ISSN: 0976-3104
SUPPLEMENT ISSUE
Rahmani and Arsiun

ARTICLE OPEN ACCESS

THE SURVEY OF THE RUNOFF WATERS CREATION AND THE FORMATION QUALITY WITH THE OBJECTIVE OF PREDICTING THE URBAN FLOOD OCCURRENCE AND ITS INFLUENCE RATE (CASE STUDY: THE CITY OF SALEH ABAD)

Mohammad Rahmani* **and Niloufar Arsiun**

Department of Urban Planning, College of Arts and Architecture, Hamedan Branch, Islamic Azad University, Hamedan, IRAN

ABSTRACT

One of the most important problems that the current societies are confronted with is the natural disasters and the unfavorable phenomena in various levels. Under such circumstances, the most logical and the most original method for keeping safe of the natural disasters unfavorable effects is to have information and recognition of the nature and the source of such incidents within the predicted timeline. One such unpleasant phenomena is the stream of the water flowing on the surface as a result of the precipitation and rain and snowfall in the periphery and within the urban areas which cause unsuitable and inappropriate conditions to appear due to passing through various regions in the cities and the situation worsens when the farm lands are destroyed and converted to urban territories which can further cause the impermeable regions of the land to expand and bring about the grounding for the creation and formation of runoff waters within the cities which can be studied from various aspects and in case that such runoffs resulting from the precipitations in the cities are not conveniently and appropriately discharged then this possibility heightens that floods can form inside the cities. In the current article the author is trying to study the urban natural and climatic statuses in the middle district of the city of Hamadan in the framework of an applied and field study and also to evaluate the city conditions in creation of the runoffs and the occurrence of urban floods. The researcher makes use of a runoff rational calculation method and attempts to estimate the impact coefficient at the time the runoff is formed and also measuring the runoff height and Debi in the case study investigated in the current study which is the city of Saleh Abad, then the researcher attempts to determine the probable time for the flood occurrence and with the information obtained the author tries to determine the urban runoffs during various seasons of the year.

Published on: 12st- Aug-2016

KEY WORDS

runoff, flood, storm water, rational calculation

***Corresponding author Email:** mohammad.rahmani1@gmail.com; nilufarrsn@yahoo.com

INTRODUCTION

If a country intends to keep pace with and advance in line with the development is incumbently obliged to sufficiently and most efficiently deploy its natural resources and to be familiar with the unpleasant consequences resulting from such exploitations. The topic of water, precipitation and the occurrence of the sudden and unexpected incidents stemming from the rainfall and snowfall in the cities which is accompanied with numerous problems and troubles and this can be studied from different perspectives. Runoffs and the urban storm waters are among the important problems in this area and it is focused on by the various fields of sciences from bioenvironmental, textural and hydrological aspects. Urban geographers, climatologists and geo-morphologists have dealt with the issue more than the others and according to the expansion of the city life which has mostly been accompanied with the environmental destructions and the occupation of the farm lands and natural resources for the purpose of building constructions and development of the cities have all led to the formation and creation of the runoffs the flowing of which in the form of surface waters and streams have brought about the flooding of the passage ways and streaming of the storm waters with their considerable destructive power and they have been found to be playing critical roles in demolishing the facilities and installations and the natural resources and the soils in the vicinity of the cities and thus such problems and cumbers regarding the city management plans and the bioenvironmental outcomes have attracted a great deal of attention and therefore, to gain a full and sufficient insight of their features and their source of

THE IIOAB JOURNAL
ISSN: 0976-3104

formation is considered as an unavoidable necessity for the city management plans within the spatial dimensions and under the specific temporal circumstances.

The introduction and the identification of the study area:
Since the case study in the present study includes the city of Saleh Abad in Hamadan Province, the researcher has tried to provide the reader with a brief realization of the province location characteristics in Iran and then the researcher deals with introducing the city of Saleh Abad and conducts the study normal investigation procedure.

The situation and the natural conditions of Hamadan Province:
Hamadan province covers a 19493 square-kilometer area, and it embraces about 1.2% of the entire country area. The Province is located within 33° and 59' to 35° and 49' of the northern latitude and 47° and 34' to 49° and 36' of the eastern longitude from the prime meridian. The province has been located in the western section of the country and it shares the same border with Zanjan Province from the north, and Lorestan Province from the south and it is tangent with Markazi province from the east and from the west it is bordered to Kermanshah and Kurdistan Provinces.

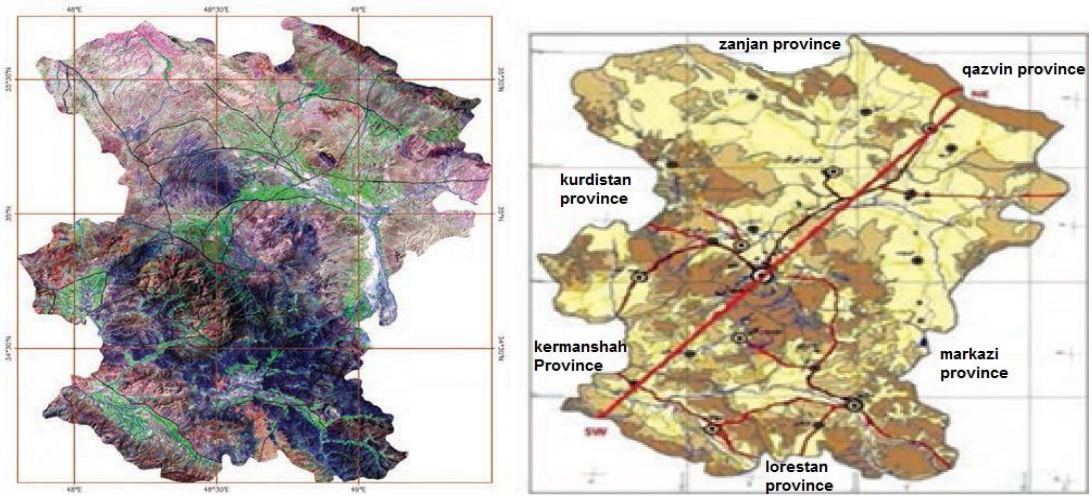
The most elevated area in Hamadan Province is the 3574-meter-high Alvand apex and it is situated between Tuyserkan and Hamadan Counties and the lowest point in the province is Amr Abad lands along Qarreh Chai river in Shora' district. Hamadan Province at the present time possesses three main entrance routes and one secondary entrance route. The province is connected to Kermanshah and Sanandaj from the west. From the east it is located adjacent to the city of Arak. It is connected to Tehran and Qazvin from the north and the Mount. Alvand is positioned in the southern border of the city. The city's access points and its being situated on one of the important connective highway routes in the western part of the country and it connects Kurdistan, Kermanshah and Ilam provinces to the city of Tehran and vice versa and this has provided the province with a significant geographical position which is of a great value in terms of the effect is has on the economical activities.

Hamadan province covers part of the middle Zagros and the central Plateau in Iran and it is generally regarded as mountainous region. The region's elevations and mountains are generally oriented along the northwest-southeast direction. Therefore, the way the mountains and the elevations are oriented has caused the province to be divided the Province into two northeast and southwest districts. The topographical status of the region includes highly elevated plain lands and sedimentary savannas and in the elevated plains the land is found to be with a lot of rising and falling and degradation and weathering show intensified trend in some sloped sections of the region. The Alvand Mountain which is almost posited in the central part of the province is oriented in the northwestern-southeastern direction and as we know the city of Hamadan is located in the northern territories of the mountain Alvand and the city is bordered by the Mount Alvand in the southern section. There are many rivers originating from the various apexes on the Alvand Mount. Hamadan Province is situated in the area of three substantial catchment provinces in the country. Each of the rivers Gamasiab, Qarreh Chai and Taldar belong to the catchment area of Persian Guld and Omman Sea, central catchment area and Caspian Sea catchment area, respectively.

The precipitation rate in a 20-year period in the city of Hamadan airport station has been calculated to be 305.7 mm. The raining variations in the city of Hamadan have been generally estimated to be very low and the standard deviation for the precipitation variations has been found to be small. Also, with the survey of the statistical yearbook of the city of Hamadan in 2010, the highest raining rate has been reported in May (75.7 mm) followed by April (54.7 mm), then March (43.9 mm) and finally August with 36.4 mm precipitations. The survey of the precipitation seasonal distribution in provincial level has indicated that 38.9% of the precipitations (that is the highest rate) have been in winter, 33% in fall and 27.8% in spring and the lowest precipitation rate, 0.3, goes to the summer. The average annual precipitation geography of the Province has been 343 mm. therefore the province is in an intermediate level from the precipitation aspect.

Figure (1): Hamadan Province aerial images/**Figure (2):** Hamadan Province topography map

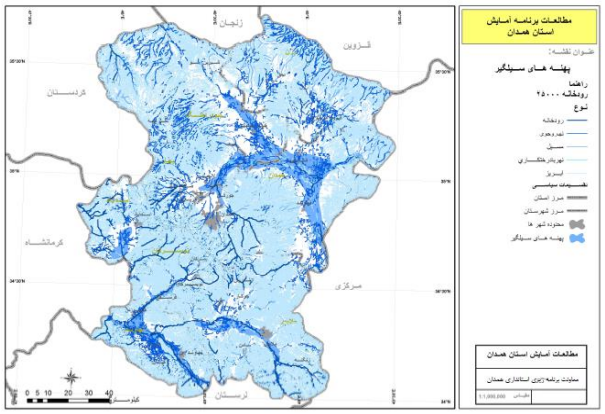
THE IIOAB JOURNAL
ISSN: 0976-3104



Hamadan Province flood-proneness:

Topography, land slope orientation, the catchment area width and the precipitation regime has brought about the conditions for the vast breadth of the province to be exposed to the flooding raids on special occasions. In the northern hemisphere of the province these flood line breadth are far more extended and continuous. The land slope in the catchment area of the Qarreh Chai River is in a form that the surface streams are collected from a vast area of land and they join in a narrow passage way. Such flood-prone passage ways begin from Jorghan and Laljin areas and they continue along Qarreh Chai River to the southeastern part of Kabudar Ahang. In this section they join with the other flood-prone area which originates from the northwestern section of Kabudar Ahang and altogether they intensify the flooding risk on the more vast breadth of the sections located on the southern part of Famnin and along the Qarreh Chai River. Finally, they get connected to another flood-prone passage way which is stretched along south-north direction on the eastern section of Ghahavand and also along another tributary of Qarreh Chai River and these altogether form the widest flood prone breadth in the entire province. Another flood-prone breadth is located on the southern hemisphere of the province. This flood-prone breadth is located along and on the marginal section of Gamasiab, Ghelghelrud and Haram Abad rivers the latter of which originates from the southern section of the city of Malayer. Another breadth which is located in the southern section of the province and it is talked of here because of its flood-proneness is situated on the southeastern section of Asad Abad and along and on the marginal border of Qarreh Chai River. In sum, 1811.3 square kilometer of the entire area of the province (9.3%) is exposed to the destruction by flood. Getting information and becoming aware of the flood-prone areas in the province can be taken as an alarming siren for the officials to take the necessary measures and establish the required preps especially on the placement sites of the buildings and in forecasting and predicting the necessary steps regarding getting the strategic activities done.

Figure (3): flood-prone breadth in Hamadan Province



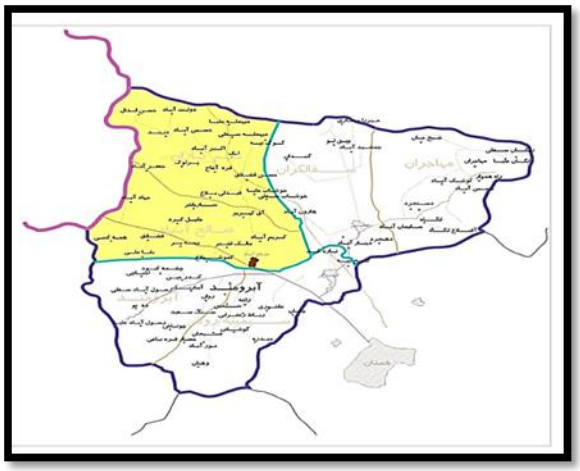
Saleh Abad is among the city points in Bahar County which covers the central part of Bahar County as the city center for Saleh Abad Section and the villages and the rural areas in Saleh Abad and Deym Karan Counties. The

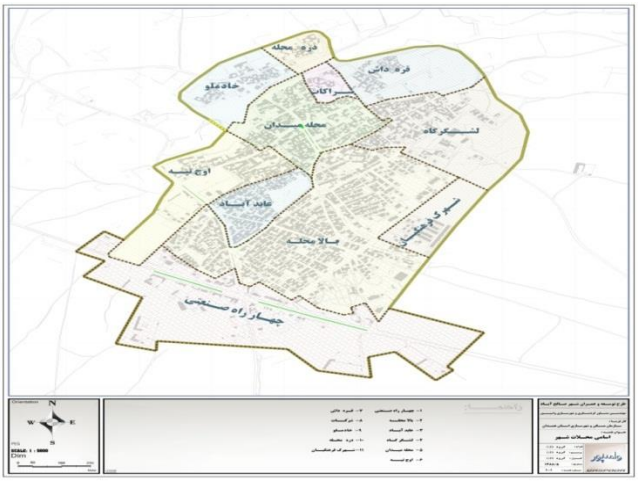
THE IIOAB JOURNAL
ISSN: 0976-3104

city is located in 48° and 21' eastern longitude and 34° and 56' of the northern latitude and it is posited within a 20-kilometer distance from the city of Hamadan. The city average elevation from the sea level is about 1780 meters. Based on the studies performed and the information which was gathered from the local elders and the trustees and the reliable white-bearded individuals a region in a 3-kilometer northern radius of the city called Hasnan was the primary nucleus of the formation of the city. The city through its being positioned on the connective routes between Hamadan and Kermanshah and Hamadan Sanandaj has been stated to be enjoying a particular position. The current situation of the city alone and in itself can be marked as an outstanding feature which causes a lot of attractions to be directed towards its spatial and relational system. And this is in a manner that the district has been considered as the entrance gate from the two western provinces to Hamadan province which is deemed to be impregnated with a lot of commercial, business and even tourism competencies for the city of Saleh Abad.

It might be possible to say that the growth and formation stages for the city of Saleh Abad have been perfected in five stages. The primary formation stage has occurred on the southern section of Saleh Abad River, in an area between Hamadan-Qorveh Road and the second stage has taken place in a radius from the primary locus of the city formation basis according to the natural and environmental conditions. In the third stage, the city of Saleh Abad seem to be following an approximation approach towards the river in such a manner that in this stage part of the city growth has been transferred well beyond the other side of the river and in the next stages of the city development, the city follows a smaller and slower growth pace especially in the Pahlavi era which has been subsequently followed by a rapid growth rate after the victory of the Islamic Revolution and the city has been found to be stretched towards Hamadan-Sanandaj Road.

Figure (4): the city of Saleh Abad situation in Bahar County**. Figure (5):** the neighborhood zoning system in the city of Saleh Abad





Based on the latest census performed by the Statistic center of Iran in 2011, the city of Saleh Abad's population was estimated 7830 people. The city is among the small cities in the province and its population has been allegedly estimated to be in a lower rate in contrast to the population in 14 cities in the province including

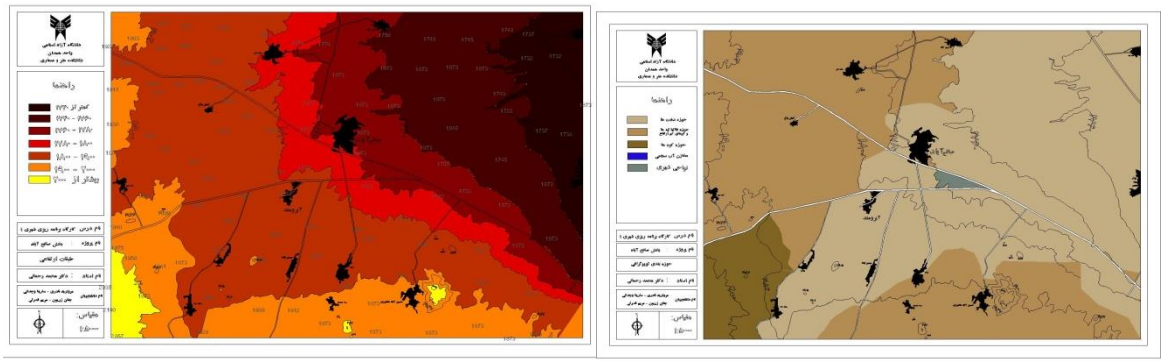
THE IIOAB JOURNAL
ISSN: 0976-3104

Hamadan, Malayer, Nahavand, Asad Abad, Tooyserkan, Bahar, Kabudar Ahang, Laljin, Meryanj, Famnin, Rezen, Ghorveh Darjazin, Jorghan, Azandaryan and it is estimated to be greater than the population in the other 9 cities in the Province.

The study area topography:

In studying the various forms of uneven terrains in the region, it has been discovered that the mountainous units of the region are oriented westward-southwestward and the hills are also in the form of low-elevated foothills which have come to take this shape as a result of schists and slates undergoing weathering and they are figured out to be enjoying a very soft slope. The plains are also situated on level lands with soft slopes. The topographical status of the city is in a form that the most important topographical features are to be seen in the western part of the region. A vast area of the city is situated in elevations lower than 2000 meters. In this way, in a general schematic overview of the city it can be said that the elevations in the city of Saleh Abad are directed southwest-northeastward. In the survey of the topographical status of the region we come across the high lands and the sedimentary terrains which are located on elevated plains with a lot of risings and fallings and the weathering can be easily understood to be more intensified in some of the sections with more steep slopes. In the alluvial terrains and on the weathering plates the slope is trivial and the studies performed by the consultant researcher indicate irrigational farming on these areas and the peripheral areas located on the suburban localities of the city. The city of Saleh Abad is located on the Bahar Plain. Hamadan-Bahar plain is limited to Alvand highlands in the south, it faces the Almabolagh Sheikhi Jan highlands from the western side and it is bordered by the Arjani Mount. Highlands from the eastern section and it is also found to be limited to the Kamarzard and Sheikhi Jan high lands from the northern section [1].

Figure (6): Saleh Abad Region elevation layer map **Figure (7):** Saleh Abad Region topographical zoning map



In surveying the topographical status and/or the appearance characteristics of the city of Saleh Abad the overall dip has been measured to be ranging from 0% to 2% and the lateral slope in a range from 2% to 5% with prominent intermediate rising and falling ground. Saleh Abad Plain has occurred on level land with soft slope. In investigating the forms of the topographical unevenness of the region we can observe that the mountainous units are directed west-southwestward and the hills are in the form of low elevated foothills which have come to take this shape as a result of schists and slates great capacity for being easily degraded and weathered and they are found to be of a very soft slope. Among the natural barriers in the face of city development plans is the Saleh Abad River in the western section of the city which is also covering some areas in the northwest and south western section of the city and semi-sparse forest cover along the river can be also named as the hindering factor on the way of the city growth and the urban textural development. Although it does not come as a surprise but it is worth mentioning that the dam built on the northern part of the river which has a very low level difference from its peripheral land has formed a semicircular line which has imposed the city traffic in a narrow bottleneck and it occasionally plays a critical role in the occurrence of the floods and flowing of the streams or the intensification of the floods and the surface water streaming and it has also been reported to have caused financial losses and damages to the peripheral lands and especially the irrigation farm lands and fortunately no life loss has been reported in the recent decades. The presence of some foothills on the west and the southern part of the city which have caused the region to take a new shape in this section does not seem to be lending itself to urban development particularly regarding the establishment of the residential areas. The irrigation farm lands on this section of the city are considered among the other factors inhibiting the city growth and among the non-natural and to some extent man-made barriers on the path to the city development there can be made reference to the placement of the city graveyard on the west and on the both sides of the subsidiary route (the old road to Alisadr cave) which ends

THE IIOAB JOURNAL
ISSN: 0976-3104

in the main Hamadan_Bijar road within a less than one kilometer distance immediately after passing over the river and the bridge which is reminded of as the English Bridge. Another non-natural barrier is Hamadan-Sanandaj Road which is located on parts of the southern and southwestern sections of the city on which the heavy traffic and the road limit and the pedestrians' safety does not allow the development of the city to the other side of the road.

Figure (8): the topographical zoning and the elevation strata map of the city figure **(9):** the map of the barriers and the hindrances to the city development

Slope:

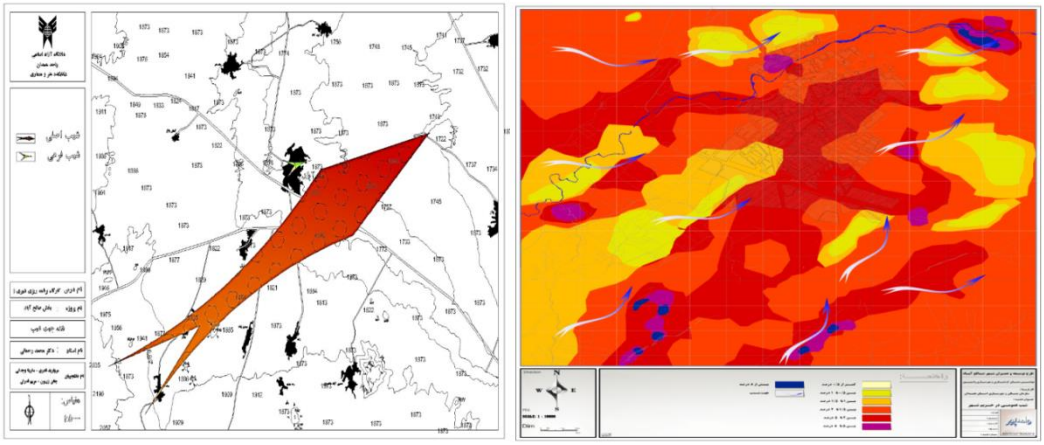
In the survey of the topographical features and statuses of the suburban areas of the city of Saleh Abad the general slope has been estimated to be in the range from 0% to 2% and the lateral slope of the area ranges from 2% to 5% with an intermediate rising and falling uneven ground. In studying the topographical features of the city of Saleh Abad one should not neglect the catchment area topography and the role played by the topographical features and the river located within such topography. The city of Saleh Abad's catchment area in the southern part of the Greater Qarreh Chai Catchment area on the border line between the two northern and southern hemisphere of the province accounts for approximately 1.3% of the entire catchment areas leading to Qarreh Chai catchment system[1].

There can be observed a less than 1% slope on the both sides connected to each other with a narrow width which are located on the eastern and southeastern section and cover the lands on the plain. The cities Bahar, Saleh Abad, Mohajeran and Laljin which are considered the fourfold cities of Bahar County are all situated in this area which are all found to be positioned on a soft slope. The slope ranging from 1% to 33% is stretched in the direction from the east towards the west and it also covers sections of the northeastern and the central area of the city of Bahar [1].

The slope area ranging from 3% to 5% dip is scattered on the southwestern section of the city and it is mostly found in the northern section. This way, the slopes reaching to a maximum degree of 5% cover a vast area of the city of Bahar. In the above slopes (below 5%) every developmental activities are estimated to be appropriate and feasible. Since the best farming lands are located on this breadth of the city, preserving such lands is a hindering factor which has to be taken into consideration regarding urban, industrial development. Slopes greater than 10% are merely only scattered on the southern and southwestern sections of the city and they do not seem to be covering a considerable area in terms of distribution [1].

THE IIOAB JOURNAL
ISSN: 0976-3104

Figure (10): the map of the dip orientation in the city of Saleh Abad**/ Figure (11):** the study area overall slope



The survey of the climatic conditions in the city of Saleh Abad:
In climatic categorization, it is not readily possible to recognize the overall climatic conditions of the area and there exists this possibility that substantial variations arise in different classifications. There has been proposed various methods for the climatic typology by the experts among which De Martin and Ambrege methods are very popular and common in Iran and they have also been practically used in the present study and the results of the climatic studies indicate that a semi-dry supra cold climate is prevalent in the area based on adjusted De Martin method [2].

Precipitation:
In Saleh Abad region the average annual precipitation level is 382 mm. The highest precipitation rate has been reported for 1979 with 670 mm precipitation and the driest year has been calculated to be 1983 with a precipitation rate of 195 mm. April with 64.1 mm is the wettest month of the year and September with 2.4 precipitation level is the driest season of the year. Winter with 42% precipitation rate is the wettest season of the year and summer with 2% precipitation rate is the driest season of the year. The number of the rainy days in the study area has been calculated to be 71.7 days per year, and February with 10.5 days has been reported to be having the most rainy days during a year and it is followed by April and then March with 9.8 days. The investigations about the maximum twenty-four hour precipitation is one of the most important factors in evaluating the likelihood for flood occurrence in a region and based on the calculations and investigations this factor has been computed to be 56 mm.

The ground water in the study area:
In the terrains and plains in Hamadan region the ground water aquifers are formed in various strata and it has been figured out that such layers and strata are somewhat connected and they altogether form the main aquifer. Ground water reservoir are mostly occurred in the alluvial layers but it has been discovered that in some of the regions, the lime strata are found to be containing springs (Vasmagh and Jeyhoon Abad) and it also has been discovered that the springs basin has been located in a relatively small area.
Generally speaking, the region has been consisted of four main plains: Hamadan-Bahar, Kabudar Ahang, Saleh Abad and Ghahavand, and Komijan. In terms of the ground water reservoirs, the plains are separated from one another by scists, Granite shales, Diorite, Maroon, and Argillacious Limestones which are impermeable layers and

THE IIOAB JOURNAL
ISSN: 0976-3104

strata. In each of such plains the ground waters have been reported to be following a unique streaming trend but the entire waters in the northern section of the region have been explored to be flowing into the central section of the plain towards Simineh Rud River and this central section to which the entire systems of the ground water pour is known as the central plain. This plain starts from Bahar Plain exit mouth in the proximity of Kushk Vilage and it is continued along the Simineh Rud River to the area the river exits the plain in the vicinity of Ghezel Hesar village. As it was mentioned before, the ground water exiting Bahar, Kabudar Ahang and Saleh Abad plains enter the central plain. The water in such areas is exploited via digging wells and aqueducts and the rest is either vaporized or it is drained by the river. Hamadan-Bahar Plain enjoys a triangular morphology which is surrounded from every direction by the peripheral high lads and the only underground passage way is a narrow strait which is located on the northeastern section of the region the apex of which is in a triangular form. The seasonal variations of the ground water is about 3 to 4 millimeters but such variations and changes have been found to be of a lesser fluctuation in the northwestern part between Bahador Beig and Saleh Abad and they are generally about 1.5 to 3 meters. The maximum ground water level has been reported on the ending days of May and early June and the minimum level has been reported in October or November and even it has been reported for December in some of the years. The hydrologic gradient can be seen in the southern, southwestern and the western section of the Plain. Exploiting the ground water was predominantly conducted on Hamadan-Bahar Plain for farm land irrigation purposes and unfortunately the substantial part of the consumptive water extracted from the plain has been for the purpose of imbibing drinkable water for supplying the drinkable water for cities such as Hamadan-Bahar, Saleh abad and other cities.

The rivers in the study area:

The intra-city watercourse and rivers are considered as the structural elements of the city and natural city corridor in causing bioenvironmental runoffs inside the city which play an effective role and also they are stated to be protecting the city ecosystem. But, in the meantime, according to their natural statuses, the river beds with a great deal of various ing effects are indicative of constant and perpetual changes and variations and they bring about weathering and in the meanwhile reconstruction of their edges. In this regard, the necessity for preserving and reclaiming the river bed and routes and at the same time paying attention to their safety and security for the city residents against the occurrence of the floods is one of the important issues among the urban problems which needs to be considered from the ecological, bioenvironmental and designing perspective free from any diminishing and negative consideration of the city rivers through the use of the rivers natural and general characteristics and finally turning their threats into opportunities for the city environment [3]. The most important rivers in the study area are as stated below:

a) Harim River:

The river existing in the northern section of the city covers an area of about 1.70 with a 1.95-square meter capita which accounts for about 1.79% of the entire city lands.

b) Saleh Abad River:

Saleh Abad River is comprised of several tributaries and it is explored to be originating from southeastern Alvand, Alusan, Kuhkar and Faravel Khaneh Mountain.

c) Bahador Beig River:

The river originates from the 2690-meter high elevations of the Mount. Almutragh and meanwhile being joined with by a secondary tributary coming from Khalil Kurd side, it pours into Saleh Abad River.

d) Simineh Rud River:

Simineh Rud River or Ghuri Chai is formed by the connections and the adjunction of the eastern-southern section rivers from the Alvand Elevations.

e) Khmigan River:

The maximum height in this area is 2520 meters. Khamigan River stems from the southern sections of the northern elevations in the Province.

The study area flood-proneness:

In spite of the scarcity of the precipitations in our country and the year-round water requirements, we are witnessing the occurrence of numerous floods with millions of cubic meter water running wasted and these floods other than causing a lot of damages and ruins and the great losses provide for the loss of millions of cubic meter water and the destruction of millions of tones of the soil. Furthermore, such floods and runoffs can cause a lot of damages to the water-delivery installations and networks. The floods in 1987 in Zahedan and Tehran and the floods in 1990 in Rasht and 1993 in Gilan and the numerous floods in 1998 in Gilan, Golestan or Mazandaran and

THE IIOAB JOURNAL
ISSN: 0976-3104

the other provinces and tens of other floods which have taken place during the recent years are but a few examples.

Based on the statistics obtained for Hamadan Province, it has been reported to be the tenth province in its rank for flood-proneness. Reportedly, every ten years we are witnessing on average 20.3 floods occurring in the region. In a period from 1990 to 2000, there has been 25 floods reported during which 12 cities and 224 villages have been damaged, so what is clear is that on a provincial level the floods occur frequently and the reasons for such repeated flooding of the area can be two human and natural factors.

Undoubtedly, floods are recognized as natural disasters but practically spates have been realized to be even heavier in terms of life losses and they are also considered as the most dreadful natural disaster in terms of the financial losses and damages they cause. In the period from 1977 to 1988 about 390000 individual have lost their lives as a result of the natural disasters and based on the reports about 58% of the casualties have been pertaining to the spates and floods and 26% have been found to be related to the earthquakes and 16% as being caused due to storms and the other disasters. The total sum of the damages caused during this ten-year period has been 700 billion dollars out of which 33%, 29% and 28% has been pertained to floods, storms and earthquakes, respectively. In this regard, the area of concern is the increasing trend seen in the casualties and damages worldwide during the recent years. But, the floods are known to have occurred as a result of two critical factors.

1. Natural factors

1.1. Natural factors include the following parameters:

a) Climate; b) ground unevenness, involving the slopes and their orientation, stone texture and the soil structure, vegetative cover.

2. Human factors:

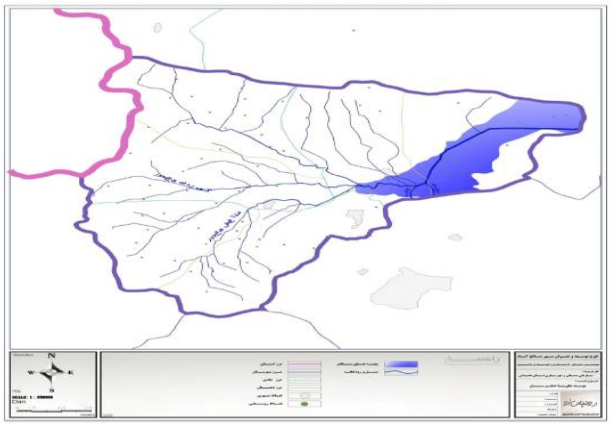
The human beings are themselves considered as one of the most important factors in flood occurrence. Population growth and the lack of sufficient information have set the grounding for the cultivation of the river limits and beds and the flood natural gullies and in case of a flood occurrence the river cannot afford to discharge its extra volume of the water and it causes huge damages in the form of runoffs and flooding. However, it is worth mentioning that the occurrence of the floods in every region is a result of the human-natural factors contrastive and parallel actions. The city of Saleh Abad is among the regions in which the human and natural factors concomitantly have formed the underlying stimulating factor for the appearance of floods in the province.

Identification of the high risk regions in the study area:

Generally, every watercourse and/or river existing is somehow a place for the transferring of the adjacent lands surface waters and in many of the cases, especially in case of normal rains, the precipitation do not seem to cause flood occurrence but when the aforementioned lands are used for urban development constructions and city building activities and as a consequence a road network is created which is substantially impermeable then the peripheral land will be deprived of about 70% of its permeability. The waters coming from the precipitations do not find a chance to infiltrate the ground and if such considerations have are taken into consideration by the city building designers and planners the waters resulting from the rains are guided towards the sewage networks and surface waters conductance grids through taking advantage of the ground's natural and non-natural slopes directly to the rivers and water canals and in doing so the rivers receive about 70% excess water to their normal water-holding capacity which has been estimated to be about 40% in Saleh Abad River and due to the appropriate organizing activities performed on the river walls on the one hand and the proper sloping of the river on the other the water is directed towards the outside of the city but it is not prevented from damaging the lands outside the city and it has also been found to have damaged the farm lands in some of the places in which the water in the river finds higher velocities in a less than 500-meter distance outside the city; thus, sufficient recognition and identification of the natural environmental conditions including topography, slope, and the ground type and also the climatic circumstances are among the critical issues in the investigations regarding collecting the surface waters. And in case of the current study, computations regarding the runoff waters or the surface waters are among the necessary issues for the estimation and prediction for the purpose of correct decision making in guiding the surface waters and also reduction of the likely and probable damages. There are various methods used for performing such activities. One such method is runoffs rational computation which is widely used in the global level and it is shown to be very promising for the small areas of about 1000 ha. In such methods, it is assumed that the raining rate is identical in the entire area. The method simplicity is one of the principal reasons behind its use.

THE IIOAB JOURNAL
ISSN: 0976-3104

Figure (12): the study area highly risky flood-prone breadth



RESULTS

Runoff rational computation in the city of Saleh Abad:

In the natural environment, the water from the precipitations flows over the ground level and it is re-circulated after infiltrating the ground. City building activities exert a heavy influence on the water cycles and such effects have also been discovered to be effective on the soil and the fauna and flora of a land. The streets' paved sections, buildings and the other factors like these act as barriers to the water infiltration to the soil and, subsequently, a great deal of the surface waters in the cities are directed towards the watercourse systems [4].

The surface water runoffs resulting from the rain is generally a function of the intensity and the amount of the rain, evaporation and transpiration, topography, soil characteristics and land use. Reviewing the historical study literature extant regarding the current study topic, we can conclude that the amount of the runoff produced in various land uses can be subject to various managerial strategies, since the evaluation and the investigation of the surface runoff variations can be useful in various land management scenarios and also the recognition of the variables effective on the runoff occurrence can be found promising in improving the management recommendations and suggestions improvement and quantification of the runoffs variations [5].

Runoff waters rational computation has been used widely in a universal level and it is generally used for small areas of about 1000 ha. In such a method it is supposed that the precipitation rate is identical in the entire area. The method simplicity is a reason why the method is widely applied and the main deficit of the method is that the factors such as soil relative humidity and the environment temperature are not considered in terms of evaporation and transpiration.

The rational method or better-known as Lioyd-Davis relation is as below:

$$\mathbf{Q} = \frac{1}{36} CIA$$

Where,

I= the rainfall intensity in cm/sec;

Q= runoff Debi in cubic meter/sec;

A= the area of the land in ha;

C= surface runoff coefficient which is extracted from the related table.

THE IIOAB JOURNAL
ISSN: 0976-3104

Determining the runoffs coefficient (c) in the study area:

In the above relation, one contributing factor is C or the area runoff coefficient and it is defined as the ratio of the rainfall which flows over the ground. Every runoff coefficient in any region depends on factors such as the ground surface permeability rate, vegetative cover, land slope ad rainfall intensity.

Table (1): coefficient (c) to be used in the rational relation formula

	Land slope in %		
	0-5	5-10	10-20
Pastures			
Sandy and gravel			
Clay and silt	0.1	0.16	0.22
Loamy	0.3	0.36	0.42
Heavy clay	0.4	0.55	0.66
Sandy and gravel			
Clay and silt	0.1	0.25	0.3
Loamy	0.3	0.35	0.5
Heavy clay	0.4	0.5	0.6
Sandy and gravel			
Clay and silt	0.2	0.4	0.52
Loamy	0.5	0.6	0.72
Heavy clay	0.6	0.7	0.82
30% asphalt	0.4	0.5	
50% asphalt	0.55	0.65	
70% asphalt	0.65	0.80	

Runoff estimation method in the city of Saleh Abad:

It is evident that for the accurate recognition of the intensity of the runoff waters on an urban level there is a need for the runoff height to be determined. The runoff height estimation method is one of the other computation methods in this part of the calculations which are required for completing the urban hydrology studies. For the calculation and determination of the runoff height we can take advantage of the relation **H=CP.**

Where,

H= runoff height;

P=rainfall or precipitation rate; and,

C= runoff coefficient.

According to the fact that the approximate area of the city has been calculated as being equal to 136 ha and the objective observations indicate that 70% of the road system is asphalted, C coefficient has also been computed as being equal to 0.80 and thus the numerical calculations for this urban area are as follows:

P has been calculated based on the maximum 24-hour average rainfall during March and April.

H=0.80 × 30.97

H (runoff height) = 24.77

The study of the runoff and flood Debi and height in the city of Saleh Abad:

In this section, we compute the runoff Debi of the waters flowing across the city during March and April and then finally we deal again with the runoff Height.

$$\mathbf{Q} = \frac{1}{36} CIA$$

Where,

THE IIOAB JOURNAL
ISSN: 0976-3104

$$\mathbf{Q} = \frac{1}{36} \times (0/80) \times \frac{31}{10} \times 136 = 9/37$$

So, based on the aforementioned formula, the runoff Debi of the road system in the city of Saleh Abad has been obtained as equal to 9.37 in cubic meter/sec. And this figure is considered very high and considerable and thus in case of a heavy rainfall it will unavoidably result in the occurrence of floods and therefore the municipality and the related administrative offices are required to get prepared for the flood occurrence during March and April with a height of 24.77 mm and a Debi of 9.37 (cubic meter/sec).

The runoff and flooding images taken in 2007 for the city of Saleh Abad and the flooded area and the urban road system filled with water streams is well reflective of the incident and it is a testimony for the accurate management and investigation importance.

The calculation of the coefficients influencing the creation of the water streams and runoffs across the city:

To get more detailed information of the water streams flowing in the area and the likely risks that may bear we need to have more informed awareness of the impact factor of the flood occurrence and intensity. The most significant factors regarding the theme of the current study are:

- The maximum 24-hour precipitation average;
- Snowfall rate;
- Soil permeability type;
- Slope;
- Gralius coefficient;
- Vegetative cover;
- Urban area shape and form.One coefficient which needs to be studied in the investigation on runoffs and floods occurrence is the sum of the maximum 24-hour precipitation rates and this has been found to be happening more during March and April for Hamadan Province with its climatic conditions and characteristics and every precipitation level has been found to be indicative of a different impact coefficient.

Table 2: the 24-hour precipitation impact coefficient rate

The index of interest	Months of interest	Precipitation rate
The average sum of the maximum 24-hour precipitation	March and April	Less than 32
The average sum of the maximum 24-hour precipitation	March and April	32- 37
The average sum of the maximum 24-hour precipitation	March and April	37-42
The average sum of the maximum 24-hour precipitation	March and April	42 and higher

Heavy rains result in the river bed overflow or the rising of the free aquifers water table and these are per se factors contributing to the occurrence of runoffs and floods. Such forms of heavy rains have been observed to sometimes be the cause of floods and landslides which are usually followed by disastrous [6]. The average sum of the maximum precipitation rate within a 24-hour period in the city of Saleh Abad during March and April in some of the years has been reported to be 31 and in some others it has been calculated to be 32. And it is worth mentioning that according to the existing studies in the development plan of the city the precipitation impact factor for the occurrence of the runoffs and floods has been obtained as being equal to 3 for the city of Saleh Abad and in order to get aware of the likely risks there is a need for the other indices and subjects to be studied and also according to the cold climate of the province the precipitation distribution system of the province and the number of the snow falling days which accounts for 45% of the precipitation total during a year can be studied from other aspects and dimensions and with having the following information available we can better map the impact factor of the interest for the city of Saleh Abad.

- The sum of the precipitation levels from November to February in the form of snowfall of less than 45 mm
- The sum of the precipitation levels from November to February in the form of snowfall from 45 mm to 60 mm
- The sum of the precipitation levels from November to February in the form of snowfall from 60 mm to 75 mm
- The sum of the precipitation levels from November to February in the form of snowfall 75 mm and higher

THE IIOAB JOURNAL
ISSN: 0976-3104

The climatic studies of the city of Saleh Abad indicate that the snowfall rate has been 63.6 mm and considering this precipitation rate the impact factor in the occurrence of the runoffs and floods has been obtained to be equal to 6.6.

The runoffs resulting from the precipitation is a critical source of pollution which exerts a great deal of effect on worsening the quality of the water in the urban areas and it has been known to sometimes be carrying heavy metals, fertilizers, pesticides, bacteria and some organic matter [7] and dealing with such issues is out of the current study scope and in continuation to this part of the study it can be stated that, in sum, and up to the present time the 24-hour precipitation impact factor obtained for the present study area is indicative of a considerable figure and in order to figure out the real status quo of the runoffs creation in the current study area there is a need for the other indices to be also investigated and in the following sections it is noteworthy that after precipitation (snowfall and rainfall) the theme slope and the survey of its status in the study area seem to be of the highest priority and its effect in the present study area on the flood and runoff occurrence can be classified as below:

- The area average slope of less than 6
- The area average slope of between 6 and 12
- The area average slope of between 12 and 18
- The area average slope of above 18

The studies conducted show that the average slope in the city of Saleh Abad is about 7.91 and its impact factor for the occurrence of the floods and runoffs in the city of Saleh Abad has been obtained as equal to 4, but it has to be noted that the effect and the intensity of the runoffs and floods across the cities is in an integral factor related to the ground structure type and the soil permeability which is evaluated under the title of soil class within the flood comprehensive categorization schemes. The rainfall effect and impact on the ground depends on its individual droplets energy and its physical characteristics as well and when these droplets hit the ground cause degeneration and weathering on the soil surface and the soil constituents and cause the constituent particles of the soil to disintegrate and this is what predominantly affecting the runoffs intensity and strength [8]. In line with what was just said, the topic of the soil permeability class should be taken into special consideration. The soil permeability class which is determined based on the soil type is one of the other factors contributing to the occurrence or intensification of the runoffs along the city road networks and passage ways and it is mostly investigated in various studies within 4 classes:

- Permeability class A: 7.5-11.5 mm per hour
- Permeability class B: 3.5-7.5 mm per hour
- Permeability class C: 1.5-3.5 mm per hour
- Permeability class D: 0.5-1.5 mm per hour

It should be noticed that as soon as the rainfall intensity exceeds the maximum permeability threshold in an urban area, the excess rain feeds the potholes and then it will flow in the form of a thin layer on the road surface and it is called the surface water. The surface streams flowing on the surface also exert an influence on the ground which depends on the intensity of the runoff waters [9] and it is usually calculated by computing the amount of the water passing a cross-section per time units. In the studies carried out based on the soil type and the city of Saleh Abad's geological surveys it has been found out that the soil permeability is classified as Type Cand it has also been figured out that its impact factor in the emergence of the surface waters and runoff waters and finally flood across the city is 5.1 which is considered an intensifying figure in creating runoffs and floods in the city but it comes as a surprise that under such circumstances dense vegetative cover can be an assisting factor and it can reduce the intensity of the damages and unfortunately the vegetative cover in the city of Saleh Abad is semi-sparse which has been shown to have a high coefficient in classifying the impact factor in creating floods and runoffs and as for the city of Saleh Abad this coefficient has been figured to be 6 and it has to be mentioned that the studies performed on the region regarding the impact factor has been revealing unpromising results which warns us for an increasingly greater focus on the issue. Of course, the vegetative cover classification in the studies on the creation of the runoffs in various areas is as stated below and the writer reckons making reference to such classifications can be of great importance in order to find a more comprehensive insight of the issue:

- dense vegetative cover,
- semi-dense vegetative cover,
- semi-sparse vegetative cover,
- sparse vegetative cover

The effect of the vegetative cover on the soil erosion is usually more complicated than it is imagined. The vegetative cover on the farm lands and the arboreal plants in striping cultivation which is corresponding to the contour lines reduces the runoffs and floods speed [10].

The area shape is one of the other factors influencing the floods and runoffs formation. And it has to be pointed out that in the subareas and the hydrological subunits there is made use of Gravelius coefficient.

THE IIOAB JOURNAL
ISSN: 0976-3104

To investigate the shape factor effect on the creation of the runoffs and floods in urban areas the Gravelius coefficient is used corresponding to the area shape as below:

- Gravelius coefficient: 1.7-2, very close to rectangular shape
- Gravelius coefficient: 1.5-1.7, close to rectangular shape
- Gravelius coefficient: 1.2-1.5, close to circular
- Gravelius coefficient: 1-1.2, very close to circular

And the studies undertaken based on the above-mentioned coefficient corresponding to the study area shape have indicated that the impact factor evaluated for the occurrence of the runoffs in the city of Saleh Abad is 4.5 and this impact factor is one of the most influential ones on the formation of the runoffs and floods in the areas across the city.

According to the factors and the indices which have been pointed out in the evaluation of the flood occurrence impact factor up to this point we can introduce an output to the runoff intensity estimation and model even flood-proneness discussed in the present study as below:

Table 3: flood proneness and runoff intensity estimation model output in the city of Saleh Abad

Name of the area	Maximum 24-hour precipitation	Snowfall rate	Area slope	Area shape	Ground texture	Vegetative cover	Total scores
Saleh Abad	3	6.6	4	4.5	5.1	6	29.2

It is deduced from the section just stated and the material presented therein that the entire cited factors and the impact factor as well are indicative of the significance of the surface streaming waters importance flowing in the city of Saleh Abad and the total sum of the study coefficients in contrast to the other areas in the province is suggestive of the idea that the city is among the highly risky flood-prone areas and when combined with the lack of the water collection systems and sewage systems and installations and fixtures multiplies the flood-driven damages to the residential locations, offices, road network and so forth and water accumulation across the city as well.

CONCLUSION

Since the researcher in the current study has attempted to determine the flood and runoff occurrence conditions and intensities within a specific temporal window and in the format of a field study therefore it can be stated that the most logical and most principle method and mean for staying secure and safe of the unpleasant outcomes resulting from the runoffs and urban floods and the damages and the losses they are usually accompanied with is the full-scale recognition of the conditions and the factors contributing to their occurrence in a local and regional scale because the more information and the more recognition is acquired about the nature, origins and the factors and particularly the occurrence timing the more the management authorities will be able to get prepared for neutralizing and resisting its inauspicious effects, dangers and dilemmas and regarding the issue it is worth mentioning that the most important dynamic parameter for the purpose of controlling the surface runoffs and reducing the flood risks and dangers should be sought out in the catchment areas management plans and the way the land uses are distributed and then these should be blended with the urban natural conditions (topography, slope, soil texture, vegetative cover, climate) in such a manner that the city development plans should not be allowed to proceed and executed without paying attention to this important theme studied within the context of the current study and it should be taken into consideration by the urban planners and designers in preparing the city building and development plans; the possibility for the flood occurrence in such plans should be combined with the determination of the ground flowing capacity and the landslide danger for every two hectares of the urban lands through the determination of an array of the ground conditions strength and weakness in creating and resulting in runoffs and undoubtedly one of the other most basic methods for combating the floods and water outflows in the urban areas is performing logistic programming in the entire spectrum of the river areas and preventing from the accumulation of garbage, dross, levees and wasted material on the river beds, city canals and streams and in case these activities are performed well the proper guidance of the concentrated waters can be easily fulfilled and it is here suggested by the researcher of the present study that the city should be divided into different physiological and hydrological areas in order for the surface water conductance projects to be better exercised and then the waters guided within such systems can be later deployed in the urban watercourses and

ISSN: 0976-3104

rivers and finally such a usability can be applied for taking advantage of the surface water systems in line with improving and enhancing the natural conditions at the periphery of the city and feeding the springs and the aquifers and ground waters would be a promising and sure outcome.

CONFLICT OF INTEREST

Authors declare no conflict of interest.

ACKNOWLEDGEMENTS

None.

FINANCIAL DISCLOSURE

None declared.

REFERENCES

[1] Tourism and Urban Development Consulting Engineers spores (1390). Saleh Abad city development plan.

[2] Meteorological Organization of Hamedan province.

[3] Moayedi Mohammad Persian date Ordibehesht 1392 National Conference on Flood Management Tehran.

[4] meeting, H., et al (1388). Recreation development riparian areas in the metropolis, Tehran, Center for the Study of Urban Planning Tehran.

[5] Nykchh et al., (1392). National Conference on Flood Management Tehran, May.

[6] Khaled, Prince (1380). natural disaster. Martyr Beheshti University Press.

[7] Human Descent (1380). Storm in urban hydrology of the basin. Chamran martyr of Ahwaz University

[8] Rajai, Abdul Hamid (1382). The use of natural geography of urban and rural planning. First Edition . Tehran, publisher side.

[9] Akan, Osman (1381). Storm in urban hydrology of the basin. Translate doctor said Iran lineage. First Edition. Martyr Chamran University Press.

[10] Zomorodian, MJ (1372). Geomorphology in environmental planning. Land (Korea) - uneven. Tehran, studying the books of Social Sciences.