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Research Paper

Analysis of Synoptic and Thermodynamic Patterns Leading to extremely Heavy Rainfall and Estimation of Water Area Resulting from Precipitation in Karkheh Basin

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Abstract

To investigate the super-heavy precipitation of Karkheh Basin, daily precipitation statistics of the basin (2005-2018), radar satellite images of Sentinel 1, Landsat, and data on specific humidity, pressure, geopotential height, omega, and wind flow have been used. The results show that the total of heavy rainfall by year shows an increasing trend. Heavy rainfall varies from a minimum of 11 to 40 days (long-term cumulative amount) at the basin level. Most of the heavy rainfall in the basin occurs in the last days of winter and the first days of autumn. The location of Siberian high-pressure, Sudan low pressure, Pakistan low-pressure surface systems and dynamic high-pressure systems of Saudi Arabia and the Mediterranean is the dominant pattern and determinant of extremely precipitation in the Karkheh catchment. The main reason for the increase in the lake's water area in extremely precipitation is not the increase in the number of days of the rainy, but the large expansion south of the Mediterranean trough, eastward movement of the Saudi anticyclone on warm seas and vertical water vapor flux north of the warm southern seas. Also, in examining the position of the jet core to create extremely rainfall, the most suitable position of the core was observed in the transverse position of 24 degrees north and longitude 42 east (center of Saudi Arabia), so that in this case the most unstable part of the jet (exit area Jet) corresponds exactly to the front of the trough on the Karkheh basin.

Keywords: Extremely precipitation, Satellite imagery, Sudan low pressure, Saudi Arabia High pressure, Sub polar Trough.

Highlight

- The synoptic conditions of super-heavy precipitation are such that in the lower levels of Troposphere, the pattern of Siberian high pressure systems,Sudan low pressure , Saudi Arabia high pressure and the combined model of Sudan low pressure - Pakistan low pressure and in the upper levels of Troposphere.
- the large expansion south of the Mediterranean trough, eastward movement of the Saudi anticyclone on warm seas and vertical water vapor flux north of the warm southern seas, It plays a major role in the intensity of super-heavy precipitation and increasing the water area of Karkheh Dam Lake.

Extended Abstract

Introduction

Heavy rainfall is when the amount of rain or snow experienced in a place is significantly more than normal. Heavy rainfall is an indicator of climate change and is dependent on climate change, because as temperatures rise, the atmosphere will be able to hold more water vapor, and warmer oceans will increase the amount of water

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evaporated into the air. Karkheh River is one of the main streams in the southwest of Iran. Due to the geographical location, topography and also its position in relation to the circulating pattern of the atmosphere, the mechanism of precipitation in this basin is very similar to the mechanism of precipitation systems in tropical regions. In most parts of the basin, even in the cold days of the year, rainfall falls in the form of rain. On the other hand, due to the precipitation mechanism of this region, most of the precipitation occurs in the form of short-term rainfall systems and sometimes in the form of small precipitation cores. Due to the hot nature and high humidity potential on the one hand and access to warm seas on the other hand, these systems cause heavy rainfall. Due to the nature (liquid precipitation) and precipitation mechanism of the systems in this basin, there is a possibility of flooding in this The basin is larger than other basins.

Methodology

Research Method In this research, the environmental method is circulating. First, the daily rainfall statistics of the watershed in an 11-year statistical period (2005-2018) are extracted for all synoptic stations. Then, based on global and national criteria for selecting heavy rainfall and extremely rainfall for the rainfall period of the basin is extracted. In the second step, after determining the number of days of heavy rain, satellite images of Sentinel 1 and Landsat radar in the days before the rain and also after heavy rain were called in the Google Earth engine system. After radiometric and atmospheric corrections of satellite images, NDWI and Log Ratio indices were used to calculate the water area and water changes of Karkheh Dam Lake. Step 3: Atmospheric data for days with extremely using the US National Oceanic and Atmospheric Administration and other related sites in the range of 10 ° E to 80 ° N and 0 to 70 ° N Extracted and plotted with geopotential moisture, omega and moisture, flow and moisture for sea levels, 1000, 850, 700 and 500 hP and jet of 300 and 250 hP in Grads environment. The systems are originated using sea level data and 1000 and 850 hPa**.**

Results and discussion

The highest frequency of heavy rainfall in the basin occurs in autumn and then winter. Heavy rainfall varies from a minimum of 15 to 49 days (cumulative is long-term) at the basin level. In addition to the 30 mm threshold for another day, another condition was considered for selecting extremely rainy days, so that at least 50% of the stations on that day had more than 30 mm of rainfall recorded. Based on the mentioned dual conditions, 7 pervasive events were identified for heavy cloud precipitation in Karkheh basin. In the occurrence of extremely, the area of Karkheh Dam Lake has been increased from a minimum of 5 to a maximum of 51 square kilometers. The main reason for the increase in the lake's water area in extremely precipitation is not the increase in the number of days of the rainy, but the large expansion south of the Mediterranean trough, eastward movement of the Saudi anticyclone on warm seas and vertical water vapor flux north of the warm southern seas. In all study samples of extremely precipitation, in the lower levels of Troposphere, the pattern of Siberian high pressure systems, Sudan low pressure, Saudi Arabia high pressure and the combined model of Sudan low pressure of Pakistan low pressure and in the upper levels of Troposphere, Saudi Arabia anticyclone and Mediterranean trough, The shape of the trough dominates the area.The transfer moisture of the warm southern seas (Oman Sea, Arabian, Red Sea) from the lower levels and the humidity of the tropical convergence region at the upper levels are the most important causes of atmospheric disturbances and heavy rainfall.

Conclusion

Extremely precipitation is one of the climatic hazards whose changes in the basin can have irreparable consequences for the region; direct feedback from extremely precipitation is pervasive floods. The results show that the total of heavy rainfall by year shows an increasing trend. Heavy rainfall varies from a minimum of 15 to 49 days (long-term cumulative amount) at the basin level. Most of the heavy rainfall in the basin occurs in the last days of winter and the first days of autumn. The location of Siberian high-pressure, low-pressure Sudan, low-pressure Pakistan surface systems and dynamic high-pressure systems of Saudi Arabia and the Mediterranean is the dominant pattern and determinant of extremely precipitation in the Karkheh catchment. The main reason for the increase in the lake's water area in extremely precipitation is not the increase in the number of days of the rainy, but the large expansion south of the Mediterranean trough, eastward movement of the Saudi anticyclone on warm seas and vertical water vapor flux north of the warm southern seas. Also, in examining the position of the jet core to create extremely rainfall, the most suitable position of the core was observed in the transverse position of 24 degrees north and longitude 42 east (center of Saudi Arabia), so that in this case the most unstable part of the jet (exit area Jet) corresponds exactly to the front of the trough on the Karkheh basin.

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