Spatial and Temporal Analysis of Precipitation over Iran Using Gridded Precipitation Data of APHRODITE

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Abstract

In order to achieve risk management of water-related disasters such as droughts and floods in Iran, it is essential to obtain knowledge of the exact quantities of spatial and temporal precipitation over the long term. In this regard, this paper presents the results of monitoring precipitation on monthly, seasonal and annual timescales during the period of 1986-2006 (21 years) over Iran using a product of 0.5-degree-gridded data sets provided by the Asian Precipitation-Highly-Resolved Observational Data Integration (APHRODITE) Towards Evaluation of the Water Resources project, namely APHRO_ME_V003R1. Spatial distribution of mean seasonal and annual precipitation shows two rainfall peaks that extend from the northwest to the southeast along the Zagros Mountains and along the Caspian Sea and Alborz Mountains in the northern part of the country.

With respect to a seasonal spatial analysis of rainfall over Iran, it is concluded that in winter, DJF (December- January- February), and spring, MAM (March-April-May), most precipitation occurs in the west, northwest and southwest along the Zagros Mountains, but in summer. JJA (Jun-July-August), and autumn, SON (September-October-November), most precipitation occurs along the southern Caspian Sea in the north.

Annual and seasonal drought condition using APHRODITE data have showed that mean annual precipitation amount were low (drought condition) over Iran in 1989, 1990, 1991, 1992, 1996, 1998, 1999, 2000, 2001 and they are in accordance with Yazdani *et al* (2011)'s study about drought analysis over Iran.

Key words: APHRODITE, daily gridded precipitation data set, high resolution, Iran

1. Introduction

Precipitation is one of the most critical input variables for water balance calculations because it is the immediate source of water for the land surface hydrological budget (Fekete *et al*., 2004). Precipitation varies across a range of space–time scales. Larger space-scale variations generally occur at longer time scales, and are associated with correspondingly larger scale phenomena in the atmosphere or ocean–atmosphere system. At all time and space scales, precipitation is inherently more variable than other commonly reported climate variables, such as temperature and pressure, with the result that precipitation measurement and analysis are more demanding (New *et al*., 2001). At larger space scales (regional to global), precipitation data are needed for climate model evaluation (Hulme *et al*., 1994a), for the analysis of observed climate change against the background of natural variability (Hulme *et al*., 1999a), for biogeochemical modeling (Cramer & Fischer, 1996) and for the construction of climate scenarios for climate change impact studies (Hulme *et al*., 1999b).

In the last two decades, various globally gridded datasets of monthly terrestrial precipitation observations have been developed, for example, the Climate Research Unit of University (CRU) of East Anglia, Willmott–Matsuura (WM), Global Precipitation Climate Center (GPCC) (Fekete *et al*., 2004). A spatial–temporal high resolution gridded ground-based precipitation dataset bank using rain gauge data over Asia under a project named APHRODITE has been developed by the Research Institute for Humanity and Nature (RIHN) in Kyoto in collaboration with Meteorological Research Institute, Japan Meteorological Agency since 2006 <http://www.chikyu.ac.jp/precip/> (Yatagai *et al*., 2009).

CRU, WM and GPCC data sets are in high resolution but monthly datasets. But the released APHRODITE data are high temporal and spatial grid precipitation data for longest period. They include daily precipitation on a 0.25/0.5-degree grid for Asia using many rain-gauge stations for the period 1951-2007.

Since the country of Iran is located in an area at risk of drought and flood phenomena, evaluating the amount of the precipitation is of significant importance. This paper aims to study spatial and temporal variability of mean monthly and seasonal rainfall over Iran, using 0.5 degree precipitation data of APHRO_ME_V003R1 (released in 2010 at http://www.chikyu.ac.jp/precip/) from 1986 through 2006. The results of this study could be applied not only to the evaluation of droughts and floods in order to achieve water related disaster risk management but also to other necessary hydrological research.

2. Data and methodology

2.1 Study area

The Islamic Republic of Iran (Iran) is located between 25°N to 40°N and 45°E to 60°E in south-west Asia and covers the area of 1,648,000 square kilometers. It is located on the world dry belt. Iran is one of the world's most mountainous countries bordering the Gulf of Oman, the Persian Gulf, and the Caspian Sea. 60 percent of Iran is covered by mountains. The central parts of the country are covered by two very dry deserts, the Dasht-e-Kavir and the Dasht-e-Lut. The topography of the country is dominated by two mountain ranges. The Alborz range in the northern part of Iran, close to the Caspian Sea extends in east-west direction with a maximum altitude of about 5,000 meters. The Zagros Mountains cross the country from northeast to southwest and reach a maximum altitude of about 3,500 meters as shown in Fig.1 (Javanmard, 2006). These two ranges play an influential role in determining the amount and distribution of rainfall over the country. The dominant flow directions of air masses are from the west and from the south. Several atmospheric and oceanic systems influence Iran throughout the year. The major ones are the Mediterranean low pressure system which enters from the west throughout the year, Siberian high pressure system (Siberian High) which penetrates into the country from the north mostly during the winter, and Sudan tropical low pressure (Sudan Low) which arrives from the southeast coner as shown Fig.1 (Golestani, 2000).

Iran is generally classified as an arid or semi-arid country. Mean annual rainfall is about 250 mm ranging from 50 mm in the deserts to 1,600 mm on the Caspian plain (Fig. 2). The precipitation occurs mostly in winter and early spring and on the average, about 40% of the annual precipitation in Iran occurs in the winter (Ghasemi & Khalili, 2008).

2.2 APHRODITE's water resources data

The APHRODITE project develops state-of-the-art daily precipitation datasets with high-resolution grids for Asia. The datasets are created primarily with observations from a rain-gauge-observation network. APHRODITE's daily gridded precipitation is the only long-term (1951 onward) continental-scale daily product that contains a dense network of daily rain-gauge data for Asia, including the Himalayas, South and Southeast Asia and mountainous areas of the Middle East. The number of valid stations has been between 5,000 and 12,000, representing 2.3 to 4.5 times the data available through the Global Telecommunication System network, and they

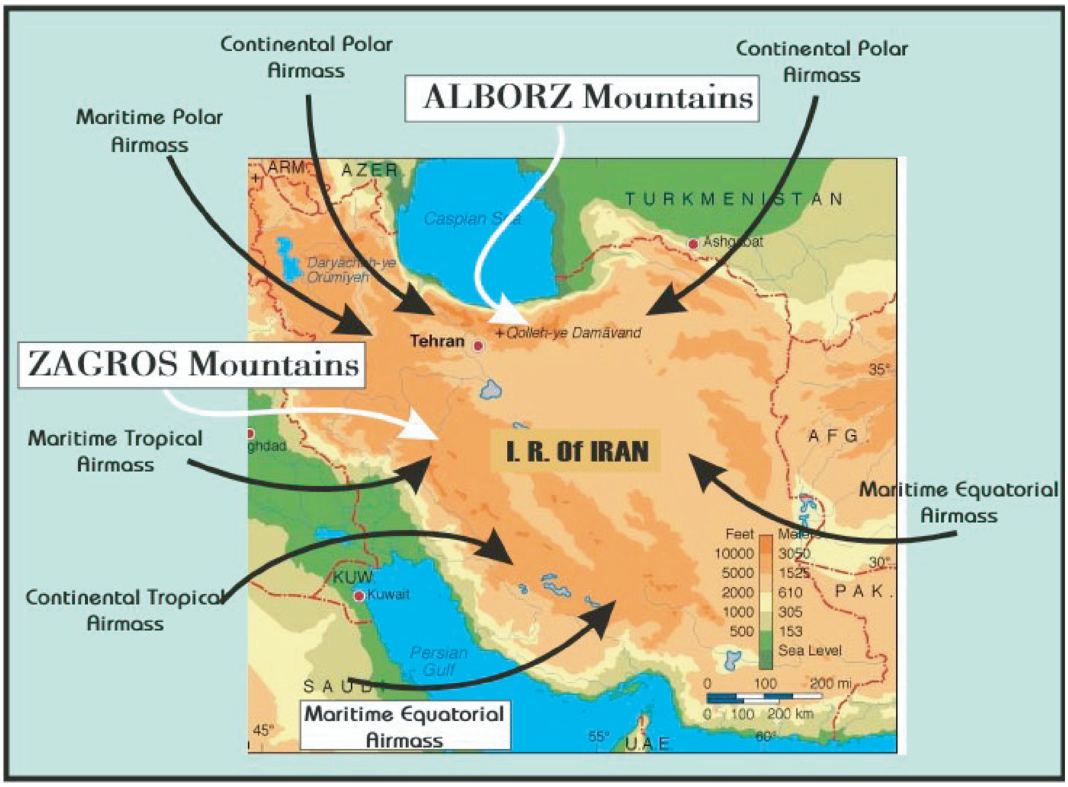

Fig. 1 Topographical map of Iran. (after Javanmard, 2006)

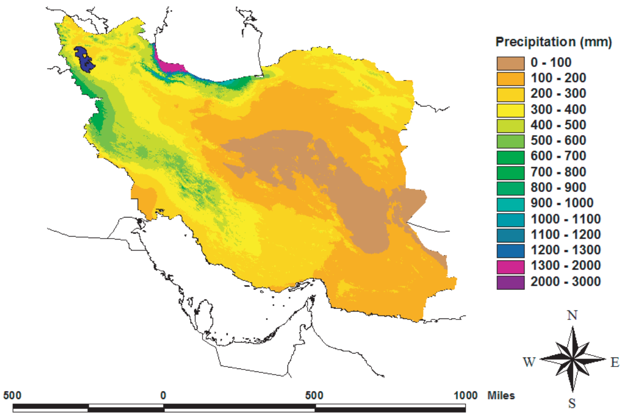

Fig. 2 Mean annual precipitation (mm) distribution over Iran 1961-1990.

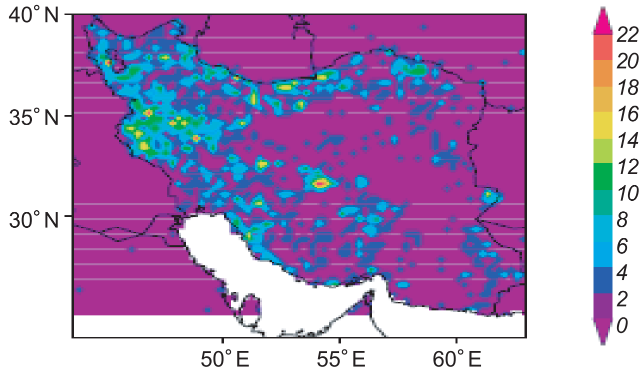

Fig. 3 Ratio of 0.05-degree grids with station (%).

have been used for most daily grid precipitation products. These products contribute to studies such as the diagnosis of climate changes, evaluation of Asian water resources, statistical downscaling, forecast improvements, and verification of numerical model simulation and satellite precipitation estimates (Yatagai *et al.*, 2009). The advantages of the released APHRODITE data are high temporal and spatial grid precipitation data for longest period of time. They include daily precipitation on a 0.25/0.5-degree grid for Asia using many rain-gauge stations for the period 1951-2007. Therefore more detail climatological studies could be carried out about temporal and spatial distribution of extreme events such as drough and flood over Iran. In this paper we have used 0.5 degree-gridded precipitation data of APHRO_ME_V003R1 (which pertains to the Middle East region) over Iran during 1986-2006 time periods (21 years). Figure 3 shows the spatial distribution of percentage ratios of the 0.05 degree grid with station data over Iran.

3. Results

3.1 Spatial analysis of precipitation over Iran

The spatial distributions of mean seasonal and annual precipitation have been derived using APHRO_ME_V003R1 precipitation data with 0.5 degree spatial resolution and daily temporal resolution over the time period 1986-2006 and are shown in Fig. 4 for the four seasons, including winter (Fig. 4a), spring (Fig. 4b), summer (Fig. 4c) and autumn (Fig. 4d), as well as annual (Fig. 4e). The spatial analysis of monthly, seasonal and annual data have been summarized in Tables 1 and 2. In most months, the first peak of precipitation mostly occurs along the southern Caspian Sea in the north, with the second peak over the Zagros Mountains in the west, which extend from the northwest through the southwest. Precipitation minima mostly occur in the Lut and Kavir deserts in the center, southeast and east of country. In winter (DJF) and spring (MAM), most precipitation occurs in the west, northwest and southwest along the Zagros Mountains in most months. In summer (JJA) and autumn (SON) most precipitation occurs along the southern Caspian Sea in the north.

The rainfall maximum in winter is about 150 mm/month in the northwest, west along the Zagros Mountains, north along the Alborz Mountains, and south as shown in Fig. 4a. It is about 25 mm/month in the center and southeast. There is no rainfall in the Lut Desert in the southeast. Figure 3b shows that the rainfall maximum in spring over the southern shore of the Caspian Sea is about 25-75 mm/month. The rainfall maximum is about 100 mm/month along the Zagros Mountains in the west and southwest and about 25 mm/month in the east, center, and south.

The mean precipitation rainfall maximum in summer appears in the north along the Alborz Mountains and Caspian Sea about 150 mm/month. It is about 25-50 mm/month in the northwest toward the southwest along the Zagros Mountains. Only in a small part of the southeast and the Lut desert is it about 10 mm/month, as shown in Figure 4c. As a result, there is low rainfall during summer over different parts of Iran and the rainfall maximum is over the north (southern Caspian seashore) and northeast. The lowest rainfall, about 1-25 mm/month, occurs in the center of Iran during all four seasons, extending eastward in autumn too (Fig. 4d). On the other hand, the highest rainfall occurs in the north, southwest and south, with about 200 mm/month in autumn and 150 mm/month in winter and spring (Figs. 4a and 4b).

Figure 4e shows the spatial distribution of mean annual precipitation over Iran from 1986 to 2006. It shows that rainfall occurs less in the center (Lut and Kavir deserts) and southeast of Iran, with about 1-10 mm/month, and the east, with about 1-25 mm/month. The concentration of rainfall is high along the southern Caspian seashore, with 25 to 100 mm/month, and along the Zagros Mountains in the west from northwest to southwest, with about 25-75 mm/month.

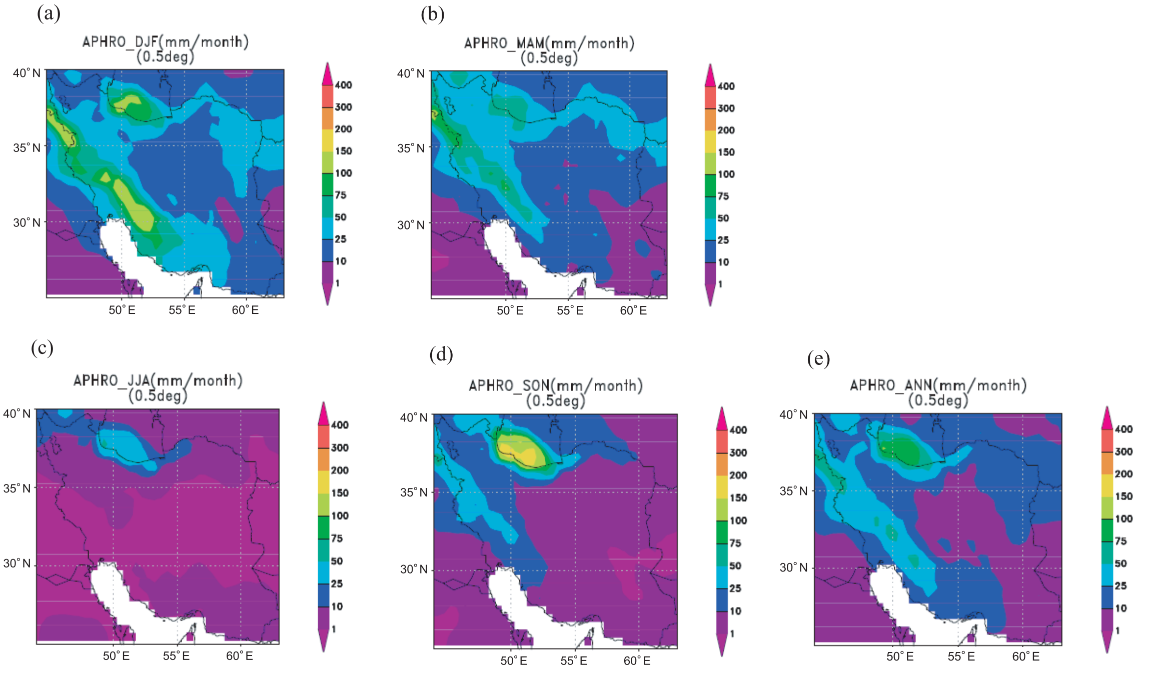

Fig. 4 Mean seasonal precipitation (mm/month) for winter (a), spring (b), summer (c), autumn (d), and annual (e) from 1986-2006.

Table 1 Mean monthly spatial distribution of precipitation over Iran.

Monthly Rainfall (mm/month) / **Month**	**Northwest**	**West**	**North (Caspian Sea)**	**Northeast**	**East**	**Center**	**South (Persian Gulf and Sea of Oman)**	**Southwest**	**Southeast**	**Maximum value (mm/month) and region**	**Minimum value (mm/month) and region**
Jan	10-50	25-200	25-100	10-50	10-50	10-25	10-75	25-200	10-25	200 (Zagros mountains)	10 (center)
Feb	10-50	25-100	25-75	10-50	10-50	1-25	10-100	25-100	1-10	100 (north and Zagros)	1(center & southeast)
Mar	25-50	50-150	25-100	25-75	10-50	10-25	10-50	25-150	10-25	150 (west & southwest)	10(center)
Apr	25-75	25-100	25-75	25-75	1-25	1-25	1-25	10-75	1-10	100 (west)	1(east & center & south)
May	25-50	1-50	1-10	10-50	1-10	1-10	1-10	1-25	1-10	50 (north west)	1
Jun	1-50	1-25	10-50	1-25	<1	<1	1-25	1-10	1-10	50 (north)	<1 East & center)
July	1-25	1-25	10-50	1-25	1-10	1-10	1-10	1-10	1-25	50 (north)	1(most parts)
Aug	1-10	<1	1-75	1-25	<1	<1	1-10	1-10	1-10	75 (north)	<1 (northwest &east &center)
Sep	1-10	<1	25-200	10-25	<1	<1	1-10	<1	1-10	200 (north)	No / less rain most parts
Oct	10-25	1-50	25-200	10-25	1-10	1-10	1-10	1-10	1-10	200 (north)	1 (most parts)
Nov	10-25	25-75	25-200	10-50	1-10	1-10	1-10	10-75	1-10	200 (north)	1 (most parts)
Dec	10-25	25-100	25-100	10-50	1-25	10-25	10-100	25-150	1-25	100 (north& west& south)	1(southeast & east)

Table 2 Seasonal and annual spatial distribution of precipitation over Iran.

Seasonal & Annual Rainfall (mm/month) / **Season**	**Northwest**	**West**	**North (Caspian Sea)**	**Northeast**	**East**	**Center**	**South (Persian Gulf and Sea of Oman)**	**Southwest**	**Southeast**	**Maximum value (mm/month) and region**	**Minimum value (mm/month) and region**
Winter(DJF)	10-25	25-100	25-100	10-50	10-50	1-25	10-150	25-150	10-25	150 (Southwest and South)	1-25 (Center)
Spring(MAM)	25-50	25-75	25-75	10-50	1-50	1-25	1-75	10-100	1-10	100(Southwest)	1-25 (Center)
Summer(JJA)	1-10	1-10	1-50	10-25	1-10	<1	1-10	1-10	1-10	25 (North)	<1 (Center)
Autumn(SON)	10-25	10-50	10-200	1-25	1-10	1-10	1-25	10-50	1-10	200 (North)	1-10 (East & Center)
Annual (ANN)	10-50	25-75	25-100	10-50	1-25	1-10	1-50	10-75	1-10	100 (North)	1-10 (Southeast & center)

3.2 Temporal analysis of precipitation over Iran

Figure 5 shows time series of monthly areal averages of precipitation over Iran from 1986 through 2006 (21 years). The maxima of monthly areal averages of precipitation have been compared in each year from 1986 through 2006. It has been concluded that the maximum monthly areal average precipitation was about 48-60 mm/month from 1986 through 1998, except December 1989, which had 40 mm/month; February 1990, which had 35 mm/month; and February, April and December 1995, which had 35 mm/month. Moreover, it decreased to 38-45 mm/month from 1999 through 2006, except Jan. 2004, which had 55 mm/month. The results are in accordance with the drought conditions which have dominated in Iran from 1999 through 2003. The annual minimum monthly areal average precipitation has occurred in JJA. The detail information has been presented in Table 3. Figure 6 shows a time series of monthly areal average precipitation over Iran from 1986 through 2006 for the four seasons, *i.e.*, winter, spring, summer and autumn from top to bottom, respectively, from 1986 to 2006. It shows that the maximum areal average precipitation occurs mostly in winter (DJF). The areal average of rainfall in DJF is about 35 mm/month. The minimum areal average precipitation occurred in summer (JJA), with less than 2 mm/month. The time series of areal averages of precipitation in spring (MAM) shows that the rainfall of March is more than that of the other months of spring. Maxima of rainfall in March occurred in 1987, 1991 and 1996 with 50, 50 and 60 mm/month, respectively, and minima occurred in 1990, 1995, 2000, 2004 and 2006, with about 20 mm/month. Areal averages of rainfall in summer months show a maximum precipitation of about 10 mm/month, and rainfall is low in all of these months for the most part. A time series of areal average rainfalls in autumn months shows more rainfall in November compared with the other months of autumn. The first peak was 60 mm/month in 1994, the second was 45 mm/month in 1986 and there were subsequent peaks of 30 mm/month in 1997 and 2004.

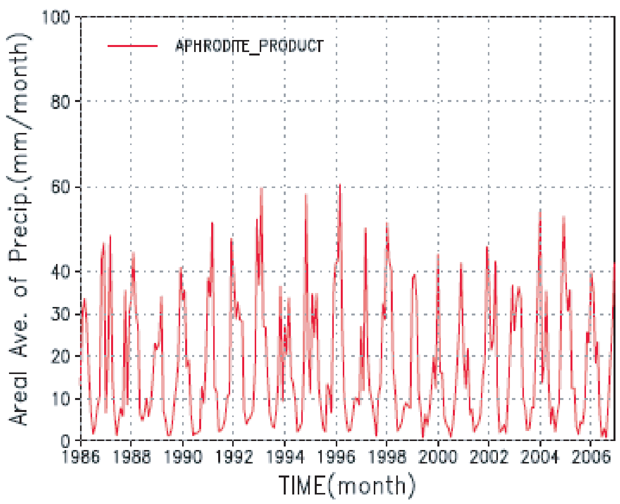

Fig. 5 A time series of monthly areal averages of precipitation over Iran from 1986 through 2006.

Table 3 Monthly occurrence of maximum and minimum of areal average of precipitation from 1986 through 2006.

Year	Month with maximum areal average precipitation	Maximum areal average precipitation (mm/month)	Month with minimum areal average precipitation	Minimum areal average precipitation (mm/month)
1986	Dec	48	Jul	2
1987	Mar	48	Jun	2
1988	Feb	45	Jun	5
1989	Dec	40	Jun, Jul	1
1990	Feb	35	Jun, Jul	2
1991	Mar	50	Jun, Jul	2
1992	Dec	50	Jul	3
1993	Feb	60	Jul, Aug	4
1994	Nov	58	Jul, Aug	2
1995	Feb, Apr, Dec	35	Jul, Aug	2
1996	Mar	60	Jul, Aug	2
1997	Mar	50	Aug	<1
1998	Jan	50	Jun	2
1999	Feb	40	Jun	<1
2000	Jan	42	Jul	<1
2001	Dec	45	Jun	2
2002	Apr	40	Jun, Jul	2
2003	Dec	38	Jul, Aug	2
2004	Jan	55	Aug	2
2005	Jan	38	Jul	2
2006	Jan, Dec	40	Jun, Aug	<1

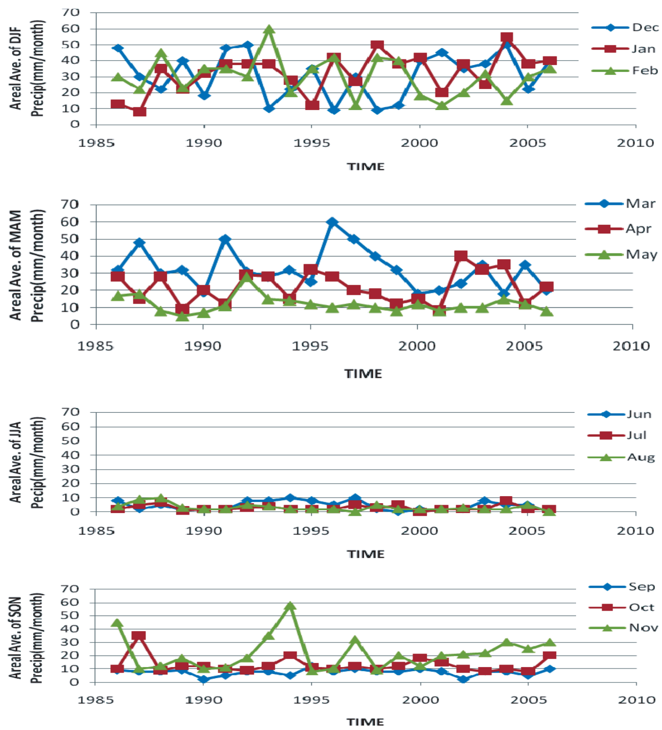

Fig. 6 Time series of monthly areal averages of precipitation over Iran from 1986 through 2006 for the four seasons, *i.e.*, winter, spring, summer and autumn, from top to bottom, respectively.

4. Conclusion

The spatial distributions of mean seasonal and annual precipitation have been derived using APHRO_ME_V003R1 precipitation data with 0.5 degree spatial resolution and daily temporal resolution over the time period 1986-2006. Precipitation mostly occurs along the southern Caspian Sea in the north, with the second peak over the Zagros Mountains in the west, which extend from the northwest through the southwest. Precipitation minima mostly occur in the Lut and Kavir deserts in the center, southeast and east of country. In winter (DJF) and spring (MAM), most precipitation occurs in the west, northwest and southwest along the Zagros Mountains in most months. In summer (JJA) and autumn (SON) most precipitation occurs along the southern Caspian Sea in the north.

Time series of monthly, seasonal, and annual areal averages of precipitation over Iran from 1986 through 2006 (21 years) have been derived. They showed that the maximum areal average precipitation occurred mostly in winter (DJF). The minimum areal average precipitation occurred in summer (JJA). The time series of areal averages of precipitation in spring (MAM) shows that the rainfall of March is more than that of the other months of spring. A time series of areal average rainfalls in autumn months, (SON) shows more rainfall in November compared with the other months of autumn.

A comparison has been carried out for annual and seasonal drought condition, *i.e.* lower rainfall amount from mean values. Figure 7 shows time series of mean areal average annual and seasonal rainfall over Iran from 1986 through 2006 using APHRODITE data. Yazdani *et al.* (2011) have studied about drought and analyzed the annual and seasonal precipitation over Iran for 33 years (1974-2006) as shown in Fig. 8. Both Figs. 7 and 8 show mean annual precipitation amount were lower than normal values (drought condition) over Iran in 1989, 1990, 1991, 1992, 1996, 1998, 1999, 2000, 2001.

APHRODITE data set is highly-resolved and daily

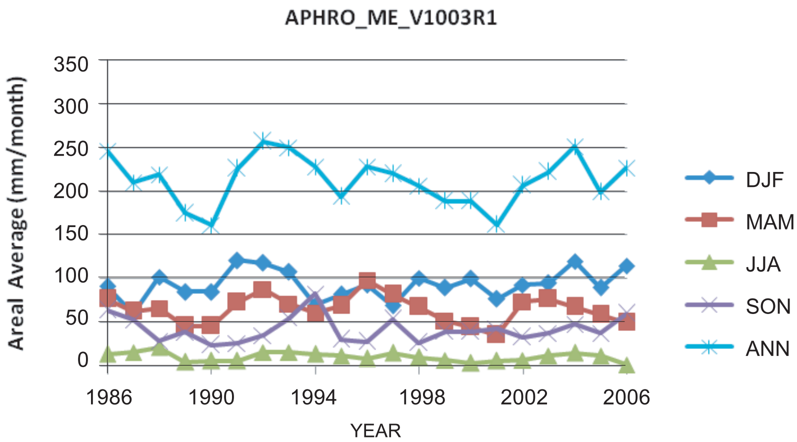

Fig. 7 Time series of mean areal average annual and seasonal (spring, summer, autumn, and winter) rainfall over Iran from 1986 through 2006 using APHRODITE data.

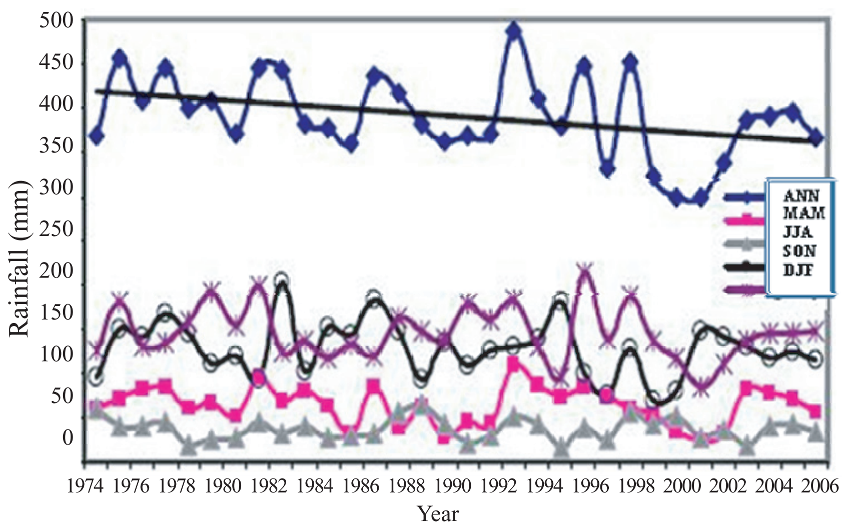

Fig. 8 Time series of mean annual and seasonal (spring, summer, autumn, and winter) rainfall over Iran from 1974 through 2006 (after Yazdani *et al.,* 2011).

gridded product. For the purpose of water risk management, analyses of extreme rainfall events (flood and drought) are important and APHRODITE data set is the very applicable product to analyze those events.

References

Cramer, W. and A. Fischer (1996) Data requirements for global terrestrial ecosystem modeling. *In*: B. Walker and W. Steffen, eds., *Global Change and Terrestrial Ecosystems*, 530-565, Cambridge University Press, Cambridge.

Fekete, B.M., J.J. Vörösmarty and J.O. Roads (2004) Uncertainties in precipitation and their impacts on runoff estimates. *Journal of Climate,* 17.

Ghasemi, A. R. and D. Khalili (2008) The association between regional and global atmospheric patterns and winter precipitation in Iran. *Atmospheric Research*, 88; 116-133.

Golestani Y., A.M.Noorian and D.R. Hudak (2000) Design considerations for the two C- and one S-band doppler weather radars in the Islamic Republic of Iran. *Physics and Chemistry of the Earth (B*), 25(10-12): 991-994.

Hulme, M. (1994) Validation of large-scale precipitation fields in General Circulation Models. *In*: M. Desbois and F. Desalmand, eds., *Global Precipitation and Climate Change,* 387-405, Springer, Berlin.

Hulme, M., E.M. Barrow, N.W. Arnell, P.A. Harrison, T.C. Johns and T.E. Downing (1999a) Relative impacts of human-induced climate change and natural climate variability. *Nature,* 397: 688-691.

Hulme, M., J.F.B. Mitchell, J. Jenkins, J.M. Gregory, M. New and D. Viner (1999b) Global climate scenarios for fast-track impacts studies. *Global and Environmental Change*, Supplementary Issue: S3-S19.

Javanmard, S. (2006) A Review Drought Early Warning Forecasting Systems in Iran (The Gap Between Current Status & What Needs to be Done), FAO project report, Ministry of Jehad-e Agriculture, I. R. of Iran.

New, M., M. Hume, P. Jones and M. Todd (2001) Precipitation measurements and trends in the twentieth century. *Journal of Climatology,* 21: 1899-1922, doi: 10.1002/joc.680.

Yatagai, A., O. Arakawa, K. Kamiguchi, H. Kawamoto, M. I. Nodzu and A. Hamada (2009) A 44-year daily gridded precipitation dataset for Asia based on a dense network of rain gauges*, SOLA*, 5: 137-140, doi: 10.2151/sola-035.

Yazdani, V., H. Zare Abyaneh and M. Shademani (2011) Analysis of frequency and zoning of drought over Iran using standard Precipitation Index, *Journal of Water Engineering*, 4: 31-43. (in Persian)

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