Zoning of Flood Risk in Kashkan River basin using Two Models WOE and EBF

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1. Introduction

Among natural disasters, floods are of the most devastating. The accurate assessment of its dangers has failed at various scales due to lack of information and knowledge about flood losses. During heavy rains, flow in a river increases rapidly and the water level rises above normal and covers the floodplain and its surroundings and causes floods. Catastrophic floods occur in the Kashkan River basin every year. Due to the abundance of floods in this region, flood sensitivity maps should be considered to prevent loss of life and economic damage. From 1955 to 2011, the Kashkan River was faced with 16 floods with a volume of more than 1000 cubic meters per second, which was one of the most severe floods in 2019 in this river. The April 2019 flood was one of the most unprecedented floods that's recorded in the last 200 years; therefore, the development of flood sensitivity maps and river area preparation to identify flood areas in the watershed is essential to improve flood management and decision making. The main purpose of this study is to evaluate the performance of the weighted evidence function and the definitive evidence function to prepare a flood susceptibility map in the Kashkan River watershed.

2. Study Area

Kashkan River is one of the most important and full of water branches of Karkheh river which collects the waters of a large area of Lorestan province. This river joins Seymareh river in the southwest of Poldokhtar in an area called Kol-e-Sefi and forms Karkheh river.

The length of Kashkan river is about 270 km and its catchment area upstream of Kashkan-Poldakhtar station is 9400 square kilometers. The main drainage system of the Kashkan river first consists of the join together branches of the Hero and Aleshtar doab rivers in the northeast and north of the basin, respectively, from east to west and north to south. These tributaries which originate from the high and snow capped Garin and Misho paro mountains along the main route joins other sub-rivers such as Cham

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Zakaria, Khorram Rud, Chulhol, and Madian Rivers. The largest recorded flood in the province was the flood on April 1, 2019 in Kashkan River with a peak discharge of 6500 cubic meters per second. The amount of damage caused by it in different sectors was estimated 11 thousand billion Tomans (report of the provincial crisis headquarters 2019).

3. Materials and Methods

The geographical location map of 260 flood points in the region was prepared based on the information of Lorestan Regional Water Company. This set was randomly divided into two groups including training group data (70%) and validation group data (30%). In this study several factors used including slope percentage, slope direction, height, distance from river, river density, distance from road, land use, soil type, slope curvature, lithology, vegetation, rainfall, NDVI, stream capacity index (SPI) And topographic wet index (TWI) were considered for zoning of flood risk potential. It should be noted that the classification of the layers was done according to the conditions of the region and experts' opinion. The tools used in this study were divided into two parts: physical tools including DEM maps, geological maps, land use and waterway, and conceptual tools including ArcGIS and Excel software. Two methods, WOE and EBF, were used. The WOE method or evidence weight method is a data-driven method used to combine data sets and is based on the use of a linear form of the Bayesian probability model to estimate the relative importance of evidence using statistics. The EBF method includes several parameters Bel or degree of confidence, Dis degree of uncertainty, Unc or degree of uncertainty, and Pls degree of reasonableness in the range between zero and one. The main part of this theory is presented by the degree of certainty and the degree of reasonableness, so the degree of reasonableness is greater than or equal to the degree of certainty. Data extracted from EBF not only estimates the spatial correlation between effective factors and flood occurrence but also the spatial correlation between classes of each effective factor.

4. Results and Discussion

According to the model of gravitational evidence and the function of conclusive evidence, southeast direction, slope of 0-5%, altitude of 448-900 m, soil type (Inceptisol/Vertisol), distance from the river (0-50), river density (0.43-0.69), residential use, rain (348-450mm), concave slope curvature, Lithology (OMq), TWI (high floor), SPI (very low), NDVI (very low) and the distance from the road (200-150 meters) have the greatest impact on creating flood potential. The maps obtained from the EBF model include degrees of certainty (Bel), uncertainty (Dis), unreliability (Unc) and probability (Pls) in the range between zero and one, and the sum of the values of certainty, uncertainty and unreliability is 1. As can be seen 47/32% of the study area is in the medium to very high risk class. Among the studied WOE and EBF models, the highest accuracy was attributed to the EBF model (0.875); Therefore, in terms of flood risk potential, the EBF model performs better than the WOE model.

5. Conclusion

In this study, two models, EBF and WOE, were used to predict flood risk potential. The largest area of areas with very high potential was observed in the WOE model. The results of the study showed that flooding is the result of various environmental and human factors. Based on the presented flood risk forecast map, appropriate management measures can be taken to reduce flood damage and casualties. Areas that have a very high potential for flooding according to the final plan should be given more attention while planning.

Keywords: Flood, Kashkan River Watershed, WOE Model, EBF Model

References (In Persian)

Alavicheh, E. Karimi, S. & Alavipoor, F. (2017). *ارزیابی آسیب پذیری مناطق شهری در برابر سیل با منطق فازی (مطالعه موردی: منطقه ۲۲ تهران)*. [Assessing the vulnerability of urban areas to floods with fuzzy logic (Case study: District 22 of Tehran]. *Journal of Environmental Science and Technology*, 5, 1-12.

Azad Talab, M., Shahabi, H., Chapi, K., & Shirzadi, A. (2018). *پیش‌بینی مکانی مخاطره سیلاب در شهر سنندج با استفاده از مدل‌های ترکیبی* [Spatial flood risk forecasting in Sanandaj city using hybrid models].Master Thesis in Environmental Hazards. The University of Kordestan.

Behdarvand, N., Kaboli, M., Jabarian Amiri, B., Ebrahimpoor, R., Asadi Aghbolaghi M., & Imani Harsini, J. (2014). *شناسایی مناطق پرخطر و عوامل محیطی مؤثر بر حملات گرگ به دام در استان همدان با به کارگیری روش مدل سازی MAXENT* . [Identification of high risk areas and environmental factors affecting wolf attacks on livestock in Hamadan province using MAXENT modeling method]. *Natural Environment*, *67*(3), 245-252.

Hoseini, M., Jafarbeigloo, M., & Geravand, F. (2015). *تعیین پهنه‌های سیل‌گیر رود کشکان با استفاده از مدل هیدرولیکی به‌منظور کاهش مخاطرات سیل*. [Determination of floodplains of Kashkan River using hydraulic model in order to reduce flood risks]. *Environmental Risk Management*, *2*(3), 355-369.

Khosravi, Kh., Maroufnia, E., Noohani, E., & Chapi, K. (2012). *ارزیابی کارایی مدل رگرسیون لجستیک در تهیه نقشه حساسیت به وقوع سیل*. [Evaluating the efficiency of logistic regression model in preparing flood susceptibility map]. *Iranian Journal of Natural Resources*, *69*(4), 863-876.

Poorghasemi, H. Moradi, H. Mohammadi, M. (2013). *پهنه بندی حساسیت زمی نلغزش با استفاده از مدل احتمالاتی وزن واقعه*. [Landslide sensitivity zonation using a probabilistic event weight model]. *Journal of Spatial Information Technology Engineering*. 1 (2): 80-69.

Rahmani, M. Oboori, M., & Mola Aghajanzadeh, S.(2015). *پهنه‌بندی خطر سیلاب شهری با استفاده از روش‌های همپوشانی ترکیب خطی وزنی (WLC) و سناریوهای میانگین وزنی مرتب‌شده (OWA) (مطالعه موردی: شهر ساری/مازندران/ایران).* [Urban Flood Risk Zoning Using Weighted Linear Composition (WLC) Overlap and Arranged Mean Weight (OWA) Scenarios Case Study: Sari / Mazandaran / Iran]. International Conference on New Research in Agricultural and Environmental Sciences. University of Tehran, Tehran.

Razavi, V., & Malek, M. (2016) . تهیه‌ی نقشه‌ی حساسیت سیلاب با استفاده از ترکیب مدل بـاور شـهودی *EBF* و تحلیل سلسله مراتبی *AHP*(مطالعه موردی: شهرستان جهـرم) [Preparation of flood sensitivity map using a combination of intuitive belief model (EBF) and hierarchical analysis (AHP) (Case study: Jahrom city]. *Journal of Surveying and Spatial Information Engineering*, *3*, 1-15.

Siahkamari, S., & Zeynivand, H. (2015). پتانسیل‌یابی مناطق مستعد سیل با استفاده از مدل شاخص امـاری و وزن شـواهد (مطالعـه مـوردی: حـوزه آبخیـز مادرسـو، گلسـتان). [Potential of flood prone areas using statistical index model and weight of evidence (Case study: Maderso watershed, Golestan)]. *Remote Sensing and GIS in Natural Resources*, *7*(4), 116-131.

References (In English)

Arianpour, M., & Jamali, A. A. (2015). Flood hazard zonation using Spatial Multi-Criteria Evaluation (SMCE) in GIS (Case Study: Omidieh-Khuzestan). *European Online Journal of Natural and Social Sciences, 4*(1), 39-49.

Bui, D. T., Panahi, M., Shahabi, H., Singh, V. P., Shirzadi, A., Chapi, K., ... & Ahmad, B. B. (2018). Novel hybrid evolutionary algorithms for spatial prediction of floods. *Scientific Reports, 8*(1), 1-14.

Chapi, K., Singh, V. P., Shirzadi, A., Shahabi, H., Bui, D. T., Pham, B. T., & Khosravi, K. (2017). A novel hybrid artificial intelligence approach for flood susceptibility assessment. Environmental Modeling& Software, *95*, 229–245

Chen, J., Zhao, S., & Wang, H. (2011). Risk analysis of flood disaster based on fuzzy clustering method. *Energy Procedia, 5,* 1915-1919.

Grahn, T., & Nyberg, L. (2017). Assessment of pluvial flood exposure and vulnerability of residential areas. *International Journal of Disaster Risk Reduction. 21*, 367-375.

Khosravi, K., Pourghasemi, H. R., Chapi, K., & Bahri, M. (2016). Flash flood susceptibility analysis and its mapping using different bivariate models in Iran: a comparison between Shannon's entropy, statistical index, and weighting factor models. *Environmental Monitoring and Assessment*, *188*(12), 656. 10.1007/s10661-016-5665-9

Pradhan, B. (2010). Flood susceptible mapping and risk area delineation using logistic regression, GIS and remote sensing. *Journal of Spatial Hydrology*, *9*(2) 1-18.

Rahmati, O., Pourghasemi, H. R., & Zeinivand, H. (2016). Flood susceptibility mapping using frequency ratio and weights-of-evidence models in the Golastan Province, Iran. *Geocarto International*, *31*(1), 42-70.

Song, K. Y., J. Oh, J. Choi, I. Park, C., & Lee, S. (2012). Prediction of landslides using ASTER imagery and data mining models. *Advances in Space Research, 49*, 978-993.

Tehrany, M. S., Pradhan, B., & Jebur, M. N. (2014). Flood susceptibility mapping using a novel ensemble weights-of-evidence and support vector machine models in GIS. *Journal of Hydrology, 512*, 332-343.

Verikiou-Papaspiridakou, E. (2003). Investigating the flooding events of the urban regions of Glyfada and Voula, Attica, Greece: a contribution to Urban Geomorphology. *Geografiska Annaler:* Topal, T., & Suzen, M. L. (2012). GIS-based landslide susceptibility mapping using bivariate statistical analysis in Devrek (Zonguldak-Turkey). *Environmental Earth Science*, *65,* 2161- 2178