Economic and Social Damage of the Flood to Nimrud area and its Management Methods

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Abstract: Since this study focuses on exploring the relationship between the variables, it is a correlation type and because of discovering the effective cause(s) of incidence is among the scientific studies. This research is a field study since the residents and local experts were referred for identifying the amount of economic-social losses and the information is collected through the questionnaire. Thus it can be stated generally that the methods used in this thesis are among the descriptive-analytical, correlative-scientific and field techniques. Geographically, the studied area (Nimrud basin) is located in the North East of Tehran in southern hillside of Central Alborz Mountains and is one of the sub-basins of Hablerud. It has five sub-basins namely Qazqanchay - Farrokhrud - Saleh Bon - Shahrabad - Omrak and the area of this region is 812.7km^2 and is selected for sampling and adaptation on the one hand and for comparing the flood susceptibility data on the other hand. In this study, three following main hypotheses have been examined: The flood in this area causes the negative social consequences; the flood in this area has the negative and economic consequences, and finally the flood control in this area is effective by using the structural and non-structural or traditional-new methods. Student's t hypothesis test has been used in order to evaluate the results. In this research, it is concluded that the above hypotheses are confirmed based on the field research and the results of calculations. On this basis, finally the suggestions have been proposed.
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Keywords: Nimrud Drainage Area, hydrology, topography, morphology

1. Introduction

Nowadays, the flood is the most common and costly natural disaster in the world and imposes the human and material losses and damage on the human population. For preventing and reducing the effects of flood, avoiding these risks, the ability to monitor and control the water level and related operations are so important. The studied area in this research is Nimrud drainage area where is located in the southern part of Central Alborz mountains north in North East of Tehran province and West of Firuzkuh County with the area equal to 812.7km^2 in the northern part of studied area. The hydrologic area of Nimrud is enclosed in Haraz River Basin in northern and western parts, in hydrologic area of Goorsefid in eastern part, in Hablerud and Delichay in southern part. Therefore, this research seeks to study and investigate Nimrud drainage area in terms of economic and social damage of flood and flood management and provide the strategies in this regard. The geographic location of this basin is shown in Figure 1.

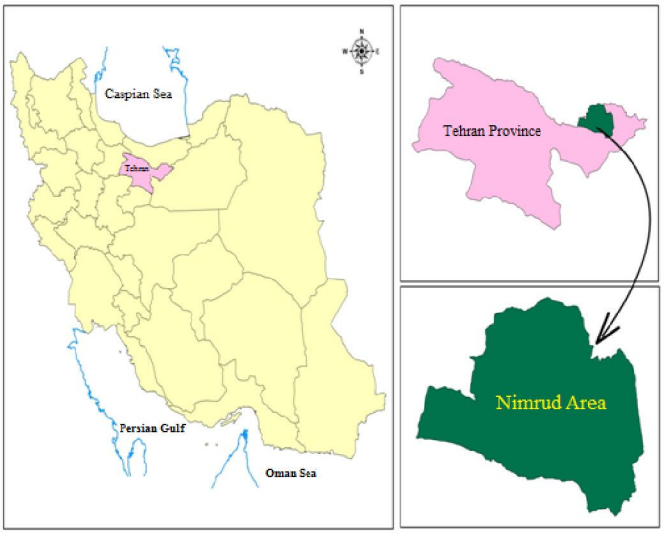

Figure (1) Geographic location of Nimrud drainage area

Nimrud drainage area is located in the north east of Tehran in the southern hillside of Central Alborz Mountains. This area is located between the geographic longitude 52° 16 10" to 52° 44 24" E and geographic latitude 35° 39, 06" to 35° 57, 11" N and is one the sub-basins of Hablerud. Based on the relative location, the highest point of Nimrud is located at an altitude of 4057 meters in Sefid Ab Mountain and its lowest point is located at an altitude of 1720 meters in the southwest area. Nimrud area is originated from the western part and flows from western to southeast side. Finally, after passing a distance of 53 km and integration of several sub-branches such as sub-basins of Qazqanchay, Shahrabad, Omrak, Farahrud and Saleh Bon at an altitude of 1720 meters this river joins Hablerud River.

Growing flood in recent years indicates that most of the regions in our country have been vulnerable to devastating floods and the number of financial and physical damage and losses of flood has been increased. According to the provided statistics by the United Nations, the flood and storm have caused the highest number of casualties and damage for the human societies among the natural disasters, so that the loss caused by the flood and storm has been over $21 billion against $18 billion loss of earthquake only in a decade. This is also true for our country and about 70 percent of annual credit of plan for reducing the effects of natural disasters and disaster headquarters in most of the past years has been spent on the damage caused by flood (Hejrati A. 2006). Table 2 shows the amount of damage caused by the flood during the years 1961 to 2001 in Iran.

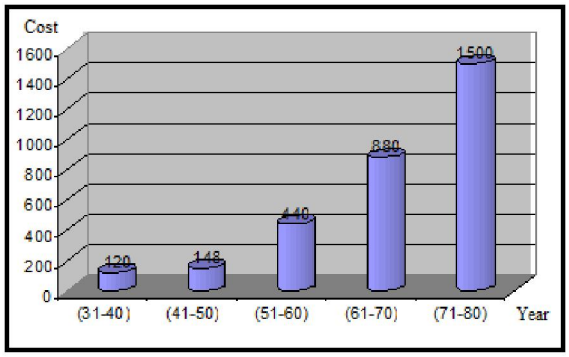

Figure (2) Amount of damage, caused by flood, during the years 1961 to 2001 in Iran
Source: Statistical Report of disasters

The main objective of this research is to analyze the economic-social damage in Nimrud area and the flood management, identifying the natural factors (Geology - Topography - Hydrology - Vegetation) and human factors (Land use change), which are more effective in the flood of Nimrud area, and to introduce the strategies for reducing the flood damage.

2. Research Literature

In the research literature, the concepts and definitions related to the watershed management studies are presented and the ideas and conducted research in this field in the country are introduced. Moreover, the results of the research conducted by relevant scholars and organizations, which conducted the research in this regard previously, are presented. A set of definitions in the field of watershed management is as follows.

Rainfall: Investigating the precipitation by using the rainfall histogram and comparing it with the corresponding flood in Nimrud area clearly indicates that the rainfall, which occurs as the showers with a high intensity, long duration, successive repetitions or wider area, is the origin of most of the great flood (Vatanfada, J., 2002).

Showers: Short-term showers with high intensity which fall locally on the small surfaces of mountainous areas or on partial surfaces of Partiajarea runoff in the great areas, in most of cases will lead to the severe floodwater which can cause the great damage on the path of subsidiary waterways without significant effects on the flow of main river (Ministry of Agriculture, 2003).

Hydrology: Watershed management id one of the essential components in the management of natural resources and the fundamental understanding of that sustainability is essential for designing and managing the renewable natural resources in the case of optimal use and access to the sustainable development at the national and regional levels (NETPA Consulting Engineers, 2004).

Leaf water: It refers to the amount of rainfall which is collected by the canopy. Four basic factors, which affect the absorption of rainfall by the canopy, are: species type, stage of plant growth, season and speed, rainfall intensity and duration (Razaghian, Hadi, 2007).

Temperature: Temperature is another important factor which plays a significant role in creating the spring torrents by affecting the snow melting (Hafezinasab, J., 2005).

Penetration: In most of the watershed areas, the Penetration factor is the most important hydrological component which determines the shape of runoff hydrograph. The major factors controlling the penetration are the soil type, season, previous moisture conditions, and the rainfall patterns (Roghani, M., 2006).

Vegetation: Vegetation is one of the factors which are effective in reducing the runoff and finally

the flood. This can be clearly seen in the forest areas and areas with suitable vegetation (Hafezinasab, J., 2005).

Climate and topography: Rivers, located in the watersheds area, are generally created according to the conditions of their formation (climate and topography) and are able to pass the flow based on the existing capacity (Omidvar, B., et al, 2006).

Basin Slope: This parameter has a significant effect on the speed of runoff and erosion of area. According to different directions of slope at the level of area, it makes the fundamental changes in absorbing the sunlight, melting the snow and rainfall distribution (Hayat-Gheibi, V., 2008).

River morphology: River morphology features such as river pattern, geometric stream bed properties, shape of bed, slope and its longitudinal sideview have the significant effect on the occurrence of flood and/or intensifying it. Among these properties, the slope is more important (Nosrati, A., 2005).

Petrology, geology and agrology of area: Hydrograph network model, which is a function of ground morphology properties and agrology, plays the important role in creating the flow of torrent. Reaction of main geological constituents and the soil produced by them play the important role in the generation of surface runoff and its severity. General landscape of area, the way of erodibility, the pattern of drainage, and finally the surface runoff generation are all affected by the geology and Petrology of area (Ministry of Agriculture, 1995).

Tectonic factors: Factors such as earthquakes, land embayment, slip of hillsides and land mass movement cause the disorder of shape and restrained order of rivers and sometimes lead to closed and accumulated water behind them and sudden discharge of river water; or the existing structures are demolished as the result of earthquake and then the devastating flood will be occurred (Hejrati, A., 2006).

Before the 1980s, it was emphasizes on the structural reduction of flood in 1970. During the 1970s, the capacity of a river against the flood was calculated in the evaluation studies. Findings of this case led to the development of non-structural methods in order to prevent the flood. During the 1980s, the plan and application of non-structural method became common. During this period, the relatively little importance attempt was done for the study of social, economic and political factors which affected the reduced flood. Lack of knowledge about applying these successful non-structural selection factors made problems for the reduction way. Furthermore, the researchers sought to evaluate the way of risk and vulnerability with high accuracy. Moreover, management programs of flood plain and the national program of flood insurance were introduced in this period. Flood geomorphology is one of the branches of river geomorphology which has been taken into account by the geology scholars and researchers particularly since the 1980s. Then the role of great and rare floods against the cumulative effect of flood with lower magnitude and higher frequency was emphasized in the eighteenth annual conference on the geomorphology entitled as the catastrophic floods in September 1987 (Baker et al, 1988). Two years later in 2000, Kreinbam et al have taken advantage of deposits of stagnant water and other natural factors including the existence of flood plain deposits such as sand, rocks and huge stones of erosion landscapes such as naked soil, bluffs and channels created by intense streams and wandering woods and damage to the vegetation in order to detect the old great floods (Benito, et al, 2005). Other sciences also helped in this regard quickly. In 2002, Lund provided an optimal combination based on the risk and sensitivity analysis for planning and management of flood plain from different methods of flood control and by using the linear program.

Some of the conducted studies in the field of flood in flood susceptible areas of Iran have been presented in Table 1 and they have been applied as the bases for the study of research area in this paper.

Table (1) Conducted studies in the field of flood in flood susceptible areas

No	Title	Researcher
1	Zoning of the flood in a part of Lighvan river by using (GIS), 2004	Ali-Akbar Bavil
2	Evaluating the effect of temporal and spatial distribution of rainfall on the flood status in a part of drainage basin Gorganrud, 2004	Hadi Razaghian
3	Estimating the maximum flood discharge by using the empirical relationships based on surface and other properties of area (Case Study: Lorestan)	Hossein Eslami
4	Investigating the flood status of country: problems and bottlenecks	Jabbar Vatanfada
5	Challenges and village participation values in flood and land management	Ahmadreza Ahmadi
6	Introducing a new method for the study and implementation of flood control in urban and rural areas by using the model RAFTS	Mohammad Roghani

7	Investigating the spatial effect affecting the flow of flood peak in order to reduce the hazards of flood (Bagh-e Malek and Manjiq Bridge basins)	Mohammad Roghani
8	Numerical simulation of two-dimensional changes in mobile-bed of river for estimating the height of flood wall	Hossein Fathian
9	Zoning the flood hazard by using the Geographic Information Systems (GIS) (Case River: Babolrud)	Golaleh Ghaffari
10	Evaluating the role of human interventions on the flood behavior in a part of Kan Creek in Tehran	Mohammad Haji Gholizadeh
11	Investigating the causes of flood occurrence in Golestan Province and the ways to prevent it	Javad Hafezi-Nasab
12	Evaluating the flood risk and management in Gorgan city	Mojtaba Khalilizadeh
13	Prioritizing the factors affecting the flood susceptibility and providing the quantitative model by using (GIS). Case Study Kan Basin	Zahra Samadi
14	Application of neural network in estimating the flood of Death (Marg) river in Kermanshah province	Vahid Hayat-Gheibi
15	Determining the role of watershed sun-basins in the intensity of flood susceptibility of basin (case study: Damavand basin)	Mohammad Khosroshahi
16	Zoning the flood susceptibility of Gavrud basin by using the remote assessment and GIS	Abdollah Nosrati
17	Zoning the flood by applying the software HEC RAS in the flood plain Silakhor Boroujerd	Hossein Zeinivand
18	Zoning the flood risk and investigating its properties in a part of middle Atrek	Mohsen Tavakoli
19	A comparative study of different streams, estimating the flow of maximum flood based on the catchment area (Case Study: Gilan province)	Saeed Jafarzadeh
20	The role of local and new knowledge in reducing the environmental damage in rural areas (case study: Khvor Rostam District)	Narges Vazin

3. Research Methodology

Since this study focuses on exploring the relationship between the variables has the correlation type and is among the scientific studies because it seeks to discover the cause(s) of effective incident factors. The research is a field study because it refers to the local residents and experts and the information is collected through the questionnaire in order to detect the rate of economic- social damage. In general, it can be stated that the methods used in this thesis are among the descriptive-analytical, correlative-scientific and field techniques.

3.1 Statistical Population and Sampling method

The studied area (Nimrud basin) is located in the North East of Tehran in southern hillside of Central Alborz Mountains and is one of the sub-basins of Hablerud. It has five sub-basins namely Qazqanchay - Farrokhrud - Saleh Bon - Shahrabad - Omrak and the area of this region is 812.7km^2 and is selected for sampling and adaptation on the one hand and for comparing the flood susceptibility data on the other hand.

3.2 Data collection

In terms of necessity and nature of subject, the collected information and data in this study are classified into two main categories each which require the specific collection method.

A. Document and library method: Data collection in this method includes the theoretical principles of subject, research background and literature and other scholars' studies, environmental conditions and variables affecting the economic and social consequences of flood. This data has been largely collected by the library method.
B. Observing method: It includes direct observations through the field operation and the indirect observations through the map and picture.

3.3 Geomorphologic properties of Nimrud drainage area

Geomorphologic properties of Nimrud drainage area have been presented in Tables two and three as follows.

Table (2) Amount of expansion (area) and quality of geomorphologic facies distribution

Unit	Type	Facies	Geomorphology Signs	4/2/1	4/2/2	4/2/3	4/2/4	4/2/5
Mountain	Regular hillside	Rock Baghradeh	Mro	392.29	1080.8	3203.33	2146.54	2568.33
		Rock Outcrop	Mro	6813.06	5622.92	8123.57	9259.05	2225.89

		Covered	Mrc	4289.51	1638.38	1035.46	2645.42	69.40
	Irregular hillside	Rock mass	Mio	1581.12	1705.18	2374.80	2340.62	683.118
		Rock outcrop	Mio	240.183	336.99	466.24	1074.31	
		Covered	Mic			515.83		
mound	Regular hillside	Rock mass	Hro		117.15		37.9	997.42
		Rock Outcrop	Hro	32.07	296.75	198.93	1295.00	6195.09
		Covered	Hrc	89.46	142.68	63.11	406.42	380.86
	Irregular hillside	Rock mass	Hio	268.54	77.97	34.38	221.99	1670.28
		Rock Outcrop	Hio				310.81	1408.59
		Covered	Hic					
Plain	Wide	Speed Plain	DrG		16.37			
		Covered Plain	DrGV					
	Intermountain	Intermountain plain	drc	252.50		16.76	151.24	892.49
River	Sediments		QaI	107.89	64.43	334.96	551.13	540.95
	Alluvial terraces		T	52.36			112.66	29.13
	Span Alluvial fan		QF	304.13	334.66	265.77	456.51	116.96
Total				**14423.75**	**11434.31**	**16633.13**	**21008.89**	**17778.57**

Table (3) Percentage of expansion and quality of identified geomorphologic facies distribution

Unit	Type	Facies	Geomorphology Signs	4/2/1	4/2/2	4/2/3	4/2/4	4/2/5
Mountain	Regular hillside	Rock Baghradeh	Mro	2.72	9.45	19.26	10.22	14.45
		Rock Outcrop	Mro	47.23	49.18	48.86	44.07	12.52
		Covered	Mrc	29.74	14.33	6.23	12.59	0.39
	Irregular hillside	Rock mass	Mio	10.96	14.91	14.28	11.14	3.84
		Rock outcrop	Mio	1.67	2.95	2.80	5.11	
		Covered	Mic			3.10		
mound	Regular hillside	Rock mass	Hro		1.02		0.18	5.61
		Rock Outcrop	Hro	0.22	2.60	1.20	6.16	34.85
		Covered	Hrc	0.62	1.25	0.38	1.93	2.14
	Irregular hillside	Rock mass	Hio	1.86	0.68	0.21	1.06	9.39
		Rock Outcrop	Hio				1.48	7.92
		Covered	Hic					

Plain	Wide	Speed Plain	DrG		0.14			
		Covered Plain	DrGV					
	Intermountain	Intermountain plain	drc	1.75		0.10	0.72	5.02
River	Sediments		QaI	0.75	0.56	2.01	3.62	3.04
	Alluvial terraces		T	0.36			0.54	0.16
	Span Alluvial fan		QF	2.11	2.93	1.60	2.17	0.66
Total				100.00	100.00	100.00	100.00	100.00

Soil erosion alters the hydrological and ecological balance of watersheds and the environment becomes unstable. In the upper part of Nimrud area, the soil particles are transferred and moved due to the water power and in transferring and moving the soil particles by water power the effects are created in the first place, where the particle were taken, and they can be seen in different forms. Tables 4 to 8 provide the details of soil erosion in this area.

Table (4) Amount of surface erosion expansion in hydrologic unit of Nimrud

Hydrologic unit code	Low surface erosion S(1)		Moderate surface erosion S(2)		High surface erosion S(3)		Total
	Ha	Percent	Ha	Percent	Ha	Percent	Area in hectares
4-2-1	6030.9	3.2	7377.6	3.1	1015.1	0.5	14423.6
4-2-2	424.6	0.2	10373.7	4.4	636.0	0.3	11434.3
4-2-3	1190.8	0.6	14626.9	6.2	815.2	0.4	16633.0
4-2-4	4722.8	2.5	9517.3	4.0	6768.8	3.7	21008.8
4-2-5	9016.2	4.8	6080.3	2.6	2682.2	1.4	17778.8

Table (5) Amount of rill erosion expansion in hydrologic unit of Nimrud

Hydrologic unit code	Low rill erosion		Moderate rill erosion		High rill erosion		Very high rill erosion	
	Area in Ha	Percent	Ha	Percent	Ha	Percent	Ha	Percent
4-2-1	4016.6	3.9	5921.2	5.8	3470.6	1.6	1015.1	0.5
4-2-2	424.6	0.4	0	0	10002.6	4.6	1007.2	0.5
4-2-3	119.9	1.1	0	0	14492.0	6.7	650.2	0.5
4-2-4	4718.2	4.5	8097.5	7.9	1033.1	0.5	7160.1	3.8
4-2-5	1904.9	1.8	2859.6	2.8	4877.8	2.2	8136.4	4.4

Table (6) Amount of stream erosion

Hydrologic unit code	Very low		Low		Moderate		High	
	Area in Ha	Percent	Ha	Percent	Ha	Percent	Ha	Percent
4-2-1	6030.9	3.7	2700.6	7.5	4485.7	2.0	1206.3	1.4
4-2-2	424.6	0.3	00		10638.6	4.7	371.2	0.4
4-2-3	1190.8	0.7	00		15307.2	6.8	135.0	0.1
4-2-4	6337.6	3.8	1024.6	2.9	7807.4	3.5	5829.0	0.1
4-2-5	5281.7	3.2	392.1	1.1	12104.4	5.4	00	00

Table (7) Area of slip plane in Nimrud area

Hydrologic unit code	Area in hectares	Area of slip plane in hectares	Percent of slip plane per hydrologic unit plane

4-2-1	14423	4522	31.1
4-2-2	11434	10639	93.05
4-2-3	16633	15307	92.02
4-2-4	21009	7404	35.24
4-2-5	17779	7560	42.52

Table (8) Status of current erosion in Nimrud area

Geology	Climate	Topography	Land surface	Land use	Soil	Streams and rivers	Current status of erosion in the area		Total
y1	y2	y3	y4	y5	y6	y7	y8	y9	R
4.10	12.14	3.27	8.90	13.16	3.52	5.60	13.42	8.84	72.76
3.19	11.71	3.26	9.50	13.79	4.02	5.84	22.33	12.80	86.43
3.18	11.85	3.27	9.43	13.75	4.04	5.79	21.81	12.39	85.50
4.18	9.36	3.04	10.03	13.53	4.71	5.14	15.58	11.15	76.19
4.65	6.80	3.04	9.58	13.13	4.40	5.15	16.89	10.22	73.77

The whole aqueducts join Nimrud River after and joining together. The heights of area enjoy it at least 5 to 6 months of year and even more than 8 months. Nimrud River is one of the major branches of Hablerud. It originates from hillsides of Rangarzadegan mountain in 31 km north-east and joins Omrak River in two km west Aliabad village, then pours into Hablerud in one km before Khomedeh Village. This river passes 54 km length of bed is in the twisting mountain. Properties of water resources in Nimrud area have been provided in Table 9.

Table (9) Water resources in Nimrud area

Hydrologic unit name	Surface water	Groundwater	Well	Spring Crater	Aqueduct
Qazqanchay	5.34	3.16	0	19	0
Omrak	4.37	1.83	0	96	0
Farahrud	9.25	1.05	0	107	0
Saleh Bon	27.24	1.87	7	83	2
Shahrabad	16.11	3.69	25	46	3

Hydrology features of Nimrud drainage area are shown in tables. The concentration time is the time when the rainwater requires reaching the output point from all parts of basin; it has been calculated by Chou method as follows.

$TC = 0.00032\ (L^{1.15} \div h^{0.385}) = 0.000325\ (53^{1.15} \div 2337^{0.385}) = 4.44$

In this formula,

L = Length of largest water way in the area in kilometer

H = Height difference between the lowest and highest point of area in meter (1720-4057)

Evaluating the amount of monthly water discharge at Nimrud station indicates that April with a percentage equal to 15.18 is among the highest water level months of year. The amount of water discharge in Nimrud area has been presented in Table 10.

Table (10) Amount of monthly discharge at Nimrud station (Hablerud)

Station	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Annually	Parameter
Nimrud (Hablerud)	7.90	6.12	5.39	5.49	5.44	6.95	15.18	13.97	10.22	8.36	5.88	6.94	6.94	Monthly maximum

	0.01	0.02	0.07	0.13	0.08	0.04	0.88	0.15	0.09	0.05	0.05	0.01	0.13	Monthly minimum
	3.54	3.74	3.58	3.24	3.20	3.81	5.53	6.98	5.59	4.13	3.31	2.92	4.13	Average

Based on the specific topography, the basins have different shapes. Gravelius Compactness coefficient has been calculated for evaluating the shape of Nimrud area as follows. Compactness coefficient (Gravelius method) is the ratio of area perimeter (P) to the perimeter of imaginary circle which its area is equal to the area of basin.

$$G = 0.28P \div \sqrt{A} = 0.28\ (139) \div \sqrt{812.7} = 1.37$$

In which, G is Gravelius coefficient, P perimeter and A the area of basin.

If the basin is a full circle, the compactness coefficient will be equal to 1, otherwise the coefficient will be higher than 1. The more this index is higher than 1, the more the shape of this basin will be longer. According to the above formula, the obtained correlation coefficient for Nimrud area is equal to 1.37. The obtained value for basin represents the circularity of basin.

3.4 Research Tools

Research Tools are generally classified into two main groups.

1- Hardware which includes:

- Different topographic and geologic maps as the basic maps for recording the field data and determining the position of phenomena and effects according to Hablerud reports.
- Topographic maps with scale 1.50000 published by the Armed Forces Geographical organization according to Hablerud reports.
- Geologic maps with scales 1.250000 and 1.100000 published by the Geological Survey and Mineral Exploration of Iran according to Hablerud reports.
- Satellite pictures taken by the Armed Forces Geographical organization for investigating the changes of target area.
- Land use maps with scale 1.250000 of Tehran province according to Hablerud reports prepared by the Institute of Soil and Water.

2- Knowledge tool including:

- According to the hypotheses of this study, the way of conducting this research is descriptive and analytical and with emphasis on field and questionnaire survey and the model HEC-GEORAS will be used for flood zoning.
- The Geographic Information System and its models and software related to the GIS will be used for analyzing the field data and information.
- Software EXCEL has been used in order for data entry and analysis and for preparing the required maps and also the software Arc view and Arc GIS has been used in this paper.
- Mathematical equations and formulas and experimental models are considered as the major conceptual tools of research which have been used in analyzing the data and information and analyzing the processes.

3.5 Reliability and validity of questionnaire

The *validity* of a study refers to the accuracy of indicators and criteria which have been made for examining the target phenomenon. Since the data collection tools in this study include the hardware (maps and satellite images) and knowledge tool (computer software and mathematical formulas and calculations), it is not necessary to do the validity of the calculation. The questionnaire is the data collection tool in the field research section. In this study, the information is collected by using the questionnaire with closed questions (seven options). Designed questionnaire was first distributed among the preliminary samples (30) of statistical sample and its defects were resolved and modified according to the experts' opinions. At the next stage, the final standardized questionnaire was distributed and collected after determining the validity. The models such as Spreitzer and Neefe's questionnaires have been used in order to design the questionnaire. Since both questionnaires are standard, their validity has been confirmed in numerous domestic and foreign studies.

The reliability indicates that to what extent the measurement tool yields same results in same conditions. In other words, "How much is the correlation between a set and of scores another set in an equivalent test which has been obtained independently on a subject group". The reliability of this research has been determined in this research by using the Cronbach's alpha. After collecting the initial data in this study with 15 questionnaires, the calculated Cronbach's alpha is equal to 0.87 and this indicates the high reliability of research.

3.6 Conceptual model of research

Integrated flood management is based on the broad concepts, which are the combination of policies, arrangements, physical and financial criteria, and focuses on the way of dealing with the flood within a framework based on the controllability and usefulness of some of the flood effects. Conceptual model of flood management is shown in Table 3.

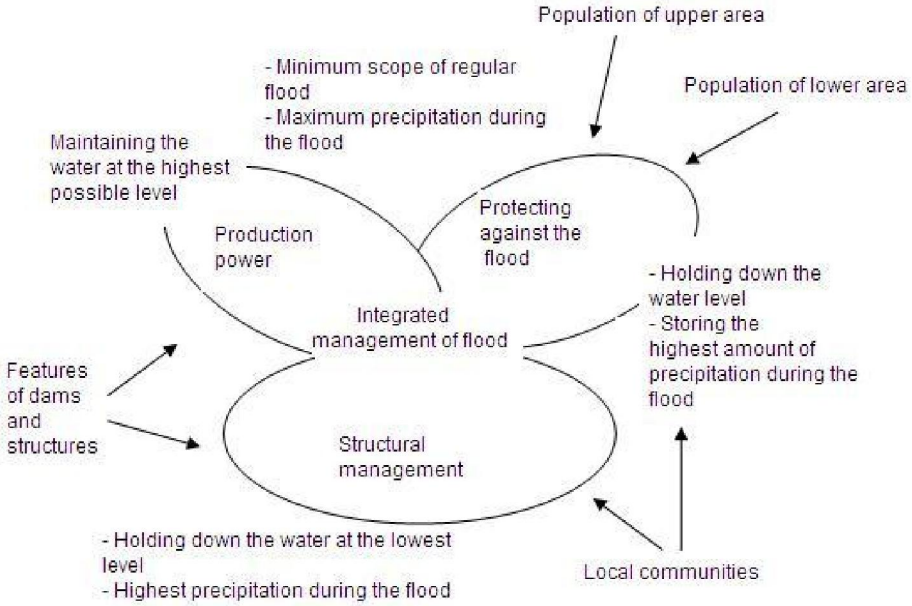

Figure (3) conceptual model of integrated flood management

4. Conducting the research

In this study, three main hypotheses have been tested as follows.

1. The emergence of flood in this area has the negative social consequences.
2. The occurrence of flood in this area has the negative economic consequences.
3. Control of flood susceptibility in this area is effective by using the structural and non-structural or traditional-new methods.

Student's t Hypothesis test is used in order to check the results. The results of calculations are presented as follows based on the order of hypotheses.

- First Hypothesis

Based on the field findings and results of Student's t test, the calculated mean equal to 12.5 and also the significant level in the alpha area 0.05 equal to 0.000 indicate the significant agreement among the residents' attitudes. Therefore, the hypothesis, which states that the flood occurrence in this area has the negative social consequences, can be accepted. Results of student's t- test are shown in Table 11.

Table (11) Results of student's t- test for understanding the status of social consequences

	Number of observations	Mean	Deviation	Standard error
Social consequences	198	12.5707	1.92830	0.13704
	Test Value = 4			
	Value	Degrees of freedom	Significant level	
	91.732	197	0.000	

The map of flood susceptibility zoning is presented in the following figure:

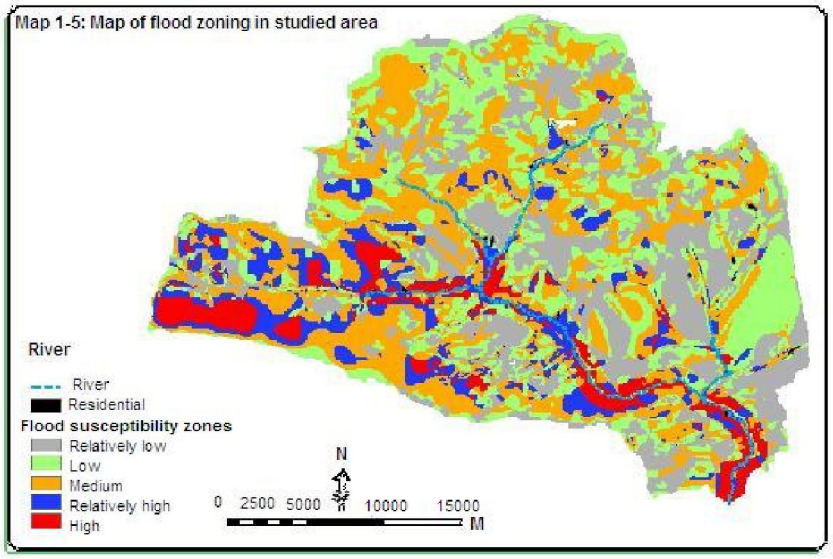

Figure (4) Map of flood susceptibility zoning

- Second Hypothesis

In order to understand the economic consequences of flood, three main criteria of damage to buildings, agriculture products and public infrastructures have been studied; moreover, based on the field results, results of Student's t-test, calculated mean equal to 14.3 and also the significant level equal to 0.000 obtained in the alpha area 0.05, there is a significant agreement among the residents' attitudes. Therefore, the hypothesis, under which the occurrence of flood has the negative economic consequences in this area, can be accepted. The results of student's t-test are shown in Table 12.

Table (12) Results of student's t-test in order to understand the status of economic consequences

	Number of observations		Mean	Deviation	Standard error
Economic consequences	213		3.14	1.62	0.11402
	Test Value = 4				
	Value	Degrees of freedom	Significant level		
	88.432	213	0.000		

The map of land use method for Nimrud river area has been presented as follows:

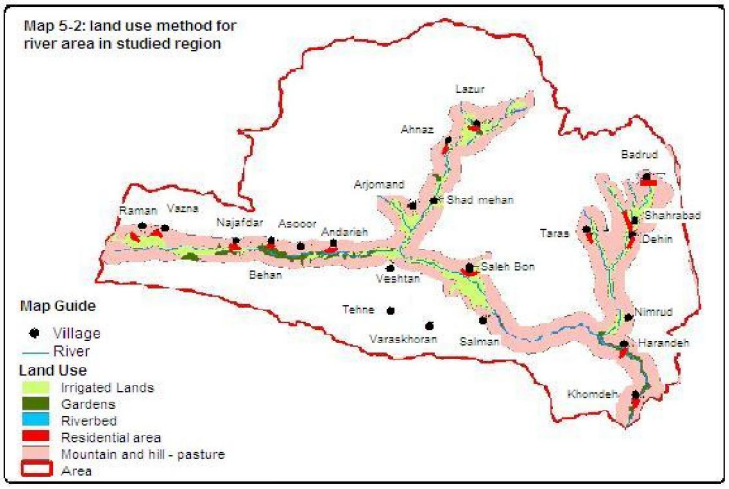

Figure (5) Map of land use method for Nimrud river area

- Third Hypothesis

Using the modern and local methods is today as one of the appropriate measures in line with improving the flood risk management. Evaluating the mean of obtained responses equal to 15 and also the calculated significant level in alpha area 0.05 equal to 0.000 indicate the significant agreement among the residents. Therefore, the hypothesis, under which the control of flood susceptibility in this area is effective by using the structural and non-structural or traditional-new methods, can be accepted. Results of student's t-test are shown in Table 13.

Table (13) Results of single-sample student's test for future flood risk management

Criteria	Responses mean	Number	Test Value	T Value	Significant level
Using the management methods	15	296	4	15.255	0.000

5. Conclusion

In this study, three main hypotheses under which the occurrence of flood has the negative social consequences in this area, the occurrence of flood has the negative economic consequences in this area and finally the flood susceptibility control in this area is effective by using the structural and non-structural or traditional-new methods, have been examined. Student's t-test has been used in order to study the results. It has been concluded in this study that the above hypotheses can be confirmed based on the field research and results of calculations. On this basis, the following suggestions are offered.

- Suggestions

The following suggestions are offered according to the studies and results of research for Nimrud area.

1. Land Use Management can increases the land resistance through optimizing the rules of sheep and goat grazing and developing the region of vegetation.
2. Procedures associated with the refinement and rebuilding of canals and aqueducts before starting the rainfall and melting the heavy snow can reduce the flood damage.
3. Creating a warning system is essential for preventing and minimizing the economic and social damage caused by flood. A regular program for using in critical conditions should include the initial warning system and management by using various methods for controlling it. Providing the predictive models, manufacturing the tools and electronic model for entering the data through the satellite images and earth radars are recommended.
4. Manufacturing two warehouses with volume 50 million m^3 in Nimrud area lasted 5 years. Improving and optimizing the land cover and arranging the vegetation and countryside during 10 to 20 years and controlling the number of livestock and livestock grazing and people's more attention for participation and cooperation in planning for flood management and prevention are suggested.

The location map of proposed reservoirs has been presented as follows as one of the main recommendations of this study:

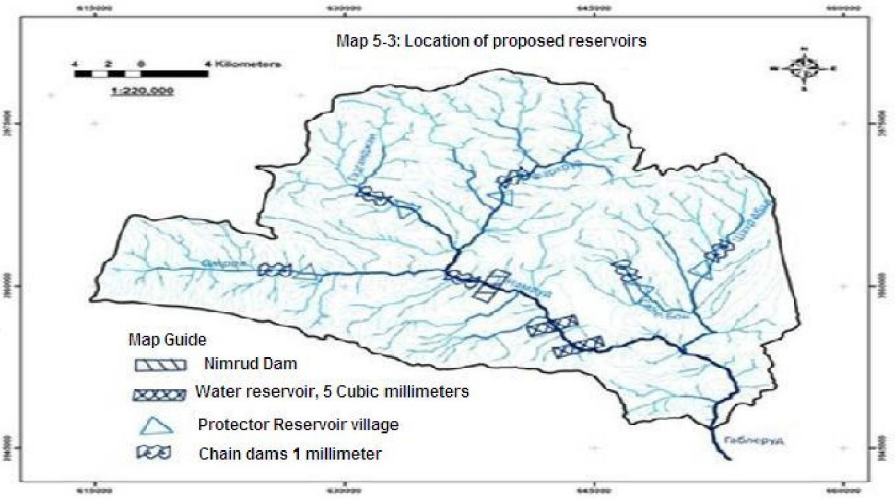

Figure (6) Location map of proposed reservoirs

- Research Recommendations

- It is recommended that more variables should be examined in future research in this area.
- Researchers should use the structural or non-structural methods in their own future studies.

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