International Journal of Scientific Research in Multidisciplinary Studies
Vol.6, Issue.5, pp.87-96, May (2020)
Research Paper
E-ISSN: 2454-9312
P-ISSN: 2454-6143

Evaluation of Climate Change by Using LARS-WG5 Model in the Selection Watershed of North Iran

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Available online at: www.isroset.org

Received: 03/May/2020, Accepted: 20/May/2020, Online: 31/May/2020

Abstract— In order to achievement of this research objectives , used the LARS-WG5 model weather-based generation models, a series of scenarios related to the IPCC (United Nations Climate Change Commision).The research area was the Talar watershead of Mazandaran Province in North of Iran. Based on the selected base period and the mean monthly rainfall and temperature of the base period ,the monthly rainfall and monthly temperature Was carried out by the latest model LARS-WG5 for the three different series used in the research for future simulations. Also, in order to better study, the minimum and maximum temperatures for future periods were calculated by the model with the base period. According of the results, it is revealed in different months of the year there was many differences between observed monthly rainfall and simulation by this model.The monthly average rainfall trend is that from 1 January to the end of the May.The average monthly precipitation increases in future periods compared to the base period. In June, the decline, rising in July and Augus and decrease in September. Also in October, November and December, we will see a dramatic increase in the amount of precipitation coming in the future.On the other hand, the months of May and October have the most rainfall changes in the coming periods.The consequences of these changes may be affected in seasonal flood events in the study area.Current and future temperatures shows the highest temperature variation in June, August and February that indicating the hot months of the year are warmer and even in February in the future. Comparison of average maximum and minimum temperatures during the base period and simulated by the HADCM3 Talar basin model hot ,warmer and confirm subject.

Keywords— Climate change, Variation of Precipitation, Temperature condition , LARS-WG model, Talar watershed

I. INTRODUCTION

One of the major environmental problems that is accepted by most scientific societies is climate change [2]. The increase in greenhouse gas emissions due to human activities has led to climate change around the world, which has affected climate parameters.[4,5,6,,24,28].The fourth report of the Intergovernmental Panel on Climate Change (IPCC) pointed out that during the past 100 years (1906–2005), the global mean surface temperature had increased by 0.74C˚ [27].

Furthermore, there is a rising trend in the frequency of occurrence of extreme hydrological events like floods and droughts nowadays due to climate change [1,31,7,10,14,32]. At the global scale, variations in climate include temperature fluctuations and changes in precipitation duration, intensity, and frequency[14]. Therefore, it is of great importance to investigate the impact of climate change on hydrology and water resources[34].

II.RELATED WORK

In the field of climate change, refers to a number of studies by the following researchers : In a study [30] Examined climate change in Po River (North Italy) They are in this research the persistence of climate signal in precipitation and temperature after the bias correction is assessed in terms of climate anomaly for 2041–2070 and 2071–2100 periods versus 1982–2011 . Results show that under both RCPs, either considering raw and bias corrected climate datasets, temperature is expected to increase on the whole Po River basin and in all the seasons; the most significant changes in precipitation and discharges occur in summer. In another study [21] Examined , Impact of climate change on soil erosion - A high-resolution projection on catchment scale until 2100 in Saxony/Germany. Results of the simulations with EROSION 3D quantify the impacts of climate change on erosion rates. Climate change will lead to a significant increase of soil loss by 2050 and a partial decrease by 2100. Not adapting soil management and land use will aggravate erosion rates.

In the research[26] they assessed the impact of projected climate change on regional water resources management. They analyzed climate change projections of precipitation for the Upper Santa Cruz River from eight dynamically downscaled Global Circulation Models (GCMs). Their analysis results indicates an increase (decrease) in the frequency of occurrence of dry (wet) summers. The winter rainfall projections indicate an increased frequency of both dry and wet winter seasons, which implies lower chance for medium-precipitation winters. The study [3] reviewed assessing the impacts of climate change on river flows in England using the UKCP09 climate change projections. They concluded from their research that Changes in high flows are largely driven by changes in winter precipitation, whilst changes in low flows are determined by changes in summer precipitation and temperature. In a study carried out by[17], the effects of the climate change phenomenon on the flow of the Zayandeh rood River in Isfahan province of Iran were studied under the general data of HADCM3 and two scenarios A2 and B2 during the two periods of 2010-2039 and 2099-2099. The analyzes indicate a decline in rainfall and an increase in temperature until 2100, especially in the second half of the century. Research by [23] investigated the effect of uncertainty on climate change on flood regime in Aydoghmoosgh area, East Azarbaijan In Iran. In the present study, at first, the monthly temperature and precipitation parameters of the seven AOGCM models of the report models (TAR) were prepared under the A2 scenario during the upcoming period and baseline period 1971-2000 for the basin. Subsequently, these values were scaled by a spatial and temporal Downscaling method. The results indicate an increase of 1 to 6 degrees of temperature and variations of 80 to 100 percent of rainfall 2050 relative. In another research [3], modeling the climate of Tehran and Mazandaran provinces in Iran using the LARS-WG climatic model and comparing its changes in the northern and southern central Alborz region were evaluated. In this research, the synoptic stations of two provinces of Tehran and Mazandaran in the period 1988-2005 were investigated and for the period 2010-2039, using the LARS-WG climatic model and the Downscaling of the atmospheric data of the general atmospheric data are predicted. The researchers concluded that in the end, due to the increase in temperature and the decrease in rainfall in both provinces, desertification will be faster in the future, which is a much larger growth rate in the southern Alborz than its northern ridge, and also the probability of rising rainfall There are flood and storms in both area, which is more probable for intense rainfall in Mazandaran with a shorter return period in Tehran.

III. METHODOLOGY

The study area located in central Alborz(North of Iran),on both sides road of Tehran, Ghaemshahr that is 210088/7 hectares. Which is in the coordinates 52 35 22/2 to 34/19 53 23 Eastern geographic longitude and 35 44 23/06 to 36 19 1/6 is located of the northern latitudes . It is drains by a main river called Talar, which stretches south to north. Its main branches include the Sorkh Abad, Shoor abad, Kabir, Bozla, Chrat and shesh Roodbar rivers.

The main river basin has a total length about 100 km ,intersects the outlet of basin with the river Kasilian. The Talar basin, which is between the minimum and maximum altitudes of 3695 meters height difference, has important heights such as the barf pajoon, varzak, chilca shamdan,chehaz , samansi, chehartab, sefidlat, trva, knd dare, siah kooh, basham, siah dare ,asemanloo,. The highest elevation at the northern end of the basin, the sheljmar zareen peak of 3910 meters and the lowest point at the outlet of the basin with a height of 215 meters from the sea level.The studied basin has mainly a branching pattern in the tree branch, parallel and rarely branching. The maximum bifurcation ratio of the basin is 7/6 and minimum is 3/2 And most of the basin working units have a coefficient of 3 to 5, and the total branching factor of the basin is 3.88. The plain area is about 22% and the average land is about 70.2% and the highlands account for about 7.8% from the total area of basin. Talar River basin after the basin outlet, it reaches about 50 km in the Ghaemshahr-Babol plain and flows into the Caspian Sea. The rainfall regime of the studied region is entirely Mediterranean. Seasonal rainfall is quite variable.%32.2 precipitation in winter, 17.2% in summer, 24.2% in autumn and 25.4% in spring. Monthly precipitation of the studied area is 11.54% in February, which is the wettest month, On January %10.8. In March and 9.7% in December The driest month of the year with 1.5% rainfall is in August. Figure 3-1 shows the approximate location of the Talar basin in Mazandaran province of Iran[20].

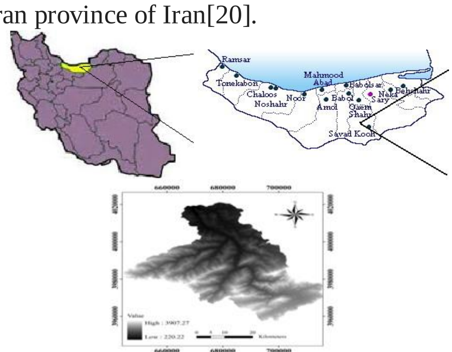

FIGURE (1): LOCATION OF THE THE TALAR WATERSHED IN MAZANDARAN PROVINCE,NORTH OF IRAN

GCM models or general circulation models of atmospheric and ocean processes are numerical models. They simulate the ice and the surface of the earth in three dimensions. These models, by considering a three-dimensional grid, typically have a 650 kilometer horizontal latitude (longitude) and a 250kilometer latitude, 10 to 20 vertical layers in the atmosphere of the land section, and more than 30 layers in the oceans, produce climatic parameters they do. Various general circulation models have been developed and designed in various research centers of the world[15,33]. Table 1 shows the profile of some of these climatic models and the country that provided it. [21].

Tab 1: Characteristic of some of the climatic models and its country of origin[22].

MODEL	COUNTRY	TRUNC.	GRID	N	L	ADJ.	ΔT_{glob}
CCSR/NIES	Japan	T21	5.6×5.6˚	2048	20	YES	4.4˚C
CGCM2	Canada	T32	3.8×3.8˚	4608	10	YES	3.5˚C
CSIRO MK2	Australia	R21	3.2×5.6˚	3584	9	YES	3.4˚C

ECHAM4/OPYC3	Germany	T42	2.8×2.8°	8192	19	YES	3.3°C
GFDL R30	U.S.A	R30	2.2×3.8°	7680	14	YES	3.1°C
HadCM3	United Kingdom	-	2.5×3.8°	7008	19	NO	3.2°C
NCAR DOE PCM	U.S.A	T42	2.8×2.8°	8192	18	NO	2.4°C

Fig2: The four IPCC SRES scenario storylines [19].

In this research, the Hadcm3 model of the Hadley Research Center of England has been used to evaluate the climate change in the Talar basin of Mazandaran Province. For prediction of future climatic data, Gharakhayl of Ghaemshahr synoptic station has been used. After studying the statistics of this station, Take the information for the years 1992-2007 of this station which was more complete has been extracted to predict the future climatic conditions. Due to the large size of the computational cells, the Earth's total atmospheric circulation models simulate climatic fluctuations with turbulence. In order to eliminate these disturbances, instead of direct use of atmospheric circulation model data in climate change calculations, the average period of this data is used. Therefore, to calculate the climate change scenario in each model, the values for the temperature (Equation 1) and (ratio) for rainfall (Equation 2) for the average long term of each month in the future or simulated baseline by the same model for each cell of the computational grid Calculated:

$$\Delta T_i = (\bar{T}_{GCM\ \mathrm{fut}\ i} - \bar{T}_{GCM\ \mathrm{base}\ i}) \qquad (1)$$

$$\Delta P_i = \frac{\bar{P}_{GCM\_fut\_i}}{\bar{P}_{GCM\_base\_i}} \qquad (2)$$

In the above relations, ΔTi and Δ Pi represent the climate change scenario for temperature and precipitation for the long-term average of 30 years of each month ($12 \leq I \leq 1$), T ≤GCM, fut, i the average temperature of the simulated 30 years by AOGCM in The future period for each month T_GCM, base, i is the average temperature of 30 years of the base period in the same period as the simulated period for each month. For rainfall, the above mentioned is established. Downscaling are done spatially and temporally. One of the Downscaling methods of spatial scaling is a proportional method. In this method, climatic variables that are simulated by global atmospheric circulation models are extracted from cellular information that is included in the study area. Time Down scaling methods can also be used to indicate the change factor method. In the change factor method, to obtain a time series of future climate scenarios, scenarios of climate change are added to the observed values (base period):

$$T = T_{obs} + \Delta T \qquad (3)$$

$$P = P_{obs} \times \mathrm{P} \qquad (4)$$

In the above relations, T_{obs} represents a time series of observation temperature in the base period. T is the time series of the temperature derived from the climate change phenomenon in the future period and ΔT is a Downscaling scenario. In the relations (4) for rainfall, the above mentioned are established.

Downscaling methods are divided into two major parts: 1. Statistical, 2. Dynamic. Using different methods of downscaling, climate change can be reviewed in the future [9]. Regional dynamic models have good spatial accuracy for climatic assessments as well as climate and climate downscale processes as far as possible. But the use of these models for the downscaling, the output of the general circulation models of the atmosphere is faced with the time constraints of the model implementation. In statistical models, in addition to the data of a general circulation model of atmosphere, the observed data is also needed to discover the statistical relationship between the data of the general circulation model of the atmosphere in the past and the observational data is required. With stochastic method, one a time can perform a statistical downscaling for a specific station.The statistical Downscaling method has more advantages compared to dynamic methods, especially in cases where lower costs and faster assessment of the factors affecting climate change are needed. Models that are used for a dynamic downscaling include MM 5 ,RegCM3, and PRECIS. A variety of statistical Downscaling models are LARS-WG,CLIMGEN, SDSM, ET & ROLL, GEM, USCLIMATE, etc. [25]. It should be noted that in this research, the LARS-WG exponential downscaling model is used.

One of the most well-known models of weather data random data generation is the LARS-WG model used to generate precipitation, radiation, maximum and minimum daily temperatures in a station under current and future climate conditions. The first version of the LARS-WG in Budapest was devised in 1990 as a tool for statistical exponential downscaling in Hungary.The LARS-WG model uses a complex statistical distribution to model meteorological variables. The basis of this model is modeling for dry and wet periods, daily precipitation and semi-experimental distributions. The outputs of this model include minimum temperature, maximum temperature, precipitation and radiation [8]. The latest model of this software is

LARS-WG5, which has been developed in the production of meteorological data in a long period of time, and Completely advanced. The LARS-WG5 model is used to model the meteorological variables of complex statistical distributions. The basis of this model is modeling for dry and wet periods, daily precipitation and semi-experimental distributions. The simulation of rainfall is modeled based on wet and dry days, while more days are referred to as rainfall that is more than zero millimeters. The length of each series is chosen randomly each month.In order to determine the distributions, the observed data in the previous period are also in the same month. To calculate dry days, rainfall is generated from the semi-experimental distribution of rainfall for a particular month that does not depend on more or more rainfall on a daily basis [11]. The inputs of this model are daily climatic statistics including rainfall, temperature and radiation, and outputs of this model include minimum temperature, maximum temperature, monthly and annual temperature, rainfall and radiation values. The data produced by the model are carried out in three stages: calibration, evaluation and creation of meteorological data. In this model, data on the general atmospheric circulation model including precipitation, minimum temperature, maximum temperature and HADCM3 radiation are extracted daily and for each network, the general atmospheric circulation model is formulated for a particular model scenario. To compile this scenario, the network data of the HADCM3 model will be compared to the baseline time .Here is the base period of 1992-2007 and the upcoming periods of 2011-2026, 2046-2061, and 2080-2095. For the implementation of the LARS-WG model, in addition to the developed scenario for each computing grid, there is a need for the characteristic file of past climate behavior. There are also stations inside that network. The mechanism of the model's operation is that it initially uses all monthly data according to the formula using the monthly data production scenario that includes the climatic behavior of the base:

$$F_{fut} = F_{obs+} (F_{GCM}^{fut} - F_{GCM}^{base}) \quad (5)$$

Calculates. In these formulas: fut: future, obs: past, then, with average maintenance, standard deviation according to the formula Changes:

$$STD_{fut} = \frac{STD_{OBS}}{STD_{base}^{GCM}} \times STD_{fut}^{GCM} \quad (6)$$

The outputs of this model include minimum temperature, maximum temperature, precipitation and radiation[18].The evaluation of the LARS-WG model is performed by comparing statistical data and data generated by the model using statistical tests and comparative charts. For this, a baseline scenario is prepared for the statistical period used and the model is implemented for the base period. To evaluate the outputs of the LARS-WG model, the visual and model data for the four parameters of minimum, maximum, rainfall and radiation temperature, as well as their statistical characteristics, including the monthly average deviation, are provided and the model's ability to create past climates of stations The analysis is analyzed. Statistical tests are used to compare the visual data and produced by the model. The statistical comparison of these data for the four parameters mentioned and its statistical characteristics including the mean monthly standard deviations, relative errors of mean values, relative error of standard deviation and correlation coefficient, and other tests (T-test) and are provided. Results indicated The model is capable of modeling the minimum and maximum temperature, precipitation and radiation periods.

IV. RESULTS AND DISCUSSION

In this research, according to the base period considered in 1992-2007, the nearest synoptic station of the area (Gharakhayl synoptic station in Ghaemshahr), the mean monthly rainfall and temperature of the base period were extracted for different months of the year Then the LARS-WG5 model used for Simulation precipitation and monthly temperature for future periods. It should be noted that according to a different types of statistical operations performed by this model, only those cases that were considered in the objectives,have been used and evaluated. Table 2 presents the geographical characteristics of Gharakhayl synoptic station in Ghaemshahr.

Tab2: Location of Gharakhayl Synoptic station in Ghaemshahr(North of Iran)

Station Name	Latitude	Longitude	Altitude(m)
Gharakhayl Synoptic station in Ghaemshahr	36.27	52.46	14.7

It should be noted that the inputs of this model were presented in the form of daily climatic statistics including rainfall, temperature and radiation. Also, minimum and maximum temperatures for future periods were calculated by the model and according to these, the value of ΔT (temperature difference) and ΔP (ratio for rainfall) calculated for the downscaling of this basin. Table 3 shows the calculation of these ratios for this basin.

Tab3: Calculation the ratio for rainfall and the difference in temperature in the Talar basin

Climate change scenarios Monthly precipitation	Climate change scenarios Monthly temperature	Average monthly temperature of the simulated period	Average monthly maximum temperature of the simulated period	Average monthly temperature of the simulated period	Average monthly temperature of the base period	Average maximum temperature of the basic period	Average monthly temperature of the base perod	Average Monthly Precipitation of Simulated Period	erage monthly ıfall of the base period	Months Year
1/17	0/04	7/38	11/94	2/81	7/34	12/48	2/92	74/96	64/12	January
1/12	0/26	8/02	12/35	3/69	8/26	13/08	3/48	62/92	56	February
1/04	0/04	10/62	14/88	6/39	10/65	15/16	6/13	71/01	69	March
1/18	0/1	15/36	19/86	10/92	15/49	20/17	10/81	56/744	48	April
1/71	0/16	19/96	24/32	15/6	20/12	24/62	15/62	41/78	35/69	May
0/81	0/73	23/61	27/81	19/41	22/88	26/38	19/75	26/76	36/62	June
1/01	0/08	25/88	30/23	21/52	25/95	30/2	21/7	36/69	36/06	July
1/1	0/34	27/74	31/15	22/33	27/08	31/71	22/44	32/93	29/88	August
0/98	0/21	23/76	28/14	19/37	23/96	28/54	19/38	80/76	82/44	September
1/41	0/26	19/1	23/92	14/28	19/36	24/45	14/27	119/77	84/75	October
1/02	0/06	13/77	18/69	8/84	13/82	18/73	8/9	123/6	120/62	November
1/15	0/17	9/5	14	5	9/33	14/03	4/62	92/79	80/69	December

In this research, the HADCM3 model was used to generate emission scenarios using the LARS-WG5 model. The series of scenarios selected in this study consists of three series-scenarios A1B, A2 and B1. In choosing a scenario series, try to use varieties according to their defined conditions, so that their variability and its impact on the future of climatic phenomena will be more specific. Based on the base period of 1992-2007, the average monthly rainfall and temperature of the base period were extracted from the regional synoptic station, the monthly rainfall and monthly temperature for the three different series and future simulations by the latest model LARS-WG5. Years of output simulation in this version of the period 2011-2026, 2046-2060, and 2095-2080 for each of the A1B, A2 and B1 series were simulated for monthly average rainfall and temperature. Tables 4 and 5 show the calculations above.

Tab 4 - Comparison of monthly rainfall of base period with rainfall simulated by HADCM3 model for different years and scenarios.

December	November	October	September	August	July	June	May	April	March	February	January		Months Year
80.69	120.62	84.75	82.44	29.88	36.06	36.62	35.69	48	69	56	64/12		Average precipitation monthly base period
66.22	184.67	143/33	109/43	27.74	35.84	45.83	39.03	54.11	75.21	64/39	80/5		
91.01	175.13	127.04	116.62	25.56	35.16	67.01	39.93	80.44	69.93	72/95	89/47	2046-2061	
68.27	425.11	139.81	95.03	16.2	22.01	45.24	37.91	81.81	82.83	68/32	83/92	2080-2095	A1B scenario
71.75	263.29	129.93	124.15	38.18	38.33	65.9	42.12	102.29	61.89	61/07	79/25	2011-2026	
91.78	292.56	135.46	119.88	35.08	46.81	41.45	27.39	81.68	64.19	87/67	67/31	2046-2061	
63.15	318.94	116.27	78.68	16.83	26.23	34.59	32.21	84.32	77.37	59/82	101/03	2080-2095	A2 scenario
77.61	269.24	110.39	117.27	23.97	32.84	76	37.17	66.43	46.65	71/07	83/52	2011-2026	
93.13	267.69	116.92	113.36	40.04	43.68	58.09	24.81	79/76	67.71	76/39	69/7	2046-2061	
88.21	277.17	103.97	92/08	32.87	35.41	40.38	41.53	90.82	80.3	61/53	94/71	2080-2095	B1 scenario

Tab5: Comparison of the monthly temperature of the base period with the temperature simulated by the HADCM3 model for many years and scenarios

December	November	October	September	August	July	June	May	April	March	February	January		Months Year
9.33	13.82	19.36	23.96	27.08	25.95	22.88	20.12	15.49	10.65	8/28	7/34		Average temperature monthly base period
9.5	13.71	19.15	23.95	27.53	26.74	24.16	20.72	16.35	11.55	8/52	7/51	2011-2026	
11.16	14.97	20.08	25.67	29.70	28.42	25.42	21.88	17.65	12.45	9.57	8/78	2046-2061	A1B scenario
11.64	15.62	21.33	27.03	31.31	30.25	27.14	25.59	18.64	13.98	9.92	9/64	2080-2095	

9.9	14.13	19.44	24.2	27.41	26.68	24.69	20.83	16.34	11.8	8.82	7/63	2011-2026	A2 scenario
10.6	14.68	20.85	25.51	29.26	28.37	25.96	22.1	17.98	12.51	9.33	8/98	2046-2061	
12.09	16.34	22.04	27.64	31.8	31.24	28.1	24.19	19.06	14.4	10.97	9/87	2080-2095	
9.58	13.6	19.22	24.27	27.59	26.77	24.43	20.79	16.23	11.6	8.52	7/61	2011-2026	B1 scenario1
10.49	14.68	20.58	24.8	28.48	26.73	25.49	22	17.71	12.21	8.91	8/53	2046-2061	
10.82	14.76	20.03	25.8	29.96	28.95	26.54	22.76	17.72	13.42	10.35	9/21	2080-2095	

The percentage of rainfall and temperature variations of simulated different models compared to the base period and calculated according to Tables 6 and 7.

Tab 6: The percentage of monthly rainfall variations for different models and scenarios

December	November	October	September	August	July	June	May	April	March	February	January	Year	Months
-17.93	53.10	69.12	32.74	-7.16	-0.61	25.59	9.36	12.73	9	14.98	25.59	2011-202	Percentage of changes Precipitation in A1B scenario
12.79	45.19	49.90	41.46	-14.46	-2.50	82.99	11.88	67.58	1.35	30.27	39.54	2046-206	
-15.39	252.44	64.97	15.27	-45.78	-38.96	23.54	6.22	70.44	20.04	22	30.88	2080-209	
-11.08	118.28	53.31	50.59	27.78	6.30	79.96	18.02	113.01	-10.31	9.05	23.60	2011-202	Percentage of changes Precipitation in A2 scenario
13.47	142.55	59.83	45.41	17.40	29.81	13.19	-23.26	70.17	-6.97	56.55	4.98	2046-206	
-21.74	164.42	37.19	-8.20	-43.67	-27.26	-5.54	-9.75	75.67	12.13	6.82	57.56	2080-209	
-3.82	123.21	30.25	42.25	-19.78	-8.93	107.54	4.15	38.40	-32.54	26.91	30.26	2011-202	Percentage of changes Precipitation in B1scenario
-15.42	121.93	37.96	37.51	34	21.13	58.63	-30.48	59.98	-1.87	36.41	8.7	2046-206	
9.32	129.79	22.68	11.69	10.01	-1.80	10.27	16.36	89.21	16.38	9.88	47.71	2080-209	

Tab 7: The percentage of monthly temperature variations for different models and scenarios

December	November	October	September	August	July	June	May	April	March	February	January	Year	Months
1.82	-0.8	-1.08	-0.04	1.66	3.04	7.56	2.98	5.55	8.45	2.90	2.32	2011-202	Percentage of changes Temperature in A1B scenario
19.61	8.32	3.72	7.14	7.35	9.52	11.10	8.75	14.01	16.90	15.58	19.62	2046-206	
24.76	13.02	9.66	12.81	15.62	16.57	18.62	27.19	20.34	31.27	19.81	31.34	2080-209	
6.11	2.24	0.41	1	1.22	2.81	7.91	3.53	5.59	10.80	6.52	3.95	2011-202	Percentage of changes Temperature in A2 scenario
13.61	6.22	7.70	6.47	8.05	9.33	13.46	9.84	16.07	17.46	12.68	22.34	2046-206	
29.58	18.23	13.84	15.36	17.43	20.39	22.81	20.23	23.05	35.21	32.49	34.47	2080-209	
2.68	-1.59	-0.72	1.29	1.88	3.16	6.77	3.33	4.78	8.92	2.90	3.68	2011-202	Percentage of changes Temperature in B1 scenario
12.43	6.22	6.30	3.51	5.17	6.47	11.41	9.34	14.33	14.65	7.61	16.21	2046-206	
15.97	6.80	3.46	7.68	10.64	11.56	16	13.12	14.40	26.01	25	25.48	2080-209	

As stated above,the LARS-WG5 model, one of the most popular weather-based data generation models, is used to generate various scenario-related scenarios for the IPCC (United Nations Climate Change Commission). Figure 3 shows the comparison of the average monthly rainfall of the base period and the simulated HADCM3 period for different months of the year.Figure 4 shows the comparison of the average base monthly temperature and simulated periods with the LARS-WG model for the study area.

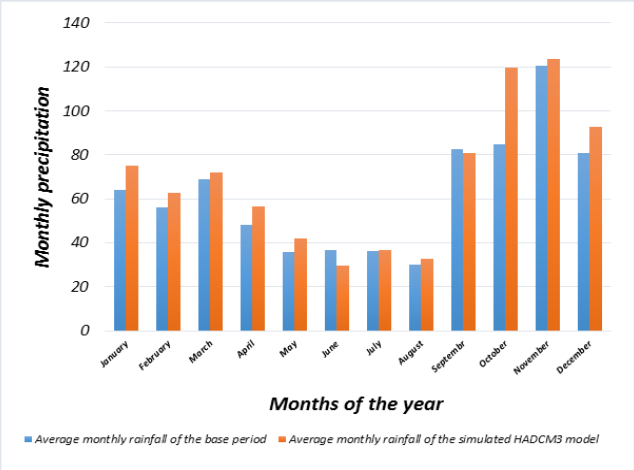

Fig. 3. Comparison of the average monthly rainfall of the base period and simulated by the HADCM3 model in the Talar basin.

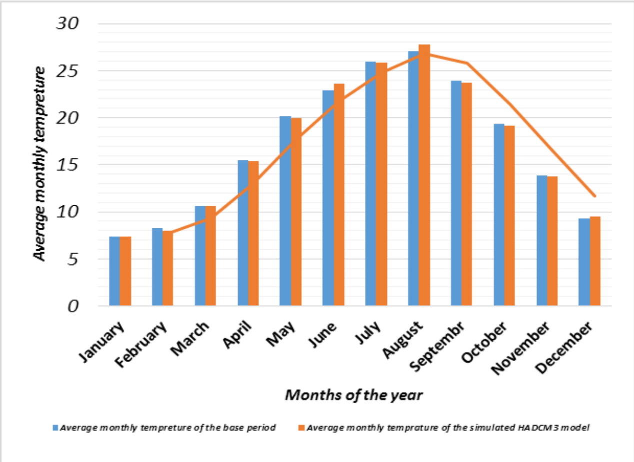

Fig 4: Comparison of the average monthly temperature of the base period and simulated by the HADCM3 model in the Talar basin.

The simulated minimum monthly temperature and the maximum simulated temperature are shown in Figures 5 and 6, compared to the base period.

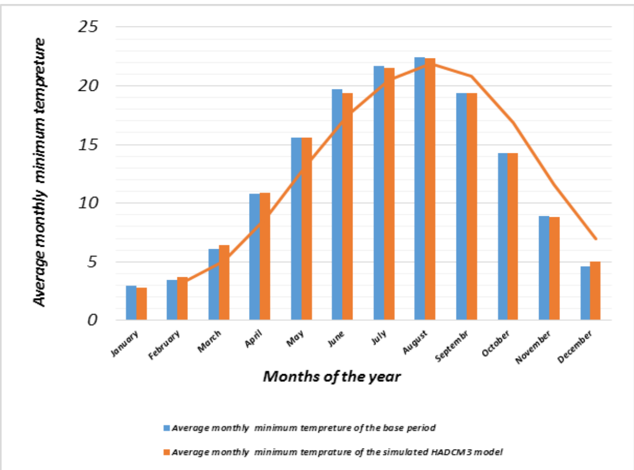

Fig 5: Comparison of the average monthly minimum temperature of the base and simulated periods by HADCM3 model in the Talar Basin.

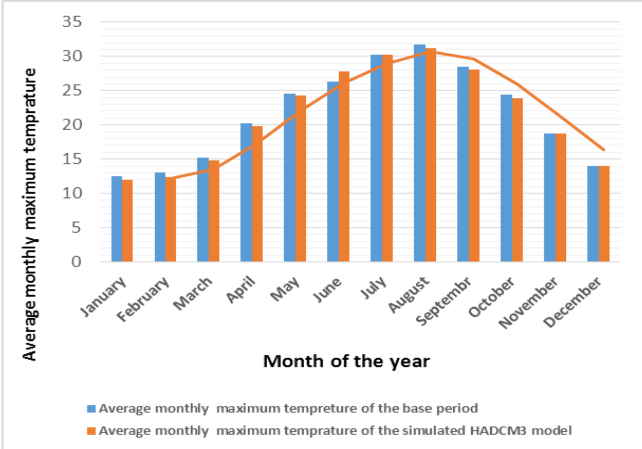

Fig 6: Comparison of the average of the maximum monthly temperature of the base and simulated periods by HADCM3 model.

Figure 7 shows the climate change scenarios of the monthly rainfall from the HADCM3 model and Figure 8 shows climate change scenarios for the monthly temperature from the HADCM3 model for the Talar basin.

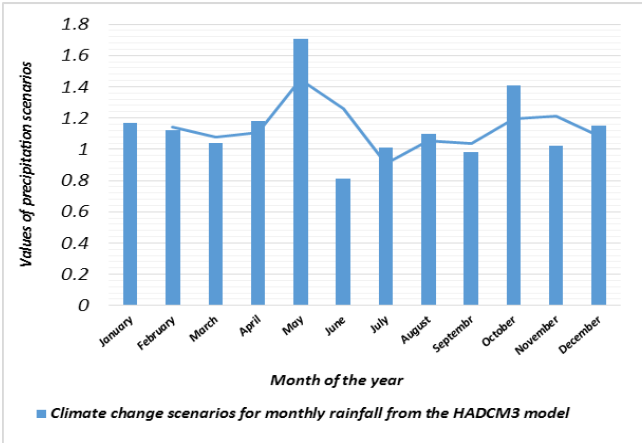

Fig 7: climate change scenarios of the monthly rainfall from the HADCM3 model

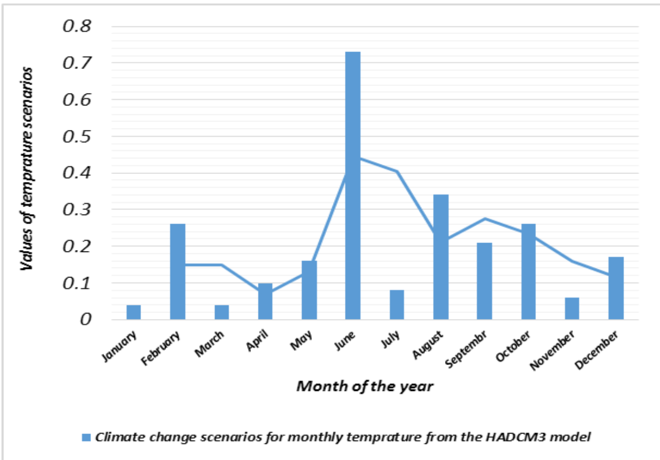

Fig 8 climate change scenarios of the monthly temperature from the HADCM3 model.

One of the cases calculated in Table 3 is the average monthly rainfall of the base period (1992-2007) and the simulation period with the HADCM3 model in the Talar basin. Comparison this table with Figure 3 revealed in the different months of the year there are many differences between observed monthly rainfall and simulation by the LARS-WG model. Changes in monthly averages have been from 1 January to the end of the month. The monthly average monthly rainfall increases in the coming periods than to the base period, declining in June, the July and August increases in September and in October, November and December, we will see a dramatic increase in the amount of precipitation coming in the future. Reducing the precipitation of the dry months due to the planting period and the water requirement of crops and rangelands has an important role in changing the hydrological processes . Its Naturally effect on other environmental factors. Figure7 the scenario of climate change of the monthly rainfall is from the HADCM3 model.

According to this chart, it can be seen that the months of May and October have the most rainfall changes in the coming periods. These changes can be more accurate in the occurrence of seasonal flood events in the studied basin. Regarding the present and future temperatures, according to Figure 8, the monthly temperature variation scenarios of the HADCM3 model for the different months of the year also show the highest temperature variation in the months June, August and February . This matter indicates the warmer months of the year more warmer and even warmer in February in future periods. Also these factors affects the flowering time of plants and causing water stress in summer seasons. Figure 4 shows the comparison of the average monthly temperature of the base period and the simulated HADCM3 model in the Talar basin.It is also clear that the months of June, July and August will be accompanied by an increase in the degree of heat in future periods, but in the months of April and May the temperature will decrease in the coming periods.These item can be examined in various aspects. The comparison of the average of the maximum and minimum temperatures during the base period and simulated by the HADCM3 model of the Talar basin (Figures 5 and 6) also shows the warmer months of the year and the confirmation of the subject.

IV. CONCLUSION

Considering the above mentioned issues about the effect of climate change in the study basin, it is noted that several researchers used a variety of methods to study this factors in any parts of the world such as:

In one research[29] evaluated the simulated impact of climate change on cereal production for multi-model ensembles of global and regional climate models (GCMs and RCMs).The study results demonstrate definitely that the choice for one or another ensemble of climate models (with different resolution) adds to the overall uncertainty in impact assessments, even when the climate projections are downscaled to the local level via statistical inference. Using scenarios from RCMs driven by a limited number of GCMs is discouraged as they would probably not give a representative range of possible impacts. In the research [16] studied Hydrological projections under climate change in 1 the near future by2 RegCM4 in Southern Africa using a large-scale hydrological model.

In this study the hydrological projections performed by using a large–scale hydrological model (WASMOD-D), which has been tested and customized on this region prior to this study. The results reveal that (1) the projected temperature shows an increasing tendency over Southern Africa in the near future, especially eastward of 25°E, while the precipitation changes are varying between different months and sub-regions; (2) an increase in runoff (and ET) was found in eastern part of Southern African, i.e. southern Mozambique and Malawi, while a decrease was estimated across the driest region in a wide area encompassing Kalahari Desert, Namibia, southwest of South Africa and Angola; (3) the strongest climate change signals are found over humid tropical areas, i.e. north of Angola and Malawi and south of Dem Rep of Congo; and (4) large spatial and temporal variability of climate change signals is found in the near future over Southern Africa.

In another study, [32] in Qiantang River Basin, East China that the final results suggest annual river runoff will likely decrease almost under all emission scenarios and time stages of the future period. Particularly, at Jinhua Station, substantial decrease of annual river runoff can be noticed, indicating less water resource possibly available for the region in future. Simulated monthly patterns show that the largest decrease will likely occur in winter while increases will occur in summer, implying possible more water-related disasters in this region. However, it is also noticed that the change signs amount could be different under any emission scenarios and time stages, indicating large uncertainty involved in the impact analysis.

Another researcher [12]studied climate change in Arizona.. Using the calibrated and validated model, they investigated the watershed response during historical (1990-2000) and future (2031-2040) summer projections derived from a single realization of a mesoscale model forced with boundary conditions from a general circulation model under a high emissions scenario. Results indicate spatially-averaged changes across the two projections: an increase in air temperature of 1.2 C˚, a 2.4-fold increase in precipitation amount and a 3-fold increase in variability, and a 3.1-fold increase in streamflow amount and a 5.1-fold increase in variability. Nevertheless, relatively minor changes were obtained in spatially-averaged evapotranspiration.

Pay attention of these studies, because the aim of the research has differences, but in general, there are many similarities in the subject matter. According, given that the results of this research can be used for further study, the following suggestions can be made in this regard:

1- Use of other climatic models and scenarios in future periods in the area to better study the subject.

2. Implementation of the LARS-WG5 model in regions with similar or different climatic conditions and study the effects of this conditions in the selection and use of the model.

REFERENCES

[1] Abbaspour, K.C., Faramarzi, M., Ghasemi, S.S., Yang, H. (2009). Assessing the impact of climate change on water resources in Iran. Water Resour. Res. 45 (10),W10434.

[2] Bailey, I, Revell,piers. (2015) . Climate Change, International Encyclopedia of the Social & Behavioral Sciences, 2nd edition, Volume 3 ,School of Geography, Earth and Environmental Sciences, Plymouth University, Plymouth, UK.

[3] Charlton , B, Matthew a,b, Nigel W. Arnell a. (2014). Assessing the impacts of climate change on river flows in England using the UKCP09 climate change projections Journal of Hydrology 519 ,1723–1738P.

[4] Christensen, N.S., Wood, A.W., Voisin, N., Lettenmaier, D.P., Palmer, R.N.(2004). The effects of climate change on the hydrology and water resources of the Colorado River Basin. Climatic Change 62 (1), 337–363p.

[5] Davidson, E.A., Janssens, I.A. (2006).Temperature sensitivity of soil carbon decomposition and feedbacks to climate change. Nature 440 (7081), 165–173p.

[6] Diabat, M., Haggerty, R., Wondzell, S.M. (2013). Diurnal timing of warmer air under climate change- affects magnitude, timing and duration of stream temperature change. Hydrol. Process. 27 (16), 2367–2378p.

[7] Dobler, C., Bürger, G., Stötter, J. (2012).Assessment of climate change impacts on flood hazard potential in the Alpine Lech watershed. J. Hydrol. 460–461, 29–39p.

[8] Downing, T.E., Harrison, P.A., Butterfield, R.E & Lonsdale, K.G.(2000). Climate Change Climatic Variability and Agriculture in Europe, An integrated assessment. Environmental Change Institute, University of Oxford.

[9] Dubrovsky, M. (1996). Validation of the stochastic Weather Generator Met&ROLL, Meteorogickeo Zpravy, Vol49, pp. 12q – 1380.

[10] Eum, H., Simonovic, S.P. (2012). Assessment on variability of extreme climate events for the Upper Thames River basin in Canada. Hydrol. Process. 26 (4), 485–499 p.

[11] Harmel, R. D, et.al. (2002).Evaluating the Adequecy of Simulating Maximum and Minimum Daily Air Temprature With the Normal Distributian, Canadian Society for engineering, 26pp.

[12] Hawkins, A. a, Enrique R. Vivoni a, b, Agustin RM b, c, Giuseppe M a, Rivera E d, Dominguez F d, e.(2015). A climate change projection for summer hydrologic conditions in a Gretchen semiarid watershed of central Arizona, Journal of Arid Environments 118 , 9-20p.

[13] haghtalab,N, godarzai, M. Habibi Nokhandan, M. yavari, A. Jafari, H. (2013). Climate modeling of Tehran and Mazandaran provinces using the LARS-WG climate model and comparing its changes to the northern and southern frontiers of Central Alborz, Journal of Environmental Science and Technology, 49-37 p.

[14] Intergovernmental Panel on Climate Change (IPCC). (2012). Summary for policymakers. Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 1–19.

[15] IPCC. (2001). The Scientific Basis of Climate Change, Contribution of Working Grop I to the Third Assesment Report of the Intergovermental Panel on Climate Change. Cambridge University Press, Cambridge.

[16] Lu L, Ismaïla D, Chong-Yu X , Frode S. (2015). Hydrological projections under climate change in the near future by RegCM4 in Southern Africa using a large-scale hydrological model, Journal of Hydrology,In press.

[17] Massh bovani, Alireza .Morid, Saeid.(2005) Effects of climate change on the flow of the Zayandeh-e-Rud River of Isfahan i. Science and Technology of Agriculture and Natural Resources. 9th issue of the fourth issue.

[18] Mikhai A. et all. (2002). LARS-WG a stochastic weather generator for use in climate impact studies. User's manual.

[19] Nakicenovic, N., J. Alcamo, G. Davis, B. de Vries, J. Fenhann, S. Gaffin, K. Gregory, A. Grübler, T.Y. Jung, T.Kram, E.L. La Rovere, L. Michaelis, S. Mori, T. Morita, W. Pepper, H. Pitcher, L. Price, K. Raihi, A.Roehrl, H.-H. Rogner, A. Sankovski, M. Schlesinger, P. Shukla, S. Smith, R. Swart, S. van Rooijen, N. Victor, and Z. Dadi.(2000). Emissions Scenarios. A Special Report of Working Group III of theIntergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK and New York, NY, USA, 599 pp.

[20] Report on the plan for integrating watershed management in thE Talar basin. (2001). Department of Watershed Studies and Evaluation, Deputy Directorate for Watershed Management, Ministry of Jihad andAgriculture of Iran

[21] Routschek A. a, Schmidt J. a, , Kreienkamp F b.(2014). Impact of climate change on soil erosion - A high-resolution projection on catchment scale until 2100 in Saxony/Germany, Catena 121, 99–109p.

[22] Ruosteenoja, K, T.R. Carter, K. Jylha, H. Tuomenvirta. (2003). Future climate in world regions: anintercomparison of model-based projections for the new IPCC emissions scenarios. The Finnish Environment 644, Finnish Environment Institute, Helsinki, 83 pp.

[23] Sadat-e ashofte, p., Massah-e Bovani, A. (2011). Investigating the Influence of Uncertainty in the Global Ocean and Oceanic Cycle Models (AOGCM) and Greenhouse Gas Emission Scenarios on Climatic Runoff Impact of Climate Change, Case Study: Qarnqo Basin, East Azarbaijan, Iranian Journal of Water Resources Research, Vol. 8, No. 2, 36 Pp

[24] Safeeq, M., Fares, A. (2012). Hydrologic response of a Hawaiian watershed to future climate change scenarios. Hydrol. Process. 26 (18), 2745–2764p.

[25] Semenov M.A.Brooks R.J. (1999). Spatial interpolation of the LARSWG stochastic weather generator in great Britain. Climate Research 11, 137-148p.

[26] Shamir E a, Sharon B. Megdal b, Carlos Carrillo c, Christopher L. Castro c, Hsin-I Chang c, Karletta Chief e, Frank E. Corkhill d, Susanna E b, Konstantine P. Georgakakos a,f, Keith M. Nelson d, Jacob P b. (2015). Climate change and water resources management in the Upper Santa Cruz River, Arizona, Journal of Hydrology 521 ,18–33p.

[27] Tian, Y., Xu, Y.P., Zhang, X. (2013).Assessment of climate change impacts on river high flows through comparative use of GR4J, HBV and Xinanjiang models. Water Resour. Manage. 27 (8), 2871–2888.

[28] Task Group on Data and Scenario Support for Impact and Climate Assessment (TGICA) Intergovernmental Panel on Climate Change, (June 2007) GENERAL GUIDELINES ON THE USE OF SCENARIO DATA FOR CLIMATE IMPACT AND ADAPTATION ASSESSMENT Version 2 , Prepared by T.R.

[29] Vanuytrechta, E. Raesa D, Willems P b, Semenovc M A.(2014). Comparing climate change impacts on cereals based on CMIP3 andEU-ENSEMBLES climate scenarios, Agricultural and Forest Meteorology 195–196 , 12–23p.

[30] Vezzoli. R. a , P. Mercogliano a,b, S. Pecora c, A.L. Zollo a,b, C. Cacciamani d.(2015). Hydrological simulation of Po River (North Italy) discharge under climate change scenarios using the RCM

COSMO-CLM, Science of the Total Environment 521–522 346–358p.
[31] Wang, D., Hejazi, M., Cai, X., Valocchi, A.J.(2011). Climate change impact on meteorological, agricultural, and hydrological drought in central Illinois. Water Resour. Res. 47 (9. for the Upper Thames River basin in Canada. Hydrol. Process. 26 (4), 485–499p.
[32] Xu, Y.P., Zhang, X., Tian, Y. (2012). Impact of climate change on 24-h design rainfall depth estimation in Qiantang River Basin, East China. Hydrol. Process., 26 (26), 4067–4077p.
[33] Yates D. N. and K. M. Strzepek.(1998). Modeling the Nile basin under climate change. J. Hydrol. Eng. 3(2), 98-108p.
[34] Zhang X a,Yue-Ping X a ,Guangtao F b. (2014). Uncertainties in SWAT extreme flow simulation under climate change. Journal of Hydrology. 515, 205–222p.

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