Flood risk analysis by using GIS/RS as tools**? Mr. Falak Nawaz****?? Mr. Mohammad Shafique****Abstract**

Muzaffarabad city is one the most severally flood affected area in northern Pakistan. It is situated at the confluence of River Neelum and Jhelum. High-class residential area and commercial activities are situated along riverbanks, which are severally vulnerable to flooding. Due to negligence of the authorities and further unplanned growth of city are disturbing the natural flow of water, especially Neelum River is flowing in the form of narrow channel, which easily overflow during flooding. Due to rugged topography and lack of further land for extension, the people are imposed to construct either double-storey buildings or multi-storeys buildings.

For a number of reasons the most frequent choice should be protection from the flooding by means of physical control of the river, but there is also a need for a more broader and comprehensive program for managing flood hazard in the study area. Flood protection has been helpful and must be continued. Side by side other preventive tools like effective planning for the growth of the city, creation of a computerized GIS database for the flood prone areas and a detail flood risk assessment mapping and zonation are required to minimise the harmful effects of flood hazard. Therefore, an attempt has been made to apply modern techniques like Geographical Information System and Remote Sensing for the assessment of flood hazard. The presence of risk assessment mapping will help the concerned authorities to formulate their development strategies according to the available risk to the area.

Key words:

Geographical Information System, Remote Sensing, Risk assessment, Vulnerability, Risk assessment, Hazard mapping.

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		number
No of Villages Affected		292
No of Persons affected		13169
No of Persons Died		54
Houses damaged	Made up of mud	3793
	Brick up of brick plus concrete	-
Houses Demolished	Made up of mud	1710
	Brick up of brick plus concrete	42
Shops Damaged	Made up of mud	55
	Brick up of brick plus concrete	255
Shops Demolished	Made up of mud	180
	Brick up of brick plus concrete	161
Mosques Damages		12
Cattle lost		3558
No of Hotels Damaged		3
Water Mills		356
Petrol Pumps		3
Saw Mills		5
Crush Machine		2
Total Area Affected in (Acres)		33083
Total Trees Affected		3563

Source: Disaster Relief Cell, Civil Secretariat, Muzaffaraba,, 2002.

DRAINAGE PATTERN

The Jhelum and Neelum are two rivers, which flow through the district. The Jhelum river, which has its source in the Varing spring in the Anantnag (Islamabad) district of occupied Kashmir. Enters near Chakoti at the confluence of Urusa nala and flows in a southeast to north west directions up to Muzaffarabad where Neelum river joins it. Then after it runs toward south along the border of Azad Kashmir and Pakistan. The Neelum River, which was formerly known as Kishan Ganga has also its source in the occupied Kashmir and enter the district in Athmuqam tehsil and flows through Neelum valley.

CLIMATE

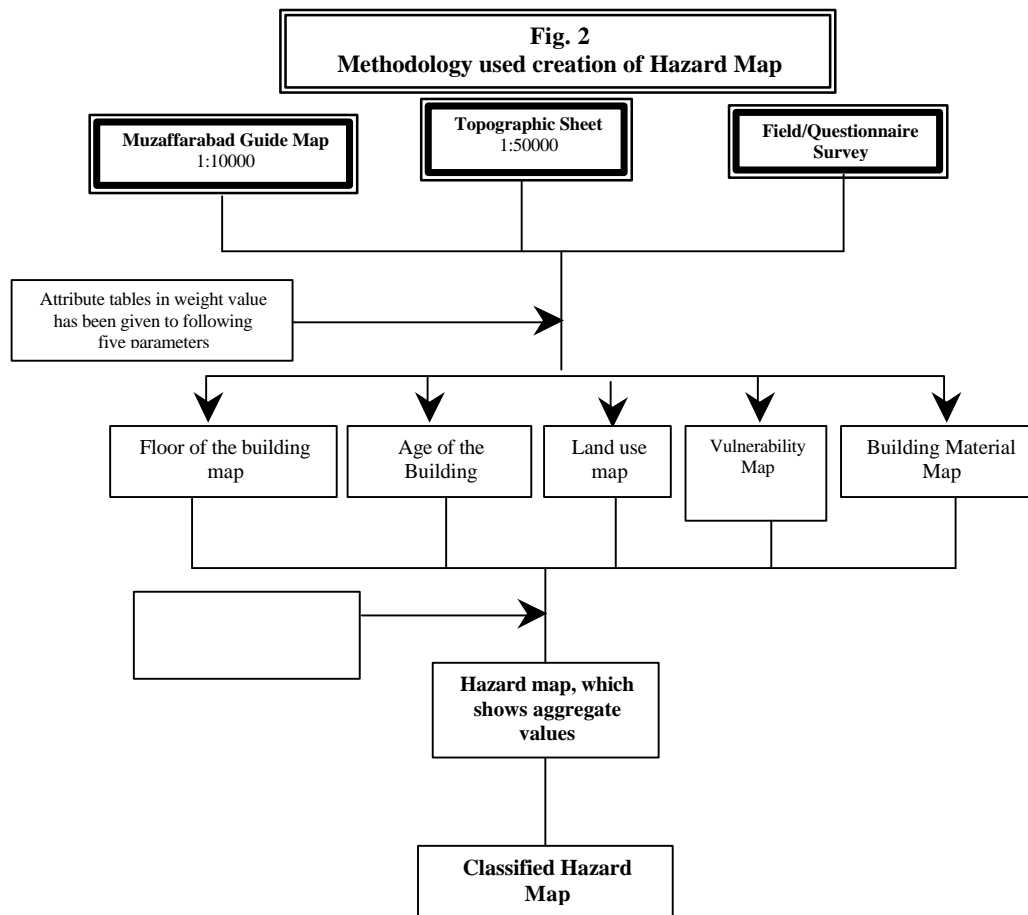
The climate varies considerably in the north and in the south. The southern part of the district experience warm summer and cold winter whereas in the north summer is cool and winter extremely cold. June, July and August are the hot months. The mean maximum and minimum temperature during the month of July are about 35^o and 23^oC. respectively. December, January and February are the cold months. The mean maximum and minimum temperatures during the month of January are 16^o and 3^oC respectively. Average annual precipitation of the district is 1511 millimeters (Table.2).

RESEARCH METHODOLOGY

The methodology was adopted in the study according to the objectives of the study, available data and techniques. The flow chart shows the methodology adopted during the this study (Fig. 2);

Months	Temperature (C ^o)		Precipitation (mm)
	Max Temp	Min Temp	
January	15.89	3.18	93.74
February	17.62	5.22	134.66
March	22.29	9.63	156.46
April	28.09	14.15	111.14
May	33.10	18.27	79.12
June	37.57	22.14	103.31
July	34.79	22.79	327.61
August	33.77	22.44	249.24
September	33.33	19.38	108.05
October	29.85	13.63	51.04
November	23.91	7.83	35.44
December	17.70	4.00	76.86

Source: District Census Report 1998, Population census Organization, Islamabad



GIS AS A NATURAL HAZARD MANAGEMENT TOOL

Nowadays GIS is emerging as a powerful tool for the assessment of risk and management of Natural Hazards. Due to these techniques, natural hazard mapping can be prepared now to delineate flood prone areas on the map. Such kind of maps will help the civil authorities for quick assessment of potential impact of a natural hazard and initiation of appropriate measures for reducing the impact. Such data will help the planners and decision-makers to take positive and in

time steps during pre disaster situation. It will also help them during post disaster activities for the assessment of damages and losses occur due to flooding. Moreover, GIS provides a broad range of tool for determining areas affected by floods or forecasting areas likely to be flooded due to high discharge of the river. With the help of sequential images of certain area, we can find out the behavior of the flood routing and damages.

CREATION OF HAZARD MAPS

For the analysis and creation of maps, researcher used the city guide map, which was purchased from the Survey of Pakistan office. The coordinates of the map were not known but taking control point with the help of Global Positioning System (GPS) on the ground, the required maps were georeferenced. With the help of screen digitising, a segment map of the city has been drawn. A separate label point map by giving unique ID number to each point was prepared. The segments map then was polygonised with the same label point map. Side by side, a separate table was prepared in which four columns were created. One for Land use, age of the buildings, material used for these buildings, vulnerability and number of storeys of the houses. For these columns separate domains were used. After putting all the information carefully, the table has been linked with the base map by using attribute command.

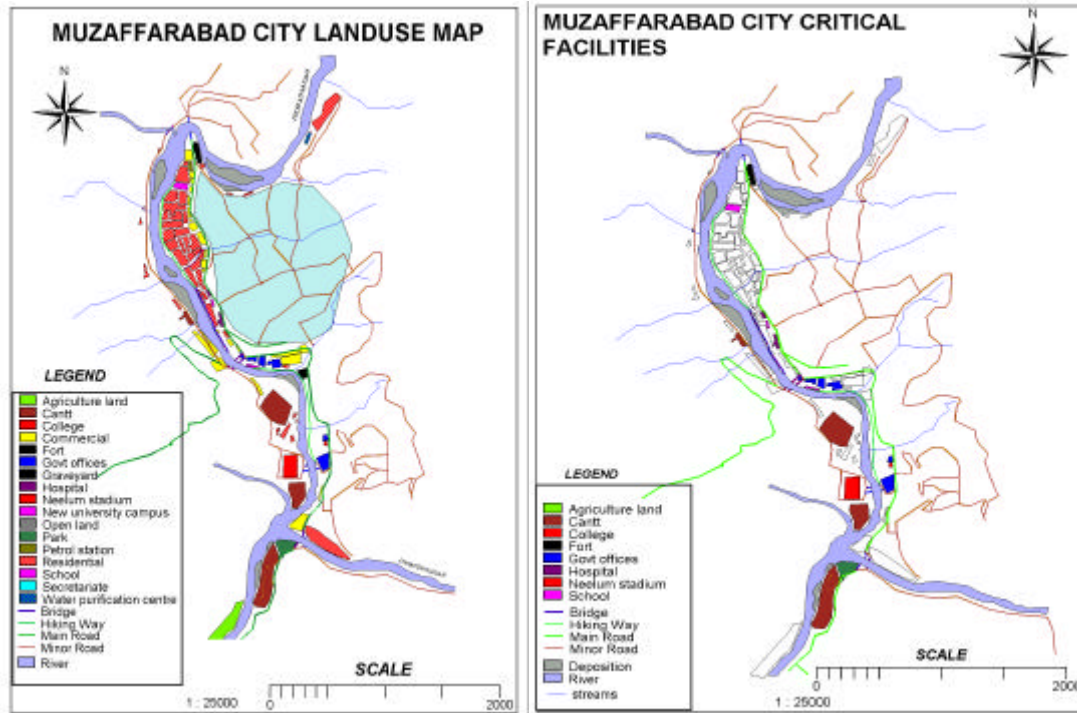
LAND USE MAP

Fig. 3 shows different land uses in the study area. It reveals that predominantly residential areas are situated at the riverbank. The map also shows that there is severe lack of land use planning. As in the lower plate, which are the high-class residential area of the Muzaffarabad city, and it is located just at the bank Neelum River. Red fort, which is the cultural heritage of the Muzaffarabad is located just on the Neelum riverbank and was severally damaged by the flood of 1992. In Makri village, the people construct their mud houses there because the land is cheap. Also most of the cantonment area is located just on the riverbank. At Domel the confluence of River Neelum and Jhelum there is high class commercial area like Five Star Hotels are located just on the river bank that are vulnerable to flooding. Some Government offices like the WAPDA (Electricity Department), Officer Club, National Bank are located at the Neelum River bank are also vulnerable to flooding.

CRITICAL FACILITIES

Critical facilities like Hospitals, Schools, Colleges, Important offices etc can play very important role during any natural hazard. All such facilities are also needed to be taking care hence these are very expensive places and also in some cases it needs utmost protection for example National Bank, Revenue office have very important and sensitive data. In case of damaging these documents, it can create very serious problems to the civil administration. So it is necessary that such critical facilities should be demarcated on the map separately. Similarly play grounds parks & open spaces even schools and colleges can provide temporary shelter to the stricken families from any natural hazards. But during the selection of such areas it is important to have a proper road link so that in emergency peoples could shifted safely and quickly. In the city, one Hospital, School, College, Cantonment, Neelum Stadium, Income Tax office, National Bank and number of other places situated which can be used as a shelter places during flooding. The map has been drawn by applying the mask command from land use map (Fig. 4).

Fig. 3 (Left): Showing Land use map while Fig. 4 (Right) Critical Facilities



CREATION OF VULNERABILITY MAPS

Office of United Nations Development Relief Organization (UNDRO), defines the term vulnerability as:

“The degree of loss to a given element or set of elements at risk resulting from the occurrence of a natural phenomenon of a given magnitude. It is expressed on a scale from 0 (no damage) to 1 (total damage)”.

Keeping in view the definition of vulnerability, some weight value has been aided to the attribute column like age, material, number of storey and vulnerability. For example those houses which were more old, with double or triple storey houses, with low quality material the dwellers use during the construction of the houses and which are more vulnerable to floods has been given low values like 1, 2 or 3 etc, likewise those houses which are newly constructed, preferably single storey, material which has been used of good quality and which are less vulnerable to flooding has been given high values (10, 9 or 8 etc) in these columns. The values that were given in the attribute columns were calculated with the help of the following formula entered on the main window of ILWIS software. The resultant map, which acquired as a result of this calculation, was a Classified Hazard map (Fig. 5).

$$\text{Hazard} = W_{\text{landuse}} + W_{\text{age}} + W_{\text{material}} + W_{\text{vulnerability}} + W_{\text{storeys}}$$

After the calculation based on the above mentioned formula, the researcher got the map which was only indicating the value by clicking on any parcels. Such kind of values makes no meanings for those people who don't know about the methodology applied, so to make the result more acceptable, a separate domain has been created in which the resultant values were divided into three classes: very high, high, moderate and low hazard areas, for example;

Weights

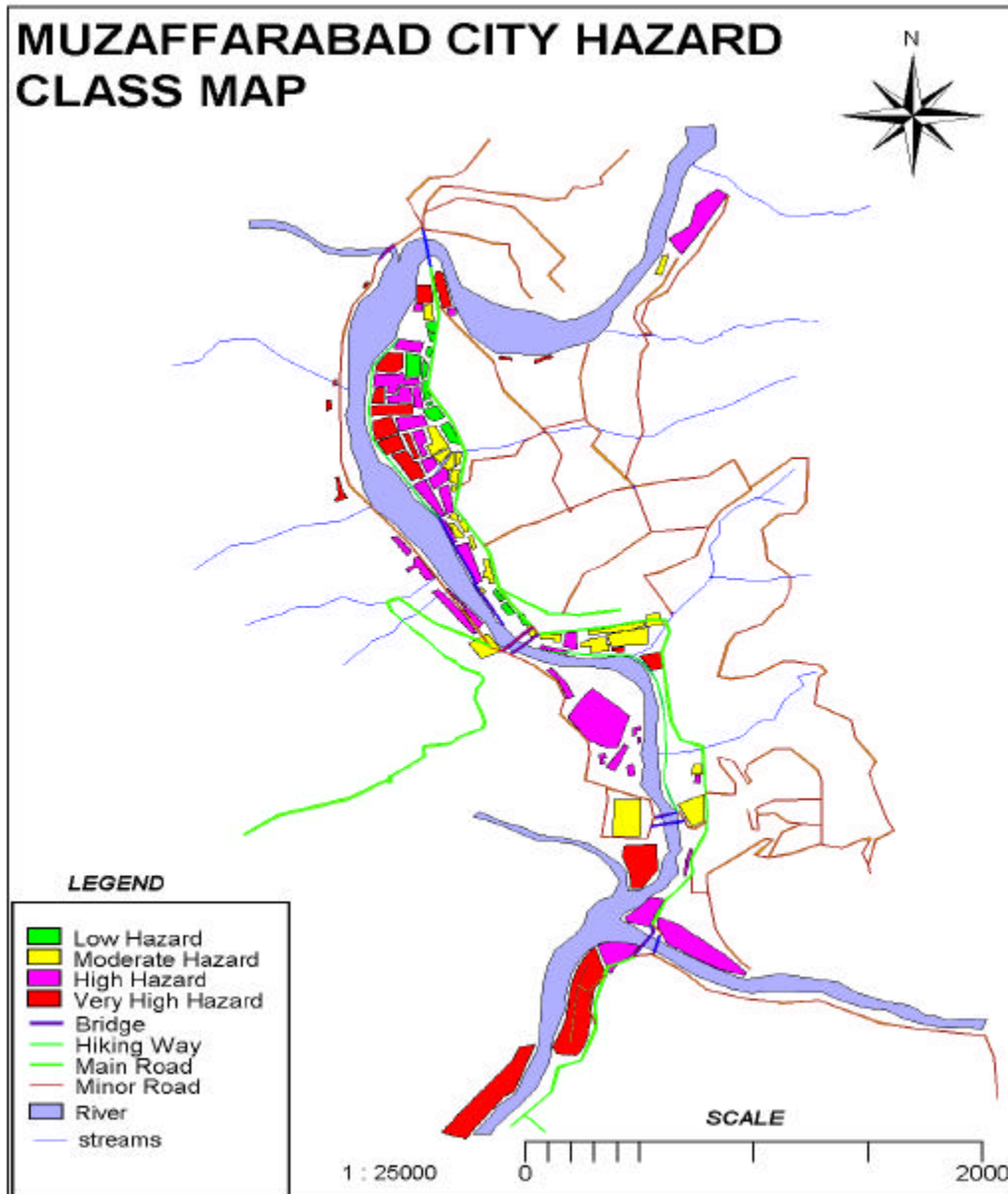
Values below than 30

Class

Low hazard Area

Values between 30-40	Moderate Hazard Area
Values between 40-50	High Hazard Area
Values between 50-60	Very High Hazard Area

Fig. 5: Classified Hazard Map produced after Slicing with different domain



FINDINGS OF THE STUDY

Following are the findings of the study, which have been found after the analysis and study of the area;

- There is severe lack of land use planning in the study area high-class residential area is located just on the river bank. There is no restriction on the construction of buildings along the riverbank.

- ❏ Due to unplanned population growth the people are restricting the natural flow of water.
- ❏ Most of the low class residential houses are situated close to the river Jhelum. These houses are very old which are expose to damaging during high flooding.
- ❏ Red fort, which is the cultural heritage of the study area, is located just on the bank of River Neelum and adversely affected by flood during the flood and also during the normal river flow.
- ❏ Government has constructed two mega projects in order to protect the high-class residential area from adverse effect of flood. One is the embankment in the middle plate just below the Red fort but it has no role in order to provide shelter to the red fort from flood damage. Another project is with the collaboration of UNDP in the lower plate area. Its primary function is providing shelter to high residential area of lower plate but it is also using as hiking way for recreational purposes.
- ❏ Flow is very low under the Chehla bandi Bridge near the Red fort, due to which temporary damming of flood water occurs during rainy season. This cause severe damages and the river rises to very high flood level.

RECOMMENDATIONS

The following recommendations are suggested.

Land use Planning

Land use planning can play very important role to reduce the adverse effects of flooding. It is recommended to adopt an appropriate landuse planning in flood prone area. The ideal form of planning would be to evacuate the flood prone completely but practically it is not possible as to involve high costs and some social problem are associated. It is possible to change the functional characteristics of the flood plain area and to apply ban on the future encroachment in the flood prone areas. The ideal application is the zoning control in the flood plains. As suggested by Kates and White in their book in 1961. They put forward a three zone division which are as following.

- ❏ Zone 1: (Prohibitive Zone): Complete ban on further encroachment.
- ❏ Zone 2: (Restrictive Zone): Certain activities like recreational parks and playgrounds etc are allowed.
- ❏ Zone 3: (Warning Zone): In case of emergency should be able to replace the effectees and be warned by the flood situation time by time.

These zones should be demarcated based on the known return period of flooding and probability of occurrence.

Hazard Assessment and Risk Mapping

In most of the countries, the concerned authorities are preparing risk assessment maps by applying GIS and RS as tools now. In this regard, recently Federal Flood Commission in Pakistan has also prepared GIS based hazard maps by indicating villages, which are prone to flood hazard. It is very much important now to regularly updating and proper maintenance of spatial data. These kinds of maps will help the authorities for quick assessment during pre and post disaster situation.

Need of a Computerized GIS Database

There is intense need for computerized GIS databases for the study area. Such data will help the planners and decision-makers to take positive and in time steps during pre-disaster situation. It will also help the planners and decision-makers during post-disaster activities for the assessment of damages and losses occurred due to flooding.

Trained Personnel

There is a need of trained staff to operate GIS database and up-date this data from time to time. Training is advised at these levels;

- ❏ Planners, decision makers, civil administration officers.
- ❏ Field/Technical staff of line department

The contents of this training program may include basic and advance technical knowledge about Geographical Information System and Remote Sensing, side by side knowledge about physical environment, socio-economic set up, institutional system and information management about the area may also be needed. Besides, seminars and refresher courses for planners and administrators should be organized. Foreign training should be given to planners and decision-makers. In this way, they will be able to know more about the natural hazard prevention and preparedness system there, which will serve as bases to review their own system.

Acquisition of RS Data from SUPARCO office

Acquisition of images especially during any particular flood event from SUPARCO office is very important. It will help the planners and decision-makers to find out the area and villages, which have been affected by flooding. If it is possible then aerial photographs of the flood peak time will further help them to stream line their strategies to mitigate and rehabilitate the flood affectees more efficiently and more quickly.

More Space for River Jhelum Near the City

On both sides of the river Jhelum, the natural flow of the river has been obstructed by the unplanned construction. It is recommended to give back the original space to the river Jhelum. It is very difficult to implement but there is no way out.

CONCLUSION

Flood hazard is destructive and frequently occurring phenomenon in the study area. Due to lack of proper warning information about the flood hazard to the people living in the flood prone area is not communicated effectively. Due to which affectees receive more damages. Due to severe lack of land use planning in the study area, the community build rather rebuild their houses not only close to the river bank. Hazard assessment and risk mapping can prove very useful tool for advance planning, which is totally missing. No importance has been given on this side. Even a computerized record of the data and archive is not available in concerned offices. Although flooding is a natural phenomenon we can not completely stop it but we can minimize its adverse effects by better planning. For reduction of vulnerability in the study area to flood hazard there is urgent need to adopt long-term strategies by skillfully combining the engineering devices with proper planning

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