Prioritizing watershed basins for flood management based on morphometric features, case study: North Alborz, basins of Golandrood watershed

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Summary

Flooding process is one of the most complex and destructive natural disasters, which endanger the social and economic conditions of societies, more than any other natural disasters. Morphometric variables of basin, would be considered as some of factors which have an influence on flood initiating. This research is done with the aim of investigating flooding potential in sub-basins of Golandrood watershed, in the southern part of Rooyan district in Noor city in Mazandaran province, with a total area of 343.86 km2. This research also tries to prioritize watershed basins with the help of decision-making models. In order to achieve this goal, we used a 1:25000 topographic map, and extracted information layers such as drainage mesh, height plot, vegetation cover, etc. in ARCMAP software. In addition, for achievement of mentioned goal, morphometric variables such as drainage density, concentration time, area ratio, length ratio, bifurcation ratio, average slope of basin, average slope of channel, roundness coefficient, compressive coefficient, main waterway length, precipitation, basin area are extracted from topographic map. We simulated floods with HEC-geo HMS, WMS, MIKE11 software, in order to evaluate the environmental, social, and economic impacts. Beside these efforts, TOPSIS multi-criteria decision-making tool, a well-known managerial model is used for sub-basins prioritizing. In this article, we investigate morphometric variables effective in the flooding process, and identify the most influential ones. Concentration time has the most ideal positive impact (0.05), and compressive coefficient has the most ideal negative impact (0.031). According to these variables and other factors, sub-basins are prioritized against flooding potential. According to results, sub-basins No's 3,10,12 with proximity coefficients (0.5478, 0.4861, 0.4622) have the highest flooding potential.

Key words: Morphometry, flood, Gland Rood

Theory / Method / Workflow

At first, information layers such as drainage mesh, co-height plot, roads, etc. are extracted from 1:25000 topographic maps. Then a digital elevation model (DEM) of the basin is generated. The surface of main basin is divided into 12 independent sub-basins according to DEM, and morphometric features mentioned below are investigated:

- Basin area
- Basin shape
- Drainage concentration
- Channel slope
- Concentration time
- Basin slope
- Intersection ratio
- Length ratio
- Area ratio

Hydrologic simulation, and basin's runoff prediction for a 30 years period (2011-2040) are performed in WMS software. HEC-HMS hydrologic model is used for evaluation of environmental, social, economic impacts. In the next step, morphometric features of basins are measured and prioritization is done with the help of multi-criteria decision-making tools such as TOPSIS, in order to handle sudden floods.

Table 1. indicators of research

Sub-basins	average slope of channel	Average of precipitation	area ratio	length ratio	bifurcation ratio	compressive coefficient	roundness coefficient	average slope of basin	average slope of channel	concentration time	drainage density	area
1	7.04	331.14	6.1	1.66	3.67	1.41	0.49	40.33	0.19	33.82	2.49	52.28
2	9.18	339.5	7.36	2.25	5	1.58	0.39	41.18	0.15	54.46	2.82	36.36
3	4.64	606.87	9.03	4.06	8.33	1.43	0.48	46.87	0.094	32.23	2.67	74.91
4	13.51	365.54	5.84	3.99	3.93	1.99	0.25	35.13	0.15	61.19	2.25	25.91
5	10.78	430.67	4.68	3.14	3.5	1.55	0.41	40.49	0.067	70.32	2.57	140.52
6	7.64	504	5.95	3.15	4.5	1.54	0.41	36.77	0.22	34.12	1.85	14.68
7	8.36	415.54	5.02	2.41	4.62	1.4	0.48	39.07	0.17	40.26	2.51	35.28
8	7.14	515.18	3.25	3.41	4	1.6	0.39	30.59	0.16	36.55	2.96	12.52
9	6.36	462	4.38	2.01	3.02	1.6	0.36	37.6	0.07	46	2.26	77.19
10	6.86	498.27	5.48	4.84	2.93	1.8	0.3	44.82	0.052	54.77	2.48	295.29
11	10.96	578.65	4.6	2.1	3.62	1.53	0.42	37.94	0.15	52.10	3.11	34.15
12	16.05	748.19	3.6	1.84	5.57	2.11	0.22	37.9	0.035	122.54	2.40	343.87
total	42.32	510	4.82	9.6	4.1	1.5	0.4	38.58	0.075	193	2.04	343.87

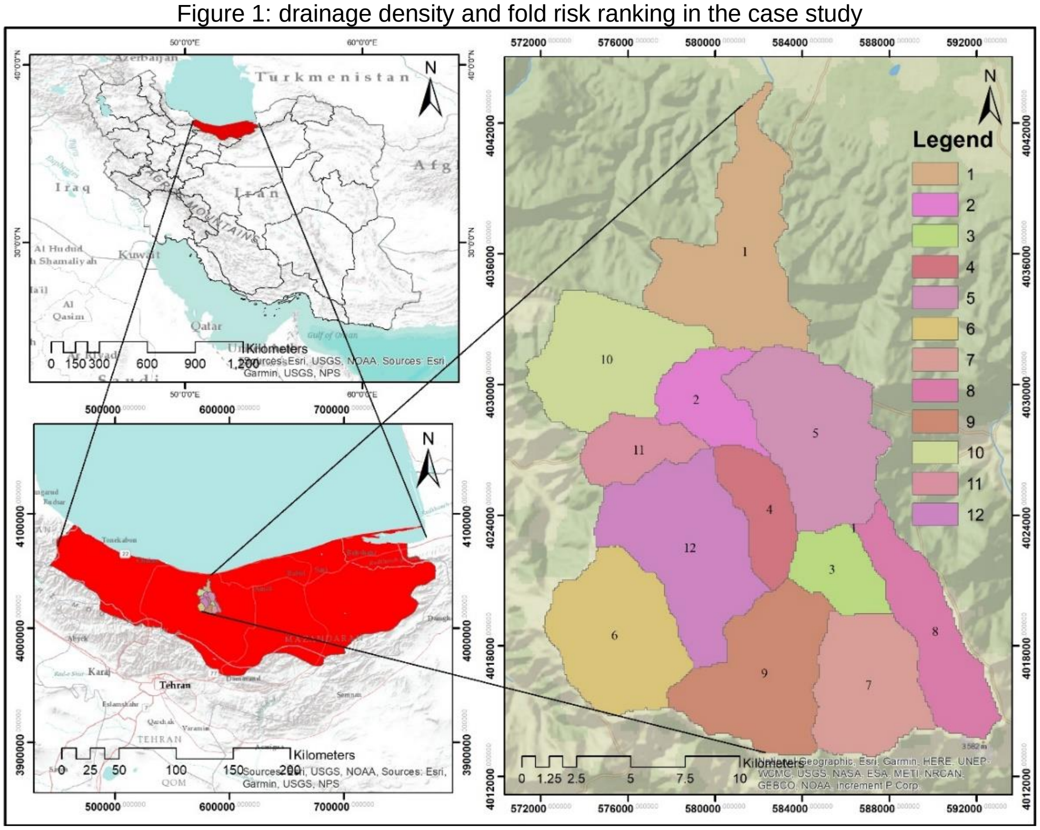
Results, Observations, Conclusions

Finally, effective morphometric variables are discussed and the most influential ones are selected. According to this variables and other factors, sub-basins are prioritized according to flood potential, and sub-basins 3, 10, 12 with proximity coefficients (0.54, 0,48, 0.46) have the highest flooding potential.

Table 2. Calculate the proximity to the positive and negative ideal solution as well as the ranking of options

	proximity coefficients	Ranking
1	0.5478	7
2	.04867	9
3	0.4622	3
4	0.3887	8
5	0.3597	5
6	0.3397	4
7	0.3394	6
8	0.3393	11
9	0.3349	12
10	0.3110	2
11	0.2985	10
12	0.2361	1

Figure 1: drainage density and fold risk ranking in the case study



Novel/Additive Information

It is the first time to study this district through hydrologic runoff simulation, flood prediction and prioritize their flood potential by TOPSIS multi-criteria decision-making model.

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