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Analysis of River Damen Rate of flow and Rainfall Data for Flood Management from Makoran Iranshahr in the South East Iran

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Abstract - This research shows a simple and cost effective way to use remote sensing & geographical information system for creating flood management plan from the available rainfall and river flow data base. It is acknowledged that accuracy of the key information, past records of flooding, depends upon the scale of the rainfall data that represents them. Although flooding is a natural phenomenon we cannot completely stop it but we can minimize its adverse effects by better planning & management system. Flood proofing of new and existing structures, flood peak values are required in the design of bridges, culvert waterways, spillways for dams, and estimation of scour at a hydraulic structure. When a flood wave passes through a reservoir its peak is attenuated, and the time base is enlarged due to effect of storage. Modification in the hydrograph is studied through flood routing. Flood routing is the technique of determining the flood hydrograph at a section of a river by utilising the data of flood flow at one or more upstream sections. Advances in the field of artificial intelligence (AI) offer opportunities for utilising new algorithms and models. Recent years have seen an increase in the intensity of extreme rainfalls and the frequency of floods caused by climate change. As a result, South Iran (Sistan and Balochestan province) is facing an ever-increasing risk of flooding due to monsoon and typhoons in the summer season. Any new construction permitted in the flood plain should be flood proofed to reduce future damages. Building codes can be developed that minimize flood damages by ensuring that beneficial uses of buildings are located above the design flood elevation.

Kewords: Flood, Intensity, Hydrology, Management, Rainfall and River.

1. Introduction

This paper describes flood risk management system applied in Iranshar District in the Makoran area. The area of the study is near the border of Iran and Pakistan, extending south to the Gulf of Oman shown in figure 1. The climate of the region varies from subtropical arid and semi-arid to temperate sub-humid in the plains of Sistan & Balochistan. , thus location up on which this study concentrates is bounded by the coastline of southern Iran and Western of Pakistan, approximately, by the line of latitude 250 to the South and the line of longitude 600 to the west. The area consists of an inland chain of steeply sloping bare rock (mountains) which drain onto a coastal alluvial plain, in this areas Damen and Iranshar channels are indistinct and are often considered at times of high flow.The occurrence of flash flooding is of concern in hydrologic and natural hazards science due to the top ranking of such events among natural disasters in terms of both the number of people affected globally and the proportion of individual fatalities. According to flood damaging 20% of the flood-related casualties occurred in Sistan And Balochestan in the period 1950–2010 are due to flash floods. The potential for flash flood casualties and damages is also increasing in many regions due to the social and economic development bringing pressure on land use. Furthermore, evidence of increasing heavy precipitation at sub-continental and global scales supports the view that the global hydrological cycle is intensifying as the planet warms. As a consequence, the flash flood hazard is expected to increase in frequency and severity in many areas, through the impacts of global change on climate, storm–weather systems and river discharge conditions [12, 13, 5].While natural disasters cannot be prevented, measures need to be taken to reduce the extent of damage, especially in a vast country like Iran with a huge population base and scarce facilities. Proper physical planning is an important tool, which one should utilize to regulate urban development as per the extent of damage anticipated. The article is a brief account of a study done on the city of Iranshar, in Makoran, a flood-affected city of Iran, where strategies were developed to link the process of urban planning to the risk and damage of flooding in the area [15].

The general public had little influence on flood management, though public opinion in affected areas fell decidedly against risk acceptance. The bund system of flood management was carried forward after independence [1]. It is important that new developments, particularly in the higher flood risk zones, are future proofed against uncertainty. Therefore it is advised that proposed flood mitigation measures associated with developments are reviewed at the detailed. The aim of this research is threefold: (i) to summarise the data from an archive of selected extreme flash flood events occurred in Makoran the period from 2005 to 2010, together with background climatic and hydrological information, (ii) to characterise these events in terms of basins morphology, flood-generating rainfall, peak discharges, runoff coefficient and response time, and (iii) to use the insight gained with this analysis to identify implications for flash flood risk management [2, 3]

Figure1. Study Area Iranshar in Makoran Sistan and Balochestan province, Iran.

2. Studies on flash flood characteristic across Makoran Iranshar

Observational difficulties of flash floods, barriers in hydro-meteorological data transfer and lack of a comprehensive archive of flood events across Makoran hinder the development of a coherent framework for analysis of flood climatology, hazard and vulnerability at the District Iranshar Makoran scale. Among the few studies with a sub-continental view,[3] reports a catalogue of the major flood events from 1950 to 2010 in the Makoran Region. In his study, characterised major floods in terms of casualties and direct damages ten out of the 25 events listed in the catalogue are classified as flash floods, and are mainly localised in Iran, Pakistan and India and some parts of Turkey. Flash flood events are also reported in Muscat and Bangladesh. In spite of the smaller areas impacted by these events, flash floods caused 3764 fatalities (i.e., 92 casualties per year in average), making 20% of the overall casualties reported in the study, largely exceeding river floods (18%), and being second only to storm-surge floods (22%). It is worth noting that fatalities due to storm–surge floods concentrate into three large events which occurred from 1953 to 1983 on coastal regions of Makoran, whereas flash floods occurred over the whole considered period in a number of Makoran regions [2].

The present work builds upon the investigation, by examining more closely the control of watershed physiography and channel network geometry on flood response, and extending the analysis to the runoff coefficient and the response time. Because of the requirement of high-resolution data, in particular spatially-distributed rainfall, I used only a portion of the events considered, and several cases, especially from Sistan region, were not included in this study [14].

Analysis the differences in the long-term regimes of extreme precipitation and floods across the Makoran range (from Iranshar to Chabahar) using seasonality indices and atmospheric circulation patterns to understand the main flood-producing processes. The analysis was supported by cluster analyses to identify areas of similar flood processes, both in terms of precipitation forcing and catchment processes. The results allowed isolating regions of similar flood generation processes including southerly versus westerly circulation patterns, effects of soil moisture seasonality due to evaporation and effects of soil moisture seasonality due to climate [3].

3. Materials and Methodology

The aim of the data collection methodology was threefold: (i) to identify extreme flash flood events representative of different hydroclimatic Makoran regions, (ii) to collect high-resolution data enabling the characterisation of the flood response for each event (in terms of response time), initial soil moisture status and climate, and (iii) to collect data for the characterisation of the morphological properties of the catchments, land use, soil properties and geology. These requirements led to focus on events with a high-resolution data coverage, and in particular with the availability of weather radar observations permitting rainfall estimation with fine spatial and temporal resolution and of discharge data from stream gauge stations and/or post-flood analysis . As a consequence, attention was focused on events occurred since mid 1990s in Makoran regions covered by weather radar systems. The preliminary identification of flash floods benefited from the collection of primary data on flash floods described by. The three steps of the methodology used for the set up of the archive are described in the following sections [4, 14,].

The flow data was obtained from year 2005, 2007 and 2010 of 12 months from January to December has been tested by computer excel program the peak discharge on December 2005 during flash flood was ranging from 4025 m^3/sec, Feb. 2005 discharge was 632 m^3/s and March 2005 discharge was 523 m^3/s the same river on the month of April suddenly rate of flow dropped to 5-10 m^3/sec even though for other months during summer rate of flow for Damen and Bampor rivers are completely drought or nil discharge according to the dry months when there is no rainfall at all in Makoran region [11].

Flood risk management can be defined as the continuous and holistic societal analysis, assessment and mitigation of flood risk. Traditionally, fluvial flood risk reduction has been concentrated on river training, construction of embankments and retention by reservoirs. Such measures, also called flood control strategies, aim at reducing the flood hazard, i.e. the probability of flooding. Attempts to decrease vulnerability, i.e. the other aspect of risk, have been of minor importance. Meanwhile, it is well recognized that structural flood control alone does not solve the flood problem. For example, discusses the dominant reliance of historical flood mitigation on dikes in the Iranshar, and comments this as an “undying love affair” with dikes. He points to the so-called levee-effect: once a levee has been constructed, the structure may generate a false sense of security, leading to greater development in the dike hinterland and reduced flood awareness and precaution [6].

Different spatial domains are involved and the effects and interventions act on different time scales. Whereas human activities in the upper three domains modify the flood hazard, activities in the lower two domains impact vulnerability and adaptive capacity. Most human effects on flood risk have rather long time scales. For example, land use change and urbanisation develop with time scales of decades and centuries and short term corrections are not possible. There has been a shift over the past one or two decades, from flood protection to flood risk management. This shift can be described in a very condensed form by three developments [12, 15].

4. Managing All Flood Events and Flood Risk

Traditional flood engineering has focused upon the definition of a design flood event and specification of systems that are intended to prevent flooding in conditions of that severity. Flood risk management, by contrast, addresses a full range of events, including those that exceed the design standard, and also addresses processes that may cause flooding even if the event is below the design standard. This may be due to unexpected failure modes or other flooding sources, such as intense local rainfall or groundwater flooding. The idea of living with floods acknowledges the illusion of complete safety against floods leading to a stronger focus on decreasing vulnerability. The emphasis in flood risk management is upon reducing harmful outcomes rather than prescriptive approaches to responding to particular flooding mechanisms.

Estimates of flood risk, the costs of options and any other (perhaps unquantifiable) costs and benefits, form the basis for decision making. There is a strong emphasis upon a proportionate response to risk, so that the amount invested in risk reduction is in proportion to the magnitude of the risk and the cost-effectiveness with which that risk may be reduced. The process of estimating risk is transparent and the results are accessible, so that risk estimates may be used to inform multiple decision makers, including the general public [13].

5. Events selection and severity

Flood strategy should cover the entire river basin area and promote the coordinated development and management of actions regarding water, land and related resources. Considering the evolution and trends, the approach to natural hazards requires a change of paradigm. One must shift from defensive action against hazards to management of the risk and living with floods, bearing in mind that flood prevention should not be limited to flood events which occur often. It should also include rare events [6].

A definition of flash flood event was required as a working principle to develop the archive and select the events. Initially, the definition of flash flood event was based on the duration of the causative rainfall, the size of the catchment impacted by the flood and the severity of the event. Consistently with the rules adopted, duration of the storm event was limited to 34 h and maximum size of the catchment area was set to 1000 km2. As a follow up, these rules were slightly relaxed to include one event with a larger catchment size [2].Severity of storm precipitation and flood response was a further requisite for event selection. The criterion adopted and met by all selected events is that the return period of the flood-generating rainfall exceeds 50 years at least for some rainfall duration. The selection of the 50-year recurrence interval as a threshold for event selection ensures consistency of the study archive with earlier archives of extreme rainfall events. Rainfall was preferred to peak discharge for assessing flash flood severity because of the difficulties in providing estimates of flood peak return period in many ungauged basins. In many cases, the events were extraordinary in terms of severity. Either rainfall or peak discharge return period exceeded 500 years (and sometimes 1000 years) for the event. The point rainfall amount recorded by one rain-gauge for the Damen river event represents the new all time record for the whole territory of Iranshar for a daily duration [12, 14].

For three out of 15 studied flash floods, discharge data were available at more than one cross-section, and for some of these several internal watersheds could be analysed. We retained all these data but for a few events for which a disproportionately high number of internal data were available. To avoid over-representing these floods in the analysis, we removed those cases where catchment properties and catchment responses were notably similar each other. As a general rule, the number of retained nested catchments is proportional to the size of the largest catchment area impacted by the flood (Amax). One basin was retained for events with Amax up to 200 km, and more basins were added for the events in which this threshold (or multiples of 200) was exceeded. The maximum number of watersheds retained for each flood (nmax) thus corresponds to the ratio Amax/200 rounded to the upper integer [3, 4].

Figure 2. Illustrates human effects on riverine flood risk including risk reduction options.

6. Rainfall data analysis

In this research investigating extreme rainfall estimation is an important task in engineering design for drainage and for flood studies. In this study annual maximum daily rainfall data are considered from two locations in the east of Iran, which are Mashhad and Chabahar, based on recent records from the period 1985 to 2010 (Iranian calendar 1364 to 1388 it means). In order to estimate rainfall intensities for various return periods, the annual maximum data series have been analysed using both the Gumbel and the Generalised Logistic (GL) distributions, and comparisons made between the different approaches. The resulting information from Mashhad and Chabahar has been applied to extend and clarify previous intensity-duration-frequency (IDF) relationships. The results show plausible agreement with other IDF curves from different countries which are presented for comparison [3].

For all the events, but three cases, the radar rainfall observations were made available for rainfall estimation together with rain-gauge data. The quantitative precipitation (QPE) problem is particularly crucial and difficult in the context of flash floods since the causative rain events may develop at very short space and time scales. The rainfall QPE problem in the context of the re-analysis of flash flood events presents a number of specificities. On the one hand, and as shown later in this paper, flash floods often occur in mountainous or hilly regions resulting in increased enhanced radar visibility problems associated with the intervening relief. On the other hand, flash floods generally result from convective rainfall which makes the visibility problem less stringent due to the extended vertical dimension of the precipitating clouds; in addition, the water changes of phase, resulting for instance in bright bands, may have relatively less impact on the radar QPE compared to more stratiform precipitation conditions. Moreover, the small spatial scale of the flash floods-generating storms, combined with the density of most rain-gauge networks, is such that just a few rain-gauge data are available for checking the radar observations at fine time resolution. However, more rain-gauge data are available for re-analysis (particularly at the event duration scale) than for real-time applications [3].

A methodology was specifically devised for rainfall estimation with use of radar and rain-gauge data. Depending on the relative locations of the impacted regions and the radar systems available, as well as their operating protocols and maintenance, the quality of the radar datasets may vary a lot for such “event-driven” analyses. The methodology is therefore based on: (1) detailed collection of data and metadata about the radar systems and the rain-gauge networks (including rain-gauge data from amateurs and from bucket analysis), (2) analysis of the detection domain and the ground/anthropic clutter for the considered case, (3) implementation of corrections for range-dependent errors (e.g. screening, attenuation, vertical profiles of reflectivity), and (4) optimization of the rainfall estimation procedure by means of radar raingauge comparisons at the event duration scale. The methodology was applied consistently over most of the events, but for the cases where only radar products were made available Damen River flood, occurred in Makoran in 2004, and the floods observed in [4,7].

From the significant of chi squared tests confirm that the log normal distribution is more suitable for the Iranshar and Makoran data, but that the Iranshar data showed differences between determined and expected frequencies that were significant at around the 5% level, but were not significant at the 1% level. In this case obviously indicates a less than perfect fit, but may be sufficient for practical purposes. In fact in conclusion the lognormal distribution appears generally appropriate for annual data. Thus it is noted that the Gumbel extreme value distribution also performed satisfactory for all three data sets analysis in figure 5 with correlation coefficients of R^2 = 0.90, 0.96, and 0.94 respectively also in figure 6 with correlation coefficients of R^2 = 0.92, 0.96, and 0.88 respectively according from this research of monthly totals rainfall in the different area of study then respectively the configuration of tested results would be refer from figure 3 to 6 accordingly [19].

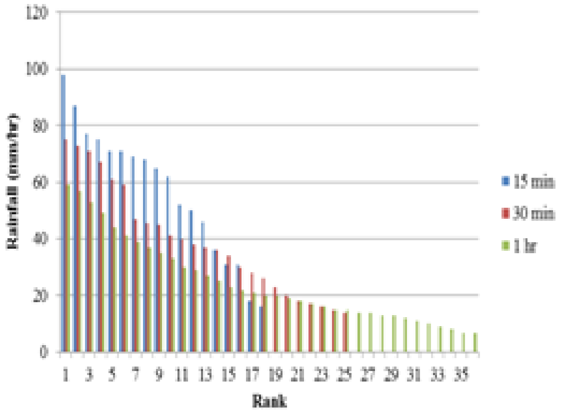

Figure3: Rainfall Intensity for 15, 30 and 60 minutes Duration in Iranshar Makoran

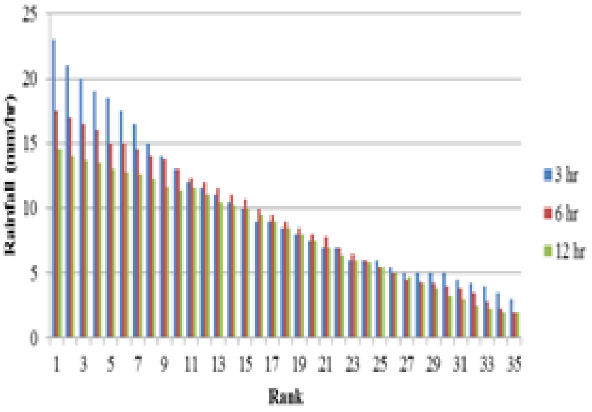

Figure 4: Rainfall Intensity for 3, 6 a 12 hours Duration in Iranshar Makoran

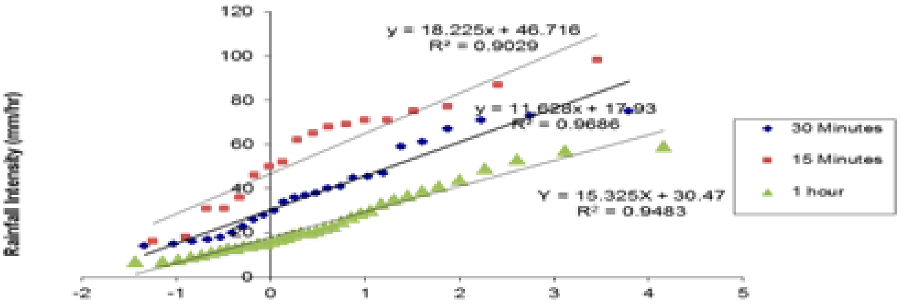

Figure 5: Gumbel distributions for 15, 30 and 60 minutes duration rainfall in Iranshar (Makoran)

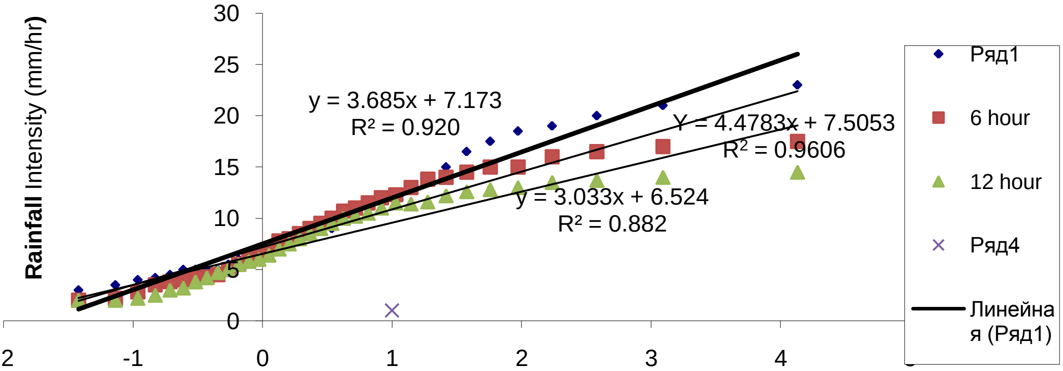

Figure 6: Gumbel distributions for 3, 6 and 12 hour duration rainfall in Iranshar (Makoran)

7. Results and discussions

Both discharge data from stream gauge stations and from post-flood analysis were available in the study. Discharge data from stream gauge stations were available for 3 cases, whereas data from post-flood analysis were used in the remaining 7 cases. Post-event analysis methods include a range of procedures for indirect estimation of peak discharges, generally encompassing the following steps: identification of the flow process (which was categorised into the following classes: liquid flow, hyperconcentrated flow, debris flow), high-water marks identification, post-flood river geometry survey, and application of appropriate hydraulic methods for peak flood computation [8]. With regard to the classification of the flow process, only liquid flows were considered in this study. Together with peak discharge values, post-flood analysis methods were used also to derive time of the raising flow, flood peak time, and rate of recession. Timing estimates were obtained based on eye witness's interviews and accounts. A standardised method for post-event analysis was used throughout the study. Estimates of flood peak for the earlier events were reviewed considering the original field notes, photographs, reports, and documentation, and conducting field visits to the flood locations [6]. Discharge data from stream gauges were obtained based on extrapolation of rating curves from smaller observed flows. The rating curves were checked to evaluate the degree of extrapolation required and to assess the quality of the final estimates. Although great care was devoted to the various steps of discharge estimations, we should note that all the peak flood data should be regarded as affected by considerable uncertainty. An accuracy of 15–20 min has been reported for the timing estimates obtained by means of eyewitnesses interviews. The large percentage of discharge data obtained from post-event analysis underlines the importance of indirect discharge estimates in setting up catalogues of flash floods. This is particularly the case for events which impact small catchment areas. Categorises catchment areas according to the method used to derive the peak flood data (stream gauge versus post-event analysis). Discharge data from gauging stations generally concern catchments which are significantly larger than those for which estimates are obtained from post-event analysis. This is not an unexpected finding: larger scale flash floods events have higher probability to be recorded by stream flow measuring stations, whereas events with smaller spatial extent generally impact ungauged basins. An implication of this finding is that systematic survey of flash floods is particularly important in the Makoran regions where these events are climatologically characterised by smaller spatial extent, such as in the sub-continental areas. Without systematic post-event analysis, it may be unlikely to develop reliable flash flood catalogues in these areas [5].

Focusing the river Damen for the purposes of water flow and gauged at two gauging station called Damen and Bampor gauging stations though the catchment for Iranshar station is 750 km2 and the catchment area for the Damen hydrometric station is 460 km2 however, the river network is a complex inter relationship of a historically. A conceptual approach that allowed some degree of perception of the hydrological processes to be expressed in mathematical form. The establishment and development of distributed monthly maximum flow analysis that account for the spatial variability of hydrological processes is appropriate to achieve river discharge in Makoran, thus the different monthly maximum discharge m3/s are illustrated in Figures 7, 8, 9, 10 , 11 and 12 which indicated various rate of flow for Damen River during wet months [9].

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 Damen during entire periods of the year 2005. In the light of the storms and flood monthly maximum the calibration of river Damen basically illustrated during month of December 2005 has been tested by computer the peak discharge was 4025 m3/s, for the February 2005 was tested 632 m3/s, for the March peak discharge has been tested by excel was 523 m3/s. Whereas for the same river on the month of April suddenly rate of flow dropped to 5-10 m3/s even though for other months during summer rate of flow for Damen 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 rate of flow than rapidly moving storms [9,11].

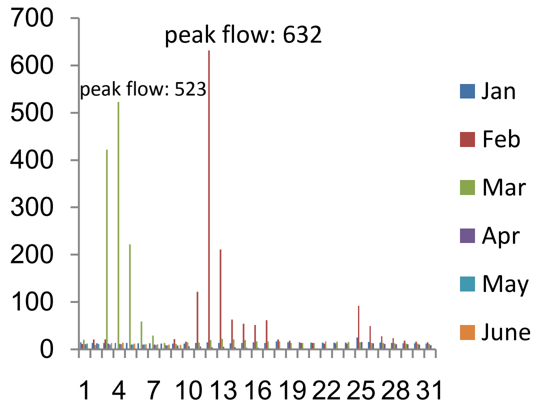

Figure 7: Monthly Maximum Rate of flow During flash flood from Jan. to 31rst June 2005

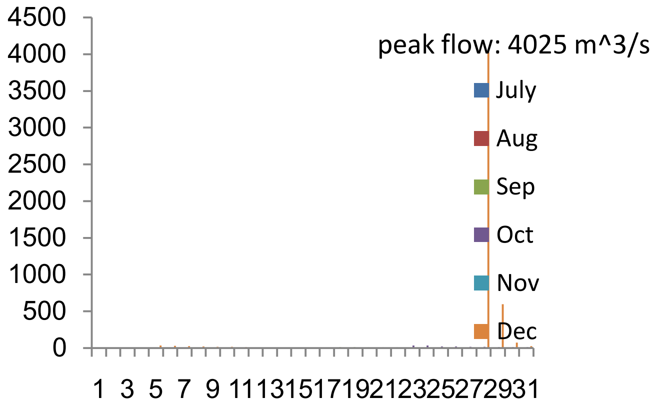

Figure 8: Monthly Maximum Rate of flow During flash flood from July to end of December 2005

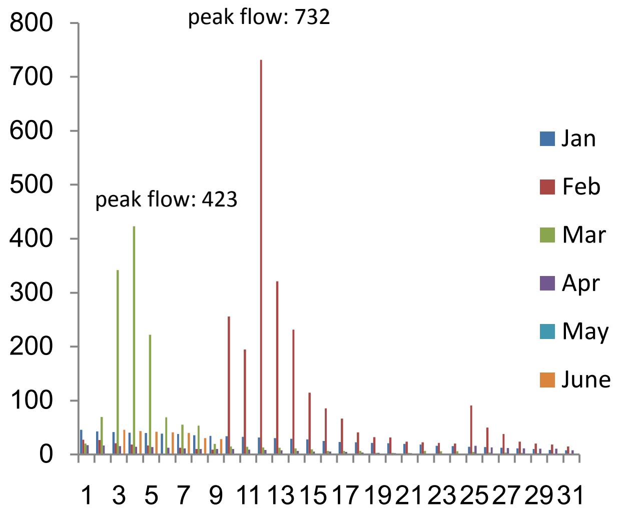

Figure 9: Monthly Maximum Rate of *f* low During Flash Flood from Jan. to June 2007

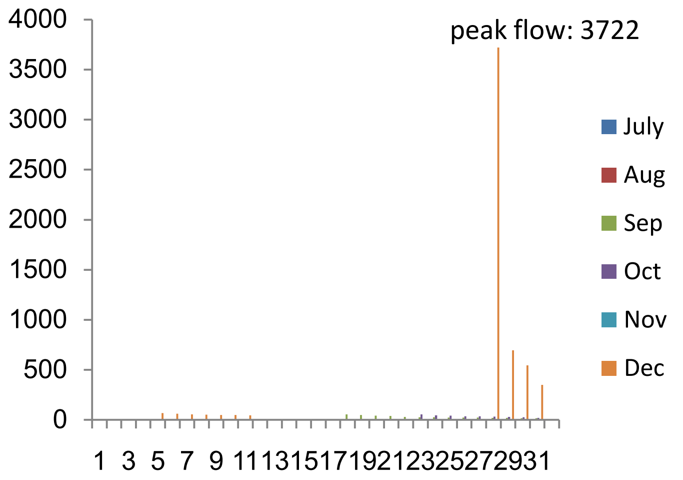

Figure 10: Monthly Maximum Rate of flow During Flash Flood from July to December 2007

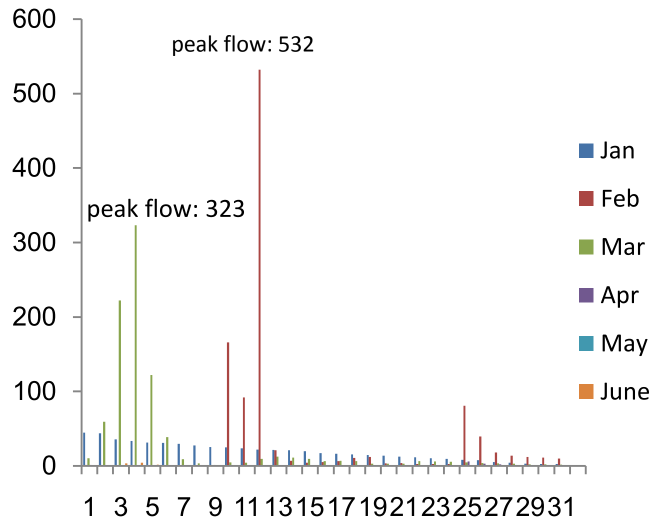

Figure 11: Monthly Maximum Rate of flow During Flash Flood from Jan. to June 2010

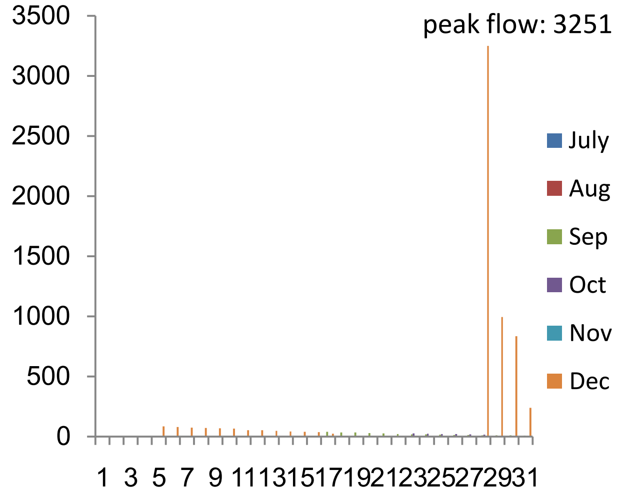

Figure 12: Monthly Maximum Rate of flow During flash flood from July to December 2010

8. Monthly mean Evaporation Analysis and Climate

For each catchment, values concerning the mean annual estimates of precipitation, runoff and potential evapotranspiration were collected from climate atlas or computed from available long-term rainfall, runoff and temperature data. For the ungauged catchments, mean annual humidity values were derived based on data from available downstream stations and from regional evaporation relationships.Data were also collected for the characterisation of the soil moisture status at the event start; these were rainfall and runoff (when available) data over the 30 days period before the event. Corresponding long-term data were also collected over the same period [10]. Geographical data include digital elevation models of the watersheds and thematic information (land use, lithology and soil maps). Digital elevation models were available at grid resolution from 20 m to 100 m. Only a short summary of the information about geology, land use and soil property is reported here, since ongoing research aims to investigate the quality and the homogeneity of this information and how these catchment properties, together with rainfall characteristics, control the event runoff coefficient.

The studied watersheds show a wide range of land uses. However, since most of the catchments are located in mountainous or hilly regions, urban and suburban land cover represents usually a limited fraction of the catchment surface. Conversely, urban areas are often located close to the outlet of the catchments. Agricultural areas prevail in hilly watersheds, whereas forests are widespread in mountainous areas. In Damen and Karwandar watersheds, large areas without vegetation cover (bare rock and scree) are found at the highest elevations. Very different geolithological conditions characterise the basins, with mountainous areas reported a number of catchments. Lakes and artificial reservoirs are present in some of the largest catchments considered here. However, their drainage areas are minor, in relation to the overall catchment, and the corresponding attenuation effects on the flood hydrograph was considered to be small [16,17].

Then all other landscape elements or underlying surface factors affect the mean runoff only in so much as they affect the amount of precipitation and evaporation, thus automatically allowing for the influence of these factors so in this regards here could be represent Iranshar Makoran Evaporation as follow as figure 13 and also monthly mean relative humidity as shown in figure 13, too [10].

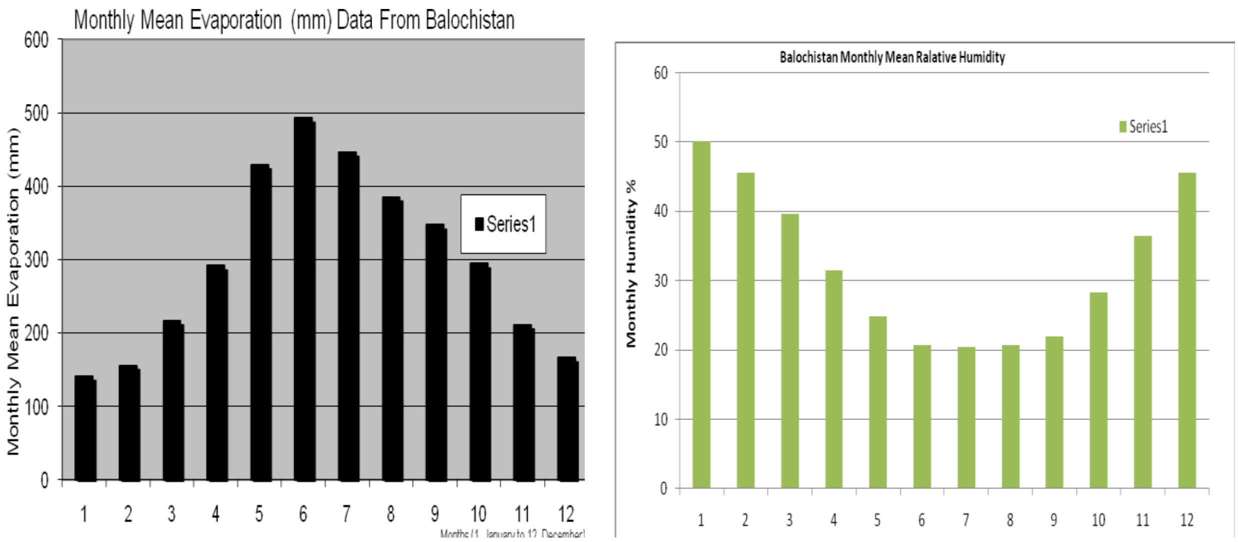

Figure 13. Iranshar Monthly Mean Evaporation and Relative Humidity

9. Conclusion

The presentation of the paper will adopt the following outline. Summarize prior studies on flood and flash flood characteristic across Iranshar Makoran. The analysis of the flood-generating rainfall, peak discharges, correlation coefficient and response time. Finally, the implications for flash flood risk management are examined, together with the conclusions from the study. Maps and curves that can be used to rank the susceptibility and implement a vulnerability analysis in the area of interest. The components of the methodology are tested in floodplain area in South Iran recently affected by floods. The results show that the methodology can provide an original and valuable insight of flood susceptibility and vulnerability processes.Sound flood risk management decision making is underpinned by flood risk analysis. Current methods applied at regional and local scales are often limited in their consideration of the potential for defences to fail. Ultimately this can lead to underestimates of the true risk and subsequent difficulties in justifying mitigation measures such as maintenance and replacement of defences. A methodology has been developed for assessing flood risk arising from fluvial and town sources that explicitly considers defence failures represented through fragility curves. Flood risk reduction has been concentrated on river training construction of embankments and retention by reservoirs.

Flood risk management is gaining importance in order to mitigate and prevent flood disasters, and consequently the analysis of flood risk components is becoming a key research topic. The components of the methodology are tested in floodplain areas in Southern Iran recently affected by floods. The results show that the methodology can provide an original and valuable insight of flood susceptibility and vulnerability processes.Extreme precipitation events are likely to become more frequent and more extreme under a changing climate. It follows that monetary damages from flooding would also increase relative to baseline, yet this relationship has not been quantified at the scale of the entire Makoran. In this paper, we quantify how climate change could affect monetary damages from flooding in the coterminous Makoran. With publicly available historical flooding and precipitation data, we estimate region-specific logistic regression models of the probability that severely damaging floods will occur under baseline conditions.

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