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Urban Floods and Importance of Them in Cities Security Planning (Case Study: Dominant Watershed on Zavvareh City)

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***Abstract*—**Development of cities and villages, agricultural farms and industrial regions in abutment and/or in the course of streams and rivers or in prone flood lands has been caused more notations in hydrology problems and city planning topics. In order to protection of cities against of flood damages, embankment construction is a desired and scientific method. The cities that located in arid zones may damage by floods periodically. Zavvareh city in Ardestan township(Isfahan province) with 7704 people located in Ardestan plain that has been damaged by floods that have flowed from dominant mountainous watersheds in past years with regard to return period. In this study, according to flowed floods toward Zavvareh city, was attempt to plan suitable hydraulic structures such as canals, bridges and collectors in order to collection, conduction and depletion of city surface runoff.

***Keywords*—**Flood, flood way, executive consideration, embankment, surface runoff network, Zavvareh.

I. Introduction

TODAY, it is obvious that in the arid and semi arid zones almost often of them have flood damages because of their development and physical expansion.

Increasing flood damages tendency in two past decades has caused a changing in management approaches from complete and certain control of runoff to attempt for reduction of its damages [7]. [4] in investigation of intensive floods found that except of limited conditions, the floods that occur in great watershed are as result of precipitation and human effects (on vegetation cover, soil, topography and river bed) has less importance. Surface runoff depletion problem is a main subject in security of populated regions against of flood damage and finally removing of probable damages in urban region [2].

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Some amounts of flood runoff can be import in urban texture despite of existing circle or linear embankment around cities, so that may be cause occurrence of serious problems such as terrific no facility, homes inundation, deposition of soil or mud in canals and streets, shops and commercial places damages by high water turbidity etc. Mentioned damages are more obvious in low land areas of cities.

Such cases have been occurred frequently in Zavvareh city in past years. These events have been caused serious damages to southern city embankment as bank erosion that resulted in its security reduction and uncertainty about stability against future floods occurrence. On this basis and according to respecting of these flood events in recent decade with various amount and intensity, it is necessary to study geomorphology and other characteristics of city dominant water ways in order to propose and plan suitable structure for security support.

The aim of this study was defined as redesign of Zavvareh city southern embankment on the basis of city dominant watershed hydrology assessments and other effective properties of the watersheds and streams.

II. Materials and Methods

A. Study Area Description

Study area is including non urban (out of city area) watersheds that are dominant to Zavvareh city in Ardestan township. Total area is 1316 km2. Zavvareh coordinates are as, 52o - 30' of eastern longitude and 33o - 25' of northern latitude. General geographic properties of Zavvareh city has been presented in Table I.

TABLE I
General Geographic Properties of Zavvareh City

Elevation from sea level (m)	Population	total dominate and effective watershed area on city (km^2)
975	7704	1316

The upstream water way of Zavvareh is as main drainage of surrounded regions. Important elevations of region are including palang mountain, Kajestan mountain, Marshinan mountain, takht-e-pachenar mountain and Jogan mountains with 2552, 2904, 3330, 2945 and 2615 elevation from sea level respectively, that all of them have located in south of Zavvareh city. Position of study area in Isfahan province has been shown in Fig. 1.

Fig. 1 Position of study area in Isfahan province

In order to dividing of study area to subwatersheds (hydrologic units) was used topographic maps (hard copy and digital format) and aerial photos [1] and then was controlled their boundary position accuracy by frequently field surveying, so total area of main dominant watershed was divided by to 13 subwatersheds (or hydrologic parcels/units) (Fig. 2).

Fig. 2 Position of 13 subwatersheds of study area

For assessment of flood discharges related to each subwatershed were determined climatic, geological, topographic, land use and vegetation cover properties of those. In water resources and hydrology and flood topics and runoffs and water ways nature in arid zones were used study references on this subjects such as [3], [6], [9], [10], [11], [12], [13]. In geological topics was used [5].

Nearest climatology station to study area is Ardestan synoptic station, where, maximum precipitation of it has been shown in Table II.

B. Embankment Types on Basis of Structure Position

TABLE II
MAXIMUM PRECIPITATION OF ARDESTAN SYNOPTIC CLIMATOLOGY STATION (MM)

Month	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sep.
Precipitation (mm)	44	33	70	51	70	75	96	57	5	3	5	0.2

In some study references, classification of embankment is from aspect of land value that will protect by embankment such as urban embankment and agricultural embankment. In some other study references embankments are classified to two main and secondary series on basis of importance and executive goals.

Main embankments construct for protection of high economic valued lands against flood damages with high return period occurrence, therefore they have maximum confidence level and highest degrees of protection and maintenance in all time of construction and utility life.

Secondary embankments are constructing between of main embankments and river or stream. These embankments can protect lands against floods with low return periods for agricultural using.

C. Water Ways Region Properties in Arid Zones

Most obvious characteristic of streams in arid and semi arid zones is no continuous water flow, where as they may have flash floods in some seasons in some years or may have low flow in another times, therefore it is not predictable for decision makers in this regions for any programming and planning. According to this property it is difficult and uncertain to determine desire return period of design floods in constructing hydraulic structures such as embankments.

D. Flood Design Determination with Accordance to Economic and Social Considerations and Standard Recommendation

According to structure of embankment and economic and social considerations it can be assumed various design flood indexes. Selection of each index depends on expected goals, importance of protected areas, technical problems and different practical obligations. Apart from design flood index, embankment construction is always with risk acceptance that depends on project useful time and selected risk of design flood. Risk amount can be calculated with following equation:

$$R = 1 - \left(1 - \frac{1}{Tr}\right)^{n}$$

Where:

n: project useful time (year) such as embankment

Tr: return period (year) of design flood.
R: expected or accepted risk

In Table III, has been presented return period of design floods according to projects useful time and accepted risk.

TABLE III
RETURN PERIOD OF DESIGN FLOODS ACCORDING TO PROJECT USEFUL TIME AND ACCEPTED RISK

Accepted risk (%)	Project useful time (year)							
	2	5	10	15	20	25	50	100
75	2	4.02	6.96	11	14.9	18	35.6	72.7
50	3.43	7.74	14.9	22.1	29.4	36.6	72.6	144.8
40	4.44	10.3	20.1	29.9	39.7	49.5	98.4	196.3
30	4.12	14.5	28.5	42.6	56.5	70.6	140.7	281
20	9.47	22.9	45.3	67.7	90.1	112.5	224.6	449
15	12.8	31.3	62	90.8	123.6	154.3	308	616
10	19.5	48.1	95.4	142.9	190.3	238	475	950
5	39.5	98	195.5	292.9	390	488	976	1949
2	99.5	248	496	743	990	1238	2475	4950
1	198.4	498	996	1492	1992	2488	4975	9953

UNESCO has reported world standard of design flood selection in several countries (as Table IV), also in this way flood standard selection has been considered as an agreement between primary investment and acceptance of flood occurrence damages according to Fig. 3.

TABLE IV
RETURN PERIOD PROPORTIONATE TO STANDARD DESIGN FLOOD IN SOME WORLD COUNTY

ountry name	Protected areas types					
	Commercial	Industrial	Urban (residential)	Rural	Agricultural	General
ustralia	50-100	50-100	50-100	-	5-50	-
runei arussala m	10	-	5	-	-	-
ulgaria	100-500	-	-	30-100	5-10	-
China	200	-	-	100	-	-
olombia	-	-	-	-	-	30
ormer) Czech lovakia	100	50	-	-	7-10	-
ng Kong	50-200	50-200	50-200	200-10	2-5	-
ungary	-	-	-	-	-	60
India	50	-	-	-	25	-
Japan	10-200	10-200	10-200	10-200	10-200	-
alaysia	5-100	5-100	5-100	5-100	5-30	-
ilippine	100	-	-	50-70	-	-
Poland	1000	500	-	100	20-100	-
Singapore	5	5	5	-	-	-
Turkey	100-500	100-500	-	-	-	-
Thailand	25-100	25-100	25-100	25-100	50-200	-
England	10-100	10-100	10-100	-	1-10	-
United state of American	25-100	25-100	25-100	-	5-25	-
Russia	1000	100	50	-	10	-
Venezuela	-	-	-	-	-	5-10
Vietnam	-	-	-	-	-	20-50

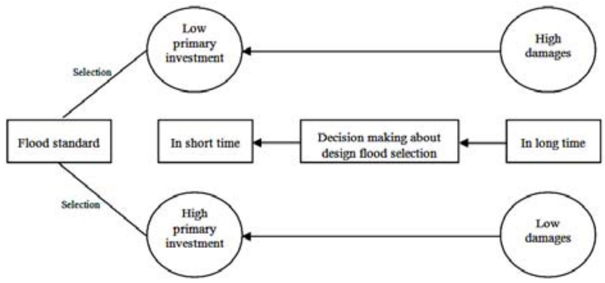

Fig. 3 Relationship between primary investment and occurred damages in long time in order to flood standard selection

III. RESULTS

A. Main Water Ways Network in Upstream of Zavvareh City

According to field surveying and needed control areas and using topographic maps and aerial photos with notation to local resident persons information it was distinguished that there is a main course of runoff from south and south- west to north aspect, so general city slope has south to north tendency, although in some city areas slope gradient has west to east tendency.

It is important to note that now exists a long and big embankment in all over of south city was been able to protect the city against flood damages in past several decades, although this embankment has been destroyed in some places because of road building, soil excavations, biologic activation of some animals and plants, etc. Figs. 4 and 5 shows position of embankment in south city and stream network too.

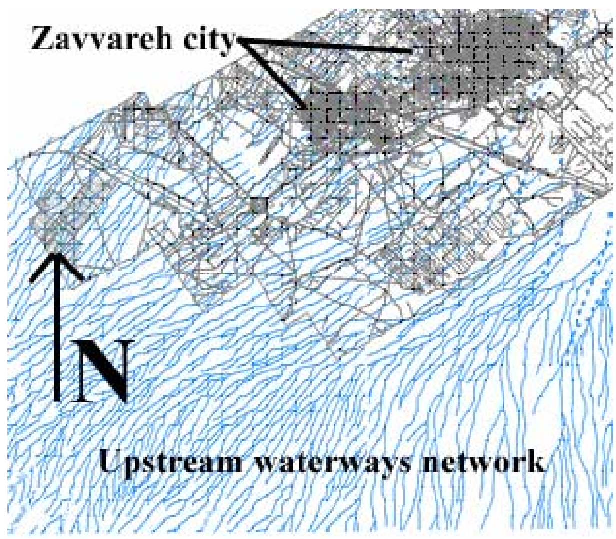

Fig. 4 Stream network in upstream of Zavvareh city (south aspect)

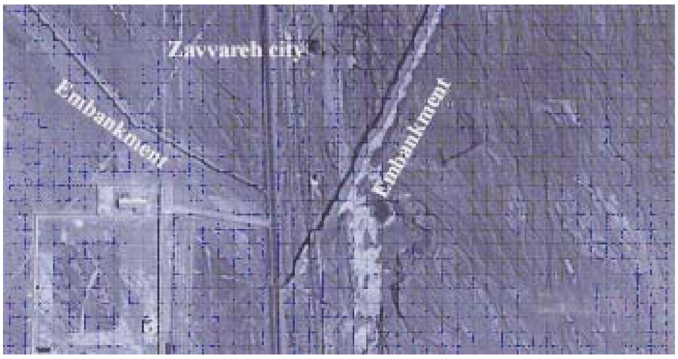

Fig. 5 Position of stream network and south embankment in south city of Zavvareh

B. Topographic and Geomorphologic Characteristics of Study Area

Study area is located in volcanic geologic zone of Urmieh-Dokhtar and is divided to two parts of volcanic and sedimentary stones.

General feature of study area is formed from mountainous areas and plain regions (Ardestan plain).

TABLE V
MORPHOMETRIC PROPERTIES OF SUBWATERSHEDS LOCATED IN UPSTREAM OF ZAVVAREH CITY(NASRI , 2004)

Subwatershed name	Area (km^2)	Main stream Length (km)	Average Slope (%)	Main stream Slope (%)	Average Elevation (%)	Elevation difference Between Outlet and maximum elevation (m)
Bagham	144.09	24.5	19.6	2.8	2153.04	815
Avanj	68.74	180	44.40	3.7	2184.52	765
Bideshk	69.22	18	30.50	2.4	2254.2	520
Neisian	128.30	16.5	18.40	1.9	2419.6	670
Ghahsareh	262.38	24.5	18.55	1.8	2270.27	800
Marbin	318.52	36.5	21.79	1.9	2073.8	1025
Dastjerd	45.28	14	13.8	2.9	2092.28	595
Sohr	50.77	14.5	8.4	2.2	2174.39	380
Godar-e-molla ahmad	127.99	21.5	4.6	1.6	2138.35	450
Mishab	308.98	31.5	10.41	1.6	2158.44	610
Zafarghand	1132.36	52.5	19.19	2.1	1829.26	1370
Kachumesghal	34.97	10	38.50	4.5	1878.8	620
Hendu abad	1316.72	64.5	21.20	2.1	1362.71	1635

C. Using Cn (Curve Number) Method in order to Estimating Flood of Zavvareh Upstream Subwatersheds

TABLE VI
ESTIMATED HYDROLOGIC PARAMETERS IN CN(SCS) METHOD IN THE SUBWATERSHEDS

Subwatershed name	CN	S (in)	TL (hr)	Tc (hr)	D (hr)	TP (hr)	QP (m^3/s)
Bagham	70	4.29	3.20	5.35	0.76	3.58	83.77
Avanj	73	3.70	9.66	16.13	2.30	10.81	13.25
Bideshk	72	3.89	1.90	3.17	0.45	2.13	67.85
Neisian	63.5	5.75	2.86	4.77	0.68	3.20	83.57
Ghahsareh	64.4	5.53	3.81	6.37	0.91	4.27	128.02
Marbin	75	3.33	3.63	6.07	0.87	4.07	163.09
Dastjerd	66	5.15	2.71	4.53	0.65	3.03	31.08
Sohr	68.5	4.60	3.35	5.59	0.80	3.75	28.24
Godar-e-molla ahmad	63	5.87	7.15	11.95	1.71	8.01	33.30
Mishab	68.5	4.60	5.59	9.34	1.33	6.26	102.83
Zafarghand	63.2	5.82	7.12	11.89	1.70	7.97	296.11
Kachumesghal	76	3.16	0.94	1.57	0.22	1.06	69.03
Hendu abad	65	5.38	7.62	12.73	1.82	8.53	285.04

QP: peak discharge, **TP**: peak discharge time, **D**: effective precipitation duration, **Tc**: concentration time, **TL**: lag time, **S**: storage coefficient, **CN**: Curve Number

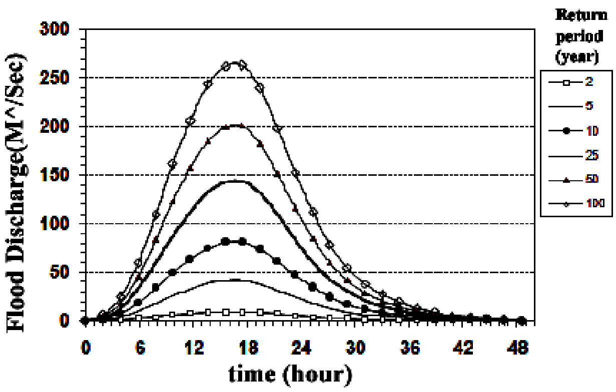

Fig. 6 Flood discharges hydrograph in the total upstream watershed

D. Economic Considerations and Project Optimization

In Fig. 7 has been showed economic analyze and project optimization in order to design flood selection in hydraulic projects related to flood control.

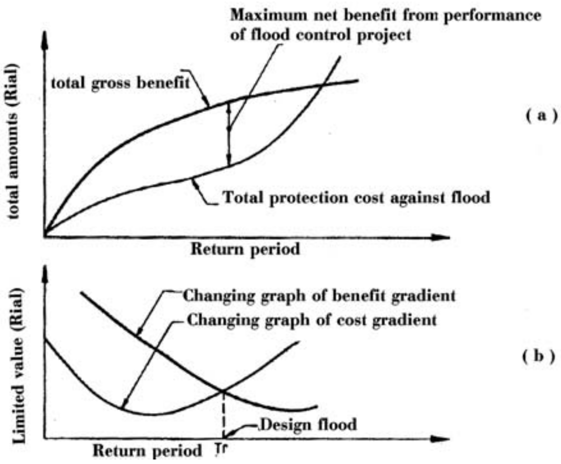

Fig. 7 General presentation of economic analysis (benefit and cost determination) and estimate of design flood in flood control projects on the basis of economic optimization

IV. Discussion and Conclusion

Accordance to mentioned preambles about arid zones waterways nature and Zavvareh upstream network of streams, it is possible that to determine accurate tendency of flowed runoff towards the city and applying protection measurements against flood damages. City development has been caused more changing in land use and more runoff coefficient because of increasing impermeable surfaces. With regards to existing of a main, circular and long embankment in south Zavvareh city and some destruction in its structure it is necessary that to assessment hydrologic parameters with specially notation to flood peak discharges with high return periods and finally redesigning of it for achievement to suitable and optimized security.

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