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Location of Synoptic Stations by Means of Geographical Information System (GIS) Case Study: Khorramabad Basin in South West Iran

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Abstract: The accuracy of the data registered in synoptic stations has a pivotal role in production of databases and analysis of climatologic and environmental conditions of various regions. Establishment of such stations has special limitations due to their significance in production of information which can be generalized in synoptic scale. Appropriate in this research, places have been proposed for the foundation of such installations in Khorramabad Basin with regard to the propounded confinements of the world meteorological organization. Then the extant stations were matched with ordinary criteria. Geographic information system techniques were utilized for overlapping of diverse information layers and production of the final location map. Fuzzy standardization method and analytical hierarchic process weighing methods were availed for effectuation of the objectives in question. The eventual location layer was engendered at the end by commingling of the different standardized layers based upon their particular weight. Optimized spots were introduced for the establishment of synoptic stations. According to the effectuated examinations and the intermingling of the layers required for location of synoptic stations, the pertinent upshots evince that the distribution of synoptic stations in Khorramabad Basin does not match the standards set down by the world meteorological organization.

Key words: Khorramabad basin % Lorestan province % Synoptic stations % Analytical hierarchy process

INTRODUCTION

Nowadays, the synoptic-stations- registered data in basins and their dispersion in basins and their dispersive of such stations in heterogeneous spots is the basis for numerous environmental and human-based plans such as founded or would-be schemes in basins, urban construction, agricultural predicaments, et cetera; hence, planners pay special attention to such data in basins and the pertinent consequences. Lack of such stations, their quantity and their inappropriate diffusion for register precipitation data in diverse sites of basins brought about the lack of information on the dispersion of meteorological data of basins especially the huge ones whose altitude features are variegated. Geographic information system and analytical hierarchy process comprise one of the most extensive polycriteria decision-making contraptions which have the capabilities to be utilized in disparate scientific and research-based aspects such as location [1]. Numerous articles and researches have been effectuated in variegated subjects in Iran and the world out of which the ensuing ones can be cited: Samih *et al.* [2] wrote an article entitled “the selection of the transference site by means of a analytical hierarchy process and Topsis in the phase-based environment and they drew the conclusion that Topsis methodology can be utilized in phase-based surroundings to solve the quandaries pertinent to the selection of appropriate sites for shifting of waste materials in Istanbul in Turkey. Vahidniya *et al.* [3] compiled an article entitled “selection of the hospital site by means of a phase-based analytical hierarchy process and the relevant derivatives”; they concluded that there is a slight difference among the three FAHP Methods especially in the selection of suitable sites. Mahler [4], Chen [5], Zhang [6] and Soheili [7] are among those who have worked in the location-pinpointing. The aim of this research is to identify and determine places suitable for the establishment of synoptic stations with regard to the vastness and extension of the rainfall affecting the intense variability of meteorological variables of Khorramabad basin and the lack of sufficient stations for registering meteorological data in diverse spot which can be used as the basis for numerous plans and variegated schemes.

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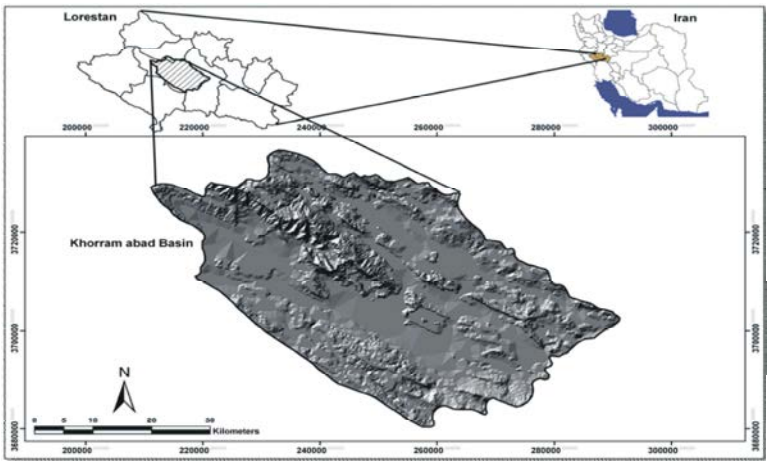

Fig. 1: Location map of the study area

MATERIALS AND METHODS

Study Area: The study area is the Khorramabad Basin, which is located in the center of Lorestan province and north of Khorramabad city. The Khorramabad Basin lies between latitudes 33°-22' N and 33°-0 N, longitudes 48°-01' E and 48°-27' E and covers an area of 2505 km2 (Fig. 1). The beginning of this basin is at Khorramabad upstream near Sarabrobat village. The pertinent outlet is situated at the end of the Vissian alluvial plain. The basin in question is regarded within folded Zagros Mountains territory. The main river or Khorramabad River originate from Chekriz altitudes and it onset extends to the beginning of town 20 kilometers northwards [8]. The basin in question is construed among semi-arid lands based upon demarton coefficient. The annual average rainfall of this basin is approximately 508 mm.

Methodology: The operations used in this research for place-finding comprise the ensuing stages:

- Definitions and determination of a collection of assessment criteria (map-based layers)
- Standardization and conversion of the values scale and the map layers quantities
- Determination of the criteria weights for layers
- Fabrication and production of standardized weight-bearing layers of the map that is to say, multiplication of standard map-based layers,
- Production of the final map

The required data and information for place-detection were forgathered at first comprising the contour map of the basin (the 1/25000 scale at 20-meter intervals), the digital map of the major waterway of the basin, the high voltage cables map, the plot of main routes and the urban areas chart. The digital-altitude patterns of Khorramabad were provided by means of topo to raster methodology.

This model was supplied with 20-meter cells. The slope map, aspect and its distance from the area of large slope were prepared afterwards. A particular weight was dedicated to each layer by means of the layer obtained in the geographic information system. All the factors and criteria were compared in a paired fashion by means of analytical hierarchy process and they were inserted in the weights matrix. After calculation of the final weight, the maps of the seven factors in question were converted in a raster manner, the distances pinpointed in each diagram was effectuated in each one of the layers, then the weights obtained from the previous stages were multiplied in them. The resulted layers were multiplied by each other and the eventual map containing the places appropriate for the establishment of synoptic stations were obtained. The aforementioned map was intermingled with the chart containing the stations of the basin comprising three stations named Badrabad, Imanabad and Rimeleh to substantiate whether the factors relevant to the establishment of stations in the basin in question have been appraised or not [9].

RESULTS AND DISCUSSIONS

The proposals of the meteorology organization were used to define the restrictions of place-detection determinants. According to the above proposals the limitations in question are as follows:

- Stations should not be established in critical slope places

- It is recommended that the stations be away from artificial quake sources such as roads
- Such stations ought to be away from high voltage transference cables
- Such stations ought to be at an appropriate distance from moisture resources
- Such stations ought to far from valleys with critical slope which can canalize wind itinerary
- They should be placed in slope aspect where they receive an average quantity of energy
- Such stations ought to a great distance away from artificial heat sources such as cities and industrial towns

The ensuing information layers were produced for effectuation of the above limitations.

- Slope
- Aspect
- Distance to road
- Distance to river
- Distance to urban areas
- Distance to critical slopes
- Distance to high voltage cables

The fuzzy non-deterministic of Standardization methodology was utilized to define the affecting scope of diverse layers in a manner that the quantities of the prepared layers were defined from zero to one. The definite Boolean methodology was utilized only in the slope aspect layer out of those cited above [9]. Thus the quantities of this layer are made up of zero and one. The phase-based function type utilized for standardization of layers is cited in table 1. As it is observed out of the six layers which are standardized based upon the phase method there are 5 incremental functions and one diminishing function in a way that higher quantities adopt higher values in incremental functions while higher Quantities take lower values in diminishing functions. The written form of these functions is inserted in table 2.

The value-based scope of layers has been designated for standardization of these layers. The above functions were used to define such realms (Table 3).

The east-west slope aspects and the north-south aspect declivities have severally values of one and zero. The analytical hierarchy process has been utilized in the last stage to weigh diverse layers. Thus the above methodology was used together with provision of a 7*7 matrix to make a binary comparison of layers. All the layers were set within the ranges of zero to 255 (integer numbers) to use the collateral programmes named analytical hierarchy process, in ArcGis software.

Table 1: the phase function type for standardization of maps

row	Effective factor	function
1	Slope	decrease
2	Distance to River	increase
3	Distance to Road	increase
4	Distance to urban location	increase
5	Distance to slope area	increase
6	Distance to power line	increase

Table 2: the type of functions used for phase membership

function	decrease function	increase function
Type function	μx= (xmax-x)/ (xmax-xmin)	μx=(x-xmin)/(xmax-xmin)

Table 3: the threshold limits in the phase-based standardization of layers

row	Effective factor	a-b	c-d	Type graph
1	Slope	0-10%	10%-416%	Linear(1)
2	Distance to River	0-200m	200-20248m	Linear(2)
3	Distance to Road	0-200m	200-7884m	Linear(2)
4	Distance to urban location	0-1000m	100-37320m	Linear(2)
5	Distance to slope area	0-500m	500-10504m	Linear(2)
6	Distance to power line	0-200m	200-18176m	Linear(2)

Table 4: the relative scale for layers comparison

Intensity of importance	Description
1	Equal importance
3	Moderate of importance of one factor over another
5	Strong or essential importance
7	Very strong importance
9	Extreme importance
2,4,6,8	Intermediate importance
Reciprocals	Values for inverse comparison

Table 5: the weights dedicated to each layer

number	Layers	weight
1	Distance to Road	0.3136
2	Distance to River	0.3136
3	Slope	0.1761
4	Aspect	0.1667
5	Distance to urban location	0.0981
6	Distance to slope area	0.0985
7	Distance to power line	0.0981

The final weight of each layer was reckoned by binary violation of layers. According to table (4) Bilateral relative valuation of layers was determined to be between 1 and 9.

The relative value of each layer as compared with other ones was reckoned by means of spatial analysis by inserting the number pertinent to each level of significance in the relevant matrix (Table 5). Each one of the standardized layers was multiplied in each other based upon their special weight by means of the raster calculator and the ultimate map was produced (Fig. 2).

(1) Locating Map=Dis-road*0.3136+Dis-river*0.3136+Slope*0.1761+Apect*0.1667+Dis-Urban*0.0981+Dis-Slope*0.0985+Dis-Power*0.0981

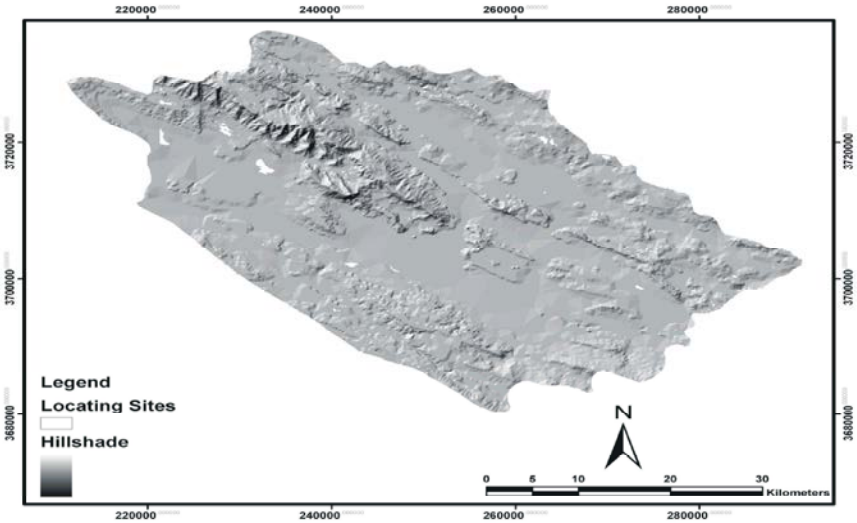

Fig. 2: Suitable places for the establishment of synoptic stations in Khorramabad Basin

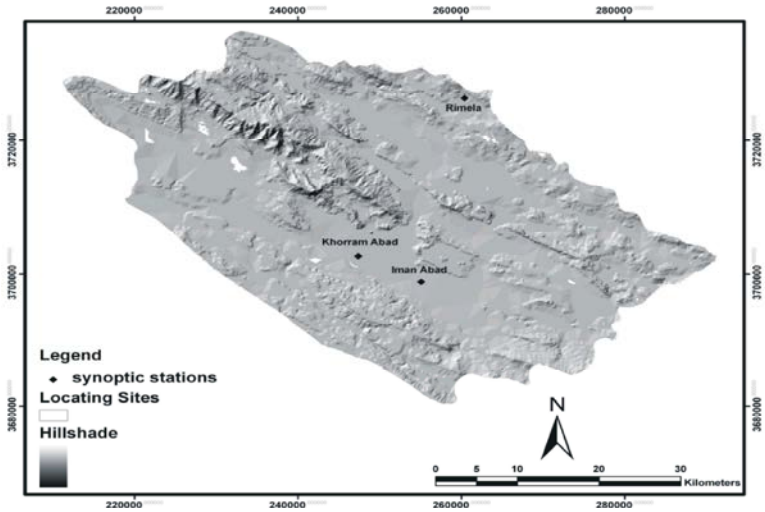

Fig. 3: Comparison of place suitable for the establishment of synoptic stations among available ones

CONCLUSION

The corollaries of this research evince that the commingling of the layers required for synoptic stations location and the dispersion of the synoptic stations available in Khorramabad Basin are not in accordance with standards pinpointed by the world meteorological organization. The comparison of the stations available in the studied limitations with spots located for the establishment of synoptic stations by means of geographical information system and analytical hierarchy process evince that only synoptic station of Khorramabad is nearer to the located spots but the other two stations are further away from the located spots. Hence, the standards set for the establishment of these stations have not been taken into account (Fig. 3). The superposition of the layers checked for locating such stations reveals the fact that Khorramabad synoptic station is established in a plaice which has the slightest distance to the road, rustic spots and even rivers whereas distance to routes is the most pivotal factor which ought to be considered in stations establishment. Thus the establishment of this station is merely compatible with factors such as slope, slope aspect, distance to critical slope area, distance to high voltage power cables, not with other factors. The criterion regarded for the establishment of stations have not been observed in the other two stations in a way that Imanabad station in the southern section of the basin is nearest to the road, river and rural spots. Hence, it is concluded that the synoptic stations available in

Khorramabad basin do not match the pinpointed standards and they have been setup in inappropriate places. Thus it is aspired that more precise action will be effectuate in the establishment of such stations in future with regard to the spots determined for the establishment of synoptic stations in Khorramabad basin by means of geographical information system and the criterion introduced by the world meteorological organization and also Studies of this type used in other basins.

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