Table 1. Synoptic stations used.

Synoptic Station	Province	Latitude	Longitude	Elevation
Piranshahr	Azarbyjan	36.70	45.15	1443.50
Sardasht	Azarbyjan	36.15	45.49	1556.80
Mahabad	Azarbyjan	36.75	45.72	1351.80
Oshnaviyeh	Azarbyjan	37.06	45.14	1415.90
Thrush	Kordestan	36.22	46.31	1522.80
Sanandaj	Kordestan	35.25	47.01	1373.40
Marivan	Kordestan	35.50	46.15	1287.00
Baneh	Kordestan	36.01	45.90	1600.00
Kermanshah	Kermanshah	34.35	47.15	1318.50
Islamabad	Kermanshah	34.12	46.47	1348.80
Ravansar	Kermanshah	34.72	46.65	1380.00
Yasouj	Kahgiloueh_Boyerahmad	30.70	51.56	1816.30
Sisakht	Kahgiloueh_Boyerahmad	30.84	51.47	2133.40
Darehshahr	Ilam	33.14	47.41	670.00
Dehloran	Ilam	32.68	47.30	232.00
Ilam	Ilam	33.59	46.40	1337.00
Ivan	Ilam	33.76	46.36	1290.00
Ezeh	Khozestan	31.85	49.85	767.00
Kohrang	Chaharmahal_Bakhtiari	32.46	50.13	2365.00
Borujen	Chaharmahal_Bakhtiari	31.98	51.30	2260.00
Farsan	Chaharmahal_Bakhtiari	32.26	50.56	2062.00
Ardal	Chaharmahal_Bakhtiari	32.01	50.66	1873.00
Lordegan	Chaharmahal_Bakhtiari	31.50	50.83	1611.00
Kohdasht	Lorestan	33.52	47.65	1197.80
Delfan	Lorestan	34.05	48.00	1859.00
Alashtar	Lorestan	33.82	48.25	1567.10
Poldokhtar	Lorestan	33.15	47.72	713.50
Khorramabad	Lorestan	33.44	48.28	1147.80
Nyriz	Fars	29.19	54.35	1632.00
Sepidan	Fars	30.23	52.00	2201.00
Noorabad	Fars	30.07	51.54	972.00
Doroodzan	Fars	30.21	52.42	1642.00
Zarghan	Fars	29.78	52.70	1596.00
Shiraz	Fars	29.56	52.60	1488.00
Kazeroun	Fars	29.60	51.65	840.00

Table 2. Precipitation indicators of climate change.

ID	Indicator name	Definitions	Units
PRCPTOT	Annual total wet-day precipitation	PRCP from wet days (P>=1mm)	mm
CWD	Consecutive wet days	Maximum number of consecutive days when precipitation ≥ 1 mm	days
R10mm	Number of heavy precipitation days	Annual count when precipitation > 10 mm	days
R20mm	Number of very heavy precipitation days	Annual count of days when P>=20mm	days
RX1day	Max 1-day precipitation amount	Monthly maximum 1-day precipitation	mm
RX5day	Max 2-day precipitation amount	Monthly maximum consecutive 5-day precipitation	mm
RX5day	Max 5-day precipitation amount	Monthly maximum consecutive 5-day precipitation	mm

PRCPTOT: Annual total wet-day precipitation: total precipitation from wet days (> 1 mm); CWD: Consecutive wet days: maximum length of a wet spell (RR ≥ 1 mm); R10mm: Heavy precipitation days: count of days where RR (daily precipitation amount) ≥ 10 mm; R20mm; Very heavy precipitation days: count of days where RR ≥ 20 mm; RX1day: Maximum 1-day precipitation: highest precipitation amount in 1 day; RX2day: Maximum 2-day precipitation: highest precipitation amount in 2 days; RX5day: Maximum 5-day precipitation: highest precipitation amount in 5 days

The highest amount of precipitation in Chaharmahal and Bakhtiari provinces due to the presence of the highest altitudes of the Zagros mountain range and the location in the path of the two Mediterranean and Sudanese rain systems, which is more than 1000 mm, and then in Kohgiluyeh and Boyer Ahmad provinces, as well as in North Zagros, the average rainfall is between It is 600 to 800 mm, so the rainiest area of Zagros forest ecosystem is located in South Zagros **(Figure 3).**

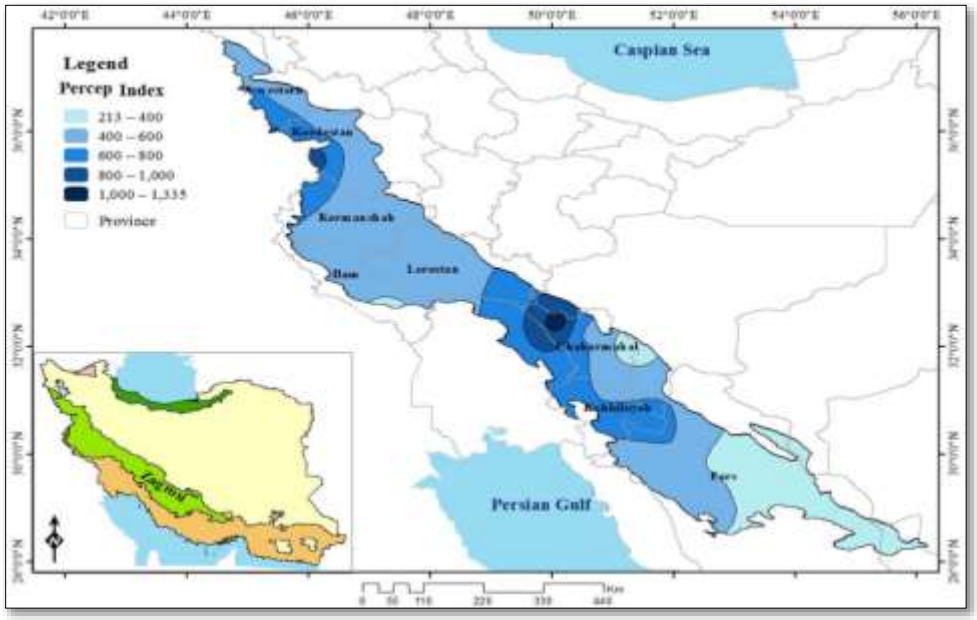

Figure 3. Spatial distribution of total annual precipitation index in Zagros forest ecosystem

Consecutive Wet Days (CWD)

This index is one of the important indices to maintain the available moisture for different forest species. Reviewing the zoning map of the annual long-term average of consecutive wet days in Zagros showed that the highest number of consecutive wet days in Kohgiluyeh and Boyer Ahmed with -8 to 10 is the day after that, Chahar Mahal Bakhtiari and

North Fars and North Zagros provinces have the highest number of consecutive wet days **(Figure 4)**.

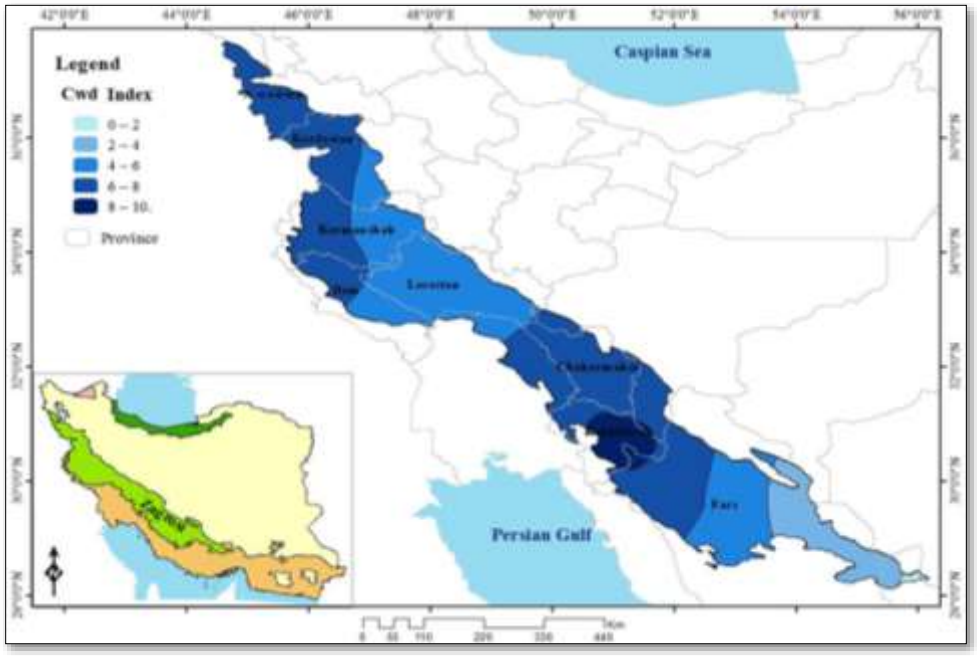

Figure 4. Long-term annual average of consecutive wet days in the Zagros forest ecosystem.

Examining the long-term maximum potential zoning map of consecutive wet days in Zagros showed that the maximum number of consecutive wet days corresponds to high altitudes in middle and southern Zagros and high latitudes in northern Zargos **(Figure 5)**.

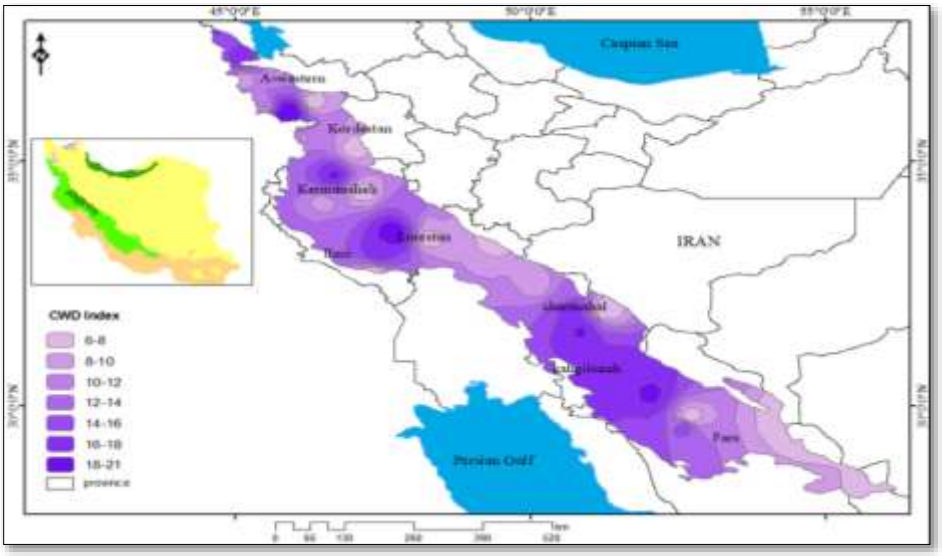

Figure 5. Spatial distribution of the potential maximum number of consecutive wet days in the Zagros forest ecosystem.

Number of heavy precipitation days (R10mm)

Examining the zoning map of the annual long-term average of the number of heavy rainfall events in Zagros showed that the highest number of heavy rainfall events is located on the border between Chaharmahal and Bakhtiari provinces of Khuzestan and Lorestan, as well as in the west of Kurdistan. The lowest number of heavy rainfall events is also located in South Fars **(Figure 6)**. Examining the long-term maximum potential zoning map of the number of heavy rainfall events in Zagros showed that the maximum number of heavy rainfall events in South Zagros was 45 to 55 events in the north of Chaharmahal and Bakhtiari province and Kurdistan province **(Figure 7)**.

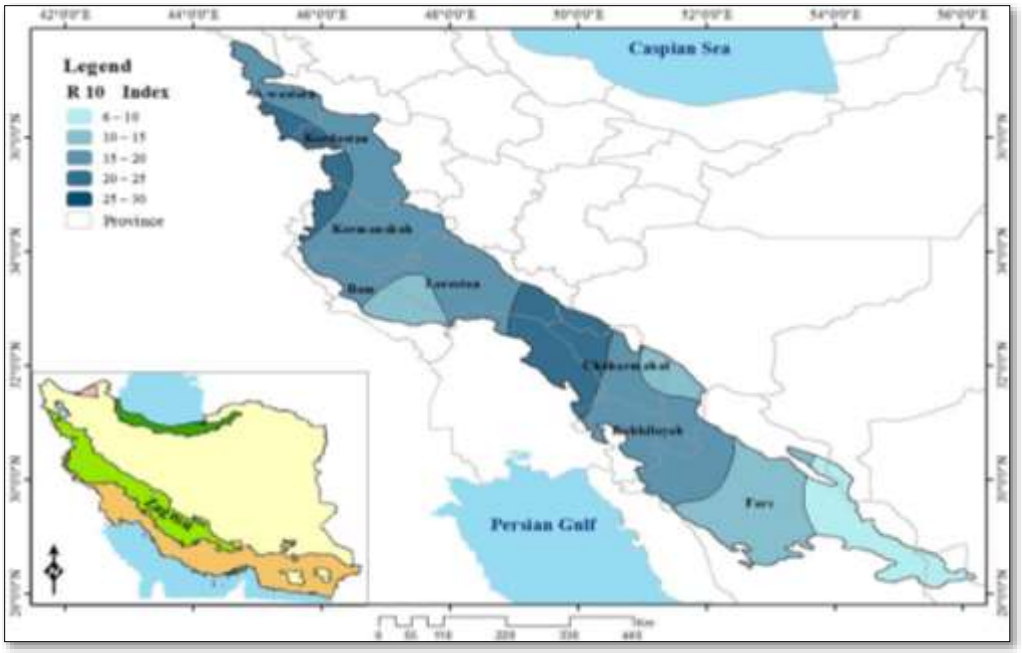

Figure 6. The long-term annual average frequency of heavy rains in the Zagros forest ecosystem.

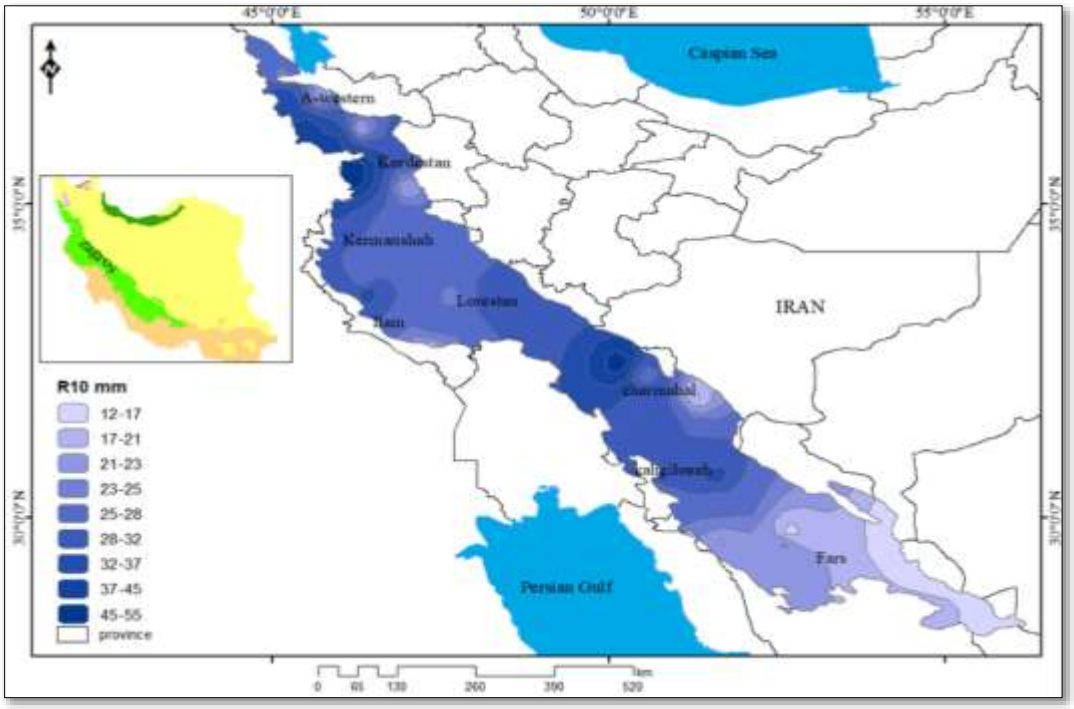

Figure 7. The potential of the maximum frequency of heavy rains in the forest ecosystem of Zagros.

Number of very heavy precipitation days (R20mm)

Examining the zoning map of the annual long-term average of the number of super heavy rain events in Zagros showed that the highest number of super heavy rain events is located on the border between Chaharmahal and Bakhtiari provinces of Khuzestan and Lorestan, as well as in western Kurdistan with -10 to 15 events. Very heavy precipitation is also located in the south of Fars and Ilam provinces on a long-term annual average **(Figure 8)**.

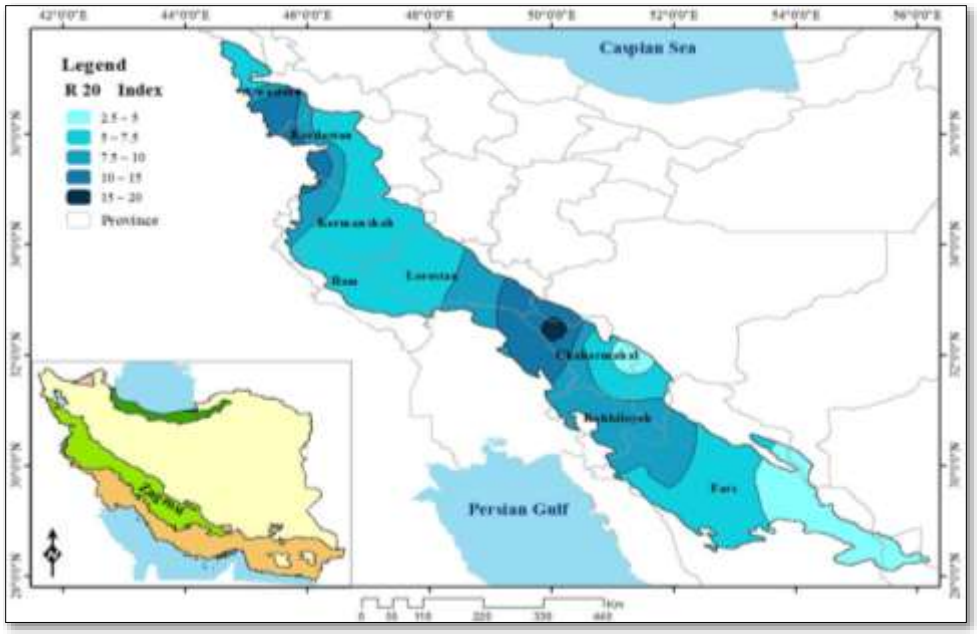

Figure 8. The long-term annual average frequency of very heavy rains in the forest ecosystem of Zagros.

Examining the long-term maximum potential zoning map of the number of **very** heavy rainfall events in Zagros showed that the maximum number of heavy rainfall events in South Zagros was 27 to 37 events in the north of Chaharmahal and Bakhtiari province and Kurdistan province in North Zagros **(Figure 9)**.

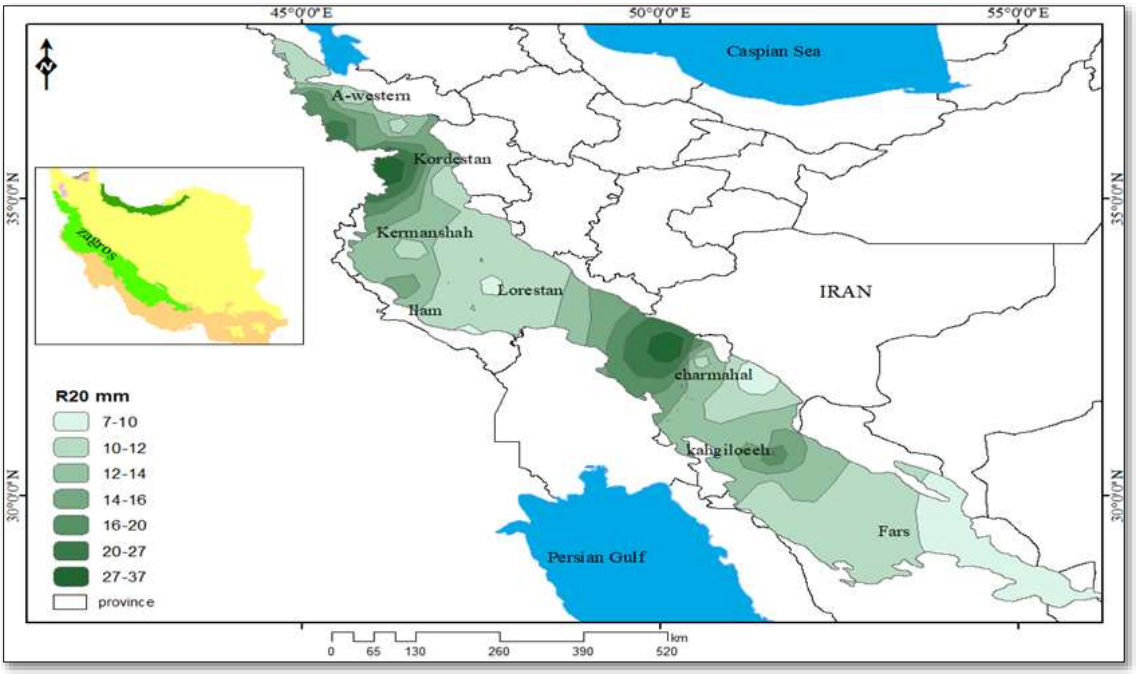

Figure 9. The potential of the maximum frequency of very heavy rains in the forest ecosystem of Zagros.

Max 1-day precipitation amount (RX1day)

Examining the zoning map of the long-term absolute maximum potential of one-day rainfall intensity in Zagros showed that the maximum potential of one-day rainfall in South Zagros in the north of Chaharmahal Bakhtiari province and west of Ilam and west of Kurdistan reaches 200 to 280 mm **(Figure 10)**.

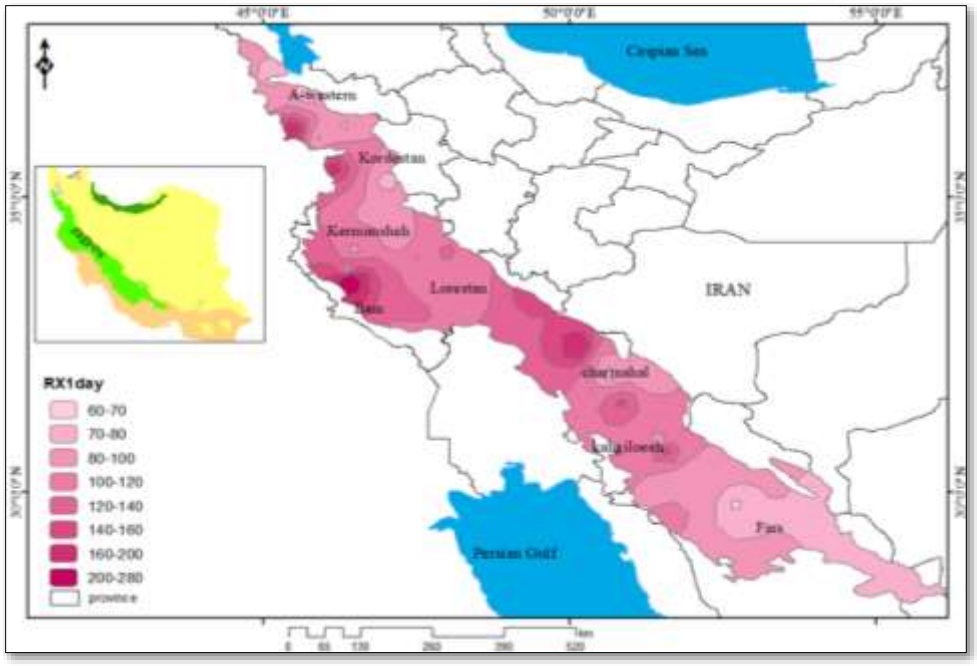

Figure 10. The potential of one-day maximum rainfall intensity in the forest ecosystem of Zagros.

Max 2-day precipitation amount (RX2day)

Examining the zoning map of the long-term absolute maximum potential of two-day rainfall in Zagros showed that the maximum potential of two-day rainfall in South Zagros in the north of Chaharmahal and Bakhtiari province and west of Ilam and west of Kurdistan reaches 200 to 280 mm. The areas of maximum two-day rainfall coincide with the areas of maximum one-day rainfall **(Figure 11)**.

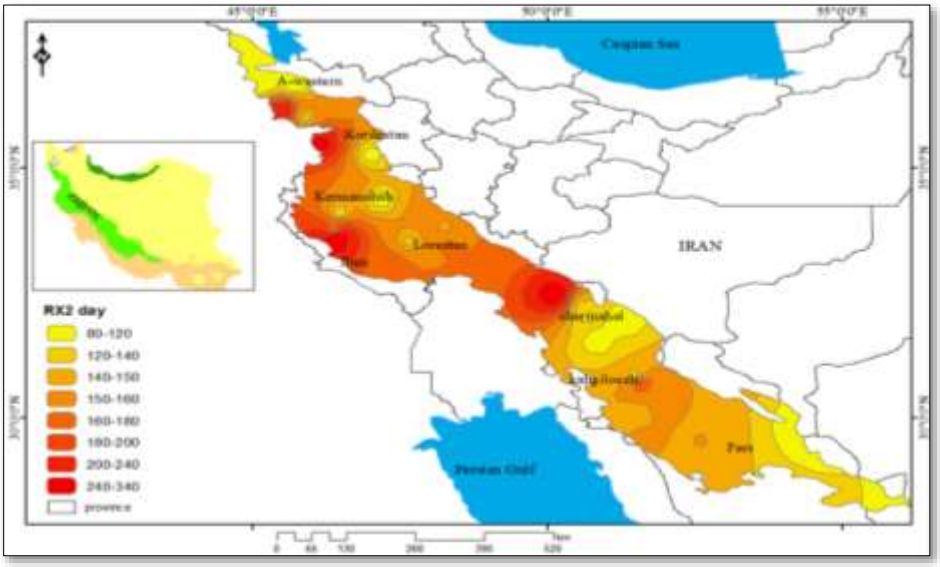

Figure 11. The potential of two-day maximum rainfall intensity in the forest ecosystem of Zagros.

Max 5-day precipitation amount (RX15day)

Examining the five-day rainfall intensity zoning map in Zagros showed that its long-term absolute maximum potential in South Zagros in the north of Chaharmahal and Bakhtiari province and west of Ilam and west of Kurdistan reaches 330 to 420 mm. The areas of maximum five-day rainfall coincide with the same areas of maximum rainfall of one and two days, with the difference that a maximum area has been added in the west of Fars province **(Figure 12)**.

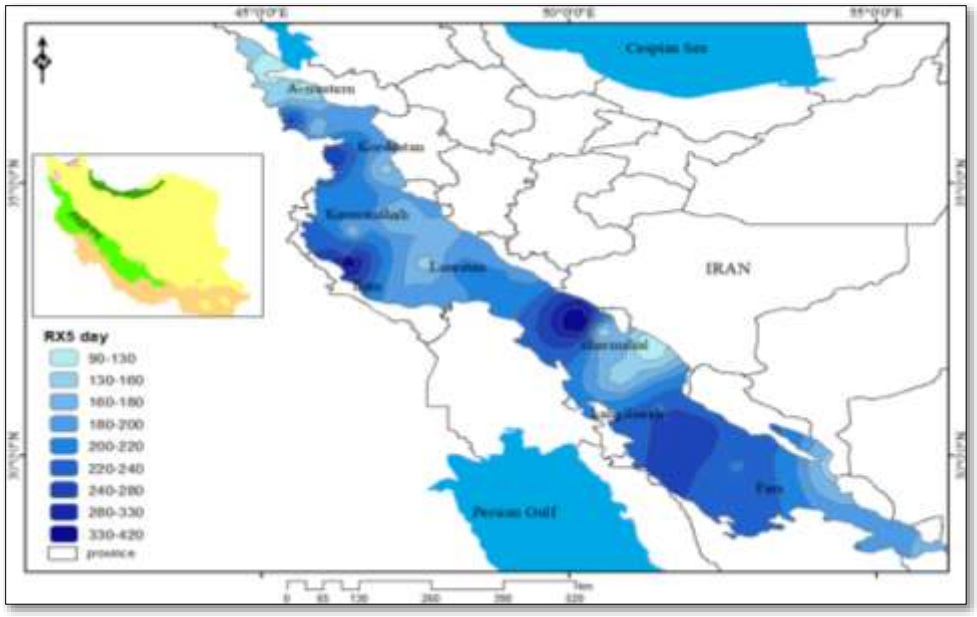

Figure 12. The potential of five-day maximum rainfall intensity in the forest ecosystem of Zagros.

CONCLUSION

The forests of Zagros are located in a position that benefits from both Mediterranean and Sudanese rainfall systems and are located in the second-highest rainfall region of Iran, but due to the influence of global warming and climate change, its rainfall is not properly distributed. And it has been accompanied by floods and droughts, both of which are harmful to oak trees; the increase in intensity and decrease in the duration of rainfall has led to the occurrence of floods and turning rainfall into runoff and preventing trees from accessing sufficient moisture. The ground does not penetrate and does not strengthen the underground water, so in the years when drought occurs in the Zagros habitat, the extraction of underground water should be minimized [55]. On the other hand, the review of sources related to this research showed that precipitation is one of the most important factors that determine the decline of oak trees, and its role was shown in many studies. The characteristics of Zagros rainfall can be an opportunity to reduce the drying of oak trees and adapt to climate change. To achieve this goal, precipitation indices were used. The investigation of the total annual precipitation index showed that the spatial distribution of precipitation in the forest ecosystem of Zagros depends on the two factors of altitude and latitude. The amount of precipitation varies from 200 to 400 mm in low latitudes and 1000 to 1350 mm in high altitudes and latitudes. The spatial distribution of the index of consecutive wet days in Zagros showed that the average number of consecutive wet days in South Zagros is -8 to 10 days, which corresponds to the highest amount of total annual precipitation. Large areas in South and North Zagros average consecutive wet days of 6 to 8 days. But the highest potential of consecutive wet days in the form of scattered nuclei throughout Zagros is 18 to 21 days. The study of the spatial distribution of the annual long-term average of the number of heavy rainfall events in Zagros showed that the highest number of heavy rainfall events is located on the border between Chaharmahal and Bakhtiari provinces of Khuzestan and Lorestan, as well as in the west of Kurdistan with 18 to 21 events and the highest potential for the number of heavy rainfall events in Zagros. South 45 to 55 incidents occurred in the north of Chaharmahal and Bakhtiari province and in North Zagros in Kurdistan province. Investigating the spatial distribution of the annual long-term average of the number of super heavy rainfall events in Zagros showed that the highest number of super heavy rainfall events corresponds to heavy rains with 10 to 15 events and a maximum potential of 27 to 37 events. The areas of maximum heavy rainfall and extra heavy rainfall both coincide with the areas with the highest annual rainfall, especially in the highlands. The one-day maximum rainfall intensity index showed that the maximum one-day rainfall potential in South Zagros in the north of Chaharmahal and Bakhtiari province, west of Ilam and west of Kurdistan reached 200 to 280 mm, and the areas of maximum 2-day rainfall intensity also had a potential of 240 to 340 mm. The same areas of one-day maximum intensity coincided. In addition to the previous areas, the maximum intensity potential of 5 days in the northwest of Fars province also reached 330 to 420 mm.

Although all precipitation indicators revealing climate change had no trend and significance, there is a good rainfall potential in the region. In the past, these rains have fallen continuously and softly with small grains and for several

days in a row, but in recent years, due to the warming effects caused by climate change and the increase in the moisture capacity of precipitation systems, the characteristics of precipitation have changed and the rains mostly fall in the form of thundershowers with large grains and a short period. Due to the trend of increasing temperature, these characteristics of precipitation will intensify in the future and it is expected that the intensity of precipitation will increase by about 7% for each degree Celsius of warming [56]. Therefore, to adapt to the changes that have occurred and the upcoming changes, by knowing the characteristics of the rainfall in the region and to exploit the available water capacity, sustainable forest management programs should be planned, because the rainfall that has the characteristics of torrential and flooding are fast. It turns into runoff and is out of the reach of the forest trees. This rain is a threat that even erodes the soil of the forest. However, by carrying out water extraction operations and its management, this threat can be turned into an opportunity to adapt and preserve. And even the revival of decayed and dried trees helped. Two basic solutions in the field of reducing climate effects; Dealing with and adapting to climate change. Since it is complicated to deal with climate change adaptation seems to be a more suitable solution. It is suggested that considering the potential of torrential rains in the entire Zagros ecosystem, such as Kermanshah province [57] and Ilam province [58], one of the two methods of storing precipitation in the form of banks Linear and crescent-shaped trees should be used to deal with the critical conditions of oak forests at risk of drying out, and by storing atmospheric precipitation to increase soil moisture and improve the health and vitality of dried trees, this great water potential in Zagros was used, which is a fundamental measure in the direction of adaptation with climate change, the aim is to preserve the Zagros ecosystem.

Suggestion Considering the long roots of oak trees and the occurrence of short and intense rains in the future, considering the effects of climate change, it is suggested that in the areas where the phenomenon of tree deterioration has occurred, rainwater should be infiltrated into the ground through watershed operations, and for This is a work of people's participation and using the knowledge of the natives of each region to try to preserve and restore the ecosystem, and finally, after a few years, compare the results with the previous ones and measure the freshness of the trees and publish the success solutions in other parts that preserving forests reduces the effects of climate change and slows down the process of changes.

“All authors have read, understood, and have complied as applicable with the statement on "Ethical responsibilities of Authors" as found in the Instructions for Authors”.

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Author Contributions: Fatemeh Dargahian: Conceived of the presented idea and developed the theory and performed the computations. Fatemeh Dargahian: Verified the analytical methods and supervised the findings of this work. All authors discussed the results and contributed to the final manuscript.

Ethical Approval: Not applicable, because this article does not contain any studies with human or animal subjects.

Consent to participate: The data of this research were not prepared through a questionnaire.

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