Identification of Synoptic Patterns Causing Heavy Rainfall in Northern Coast of Persian Gulf

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Extended Abstract

Introduction

Sometimes, the showers of the northern coast of Persian Gulf are very heavy and disastrous and hazardous. They cause heavy damages to the people and the infrastructures of the region. Therefore the economic development of the area is highly dependent upon the identification of the cause and management of these hazardous phenomena. The main factor controlling the surface climate is the pressure patterns of the atmosphere. Therefore, the main objective of this study is to identify the synoptic patterns of these showers. Thus, we can predict their occurrence and mitigate their damages. The successful achievement is dependent on two major factors: (a) the methodology of pattern recognition and (b) identification of actual patterns. Most of the models of pattern analysis are linear while the atmospheric processes are non-linear in nature. Any methodology that neglects the nonlinear nature of atmospheric phenomena would result in inadequate classification of atmospheric circulation. For this reason, this research has used the nonlinear models of classification algorithms to identify the pressure patterns of the heavy rains of the area.

Methodology

The study was based on the hypothesis that the daily atmospheric circulation can be explained by the geo-potential height of 500 hPa level, precipitable water, and the velocity of vertical

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patterns and heavy rainfall, the data have been collected through 15340 days (1966-2007) for these three variables of 289 grid-points, with a resolution of 2.5 degrees, from NCEP database. Daily rainfall data for the same period have also been gathered for Bandar-e-Abbas, Bandar-e-Lengeh, Boushehr, and Abadan stations from Meteorological Organization of Iran. First, the daily circulations as micro-patterns have been classified using self-organizing map (SOM) algorithm, a type of unsupervised neural network. This algorithm begins to calculate the Euclidian Distance between an input vector and all of the weight vectors to find the 'winner' unit (BMU) with the weight vector closest to the input vector. The calculation continues to update all the weight vectors, especially those within neighbouring radius .The iterative calculation proceeds towards the projection of similar data samples in the high dimensional, complex input data space to an identical unit area in the map. As a result, the neighbouring units in the map are similar to each other while distant units are dissimilar. Then, the U*-matrix, as a suitable method for two-dimensional visualization of the trained SOM that enabled us to recognize the degree of the similarity among adjacent units in the two-dimensional map, was employed to identify boundaries among clusters and to extract the actual number of meso-patterns. Finally, K-means method was utilized to cluster these meso- patterns into distinguished macro patterns.

Results and Discussion

The results revealed that SOM, by classifying the micro-patterns into 289 meso-patterns, could discriminate the days of warm and cold periods with an accuracy of more than 99 percent. These patterns were classified into 11 macro patterns through the U*-matrix and K-means models. Through displaying the number of heavy rainfall events in each station on each unit of SOM, it was specified that four macro-patterns explained up to 83 % of heavy rainfall events of the region. These patterns are named as follows: Pattern No. 4 as Syria trough becomes deeper, Siberian high pressure moves towards west, and the moisture of Arabian and Oman Seas move to PG. Similarly, the identification of pattern 6 is possible by Sudan low, subtropical jet stream velocity increase, and its base decreases. Pattern 7 is identified by cut-off low system, very low pressure, and closed low up to upper troposphere. Pattern 9 is specified by two characteristics: (a): the simultaneous presence of warm and cold season components of atmosphere during the seasonal change, and (b) dense isobars over PG.

Conclusion

On the basis of the results, we concluded that the combination of SOM classification method, U*- matrix and K-means clustering methods can be employed as an appropriate instrument to classify nonlinear atmospheric variables, in one hand, and to resolve the problem of extracting the actual synoptic patterns, on the other. Of the four synoptic patterns of heavy rainfall, cut-off low and seasonal transition patterns should be taken into account more seriously because of the persistence and startling nature of their heavy rainfall as well as the vulnerability of society for the probable damage.

Keywords: ***Heavy Rainfall, K-means, Persian Gulf, Self-organizing Map, Synoptic Pattern, U*-matrix.***