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MULTI-HAZARD RISK ASSESSMENT OF QURUMBAR VALLEY, GHIZER, GILGIT BALTISTAN, PAKISTAN

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ABSTRACT

Being located in a seismically active zone, these mountain valleys are exposed to different hydro-meteorological hazards like rockfall, debris flow, landslide, ice avalanches, and glacial lake outburst flood (GLOFs). The present study is to investigate different multi-hazards and their prevailing risk in the particular area of Qurumbar valley Ishkoman. In the mid-nineteen and twenty centuries at least six devastating glacial lake outburst floods (GLOFs) has been recorded, initially, only the Qurumbar glacier was considered as the main cause of this outburst flood, later field investigation and interview from local inhabitant revealed that nine more tributary glacier are existing in the area. The recent outburst of flood in the Badswat area of Qurumbar Ishkoman is also considerable, submerging 12 houses and a stretch of roads. Apart from it, the physical vulnerability of the area is increasing, as new areas are being used for housing with the increase in population. The study area is exposed to several other natural hazards like rock fall, debris flows, ice avalanches, and bank erosion. The present study is based on quantitative and qualitative approaches in assistance with GIS/RS an emergent application. The following methodologies were adapted to gather the primary and secondary data for GIS/RS processing. The primary data comprises GIS data and procurement and development and field data. The field data contain ground-truthing /validation. The community-based Hazard Vulnerability Risk Assessment (HVRA) was also carried out to know about human perception. Secondary data has been collected from different literature. Both the data were put into GIS for the processing which gives us our final developmental tools in the form of maps. The hazard and risk map of the Qurumbar Ishkoman depict that flash floods, debris flow, bank erosion, and GLOFs account for major hazards in Qurumbar valley. It is concluded based on our outcomes i.e., hazard and risk maps that earthquake is the main hazard of the area while flash floods, GLOFs, debris flow, bank erosion and the bank collapsed are the main hazards of the area. It is very important to systematically integrate map information into the planning and management process which contributes to a safer environment.

KEYWORDS: GLOF, Hazard, Risk, HVRA, Qurumbar, GIS&RS

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1. INTRODUCTION

1.1 Background

Hazards are threats that have the potential to harm people, livelihood and the environment. Risk is the measure of the possibility or the probability of the harm, causalities or losses of lives as a result of a hazardous event. In the world there are various areas which are uncovered to several types of

natural hazards each with their own (spatial) character. All the geological, physical, and meteorological activities output spell-out in the form of geophysical and hydro-meteorological hazards which include landslides, GLOF, land erosion, debris flow, flooding and earthquakes posing a continuous threat on the local residents as well as to the environment. The increasing population vulnerability to these multiples hazards is intensified by socio-economic factor like poverty, unavailability of land use methods and lake of awareness resulting in seismically weak housing stock in disastrous prone areas ultimately expose the communities more to these natural hazards.

Pakistan generally Gilgit-Baltistan particularly fall in disaster prone zone. Being located in seismically active zone, the mountain valleys in northern Pakistan are always prone to hydro-metrological hazards like landslides, rock fall, debris flow, snow or ice avalanches, glacial lake outburst floods (GLOF), flooding and erosion. Climate changes induce hydro-meteorological and geo hazards are key concern in Asia and their impact on life, livelihood and environment has been increased in Gilgit-Baltistan in general and in Qurumbar valley in particular. The research project is implemented in specific location (Qurumbar village of district Ghizer tehsil Ishkoman). The local population is heavily exposed to these natural phenomena. The physical vulnerability is also increasing with the passage of time as new areas are used for housing, business and agriculture which are at risk from natural hazards. Beside the population's exposure to natural threats the socio-economic conditions in Qurumbar valley are unfavorable. An important issue in the whole Northern area is an indication of an unfavorable climate which is constantly changing having impact on nature [1]. Peoples notices change in snow fall (stronger event with subsequent avalanches), more frequent thunderstorm as well as earlier start of hot and dry season.

Beside the normal natural events which occur frequently having limited geographic extent, a number of past historic (catastrophic) events like the 1893 and 1905 Qurumbar glacier lake outburst floods (GLOF), or the 1858 Sarat rock avalanche with subsequent catastrophic lake outburst flood occurred in northern areas and destroyed numerous villages along the main river downstream, [2]. Recently a glacial lake outburst flood (GLOF) in Badswat valley of tehsil Ishkoman has blocked the flow of Qurumbar River, forming a lake, which have submerged 12 houses, and destroyed a stretch of road. Efforts to transport aid items to the effected region are hindered by the destruction of road, while fear of potential flood that might be caused if the lake barrier break has also increased among the peoples living downstream. GIS and RS are modern tools to minimize the hazard impacts. Destructions from natural hazards and disasters can be reducing by proper monitoring, assessment and mitigation of natural hazards. GIS is also helpful in mapping of hazardous areas [3]. One of the general's aims of the study is to identify multi hazards prevailing in the area and finally formulating different maps like risk and hazard maps for landuse planning and emergency management which are also helpful for assessments, monitoring and mitigation of hazards so to reduce the risk of hazards.

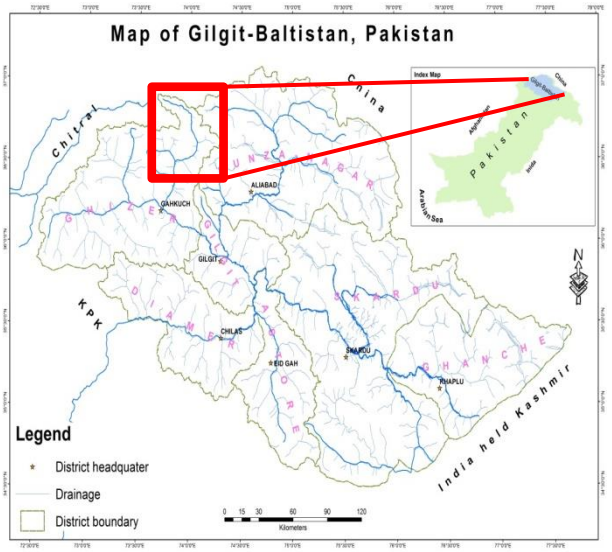

Figure 1: Location map of study area (Qurumbar valley)

1.2 Study area

The Qurumbar valley (Figure 1) is situated in the eastern Hindukush (36º 30'-36º 45' N73º 45' -74º 10' E). The highest catchment area is the peak Kampir Dior (7168 m) belonging to the western corner of the batura yashkuk mountain group. The 90 km long Qurumbar valley initiate in the Qurumbar pass (4250 m) and drain near to the Immit into the Ishkoman valley and at Gahkuch into the Gilgit River. The topographic setting of the valley courses changes again and again with the passage of time between expansive, basin-like valley sections and narrow gorge like valley sections. Qurumbar valley lies in the dry temperate zone where average rain fall is less than 200 mm per year and mono cropping is practiced. Approximately 93% of the total Qurumbar population is engaged in agriculture activities. Other sector of the economy comprises of livestock, forest product, handy craft production, business and trade and transport. The long-term weather pattern in High Mountain is subjective by the board circulation pattern and linked with the position in continental mass and the immediacy to the ocean [1]. There are four meteorological stations in Gilgit-Baltistan that are providing information on different aspect of weather. [4]. Weather data study from 1980 to 2006 revealed that Bunji, Skardu and Gupis with an increase of mean temperature was observed. During monsoon the western Himalaya Mountains act as a fence for vapor laden winds, these mountains received more annual precipitation than North Mountains of the Gilgit- Baltistan [5].

1.3 Historical profile

: A few remarks on glacier lakes and dams in the Qurumbar valley are mentioned in the form of travel descriptions by Hayward [6], Biddulph [7], Drew [8], Stein [9], Schomberg [10]. Kreutzmann [11] investigated the settlement history of Ishkoman valley with particular attention to the influence of glacial flood on the settlements pattern. In the framework of a wider study on landslide- interrupted fluvial system [12] provide the first overview of Qurumbar glaciers barriers. At least six major flood events occurred in the year 1844, 1860/1861, 1865, 1893, 1895 and 1905 in the Qurumbar valley [13], from which the 1905 flood supposed to be the most devastating one, the Qurumbar glacier was primary made responsible for the outburst, but the actual origin of the flood was unknown. Geomorphic field investigation and further studies in assistance with the interview from the locals reveled that nine tributary glaciers in the Qurumbar valley had blocked the main valley in former times.

Gilgit-Baltistan possess unique topography and climate conditions which are building the basis for extensive natural processes like floods, debris flows, rock fall, or landslides and earthquakes. Every year these hazards are directly threat to life, livelihoods and ecosystem, ultimately emergency situation demands relief and rehabilitation [14]. Ghizer District of the

Gilgit-Baltistan is vulnerable to various natural hazards and disasters including earthquakes, flash floods, debris/mud flow, land/rock slides, and Glacial Lake Outburst Floods (GLOF) avalanches, terrain movements and less intensity [15]. Common hazard of the Qurumbar valley are flash floods, debris flows, rock falls, land sliding, erosion, cloud burst, thunder lightening and mud flow.

2. DATA AND METHOD

The study is primarily based on qualitative and quantitative research in assistance with GIS/RS an emergent application. In order to gathered secondary data various sources have been consulted. The whole work of multi hazard and risk assessment has been undertaken by looking into the disaster of the past, potential hazards of today, vulnerability analysis of people, coping capacities of communities, and fragility of environments.

2.1 Data

Primarily Remote sensing data acquired from http://glovis.usgs.gov which is further processed using of GIS/RS techniques (ArcMap and ENVI). Advanced Spaceborne Thermal Emission and Reflection Radiometer (*ASTER*) Digital Elevation Model (DEM) was also used in this study. Furthermore, Google Earth images and Field data is used for accuracy and correlation of our results with our results in order to make a good hazard and risk maps. The field various geomorphic features haven been identified that give us clue about the possibility of hazardous process. Secondly in the field we also analyze the features which give us indication about past activity in a particular location).

Furthermore, following task have been performed at every location in order to collect real data: specifically;

- Geomorphic features (debris slopes, fresh or weathered boulders at the foot of a steep cliff, shape of valley) have been examined. At the same time aerial photograph has been taken.
- Mapping of potential hazards and their location on Global Positing System (GPS) reading in geological perspective has been done for various localities that were reportedly more vulnerable to natural hazards.
- Hazards/events name have been noted and have been located on base map with risk level mentioned as high, low, inferred, potential or unknown.
- Human perception (community baseline from community-based Hazard Vulnerability Risk Assessment (HVRA))

Interviews with key informants had been done in order to know about the extent and damages caused by various natural hazards.

2.2 Method

Kienzholz [16] analysis hazards assessment based on independent methods were used for this study.

- ***Past event:*** this method let us know about the magnitude (size, extent) of a particular event occurred in a particular place. Based on several data of past event a time series can be framed for a particular place. The local peoples who are the witnesses of the events (usually elderly citizen) can provide us necessary information related to past event. We can also consult literature for this purpose.
- ***Field evidence:*** The occurrence of a hazardous process in a particular place often left geomorphic indication which helps us to indicate the hazardous process. These geomorphic features are often examined closely which includes aspects like slope,

bedding, or other parameters of rock and debris slopes. Apart from that in the field we also encountered features that are related to some past event occurred at that particular place (e.g. at the foot of steep cliff, we found fresh or weathered boulders, the shape and extents of debris fans indicate debris flow activity in the past).

3. RESULTS AND DISCUSSIONS

3.1 Hazard analysis

Qurumbar valley is mainly affected by the following type of hazards: flash flood, debris flow, Rock fall, bank collapse, glacial lake outburst flood to name some. Under extreme condition snow avalanche may occur. The distribution of thee hazards clearly depend on the relief (Figure 2).

Remote Hazards: The area is covered by various glaciers. As the past profile indicate that so many catastrophic glacial floods have occurred in the past blocking main Qurumbar River causing massive damage to downstream area. GLOFs and flash floods mostly recorded from Qurumbar glacier due to climate change. This event has been increased in the valley in 2009-2010 and ultimately increased rate of river bank erosion along Bank River. Lower area along the river bank is highly vulnerable for flash flooding while the streams floods impact on Agri-land is considerably in the Qurumbar valley because the land is adjacent to the streams and the rivers.

Local hazards: Among the local hazard Rock fall is the widest spread phenomenon in the village. All small and large stream of the valley bring load of mud, rock and debris downstream of the valley. Bank collapsed is more common near the down slope end of the village. The rate of failure is directly related to human activities, like flood irrigation, construction activities and seepages.

Vulnerabilities Assessments: During the study mainly, the vulnerable elements were identified and mapped. As far as socio-economic vulnerability of Qurumbar valley is concerned, it is not good comparatively other valleys of district Ghizer. Access to the health facilities and other basic needs are big issue for local communities during emergency situation but they access some facilities in Chatorkhand valley tehsil head quarter of Ishkoman valley. Awareness regarding health and hygiene, environment and natural disaster is satisfactory but lack of financial resource is the key concern. Poor people are surviving in the risk areas and they don't have option to change the vulnerable area. Moreover, they build their houses along the river bank and in other hazardous zone areas.

Capacity Assessments: Despite having awareness about the natural hazards in their surrounding yet seldom applies the knowledge and awareness in their plan toward future. The capacity to cope with risk and disaster are not too different from one, location to the other in Qurumbar valley. The preparedness of individual's households for immediate disaster response is very small. Local community self-help is structured is some valleys. VERTs and CERTs teams are active in some valleys in order to cope with sudden events. These are major findings of the study.

- Qurumbar has been badly impacted by flash flood and GLOFs in the past but bank erosion is continuous hazards for productive agriculture land.
- Qurumbar glacier and other glacier existing in the study area are susceptible for climate change and can caused GLOFs in the future.

- Flash flood affects the living zone along the bank of the river and poses a serious threat on productive land.
- Seasonal water flow from the creeks is yet another potential hazard with probability of making larger impact on productive land.
- Bank collapse along the Ghizer River is subjected to seasonal fluctuation of water level.
- Clues about active landslides were not admissible in the study area. The study area lies in zone 3 according to micro-seismic zone of Pakistan by [17]; [18].
- Earthquakes related to MBT doesn't have a harsh impact on the area though earthquakes related to Main Karakoram thrust, main mantle thrust, Raikot fault and Stak fault can pose seismic hazard to area under study, but according to people not a single structure was collapsed in the historical events yet the risk persist.

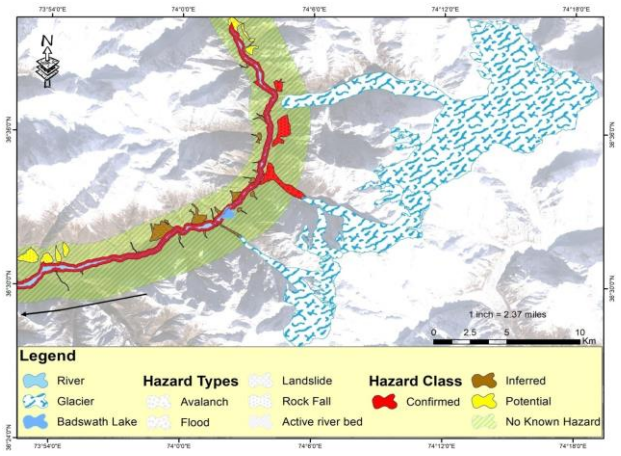

Figure 2: Hazard Map of Qurumbar Valley

3.2 Use of hazard map

For sustainable development and hazard risk management strategies, it is very important to know how to use these developmental tools i.e., hazard and risk maps (figure 3). In the following areas of interest these maps can be used as developmental tools:

A. Prevention of further Risk and adaption to the changing environments:

- Probability of occurrence of certain hazard depicting by the maps with scientific clues and logics with be share with communities in their native language.
- These maps can be used as a tool for land use planning at local village level.
- Can be used to raise the awareness and building the local capacities of communities.

B. Reduction of existing Risk

- In overall risk management, prioritization of risk and their risk reduction can be done.
- Preparedness of local communities can be enhanced by using risk or over view maps.
- Via these maps' prioritization of vulnerable sites for mitigation can be traced.
- After identifying vulnerable elements in hazard map which make a particular area susceptible for future danger, are addressed by putting protective wall considering the magnitude of the process like in case of flooding

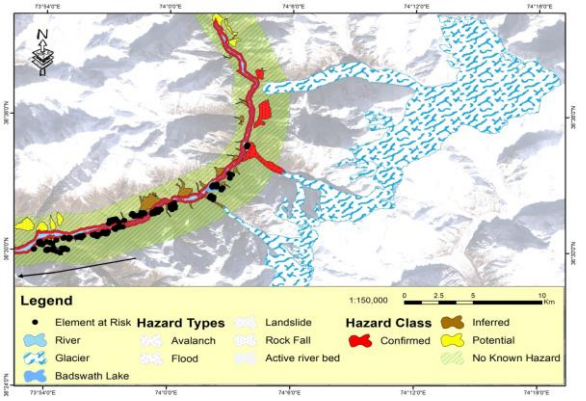

Figure 3. Risk Map of Qurumbar Valley

CONCLUSION

In the study area the vulnerabilities are relatively high and the capacity to cope with the risk and disaster is low. The overall information about prevailing risk in their surrounding is low and the

awareness for risk reduction is very limited. As hazards are changing and vulnerabilities are developing in one way or the other so Risk is not constant. A clear indication of impact of climate change on hazards condition can be imagining. The likelihood of slope dependent process like debris flow, rock fall, flood increase with more humidity. On the other hand, more humidity is favorable for growth of vegetation. More dense vegetation cover would then constitute, in contrast, more instability of slopes and banks. With the increase in temperature, the melting of glacier is expected with which the development of lake is possible. Such lake develops relatively fast and can break our producing catastrophic flood (GLOFs). This dilemma is very important in my study area context based on historic context and future planning. The physical vulnerability is remarkably increasing with the passage of time. With the increase in the population many new houses and infrastructure were built in unfavorable conditions. Such kind of ill-planned developmental intervention can result in sever disaster with serious impact. On the other hand, the capacity to cope with the disaster is slowly increasing with the awareness to build local response team and with external money for recovery.

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