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Research Paper

Flood Risk and Flood Management Regional Model Of Climate Change In Sistan and Balochestan (Makoran) South East, Iran

Mohammad Anwar Zainudini [*1]
[*1] *Department of Oceanography, Faculty of Marine Sciences, Chabahar Maritime University, Iran*

ABSTRACT:
A holistic perspective on changing rainfall-driven flood risk is provided for the late 20th and early 21st centuries. Economic losses from floods have greatly increased, principally driven by the expanding exposure of assets at risk. It has not been possible to attribute rain-generated peak stream flow trends to anthropogenic climate change over the past several decades. Projected increases in the frequency and intensity of heavy rainfall, based on climate models, should contribute to increases in precipitation-generated local flooding (e.g. flash flooding and urban flooding). Flood is a recurring calamity in Iran. Every other year, it destroys infrastructure and claims hundreds of lives. Thousands of people have become the victim of floods in Iran. It is difficult for developing countries like Iran to control and curb the menace of flood.
Flooding is the most devastating natural hazard in Iran and the recent flooding has demonstrated its severeness. Floods are common throughout the country. However, their characteristics differ from region to region. Flooding behavior of the major basins and flood management at the national level are investigated in this article. Monsoon rainfalls are the main source of floods in the Malooran River (Fanooj), while Mediterranean Waves and Cyclones, which are generated over the Arabian Sea, induce flooding in the Sarbaz River and the Makran Coastal Area. Fluvial floods in the Malooran Basin have caused major economic losses. Mainstreaming disaster risk reduction in the areas of water, sanitation, health, shelter and livelihoods can enhance community resilience to future disasters by providing stronger shelter, water and sanitation structures which can withstand floods better; and increasing people's assets and knowledge.
KEYWORDS: *Flooding, Disaster, Risk, mitigation, planning, management.*

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I. INTRODUCTION

The Special Report on "Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation" of the Intergovernmental Panel on Climate Change (IPCC), here abbreviated to SREX report [1], critically assessed the recent scientific literature on climate change and the impacts from extreme events. The report was the product of a multi-national and multi-disciplinary authorship from Working Groups I and II of the IPCC, assisted by a large pool of academic and government experts involved in the multi-stage review process. A very wide range of information, opinions and hypotheses were assessed and a prioritization of topics established, with respect to their importance, likelihood and confidence.

Flood is a recurring calamity in Iran. Every other year, it destroys infrastructure and claims hundreds of lives. Thousands of people have become the victim of floods in Iran. It is difficult for developing countries like Iran to control and curb the menace of flood.

Settlements in hazard-prone areas have been growing rapidly since 1950s [1]. For the earning reasons, people move towards flood plains and make vulnerable safety with dykes [2]. The increasing disaster-loss is also because of human choice to settle and live in flood-prone areas and this ratio is observed more in developing countries where the fragile economies become even feebler afterwards [3]. Environmental change which is leading towards rising of the level of the sea and severe weather conditions in the result of global warming and trends towards urbanization in developing countries are key factors of flood disaster. The ratio will even pick the pace up by next 50 years [4].

Geographically, the position of Iran full of natural threats [5]. According to its physical features that comprise mountains and flood plains, Iran faces huge threats of all the kinds of disasters. Among all the types of natural disasters in Iran, flood contributes its disastrous effects up to ninety percent [6]. Iran has been counting financial and economic loss as a result of flood devastation. Many observers are of the view that recurring floods are also one of the causes of depreciating economy. Flood is known as a natural hazard which is difficult to control in Iran. Regions with different features have been exposed to various natural catastrophes with striking visibility and impacts particularly during past decade. The boosting amount can be ascribed to hydro-meteorological phenomena and climate change. The increasing ratio and severity of the natural disasters have been seen during the 21st century that is smashing social, economic and physical infrastructure. None of the plane-settled regions are secure from flooding in Iran [7].

II. METHODOLOGY

Using PRISMA methodology [8] of literature review, 24 articles were retrieved using Pub med and Google Scholar databases and country level reports on 2016 Iran Floods. 14 articles were included in the initial review. 10 articles were excluded from the review after reading the whole content because they did not match the objectives of the literature review and the inclusion criteria. A total of 14 articles were included in the review including two national reports. (Figures 1 and 2). Key words used to search the articles are: Iran and floods, impact of Iran floods, disasters in Iran, monsoon rains in Iran, Disaster management Policies in Iran, NDMA, Poverty and floods, Disaster profile of Iran. Database searches were performed during November-December 2016 to retrieve the articles related to Flood-Disasters in Iran. Inclusion Criteria: Studies from 2001 to 2016 were retrieved on Floods in Iran. All the Government sites responding to flood response were also included in the review. Exclusion Criteria: Studies focusing majorly on earthquakes in Iran or any other natural calamity during 2001 to 2016. Though the articles published in the last 15 years were of prime concern initially but data from a few older articles were also extracted in order to give meaning to the paper [9].

Figure 1: Study area of Makoran (Sistan and Balochestan) region under flash flood 2016 in Southern Iran

III. FLOOD MITIGATION ACTIVITIES

Flood mitigation activities do occur annually in Iran under the auspices of the FFC and the provincial irrigation departments. These departments plan, design, construct, and maintain flood protection works through flow measurement at specific sites on rivers, canals, and construction, and maintenance of flood protection irrigation channels, small dams and protective works [10].

However, there is no easily available master plan linked to a national hazard and vulnerability atlas which could highlight the main points of vulnerability throughout the country and help in analyzing whether these departments are focused on the most crucial points of vulnerability and how effectively and efficiently they are addressing them [11]. In addition, reduction of mitigation is a serious issue in Iran due to the construction of large-scale development project without adequate analysis of their impact on disaster risks. [12] Thus, communities view several large-scale projects as having increased their vulnerability, e.g., the World Bank-funded Left Bank Outfall Drainage Project (LBOD), is viewed as having blocked most of the natural rainwater flow. [13] People feel that it is important that the government re-opens all these flows so that access rainwater would drain its self out. Such projects are altering delicate ecological balance, enhancing environmental degradation, exacerbating conflicts over resources and enhancing power inequities within the country [14]. Therefore, flash flood disasters occurred in Sistan and Balochestan regions on cities on 2016 which is illustrated in figure number 2.

Figure 2: River Damen Overtopped levee at District Iranshar (Makoran) during flash flood 2016

IV. FLOOD DISASTER RISK REDUCTION PREVENTION AND MITIGATION

Flood control refers to all methods used to reduce or prevent the detrimental effects of flood water. Some of the common techniques used for flood control are installation of rock berms, rock rip-raps, sandbags, maintaining normal slopes with vegetation or application of soil cements on steeper slopes and construction or expansion of drainage channels. Other methods include levees, dikes, dams, retention or detention basins. After the flood disaster that happened in 2009, some areas prefer not to have levees as flood controls. Communities preferred improvement of drainage structures with detention basins near the sites [15].

Although individual flood events cannot be linked with certainty to climate change, a rise in global floods is increasingly seen as a partial factor to global climate changes. As such, a reduction in their frequency will require international coordination by all countries. [16] Given its high vulnerability to floods, Iran (Makoran) must play an active and meaningful role in global climate change negotiations and increase its contribution. The government of Iran had set up a Climate Change Ministry in 2010 and the NDMA has been merged into it recently. [17] However, the ministry is too new at the moment to have taken any major steps to deal with climate change. The high degree of deforestation that has occurred throughout Iran is also contributing to increased occurrence of floods. Extensive deforestation in the upland catchment area for timber and fuel wood reduces the water-retention capacity of the forest eco-systems. This can increase surface water runoff and soil erosion, increasing the quantity, velocity and sediment load of the headwaters entering the river system. In turn this causes repeated landslides, damages riverine infrastructure and results in further siltation of the downstream water channels. While some small-scale reforestation programs exist, major steps are needed to reverse the deforestation. [18] Another major factor undermining people's strength is the social structure in rural Iran since resources are controlled by local elites, such as landlords and tribal leaders. Land ownership is heavily concentrated in Iran and poor communities are often pushed into cultivating marginal land, which is less productive and also located in areas more vulnerable to disasters. [19] During the 2010 floods, there were numerous complaints against landlords and government officials conspiring to divert floods away from the lands of rural elites and towards their lands.

V. DISASTER PREPAREDNESS AVOIDANCE AND RESPONSE

The level of preparedness for floods in Iran is higher than for other natural hazards. The Ministry of the Interior through the National Crisis Management Cell round-the-clock monitors emergencies. It coordinates with the provincial Crisis Management Cells and all other security agencies to provide information for any emergency situation. However, in practice, these institutions require more effective capacity for dealing with large- scale disasters as evident during the 2003 earthquake and 2010 floods. Practically, only the Iran Army, because of its superior communications, transportation facilities, and skilled human resources, has a high degree of effective relocation, rescue and immediate response capacity. The DDMAs, which are the main implementation focal points during emergencies, mentioned their dependence on the army and NGOs for disaster response purposes. Most District authorities currently lack the capacity to implement the plans in even medium scale emergencies [20].

Flooding has many impacts. It damages property and endangers the lives of humans and other species. Rapid water runoff causes soil erosion and concomitant sediment deposition elsewhere (such as further downstream). The spawning grounds for fish and other wildlife habitats can become polluted or completely destroyed. Some prolonged high floods can delay traffic in areas which lack elevated roadways. Floods can interfere with drainage and economic use of lands, such as interfering with farming. Structural damage can occur in bridge abutments, bank lines, sewer lines, and other structures within floodways. Waterway navigation and hydroelectric power are often impaired. Financial losses due to floods are typically millions of dollars each year [21].

VI. RIGHT BASED APPROACH ON DISASTER MANAGEMENT

To develop a rights-based, constitutionally-mandated perspective on disaster management, it would be useful to link Iran constitution ACT, which requires the government to safeguard and protect the lives and properties of all citizens. A more participatory and consultative approach in developing the Act would also be helpful. Iran current socio-economic development path has created disaster risk by increasing people's exposure to extreme flooding during heavy monsoon rains [22]. To prevent future catastrophic floods a fundamental change in the country's development path is needed that decouples exposure and vulnerability from economic growth and is more in harmony with the functioning, capacities and thresholds of the natural environment [23]. It is apparent the catastrophic flooding in Iran was far from "natural" or an "act of God" The catastrophic flooding in the country could have been curtailed with the benefit of hindsight and given the optimum management of its political, social and economic spheres by the government. [24] In this respect adopting a risk management approach in the post-disaster recovery offers a unique opportunity to build a safer more resilient society that provides for the basic protection and wellbeing of its citizens; [25] in the short term the increased sense of awareness and interest for disaster risk reduction can provide the impetus to raise levels of disaster preparedness through developing forecasting, early warning and evacuation systems. In the longer term, the greatest opportunities to prevent future disasters lies in harmonizing actions on disaster risk reduction, climate change (mitigation and adaptation) and livelihood resilience to address the "underlying drivers" that configure risk in the first place [26].

VII. FACTORS CONTRIBUTING TO FLOODING PROPENSITY

Flooding propensity in an area can vary greatly with a change in the: (a) amount of runoff that results from precipitation in a watershed, (b) water carrying capacity of a drainage basin, and (c) change in land elevations with respect to riverbeds and sea level [27]. An increase in runoff component of the hydrologic cycle in a watershed, a decrease in water carrying capacity of a drainage system, and a decrease in land elevations will increase flooding propensity in an area. Therefore, the flooding problem and the solutions to such problems can (or should) be analyzed in the context of these three fundamental parameters: runoff, water carrying capacity, and land elevations. We need to analyze land use practices in watersheds during the last few decades that have potentials to impact hydrodynamic behaviors of rivers, affecting three vital parameters mentioned above [28].

VIII. RIVERBED AGGRADATION:

Riverbed aggradation is most pronounced for the Mashkid and Sarbaz rivers its distributaries. From the border with Pakistan to the point where the Mashkid meets the Kich River, the riverbed has aggraded as much as 5-7 meters in recent years [29].

According to a study done by water resources department [30], the average width of the Sarbaz river has decreased from 1.27 km in 1998 to 1.01 km in 2003. Riverbed aggradation is so pronounced in Balochestan that changes in riverbed level can be observed during one's

lifetime. For example, the Old Sistan and Balochestan Rivers were navigable for steamers only about 30 years ago, and is presently an abandoned channel. This situation is true for many other distributaries of the Sarbaz and Fanooj Rivers, such as the Kajoo, Damen, Bampour, Rivers, etc. Riverbed aggradation reduces the water carrying capacity of rivers,

causing bank overflow. This recent increase in riverbed levels must have contributed to the increased flooding propensity in Iran [31].

Soil erosion: Ploughing makes the land surface more susceptible to soil erosion. Surface run-off can easily wash away the topsoil from cultivated lands. This surface erosion reduces land elevations, which in turn increase flood intensity in an area. According to the Report of the Task Forces (RTF) on Iran Development Strategies for the 1990s [32], soil erosion is a serious problem in many parts of Iran. Hilly areas in Balochestan, Makoran, and Sarbaz Hill Tract districts are more susceptible to soil erosion. About 55% of Iranshar Hill Tract area is highly susceptible to soil erosion (16). Heavy monsoon shower removes the surface soil through runoff. Parts of eroded sediments are deposited on the riverbeds, reducing the water carrying capacity and increasing flooding propensity in a watershed [33]. Soil erosion also reduces land elevations and increases elevations of riverbeds, contributing to increased flood depths. The land elevations in other parts of Iran must have been reduced over time due to soil erosion. A side from this, the tilling on the mountain slopes of the Sarbaz is thought to be responsible for massive soil erosion in Iran (21, 22, 23), which eventually causes rapid riverbed aggradation in Makoran [34]. Moreover, construction sites in cities can contribute to soil erosion if silt fences or retention ponds are not employed properly [35]. In Iran, no such measures are in practice at construction sites.

Deforestation in the upstream region: A rapid increase in population in the Iran Subcontinent over the course of the 20th century has resulted in an acceleration of deforestation in the hills of Sarbaz to meet the increasing demands for food and fuel wood [26]. Deforestation of steep slopes is assumed to lead to accelerated soil erosion and landslides during monsoon precipitation, which in turn is believed to contribute to devastating floods in the downstream regions such as in Iran. Deforestation within Iran also contributes to the soil erosion. The amount of forest cover in Iran has been reduced from 15.6% in 1983 to 14.6% in 1985-86, and eventually to13.4% in 1997 (16).). A minimum of 25% forest cover is suggested for a healthy ecosystem. The amount of forest cover in Iran at the present time believed to be less than 10% [39].

Local relative sea-level rise: The ultimate destination of all rivers is the ocean. The land elevations are measured with respect to the sea level in an area. Therefore, any change in the sea level causes land elevations to change as well. At the present time the sea level is rising globally [36]. If the sea-level rises in an area at rates faster than the rates of land

IX. RESULTS AND DISCUSSION

Then, the significant of the figures illustrated for different wet months shown the rate of flow for the region under study and a good translation lagging behind river Kajoo during entire periods of the year 1983. In the light of the storms and flood yearly maximum the calibration of river Sarbaz basically illustrated during year of 1983- 2016 has been tested by computer the peak discharge was 4580 m^3 /sec, for the 1986 was tested 256 m^3 / sec, for the 2010 peak discharge has been tested by excel was 1504 m^3 / sec where as for the same river on the month of April suddenly rate of flow dropped to 4 m^3 / sec even though for other months during summer rate of flow for Kajoo river is completely drought or nil discharge accordingly to the dry months when there is no rainfall in Makoran region, this is the link between rainfall and storm characteristics and its effect on monthly maximum discharge have been dealt with in the past also the storms characteristics mainly considered were the storm pattern, might be speed and direction of rainstorm moving in the downstream direction produces a higher peak flow than storms moving upstream which can be concluded that storms moving at the same speed as the stream velocity have more impact on peak discharge than rapidly moving storms [34]. Thus peak discharges are shown during flash flood which is illustrated in figures number 3 to 5.

The flow data was obtained from 1983 to 2016 has been tested by computer excel program the peak discharge was ranging from 4580 m^3/sec the same river on the month of April suddenly rate of flow dropped to 4 m^3/sec even though for other months during summer rate of flow for Kajoo rivers are completely drought or nil discharge according to the dry months when there is no rainfall at all in Makoran region [37].

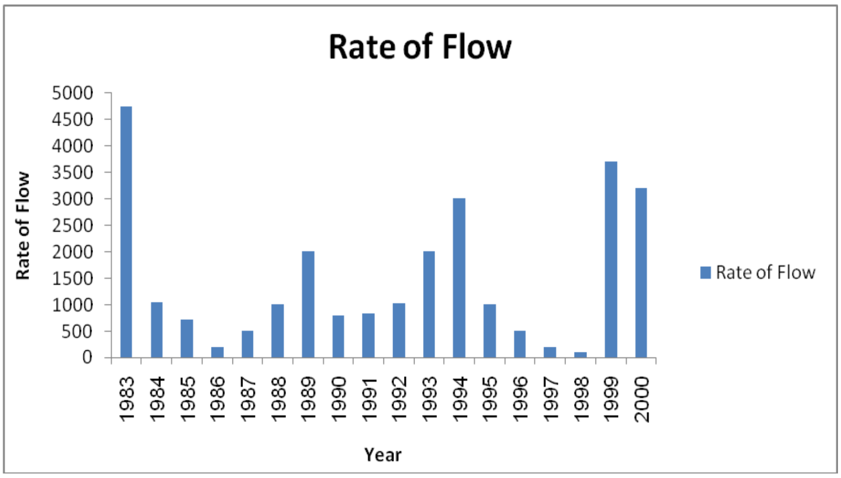


Figure3: Maximum Rate of flow of River Fanooj from 1983 to 2000

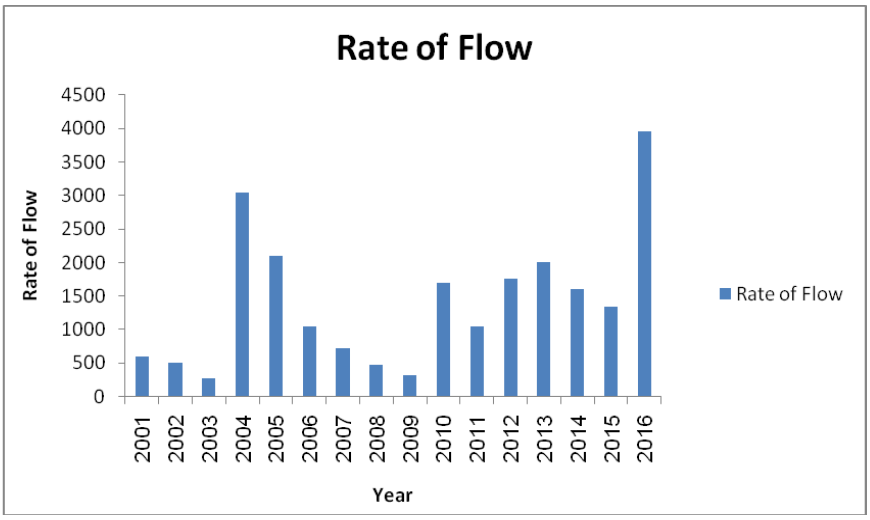


Figure 4: Maximum Rate of Flow of River Fanooj from 2001 to 2016

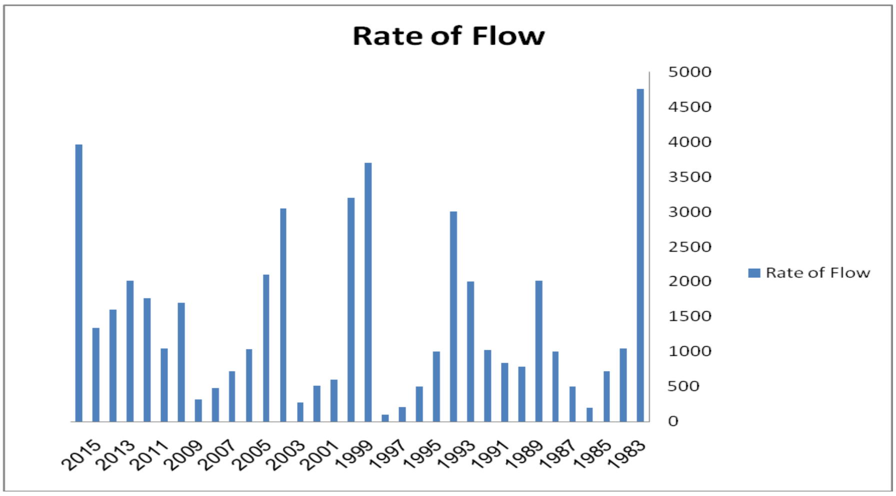
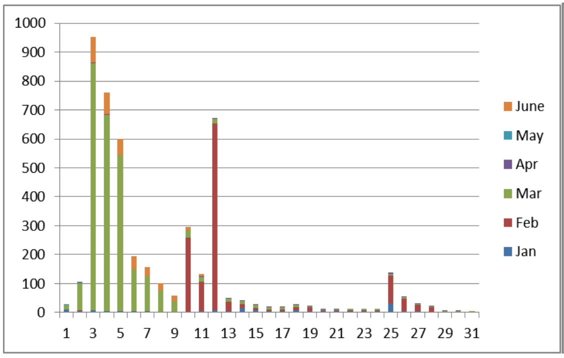


Figure 5: Maximum Rate of Flow from 1983 to 2016

Therefore, the significant of the figures illustrated for different wet months shown the rate of flow for the region under study and a good translation lagging behind river Kajoo during entire periods of the year 2012. In the light of the storms and flood monthly maximum the calibration of river Kajoo basically illustrated during month of December 2012 has been tested by computer the peak discharge was 4580 m^3 /sec, for the February 2012 was tested 256 m^3 / sec, for the March peak discharge has been tested by excel was 854 m^3 / sec where as for the same river on the month of April suddenly rate of flow dropped to 4 m^3 / sec even though for other months during summer rate of flow for Kajoo river is completely drought or nil discharge accordingly to the dry months when there is no rainfall in Makoran region, this is the link between rainfall and storm characteristics and its effect on monthly maximum discharge have been dealt with in the past also the storms characteristics mainly considered were the storm pattern, might be speed and direction of rainstorm moving in the downstream direction produces a higher peak flow than storms moving upstream which can be concluded that storms moving at the same speed as the stream velocity have more impact on peak discharge than rapidly moving storms. Thus peak discharges are shown during flash flood which is illustrated in figures number 3 and 4 [38].



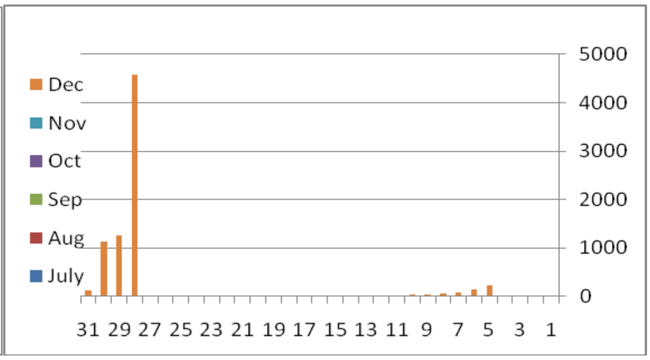


Figure 3: Monthly Maximum Peak Discharge m^3/s (test 1) From Jan. To June

Figure 4: Monthly Maximum Peak Discharge 4580 m^3/s (Test2) from July to December

Analysis of historic data shows that the magnitude, intensity, and duration of floods have increased in Makoran during the last few decades. It also appears that most of the flood control embankments experienced breaching since their completion, and are not very effective in reducing the damage to the environment, economy, and property. It is argued that solutions to flooding problems require an understanding of the long-term factors that contribute to increased floods, which include: unplanned urbanization, soil erosion, local relative sea-level rise, inadequate sediment accumulation, subsidence and compaction of land, riverbed aggradation, and deforestation. To mitigate flooding propensity in Southern Balochestan, both the government and people will have to adopt water- shed scale best management practices (BMPs) – a series of activities designed to: (a) reduce the run-off, (b) increase the carrying capacity of drainage system, and (c) increase land elevations. Proposed BMPs are: floodplain zoning, planned urbanization, restoration of abundant channels, dredging of rivers and streams, increased elevations of roads and village platforms, building of efficient storm sewer systems, establishment of buffer zones along rivers, conservation tillage, controlled runoff near construction sites, adjustment of life-style and crop patterns, good governance, and improvement on flood warning/preparedness systems [39].

X. CONCLUSION

Iran is a developing country and does not have the resources to be able to cope with and recover from numerous large-scale disasters. It needs to take steps to reduce exposure and vulnerability, to mitigate the impact of disasters, and prepare for these so it can respond effectively when they occur. In other words, it needs to strengthen its disaster risk management.

While Iran has set up the DRR governance system, it needs greater funding, political will, and coordination to work more effectively. Most of the focus is on avoidance and response, the least sustainable form of DRR and even these activities are not highly efficient or effective. Mainstreamed DRR work in the areas of water, sanitation, health, shelter and livelihoods can enhance community resilience to future disasters by providing stronger shelter, water and sanitation structures which can withstand floods better; and increasing people's assets and knowledge.

Formulating solutions to flooding problems requires a comprehensive understanding of the geologic settings of the region, and a better knowledge of hydrodynamic processes that are active in watersheds. Only solutions that take into account the underlying long-term factors contributing to flooding problems can prevail. Such contributing factors are as follows: unplanned urbanization, soil erosion, local relative sea-level rise, inadequate sediment accumulation, subsidence and compaction of sediments, riverbed aggradation, and deforestation.

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