Modern Environmental Science and Engineering (ISSN 2333-2581)
November 2015, Volume 1, No. 5, pp. 255-268
Doi:10.15341/mese(2333-2581)/05.01.2015/007
Academic Star Publishing Company, 2015
www.academicstar.us

Hazard Vulnerability Risk Assessment of District Gilgit, Gilgit-Baltistan, Pakistan

Farasat Ali[1], Babar Khan[1], Garee Khan[1], Yawar Abbas[2], Ejaz Hussain[1], Ambar Masud[3], Karim Akber[1] and Rizwan Karim[4]

1. World Wide Fund for Nature Pakistan, Gilgit, Gilgit-Baltistan, Pakistan

2. Department of Earth and Environmental Sciences, Bahria University, Islamabad, Pakistan

3. United Nation Development Programme, Pakistan

4. Department of Forestry & Range Management, PMAS-Arid Agriculture University, Rawalpindi, Pakistan

Abstract: Gilgit-Baltistan of Pakistan in general and district Gilgit in specific vulnerable for climate induce hydro-metrological hazards and its impacts. The community based hazard vulnerability risk assessment study recorded key climate change induced hydro-metrological hazards, vulnerabilities and capacities in district Gilgit. The study documented major hazards included floods (flash floods), prolong droughts, heavy rainfalls/ snowfalls, clouds bursts, avalanches, landslides, river bank erosion and epidemics. Prioritization or ranking wise floods are more frequent in the study area. The total settlement area of the district is 136.436 Sq.Km out of which 15.67354 Sq.Km is considered to high vulnerable for floods and other hazards.

They are vulnerable in terms of critical facilities, livelihoods options, ecological resources, motivationally and organizationally extreme events. Capacity of the local community and district Government is weak like lack of knowledge, resources and skills and this study provide local viable options to reduced risks from natural events.

Key words: hazard vulnerability risk assessment, hydro-metrological hazards, critical facilities, vulnerability, high frequent, motivational vulnerability

1. Introduction

Hazard vulnerability risk assessment (HVRA) studies examine the hazards that may impact a community and the risk that each hazard event poses to the community as a whole and to vulnerable elements of the community [1]. HVRA is a critical part of every emergency programme (Provincial emergency programme, 2004) [2]. The hazard vulnerability risk assessment is crucial for emergency preparedness, immediate response, mitigation planning and long term recovery from disasters [3]. The benefit of the vulnerability integrated hazard risk assessment approach is that it allows abroad collection of potential risk factors to be explored [4]. Vulnerability and hazard risk assessment variedly undertaken worldwide, however, the common factors for vulnerability, raking, index, etc are relatively inverse to what parameters are used in human development index thus , better human development index is indicative of higher coping capacity and low vulnerability [5]. Hazard, vulnerability and risk are correlated to understand past losses and susceptibility to future losses [6-8]. The term hazard refers to a dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental

Corresponding author: Farasat Ali, MS Environmental Sciences, World Wide Fund for Nature Pakistan; research areas/interests: climate change. E-mail: farasatwwf@gmail.com.

damage (United Nations, international strategy for disaster reduction) [9]. Vulnerability refers as the degree of fragility of person, a group, a community or an area towards defined hazard. Vulnerability is set of conditions and processes resulting from physical, social, economic and environmental factors that increase the susceptibility of a community to the impact of hazard (The ESPON Hazard project (2003, p. 19) [10]. Vulnerability is an essential part of hazards and risk research and refers to the susceptibility of people, communities or regions to natural or technological hazards [11]. While risk define as expectation value of losses (Death, injuries, property, etc that would be caused by a hazard, Disaster risk can be seen as a function of the hazard, exposure and vulnerability as follow (Asian disaster reduction center, 2005). Pakistan is one of the most natural disaster prone countries in the world [12]. Hydro-metrological hazards particularly heavy rain falls induce flash floods are permanent feature of the Pakistan [13-15]. All provinces of Pakistan including Gilgit-Baltistan are vulnerable to geo-hydro metrological disasters [16, 17]. The unique geography and environmental conditions of Gilgit-Baltistan increased vulnerability of the area in the country [18-20].

2. Methodology

2.1 Study Area

District Gilgit is strategically the most important district and the capital of the Gilgit-Baltistan. The area lies on N 35°55' 0" and E 74°18' 0" and bounded by Hunza-Nagar to the north; Skardu, Astore and Diamer to the south; and Ghizer District to the west. The total covered area of district is 38,000 square kilometers (14,700 sq mi) [21]. The region is significantly mountainous and lying on the foothills of the Karakoram Mountains with an average altitude of 1,500 meters (4,900 ft). It is drained by the Indus River, which rises in the neighboring regions of Ladakh and Baltistan. Average annual rain fall recorded 120 to 240 millimeters (4.7 to 9.4 Inc). The piercing sunrays may raise the temperature up to 40°C (104°F), yet it is always cool in the shade. As a result of this extremity in the weather, landslides and avalanches are frequent in the area.

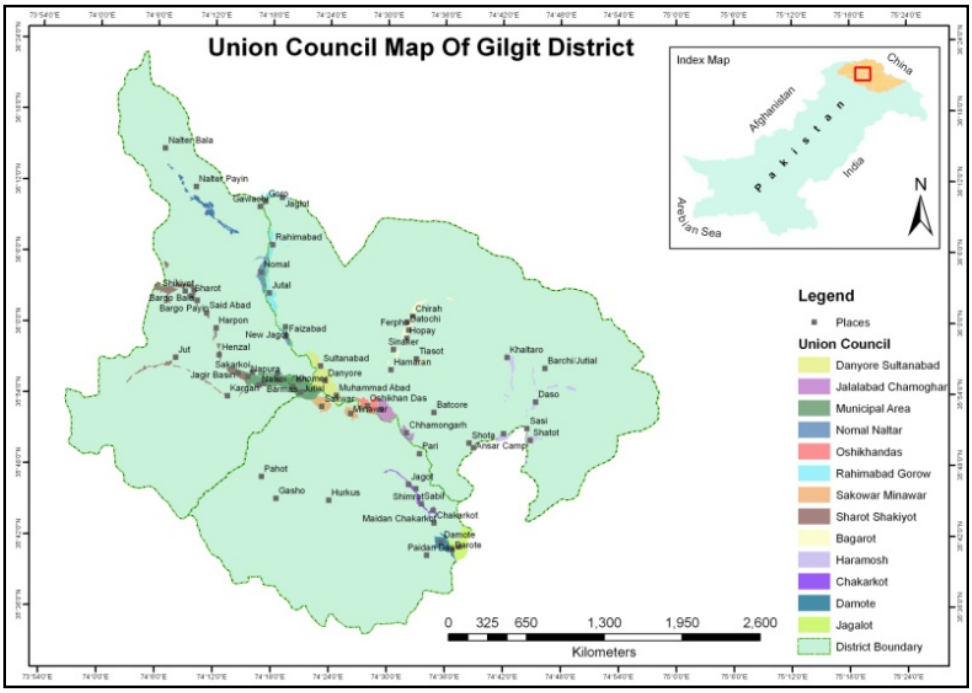

Fig.1 Union councils Map of District, Gilgit

2.2 Assessment Methods

The hazard vulnerability risk assessment (HVRA) is a step by step process that enables an HRVA committee chair, and a small working group, to complete a hazard, risk and vulnerability analysis (Provincial emergency programme, 2004) [2]. This community based HVRA was conducted in three steps, i.e., identification of hydro-metrological hazards, assessing the vulnerabilities and documented the capacities**,** community basedhazard assessment is the identification, list down and description of nature of hazards in terms of its recurrence, reasonability, location, possibility of early warning and general knowledge of the people about the hazard. It is further divided into two steps; the hazard identification and hazard analysis [22]. Agree that Hazard mapping of risk area from natural hazards and disasters are valuable information and communication tools. We used various tools such as hazard maps (developed through arc GIS 9.3), historical profile and hazard matrix to identify and assess the hazards. Coburn *et al.* (1994) [23] added as Vulnerability is the measure of how the element at risk in a geographic region would be damaged if they experience same level of hazard. Community based Vulnerability Assessment is the identification of what elements are at risk and why (refer to unsafe conditions, dynamic pressures and root causes).Vulnerabilities are future divided as physical, social, attitudinal and economic. We used hazard maps, transect walk, seasonal calendar, livelihood analysis, Venn diagram, semi structured interviews, problem tree and ranking as tools to assess the vulnerabilities with in the district. Community based Capacity Assessment is what people's coping strategies are; what resources are still available; who has access and control over these resources? Capacities are further classified into physical, social, attitudinal and economic capacities. Hazard map, historical profile, seasonal calendar, gendered resource mapping, focus group discussion, livelihood/coping analysis, institutional and social network analysis were used as tools for capacity assessment, In addition of Microsoft Excel for statistical analysis and arc GIS 9.2 for hazards mapping and other.

3. Results and Discussions

3.1 Hazard Identification

Based on the hazard maps (Fig. 2), personal observations, community response and historic profile; floods, landslides, river bank erosion and avalanches are the major hazards in the district Gilgit, associated with water and weather changes pattern. Besides these; droughts, cold spells and epidemics are some other hazards, observed and identified by the community. A brief description of each is as under.

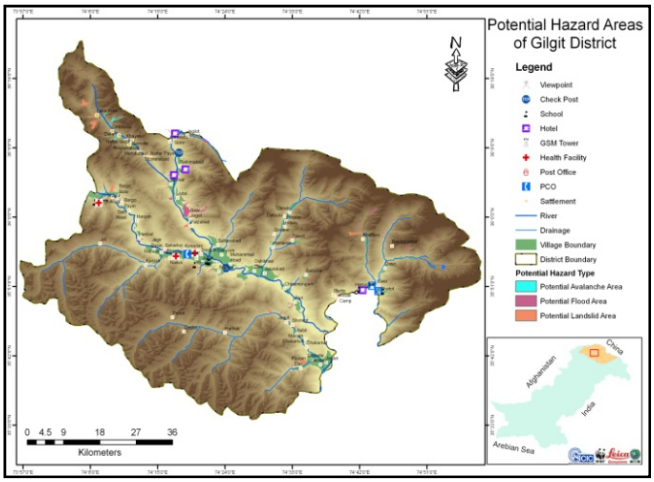

Fig.1 Hazard Map of Study Area

3.2 Floods

Floods are permanent feature of Pakistan [13-15]. Pakistan is highly vulnerable for floods and Hydro-metrological events [24]. The hazard identification and assessment process shows that flood is the major hydro-metrological hazard in the study area and is of various kinds, the cloud burst flood, flash flood, glacial lake outburst floods and the river flood. According to the historic profile, observations and geographic location of the district, heavy rain fall is the origin of such floods but river floods are mostly triggered by increased temperatures in the summer. According to the hazard map, the total settlement area of study area is 136.436 Sq.Kmout of which15.67354Sq.Kmis considered to high vulnerable for floods. Amongst the twelve union councils, the major flood area,.3846sq.kmlies between Jutal and Jagot but most vulnerable are, Sakarkoie, Konadas, Naltar, Jutial, and Jaglot Gorow. The flood Nullahs are very near to settlements and average speed on set is just 27 minutes, gives the community very little time to evacuate them-selves. As compare to above mentioned union councils, Haramosh, Sai Jaglot, charkorcot and Damot have floods but the average speed on set is one and half hou,thus causing less harm to the communities. The frequency of floods is usually 2 to 3 times a year and usually from end of June to mid August. There are 110 flood points in the whole district including Nullahs, rivers and channels. Amongst them 21 are in Sharot-Shakyot over an extended area, 16 in Municipal and 15 are in Nomal which covered less area and this cause more damage to the settlements.According to community and historical profile; sever floods over few decades were 1980, 1994, 1996 and 2010.

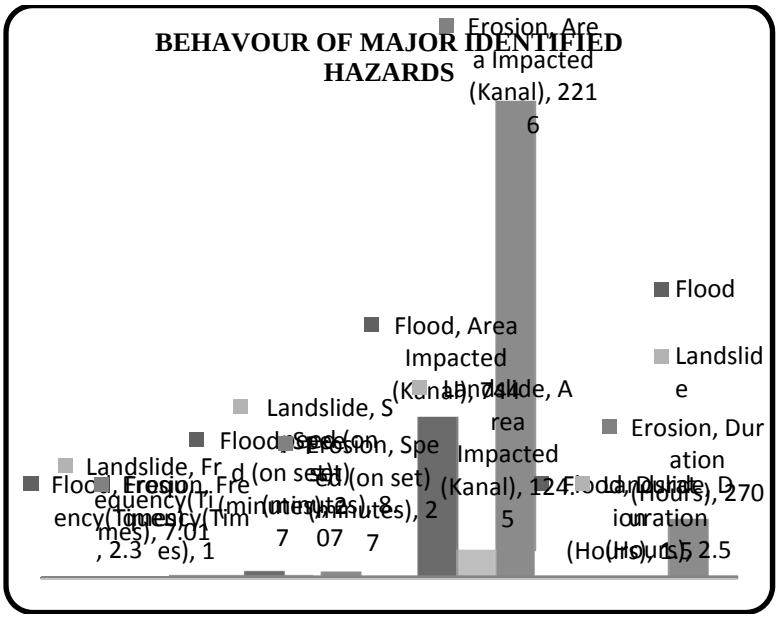

Fig.3 Behavior of Major Identified Hazards as Perceived by the Community, Historical Profile, Personal Observation and Discussions

3.3 Landslides

Landslides are among the most hazardous natural hazards. In last few decades attention has been increased to asses' landslides hazards and its spatial distribution to be described [25]. Landslides signified 4.89% of the natural disasters that impacted worldwide during years 1990 to 2005 [26]. Land sliding is the second major Hazard in the district and triggered as a secondary hazard of heavy rainfall in summer and intense snow fall in winter. According to the community observations, the average frequency is 5-6 times a year and usually stays for 1 hour. In this

duration it usually cause harm to homes especially in Sakarkoie and even to human lives in Kargha and Naltar valleys. Social forestry, agricultural land and cattle sheds are under threat of landslides in all most all the union councils. The hazard map shows 23 potential landslides points in the whole district with 4 in Sharot-Shakyot and Haramosh and 3 in each of municipal area, Bagrot and Charkorcot. The average speed on set for landslide is every short, i.e., 8.07 minutes. The landslide point in Naiko Gilgit is highly threatening as the speed on set is just 02 minutes and average duration is 1 hour and as a result of 2010 rain it caused damage to 07 houses (Muhammad Ismail from Naikoi). The landslides in Naltar and Jutial Nullah are also very potential and even can enter the homes in Naltar but in case of Jutial the speed on set is 30 minutes and the plantation on its way gets damaged but serves as barrier to reduce the harm to homes, cattle sheds and human lives (Sher Nadeer from Jutial).

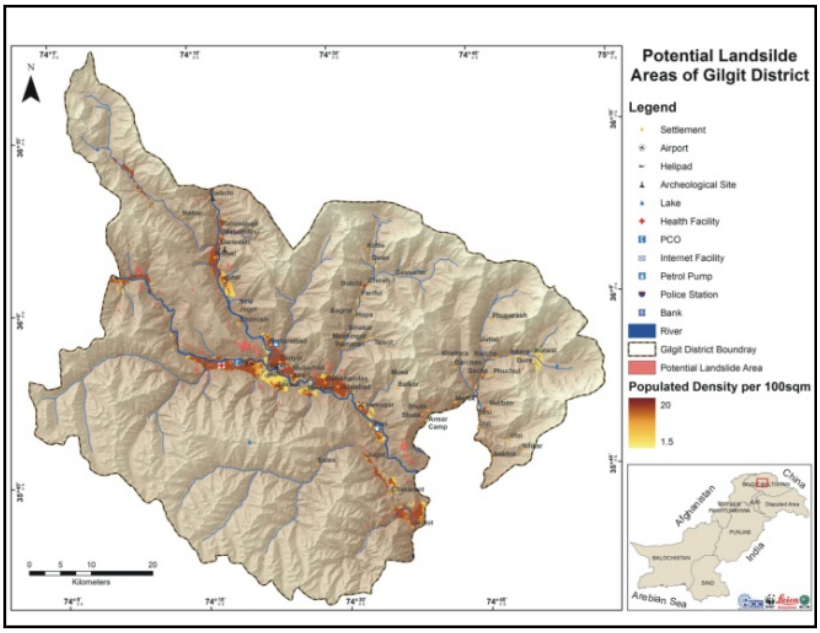

Fig.4 Potential Land Sliding Map of the Area

3.4 River Bank and Nullah Erosion

Soil erosion is serious problem of Pakistan due to deforestation, overgrazing and improper land use [27]. Lack of watershed management ultimate contribute large amount of eroded load in major rivers of the world, 13 major rivers of the world annually caring 5.8 billions tones of sediments load including Indus river which annual caring load is 435 millions tones consider as third largest sediments caring river [28]. Highest rate of erosion is recorded between Indus watershed and Terbela upstream side, it is estimate that 5, 00, 000 tones of sediments contribution per day by Indus and the dam has lost about 35% of its reservoir capacity within twenty four years. Similarly, Warsak and Khushdil Khan Reservoirs have almost silted up [29]. River bank erosion triggered as a secondary hazard of floods and increase in summer due to heavy melting of glaciers from upper Indus river basin. The erosion rate depends on volume of water and is usually very high from June- September in the study areas. An average of 2216 Kanal is ruined every year as a result of erosion especially along the banks of Shrot, Shakyot, Bargo, Thingee, Hanzal, Baseen, Sakarkoie and Konadas by the Ghizer River (Fazul-u-Rehman from Konadas). Erosion to the agricultural land is very high in Sakwar and Naltar as result of flow of Nallah water

in high volume and speed (Muhammad Tahir from Sakwar).

3.5 Avalanches

Avalanche is again a major identified hydro -metrological hazard in the district. It usually occurs in winter when there is heavy snow fall and frequency could be 5-7 times such as in Naltar. The speed on set is just few seconds to few minutes (Akbar Hussain, Naltar). According to the hazard map there are 10 avalanche points in the district with 01 in Sharot, 01 in Haramosh, 02 in Bagrot and 06 in Naltar, covering an area of 1.8601sq.km. The potential avalanches usually cause a huge damage to natural forest and cultivable land in Naltar (Garee Khan, GIS expert).

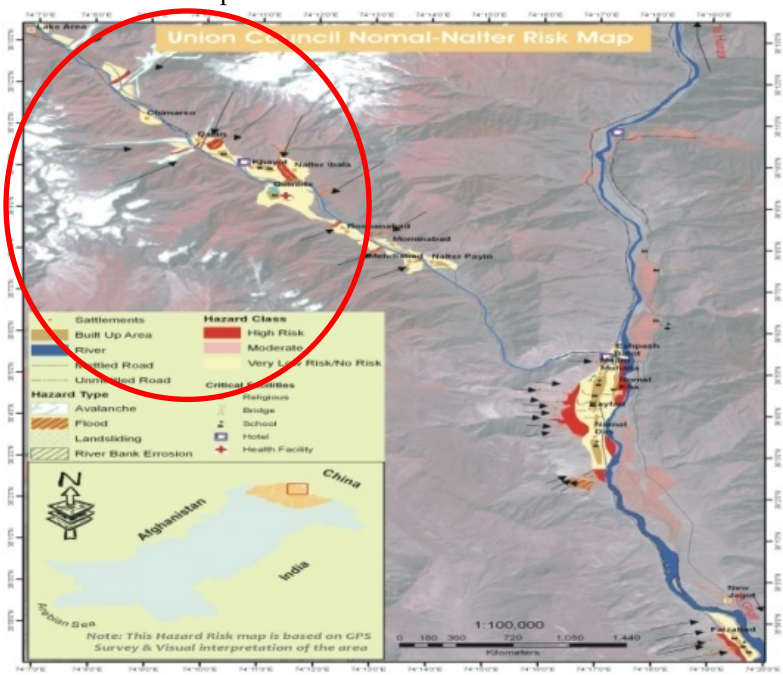

Fig.5 Avalanches Areas

3.6 Epidemics

Communities have also identified epidemics as a secondary hazard of floods and cold spells. The hazards usually occur after heavy rain fall, floods and especially in winter when the temperature reduces below normal. The diseases include gastro intestinal diseases, eye infections and skin problems (Haider Abbass from Nomal). As a result of rain, the drinking water sources such as channels in Kargha Naltar, Oshikhandas and Bagrot gets contaminated and leads to the water born diseases. In 2010 many children suffered from Diarrhea and eye infections in IDP camps in Nomal and Jutal because of unhealthy hygienic conditions and polluted water (Rasheed-u-Din, DDMA). Such diseases usually remain for one week to twenty days but get prolonged when the access to health facilities is limited or unavailable (Muhammad Ali, Haramosh).

3.7 Droughts

Today globe is facing the impacts of abrupt climatic changes like El-Nino heavy rainfalls, and conversely drought, poor crop yield and starvation in those areas which accustomed to more rains. Drought is a normal, recurrent feature of the climate although many incorrectly considered it as a rare and random event [30]. During recent past (1998-2001) Pakistan has faced one of the worst droughts of its history due to extremely low rainfall [31]. Drought is also identified as hydro- metrological hazard in the district which trigger as a result of less rain fall or no rainfall. The

frequency is usually 10-15 years and average duration is 03-04 years. The droughts usually cause damage to agricultural land thus leading to economic downfall of communities.

3.8 Vulnerability Assessment

The statement of the vulnerability is a communal circumstances, a measure of societal resistance or resilience to hazards [6, 32]. Vulnerability define as a set conditions and processes resulting from physical , social, environment and economical factors, which increase the susceptibility of a community to the impact of the hazards (ISDR, 2004). Generally, the vulnerability of a system against a certain hazard is not easily assessed. Three routes for the assessment can be distinguished as economic vulnerability, social vulnerability and cultural vulnerability [33]. There are three major dimensions of vulnerability included economic, social and ecological [11]. In this study vulnerability is classified as physical, including infrastructure; economical, mainly about the livelihood sources; ecological which covers important aspects of environment fragility, organizational and motivational. The degree of vulnerability is categorized as high, medium and low risk.

3.9 Physical Vulnerability

Social vulnerability as a complex set of properties that includes a person initial wellbeing, livelihoods and resilience, self protection, social protection and social and political networks and institutions [34]. Social vulnerability as“a multidimensional concept that help identify those properties and experience of the community (and individuals) that enable to respond and recover from natural hazards” [34]. The key critical facilities identified by the community within the district are hospitals, mosques, major water supply systems, electric supply, markets, shops, communication facilities, homes, bridges and roads. Risk to the facilities in the below graph are indicated by various colors H = High, M= medium and L = Low. It was found that almost 98% of the schools, in the selected union councils are under government system and out of which 21% are at high risk of getting damaged mostly by flood and some by landslides. Usually the schools are bit away from the flood points in all most all the union councils accept for the primary school in Kargha, 02 primary schools in Cheera Bagrot, primary school in Oshikhandas, 03 primary schools in Jaglot Gilgit,02 middle schools in Minawar-Sakwar, primary school in Naltar Paeen and primary school in Nomal. There is only one university in the district i.e the KIU but is at high risk of flood in the hunza and Gilgit River, similarly the women degree college at river view road is also at risk of high level flood in Gilgit river but the high level wall may protect the building from getting damaged (Community response and personal observations). There are 37 health units in the study area. Including 10 hospital and 27 dispensaries and out of that 03 main hospital, i.e., Aga Health Centre in Cheenar Bagh, Vision International Hospital and Kashorte hospital are at high risk of flood either in Hunza or Ghizer River. Collectively 27% are at high risk, 27% at medium and 46% are low risk. A total of 258 mosques were recorded during the survey, including few Imam Bargahs and Jamat Khanas out of which 22% are at high risk, 21% at medium and 57% are at low risk. The water supply systems include pipelines and water channels, being given by government and Aga Khan Planning and Building Services of Pakistan (AKPBSP). Out of 81 recoded systems, 54% are at high risk of floods and landslides such as 06 in Sai Jaglot, 03 main waters supply systems in Gilgit town, 06 in Datochee Bagrot, 05 in Nomal-Nalter and 05 in Jaglot Gorow. The electric supply systems include hydel power stations and the distribution lines. According to the community and past experience the distributions lines get damaged in all most all the union councils, in one or the other ways but the major hydel power stations such as the Nalter, Jaglot-Gorwo and Kargha are at high risk of floods and landslides. In 2010 flood, out of 07 hydel power

stations, 04 totally collapsed in Kargha and Nalter and Gorow power stations got damaged (Sayed Ghaieb Ali Sha, Tehsildar, Municipal Area). 84% of the recorded small shops and few markets and 72% of communication facilities mostly the landline systems are at low risk. Since the satellite based communication system is mostly in use in the whole district which could face a little or no damages as a result of the floods or landslides. According to a recent survey of BISP the total households in Gilgit-District are 23569 and the HVRA assessment recoded 18284 households in the selected union councils of the district which makes 77% of the total so out of 77%; 32% households are at high risk such as in Haramosh, Bargo, municipal area, Jaglot-Gorow, Kargha, Nomal-Nalter and Jutal. Besides this, 19% at medium and 49% are at low risk of floods and landslides. The roads are usually classified as metal, non metal and link roads and study showed total number of 109 roads out of which 33% are at high risk usually link roads but also includes the main roads such KKH, University road, Ghizer road and Kargha Road are at high risk. Alongside 25% are at medium and 42% are at low risk of floods and landslides. Since the main road are at high risk which usually seizes the life in the whole district. The bridges include suspension, small wooden bridges and the cemented bridges at the main roads. Out of 104 receded bridges 67% are at high risk which mainly includes the wooden bridges including 18 on Haramosh, 16 in Nomal-Naltar, 10 in Sai Jaglot,08 in Bargo-Shakyot and 05 main bridges in Gilgit Town and Baseen are at high risk of floods and landslides.

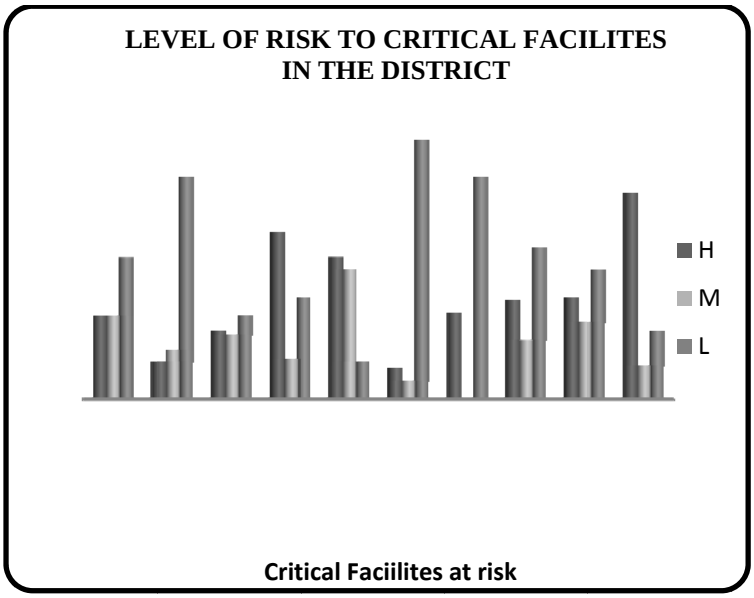

Fig.6 Level of Risk to the Critical facilities of Study Area, Blue Color Represent High Risk, Red Color Represent Medium Risk and Greenish Color Represent Low Risk

3.10 Vulnerability to Livelihood Options

Economic vulnerability admit that societies, especially large urban centers, are especially vulnerable because the destruction of important and extensive systems of communication and infrastructure is costly and can have vast consequences on economic stability [35]. The Agriculture, livestock rearing, business, tourism, jobs and labor are the various income sources in the district. The graph below shows that, agriculture is being severely affected (100%) by Hydro-metrological hazards from last few decades. An approximate calculation during the process shows an average of 2216 Kanal of agriculture land get ruined by river bank erosion only. Not only the agricultural land also the crops of wheat, potatoes, maize and corn get damage, bringing about heavy lose of income to the poor people (Ghulam Qader,Baseen). Besides

agriculture, livestock is the 2nd main source at high risk, i.e., 75%. Floods, landslides and avalanche usually kill or damage cattle sheds in Kargha, Haramosh, Naltar, Sai Jaglot and Bagrot Nullahs (Sabeer Hussain, Tehsildar). Most of the times the cattle die because of lack of fodder and diseases during floods (Abbass Shah, Bagrot having 200 goats), Since the district is headquarter of Gilgit-Baltistan region so a good portion of people are associated with business and jobs. The assessment shows that 37% of the people, associated with business gets affected during any calamity such as the floods mostly in Gilgit Town and Danyor due to blockage of roads, damage to business places and loss of electric and communication facilities. Similarly 14% of job holders and 22%, affiliated with tourism gets disturbed by the hydro metrological hazards.

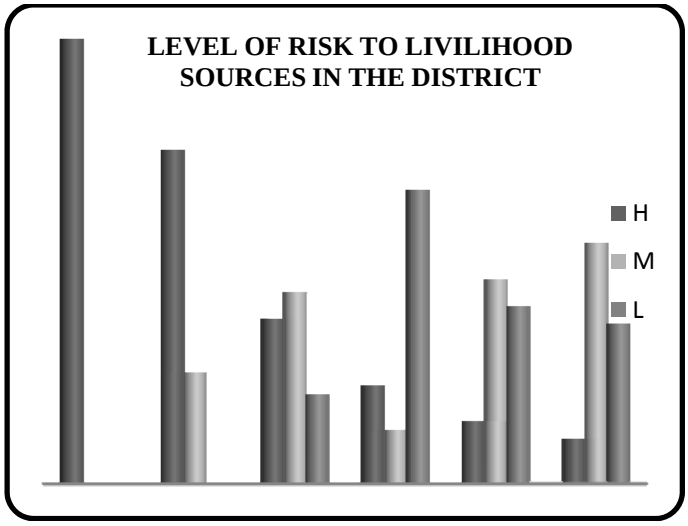

Fig.7 Level of Risk to Livelihoods Options Blue Color Represent High Risk, Red Color Represent Medium Risk and Greenish Color Represent Low Risk

3.11 Ecological Vulnerability

Ecosystem vulnerability is "the failure of an ecosystem to tolerate stressors over time and space [36]. Environmental vulnerability can be either natural or exterior, natural vulnerability is related to internal factors while external vulnerability related with external factors [37]. The key ecological assets identified by the community are; forests, wildlife, lakes, pastures, springs, rivers and medicinal plants. Amongst these main features; forests are at high risk (80%), which includes both natural and social forest. Hanuchal forest area in Haramosh is at high risk of avalanche, Sai Jaglot at high risk of cloud outburst floods and landslide, Datochee Bagrot forests at high risk because of high glacier melt in summer and cloud burst floods, Naltar forest at high risk of avalanche and flood, Kargha forest is at high risk of avalanche and Nullah flood, Forest in Danyor Nullah at high risk of avalanche and cloud outburst flood and forest in Jaglot-Gorow is at high risk of cloud burst. Social forestry in Nomal, Baseen, Thing, Chilmisdas, Gawachee is, at high risk of river and Nullah flood. According to the assessment 78% of the pastures are at risk such as 09 pasture in Nomal-Naltar, 02 in Jalalabad,03 in Datochee Bagrot,04 in Haramosh,06 in Sai Jaglot and 03 in Minawar-Sakwar are at high risk of floods and avalanche. 33% of the wildlife is at high risk usually of floods, avalanche or because of lake of fodder during a disaster. 28% of the lakes at lower elevation such as in Nomal-Naltar and lakes in Jutial Nullah are at high risk of cloud burst floods. Natural springs usually in the settlement area are at high risk of floods (70%) such 05 in Cheera Bagrot, 02 in Barmas of Muncipal area and Khol spring in Datochee Bagrot. Since Gilgit river is the main collecting Basin for

Hunza, Ghizer and Shayok river so the flood in any of these rivers also cause huge flood in Gilgit river causing dame to the river ecosystem. Out of the study areas 33% responded that the medicinal plants are at high risk such in Naltar, Kargha, Haramosh and Sai Jaglot.

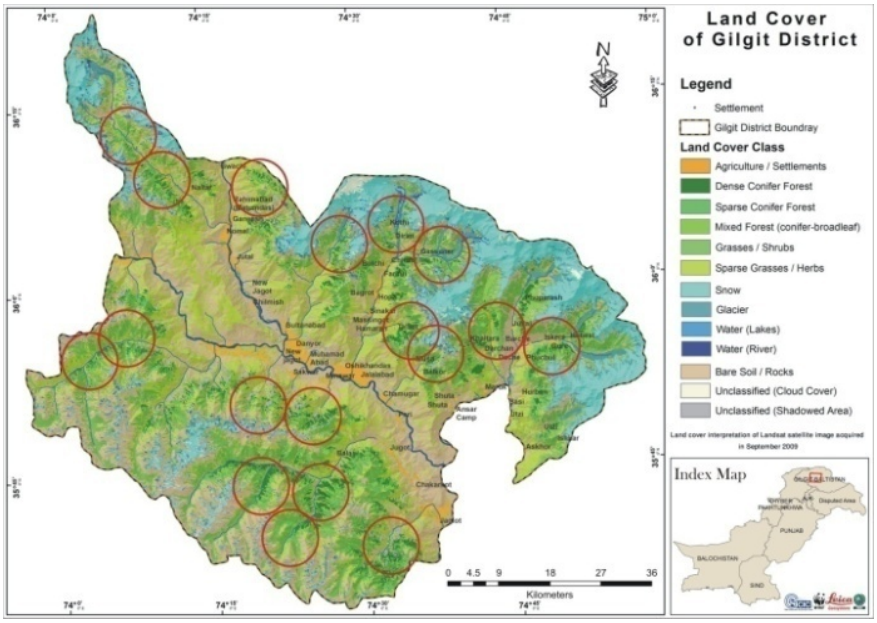

Fig. 8Vulnerable Forest Patches

3.12 Organizational Vulnerability

Vein diagram method was used to assess the organization vulnerability in the study area and it shows that Aga Khan Rural support Programmeis major player for socio economic development in few selected sites of district Gilgit. Out of 16 study sites only 05 have village emergency response teams such as Danyor, Nomal Naltar, Bagrot, Municipal Area and Jalalabad, formed by FOCUS Humanitarian assistance Pakistan and WWF-Pakistan. 05 of the study areas, i.e., Bargo, Danyor, Zulfiqarabad in Muncipal Area, Oshikhandas Das and Nomal have VOs and WOs, formed by AKRSP. Besides this Haramosh, Jalalabad and have Bagort their development and conservation committees. Community of Naltar-Nomal, Minawar-Sakwar, Kargha, Jaglot Gorow are attached with NAPWD because of the constant electric supply systems and their jobs. After the flood of 2010 most of the study areas are developing linkages with Gilgit-Baltistan disaster management authority and FOCUS-Pakistan (Rasheed, GBDMA). The overall result shows that the communities in the study area are not highly vulnerable in terms of organization but the linkages with various development and other organizations working for DRM, is bit weak

3.13 Motivational Vulnerability

Only two types of questions were asked to assess the motivational vulnerability of the people, i.e., is any kind of hydro metrological hazard a risk or opportunity for them. 99% of the respondents were of the view that, they are totally risk for them as they affect their lives and livelihoods but 1% think that, hazards are also opportunity for them. The flood of 2010 in Sakwar left fertile soil on agriculture land that could play role in agricultural productivity the next year (Muhammad Tahir, Sakwar). After the flood in 2010 a lot of poor people got free food items as a relief from FOCUS, GBDMA and UNDP, which other wide is very difficult for the communities in Kargha to store for the harsh winters. Many people have lost their kacha homes in Naltar and Kargha and they are about to get compensation for the loss and they would be able to

build new homes, more resistant to floods (Muhammad Rehman, Kargha).

3.14 Capacity Assessment

(1) Physical/Material

It was difficult to calculate the individual income, land as a property and savings in the district but collectively it was found that in every study area, the people have common areas which could be used during a difficult time. All the school buildings either government or private which are at low risk (70%), and mosques (57% at low risk) serves as collective capacities of communities to be used to keep people or other resources during a time of calamity. For example in Haramosh people responded that they have 02 Bulldozers(Government ownership),03 tractors, 25 schools,02 pologrounds,01 ten bed hospital,04 basic health unit,01 veterinary hospital and 1900 capable people; adds to the social and material capacity of people. With this example of Haramosh the other study areas such as Jutal, Danyor, Oshikhandas, Sai Jaglot, Municipal area and Bagrot have the similar resources available within the community, which can be used during a difficult time.

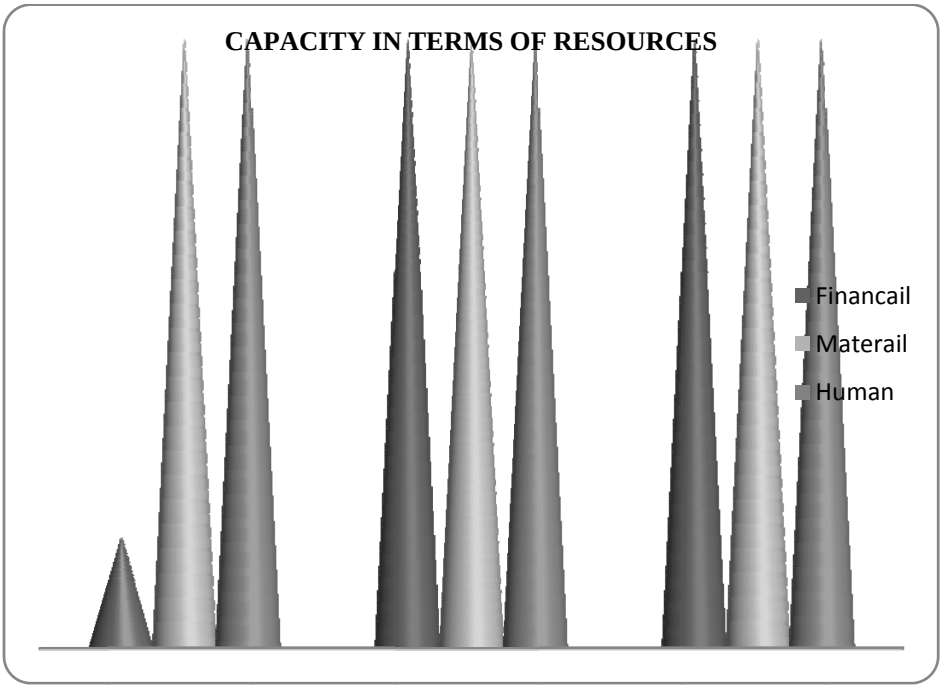

Fig.9 Resources in Terms of Capacity

(2) Social and Organizational Capacity

The study revealsthat, individually 70% of the people are poor so can not help themselves but collectively community is strong. 80 percent of the population belongs to 18-50 age group but just 10% are old age who are most vulnerable in such calamity situations. Out of 16 study sites only 05 have village emergency response teams such as Danyor, Nomal Nalter, Bagrot, Municipal Area and Jalalabad, formed by FOCUS and WWF-Pakistan. These teams have trained people and kits with basic equipments such as first aid box etc. 05 of the study areas, i.e., Bargo, Danyor, Zulfiqarabad in Municipal Area, Oshikhandas Das and Nomal, have VOs and WOS, formed by AKRSP. Besides this Haramosh, Jalalabad and have Bagrot have their development and conservation committees. During the study all the respondents (100%) said that they have various skill, indigenous knowledge, material resources and human resource available but are not unite or prepared for an emergency situation. Oshikhandas Das, Danyor, Municipal area, Bagrot, Haramosh, Jutal and Jalalabad

have Ismaili and Imamia scouts and volunteers, adding to their human capacity. Most of the communities in the study area are very attached to AKRSP,NAPWD, GB education department, GBDMA and FOUS but have weak relations with Animal Husbandry, police, AKPBSP, etc.(Veen Diagram, Annexure 2).

4. Conclusion

ThroughHVRA process, it was concluded that, flood, river bank and Nullahs erosion, land sliding and avalanches are the major hydro metrological hazards, in the district. Amongst them floods and landslides are more damaging to livelihood sources, infrastructure and to the ecological assets such as the forest. River and Nullah erosion are also main hazard but can cause more damage to agricultural land. Avalanche has a major impact on ecological assets such as forest and pastures. In terms of physical vulnerability such as infrastructure, the overall percentage is low but individually; bridges, water supply systems, electric supply systems and communication facilities are at high risk. The major electric hydel power stations at Naltar, Kargha and Gorow are at high risk it is because the source is water and this can hinder not only power supply to the homes and other facilities but impacts business, hoteling, jobs and other activities. Similarly the water supply systems such as the ones in Gilgit town, Sai Jaglot and other study areas are at high risk because the source is either spring or glacier water and the flood or land sliding in any of these locations disrupts the systems. 21% of the schools are at risk but amongst them approximately 99% of primary schools are in this category and 21% of mosques are at high risk, although the percentage is low in terms of total but most of the kids and old age people are vulnerable because children are enrolled in primary schools and old age people mostly go to the mosques. Similarly the main roads i.e. KKH, Kargha road, Naltar road and University road are at high risk of floods as they lie along the major rivers, Hunza, Ghizer and Gilgit so damage to these critical facilities disrupt the whole system of Gilgit-Baltistan region as the district is the headquarter of province. Amongst the critical facilities, forests either natural or social, is at high risk, which serves as natural barriers to minimize the risk or harm to human lives and their property, which in one way is good but if a lot of plants get uprooted, the area becomes more prone and vulnerable and also the forest ecosystem gets weak. Majority of the people consider hazards as risk for themselves, as they have a major impact on agriculture, which is the main livelihood source of people so are motivationally and economically vulnerable but with the major events such as the flood of 2010, few people have started realizing that, the hazards are an opportunity as well, especially for poor when they get compensation or loss and relief items of food and fuel. Because of the strong relationship of communities with AKRSP for socio economic development they have sense of institutional development in the form of VOs and WOs (most of which are non functional) but the platform is available and based on that FOCUS and WWF-Pakistan have formed VERT and SERT teams. Individually people are socially vulnerable as most of them are poor but collectively they have capacities such as the buildings, vehicles, oil and food depots, polo grounds, volunteers and skilled people but still they have not become unite to work for disaster preparedness and management, at community level. They communities also have indigenous knowledge of climate change risk reduction such as the local early warnings systems, food storage and local homes but with advent of modernization people are giving up the knowledge which is really important to document and use.

Acknowledgement

This research work was conducted Under Regional Climate Risk Reduction Project in Himalayas, financial supported by United Nation Development Programme Bureau of crisis Prevention and recovery and Disaster Preparedness European Commission on Humanitarian Organization and implementing partner

was World Wide fund for Nature Pakistan. The authors wish to thank World Wide Fund for Nature Pakistan, Gilgit-Baltistan supporting staff members for their kind support and help during field studies. We offer our warmest gratitude and heartiest appreciation to the communities of the district Gilgit for their contribution of the time and knowledge through participation in the consultative sessions and meetings. Special thanks to Dr. Ejaz Ahmed and Ambar Musud for their sagacious suggestions, comments and guidance throughout the endeavor.

References

[1] EmergeX Planning Inc, Hazard risk and vulnerability assessment regional district of Nanaimo(UN Published), Final Report, EmergeX Planning Inc. 1202-700 West Pender Street Vancouver, British Columbia, Canada, 2006, p. 1.

[2] Ministry of public safety and solicitor General, Provisional Emergency Programme, British Colombia Hazard, risk and vulnerability analysis tool kit, 2004, p. 2-1.

[3] Birkmann J., *Measuring Vulnerability to Natural Hazards-Towards Disaster-Resilient Societies*, UNU-Press, Tokyo, New York, 2006.

[4] Turner II B. L., Kasperson R. E. and Matson P. A. et al., A frame work for vulnerability analysis in sustainability science, in: *Proceedings of the National Academics of Sciences USA*, 2006, pp. 8074-8079.

[5] Anil K. Gupta, Sreeja S. Nair and Vinaly K. Seghgal, Hydro-metrological Disasters and climate change: Conceptual issues and a data needs for integrating adoption into environment-development framework, *e-journal Earth Science India* 2 (2009) (II) 130.

[6] Blaikie P., Cannon T., Davis I. and Wisher B., *At Risk: Natural Hazards, People's Vulnerability, and Disaster*, New York, Rout-ledge, 1994.

[7] Cutter S. L., *Vulnerability to Environment Hazards, Progress in Human Geography*, 1996a, pp. 20, 529.

[8] Cutter S. L., Societal response to environmental hazards, *int. soc. Sci. J.* 48 (1996b) 525-537.

[9] UNISDR, Terminology on reduction, accessed 23-09-2011, available online at: http://www.unisdr.org/eng/terminology/termionology-2009 -eng.html.

[10] ESPON Hazards Project 2003, The spatial effects and management of natural and technological hazards in general and in relation to climate change, Ist interim Report, March 2003.

[11] Kumpulainen S., Vulnerability concept in hazard and risk assessment: Natural and technological hazards and risks affecting the spatial development of the European regions, *Geological Survey of Finland*, special paper 42, 2006, pp. 65-74.

[12] Ahmad F., A study of glaciological and hydrological problems of Hanza Valley and River Indus between Besham and Thokot (unpublished), Filed Report, Department of Geography, University of the Punjab, Lahore, Pakistan, 1990.

[13] Dales G. F., Civilization and floods in the Indus Valley, *Expedition* 7 (1965) (4) 10-19.

[14] Snelgrove A. K., *Geohydrology of the Indus River, West Pakistan*, Sindh University Press, Hyderabad, Pakistan,1967.

[15] Ward R., *Floods: A Geographical Perspective*, The Macmillan Press Ltd., London, 1978.

[16] Ghauri M. I. K., Relation between floods and cyclones in West Pakistan, *Geografia* 2 (1963) (2) 123-126.

[17] Gazdar M. N., *Environmental Crisis in Pakistan*, The Open Press, Kuala Lumpur, 1987.

[18] Ahmad F., Kazi S. and Abbasi A. A., Evolution of drainage in the Indus Plain, *Pakistan Geogr. Rev.* 15 (1960) (2) 38-49.

[19] Karpov A. V. and Nebolsine R., West Pakistan and the Indus Valley, *Indus* 5 (1964) (1) 5-32.

[20] Ahmad F., Evolution and changes in Indus River system, in: *8th All Pakistan Geographical Conference*, 7-10 April 1996, Peshawar, Pakistan.

[21] Ali M., Atlas of northern areas, Map-1. Geography Department, Government Postgraduate College, Gilgit, 2000.

[22] Cannon T., Blaikie P., Davis I. and Wisner B., *At Risk: Natural Hazards, People's Vulnerability, and Disasters*, Rutledge, London, 1994, pp. 124-145.

[23] Coburn A. W., Sspence R. J. and Pomonis A., *Vulnerability and Risk Assessment*, Cambridge Architectural Research Limited, Cambridge, UK,1994.

[24] Ahmad F., Kazmi S. F. and Pervez T., Human response to hydro-meteorological disasters: A Case study of the 2010 flash floods in Pakistan, *Journal of Geography and Regional Planning* 4 (2011) (9) 518-524.

[25] G. Metternicht, L. Hurni and R. Gogu, Remote sensing of landslides: An analysis of the potential contribution to geo-spatial systems for hazard assessment in mountainous environments, *Remote Sensing of Environment* 98 (2005) 284, 303.

[26] D. P. Kanungo, M. K. Arora, S. Sarkar and R. P. Gupta, A comparative study of conventional, ANN black box, fuzzy and combined neural and fuzzy weighting procedures for Landslide susceptibility zonation in Darjeeling Himalayas, *Engineering Geology* 85 (2006) 347, 366.

[27] A. Nasir, Uchida Kazunori, M. Shafiq and M. Khan, Monitoring soil erosion in a mountainous watershed under high rainfall zone in Pakistan, *J. Rural Environ. Eng.* 43 (2002) 23-30.

[28] Belaud G., Khan A. K. and G. Nabi, Sediment behaviour of Sangro distributery, Mirpurkhas sub-division, Sindh, *International Irrigation Management Institute (IIMI) Report No. R-50*, 1998, p. 69.

[29] Ashraf M., Fayyaz-ul-Hassan and M. A. Khan, Sustainable environment management: Impact of agriculture, *J. Sci., Tech. Develop.* 19 (2000) (4) 51-57.

[30] Wihite D. A., *Drought Encyclopedia of Earth System Science*, Academic Press, San Diego, California, 1992, pp. 81-92.

[31] Chaudhry Q. Z., History's worst drought hit Pakistan, *Farming Outlook*, July-September 2001; Soil, Agriculture, Fertilizer & Environmental (SAFE) Foundation, Pakistan, EFB, 2002; Policy Document on Drought Preparedness and Crisis, 2001.

[32] Hewitt K., *Regions of Risk: A Geographical Introduction to Disasters*, Essex, U.K.: Longman, 1997.

[33] Pistrika A. and Tsakiris G., Flood risk assessment: A methodological framework, *Water Resource Management: New Approaches and Technological*, European Water Resources Association Chania, crete-Grece, 14-16 June, 2007.

[34] Cannon T., Twigg J. and Rowell J., Social vulnerability, sustainable livelihoods and disasters, Report to DFID Conflict and Humanitarian Assistance Department (CHAD) and Sustainable Livelihood Support Office, 2003.

[35] Comfort L., Wisner B., Cutter S., Pulwarty R., Hewitt K., Oliver-Smith A., Wiener J., Fordham M., Peacock W. and Krimgold F., Reframing disaster policy: The global evolution of vulnerable communities, *Environmental Hazards* 1 (1999) 39-44.

[36] Williams L. and Kaputska L., Ecosystem vulnerability: A complex interface with technical components, *Environmental Toxicology and Chemistry* 19 (2000) (4) 1055-1058.