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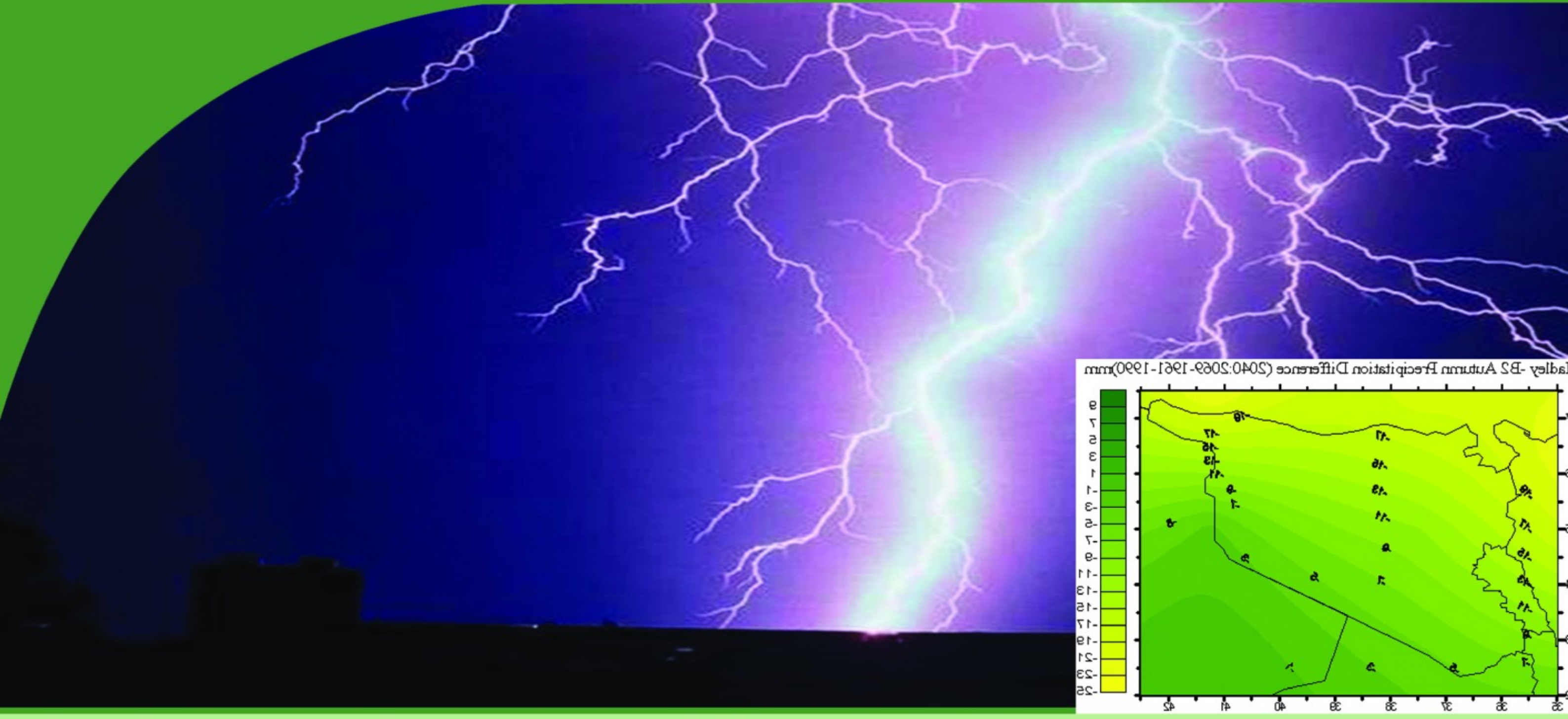
Vulnerability Assessment of Climate Sector in Syria



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Programs Containing Measures to facilitate Adaptation to Climate Change

Project Title

Enabling activities for preparation of Syria's initial national Communication to the UNFCCC, (Project Nr.00045323).

National Project Director
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March 2009

Syria - سورية

Project Title: "Enabling activities for Preparation of Syria's initial National Communication to UNFCCC", (Project Nr. 00045323).

The project implemented in the ministry of local administration and Environment (MLAE)/General Commission of Environmental Affairs (GCEA), in collaboration with Global Environmental Facility (GEF) and United Nation Development Programm (UNDP) in Syria.

Vulnerability Assessment and Adaptation of

Climate Sector in Syria

(INC-SY_V&A_ Climate -En)

National Project Director

Dr. Yousef Meslmani

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March / 2009

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Steering Committee:

Headed by Eng. Hilal Alatrash Minister of Local Administration and Environment, and membership of:

Mr. Ismail Ould Cheikh Ahmed	United Nations Resident Coordinator and UNDP Resident Representative in Syria.
Dr. Taysir Raddawi	Head of the Syrian's State Planning Commission.
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Consisting of General Director of General Commission for Environmental Affairs, Energy & Environment Team Leader / UNDP - Syria, National Project Director, National Project Coordinator, and the representatives of: Ministry of State for Environmental Affairs, State Planning Commission, Ministry of Agriculture and Agrarian Reform, Ministry of Irrigation, Ministry of Industry, Ministry of Electricity/National Center of Energy Researches, Ministry of Housing and Construction, Ministry of Transportation, Ministry of petroleum and Mineral Resources, Meteorological Directorate, Universities, Scientific Researches Centers, and NGOs.

This report has been approved unanimously by the technical committee, during the Technical Workshop which took place on 24/ 03/ 2009 in the Dedeman Hotel Palmyra.

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1. Climate changes: Temperature and precipitation trends for the period 1955-2006.

The conclusions of this section are highly qualitative and require further build up in the next National Communication. There is a need for capacity building and financial support for major long term ecological studies and development of local predictive models in order to improve the quality of the findings of this section. Therefore the predicted impacts need to be viewed with consideration to high uncertainty of the conclusions. This chapter describes the impacts and vulnerability of climate change in Syria considering the summary of work related to climate change trends as well as case studies with the vulnerability of water resources, agriculture, human health, natural ecosystems, energy, wastewater, information related to coastal zone management efforts and the relation with climate change and sea level rise are also included. In terms of adaption to climate change, the implementation for protection of natural system in order to boost up the resilience capacity of those and recommended measures for adaption are briefly addressed in the chapter.

1.1 Climate Change Scenarios

1.1.1 Introduction

The process of assessing the vulnerability of certain sectors, such as agriculture, water resources and biodiversity etc, to climate change requires the construction of predicted visions of what the future climate would be under physically reasonable assumptions of greenhouse-gases concentrations. These visions, the climate change scenarios, are to be compared them with a picture representing a non-changed climate, the baseline climate scenario. The results of such comparison can then be used as indicators for the future impacts that might be experienced by the considered sector.

In this section, stations cover climatically region of Syria has been check and analysis to Developing baseline climatic data and development of climatic scenarios for Syria will be described. The section will also cover statistical methods used in the trend analysis of selected meteorological parameters in the region. A comparative evaluation is presented to assess change in temperature and rainfall under different scenarios by comparing with the baseline data (stander normal means 1961-1990)

Table (1): Meteorological station records used in this study

Average surface precipitation over the record .period are given for December, January and February (DJF), March, April and May (MAM), June and August (JJA), September, October and November (SON) and .December, October and November (annual).

Station Name	Latitude (N)	Longitude (E)	Altitude (meter)	Record	No. Years	Precipitation (mm)				
						DJF	MAM	JJA	SON	Annual
Lattakia	35° 36''	35 46	9	1955-2006	52	430.7	150.9	10.6	170.0	762.1
Hmmam	35 24	35 56	48	1956-2006	51	456.8	173.9	13.6	164.6	808.8
Safita	34 49	36 08	370	1955-2006	52	590.3	253.5	8.6	232.7	1085.1
Tartous	34 52	35 53	5	1957-2006	50	484.4	165.8	8.7	181.6	840.4
Tel Abiad	36 42	38 57	348	1957-2005	49	138.7	89.0	1.8	48.1	277.7
Jaraplus	36 49	38 00	351	1955-2006	52	158.2	95.6	4.9	56.6	315.2
Aleppo	36 11	37 14	385	1955-2006	52	162.6	95.4	2.8	58.2	318.9
Atheria	35 22	37 47	460	1974-2006	33	97.0	56.0	2.2	30.6	185.7
Meslmieh	36 20	37 14	415	1955-2006	52	164.4	95.5	2.6	62.0	324.5
Idleb	35 56	36 37	451	1955-2006	52	279.4	131.2	4.0	83.7	498.2
Hama	35 07	36 24	305	1955-2000	46	182.5	88.3	3.7	58.1	332.5
Salamiyh	35 01	37 02	448	1955-2006	52	154.9	81.4	3.5	51.4	291.2
Al Rastan	34 56	36 44	390	1960-2001	42	204.0	92.0	2.3	65.7	363.9
Homs	34 46	36 43	483	1955-2006	52	242.8	97.7	2.8	71.0	414.3
Damascus Int. Air Port.	33 26	36 32	610	1955-2006	52	75.2	27.9	0.4	28.5	132.0
Mezzeh Air.Dam	33 29	36 13	730	1955-1997	43	119.2	46.9	0.4	38.8	205.3
Kharabo	33 30	36 27	620	1955-2006	52	87.9	33.5	0.2	31.0	152.5
Dara	32 36	36 07	543	1958-2006	49	155.0	60.1	1.0	32.6	248.6
Nabek	34 01	36 44	1329	1955-2006	52	53.6	37.5	1.3	26.7	119.0
Serghayia	33 48	36 10	1409	1962-2005	44	351.4	149.2	0.8	92.6	594.1
Qunetara	35 49	33 08	941	1986-2006	21	393.6	127.6	3.1	93.4	617.8
Sweida	32 44	36 34	1015	1955-2006	52	201.6	89.6	0.3	45.3	336.7
Palmyra	34 33	38 18	400	1955-2006	52	57.4	44.0	0.4	25.3	127.1
Maskaneh	35 59	37 59	350	1957-1999	43	111.6	65.7	2.0	38.8	218.1
Deir Ezzor	35 17	40 11	215	1955-2006	52	76.0	52.9	0.8	23.0	152.6
Abuo Kamal	34 26	40 55	175	1955-2006	52	62.5	45.3	0.5	19.3	127.5
Raqqa	35 54	38 59	246	1955-2006	52	94.8	66.4	0.9	30.3	192.4
Al Tanf	32 29	38 40	712	1955-2000	46	43.0	36.2	0.4	25.5	105.0
Qoumishlie	37 02	41 12	449	1955-2006	52	208.3	149.9	2.6	57.2	418.1
Hassakeh	36 34	40 43	307	1955-2005	52	131.5	99.2	1.2	41.9	273.8

A study on the baseline climatic change scenarios was conducted. Out of the network stations of the Syria meteorological, data from only 30 selected synoptic stations were utilized in this study. These selected stations with their coordinates in terms of latitudes and longitudes, elevation above mean sea level, and record lengths are listed in table 1, and depicted in Fig. (1). The selection of 29 stations was dictated by the Length and continuity of there.

Meteorological records: In identifying the climatic baseline period, the best compromising (records wise) selection is found to be a 52 years period, from 1955 to 2006. It consists of the monthly mean values of the surface air temperature and total rainfall. Upon inspection of the collected data, few missing values were found. The stations that do not fulfill these criterions are eliminated from the study data, these were treated and adjusted by applying the (WMO; World Meteorological Organization) accepted statistical methods in estimating missing data, and supported by a graphical interpolation.

The data set are analyzed for outliers, and those identified as outliers to a present threshold value according to Barnett and Lewis third edition 1994. Finally, the time series analysis for non-climatic event that might have taken place during the life station, and detection and adjustment of such in homogeneities in the time series are made following a procedure developed by *Hanssen-Baure* and *Foreland* (1994).

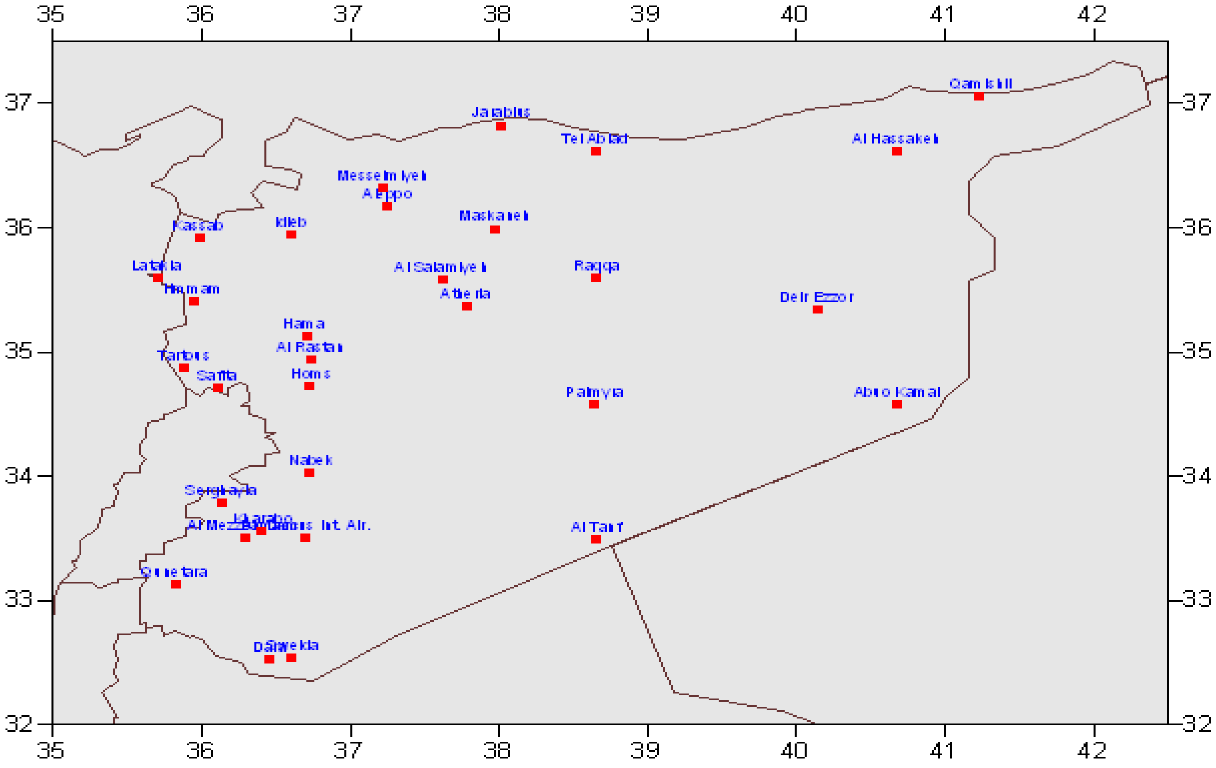


Fig. (1): Distribution of Syrian Climate Station Used In Studies

1.2 Baseline climate conditions (Impact assessment)

Syria Arab republic is country with an estimated area of 185,180 km^2. Its climate varies from one region to another because its influence of the significant variation in its topography, and prevailing meteorological systems. A comprehensive description of climate cannot be produced without considering these factors. A map showing various types of Syrian terrain was obtained the coastal district, western inland district, western inland mountains, step district and North eastern district.

The Syrian climate as a part of the eastern Mediterranean region is determined by dynamic factors that are related to the circulation of the atmosphere and air masses within and outside the region, including the semi-permanent pressure systems of the cold Siberian high pressure that dominates the winter; the Indian Monsoon low pressure that prevails in summer; and the heat lows of North Africa (*Khamaseen*).

In addition the mid to high latitude westerly's. At other times, particularly during winter and in the transitional seasons, moving depressions and associated weather, accompanied by the extension of the Sudan trough, affect the area. Topography has an important role in climate.

Three climate parameters were selected to describe the general characteristics of the climate in Syria during the baseline Scenario. These are: surface air temperature and precipitation. The first two parameters are commonly used in all climate change studies. Analysis of the annually and seasonally averaged values of these three parameters were carried out and displayed in a series of symbol map.

The detailed characteristics of the climatic of Syria were then deduced from these charts as briefly discussed in the following paragraphs. In order to reveal the climatic trends during the baseline period, the annual mean values of the three climate parameters were plotted in temporal graphs for the stations representing the identified climatic zones.

The baseline period is divided into two parts, and the trends of parameters were judged from the difference of the mean values corresponding to these two sub-periods for all stations. Results then plotted in maps to show the spatial variations of precipitation trends in Syria.

1.2.1 Precipitation trend seasonal and annual trends

As for precipitation trends, there is no doubt that any persistent change in precipitation pattern or in the characteristics' of the precipitation (intensity frequency and duration), would have significant consequences for the environment. Thus global warming studies pay special attention to the crucial climate variable. There are, however, difficulties in identifying climate change signals in precipitation.

Some of these difficulties are related to the quality of the data, given precipitation measurements are prone to several types of errors, the length of the precipitation data highlights another difficulty in tracking the climate change signal, since precipitation is temporally, as well as spatially ,a highly variable parameter. Sometime it is possible to detect A trend in a short time series of precipitation, which, in reality, could be a part of long-term variability. Therefore, care has to be taken when interpreting the trend analysis of precipitation data. In the trend analysis, we deployed commonly used nonparametric Mann-Kendall method to identify trend in quality controlled stations data.

Figure (2) Show the results of the Mann-Kendall trend test for the four seasons. Coherent area of significant change in precipitation can be seen in both winter and autumn seasons. Winter precipitation in the all northern and north eastern zone of Syria has decreased in the last five decades. Autumn precipitation, on the other hand, has increased at a station that lies mostly in northern zone of the central Syria. The reasons behind those changes are not well understood, they definitely require a comprehensive study into the link between cyclone tracks and these changes .in the other seasons (spring and summer), and there are only a few station which statistically significant changes.

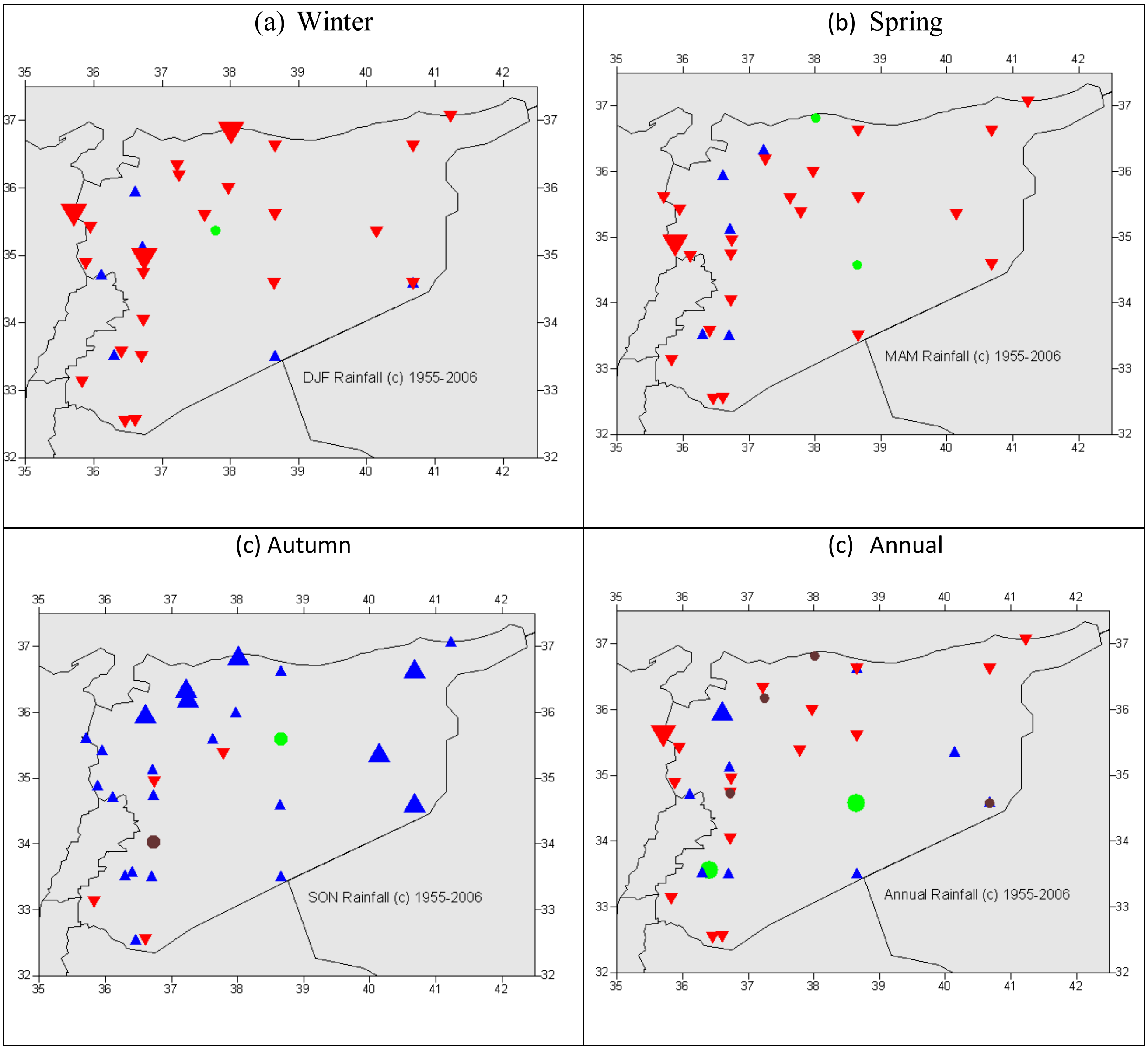


Fig. (2): Seasonal and Annual Precipitation Trends for the period 1955-2006

● *denotes no trend* ▲ *significant increase* ▴ *insignificant increase*
▼ *significant decrease* ▾ *insignificant decrease and* ●*insignificant increase and decreases*

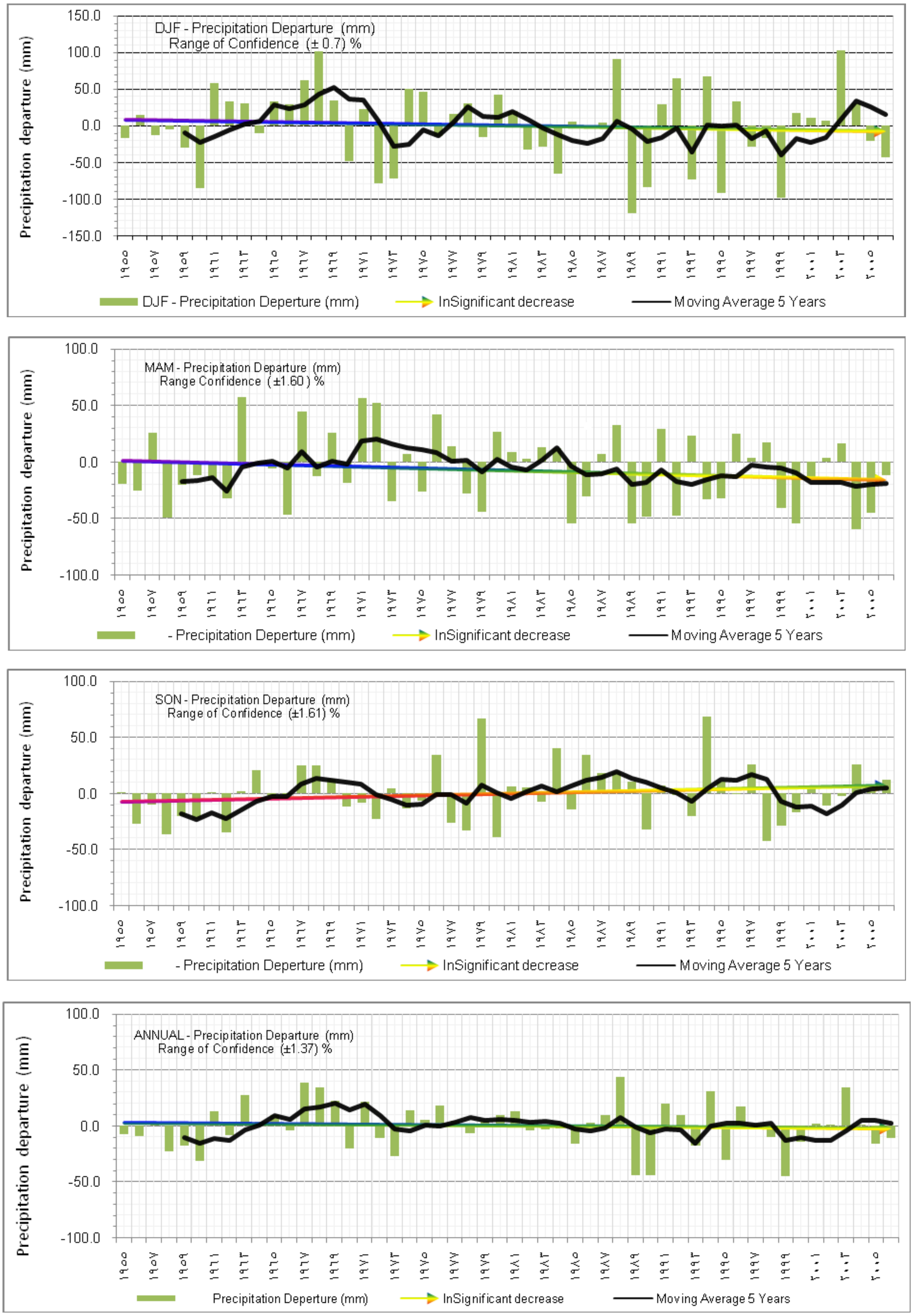


Fig.3: Departures of the surface air temperature for 30 Syrian stations.

Plots are shown for December–February (DJF), March–May (MAM), June–August (JJA), September– November (SON) and December–November (annual). Departures are calculated from associated long-term record means.

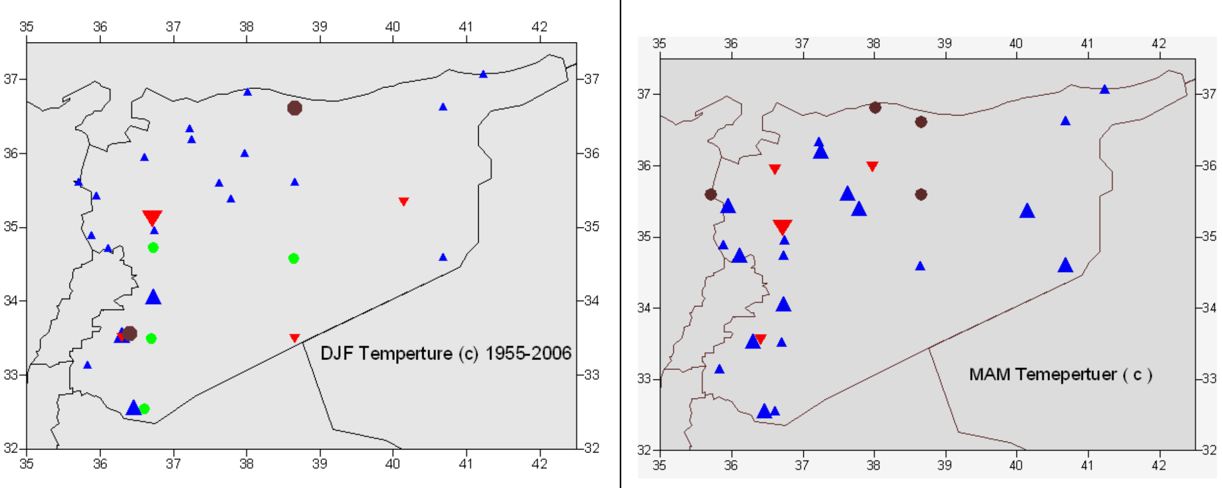
1.2.2 Temperature trend seasonal and annual trends

As for precipitation trends , the temperature is variable that can be measured easily and more accurately at meteorological stations, therefore uncertainties resulting from measurement errors are of lesser concern for temperature. Nonetheless, climate change singles in temperature are usually contaminated by of urban stations effects because most of the station in Syria or elsewhere have been gradually by city residential and/ or commercial areas. It's therefore, difficult to separate climate change signals from urban station effects on temperature time series, Figure (4). Illustrates the result of Mann-Kendall trend analysis applied to seasonally average annual temperature series between "1955-2006".

The most prominent feature is widespread increase in summer temperature. summer temperatures increase mostly in the coastal region and western in land western .Maybe there is urban influence but there no study for this phenomena .Winter also show a general tendency to decrease in Syria. It can be noted that the more significant ones are mostly concentrated in the costal stations. During spring and autumn seasons.

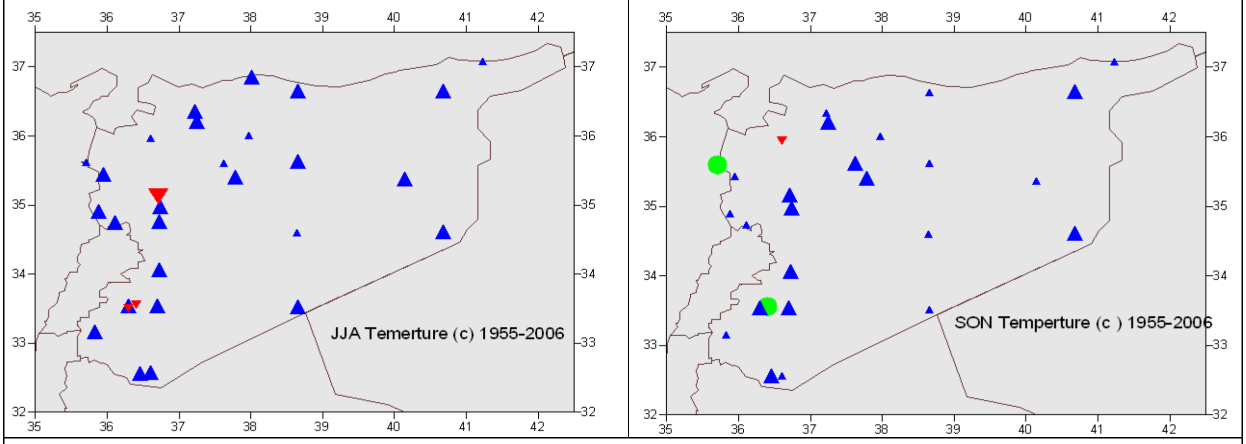
Table 2: Meteorological station records used in this study: Average surface air temperature over the record *.period are given for December, January and February (DJF), March, April and May (MAM), June, July and August (JJA), September, October and November (SON) and December, October and November (annual).*

Station Name	Latitude (N)	Longitude (E)	Altitude (meter)	Record	No. Years	Temperature (°C)				
						DJF	MAM	JJA	SON	Annual
Lattakia	35° 36''	35 46	9	1966-2005	40	12.8	17.7	25.8	22.0	19.6
Hmmam	35 24	35 56	48	1955-2005	51	12.5	17.0	24.9	21.5	19.0
Safita	34 49	36 08	370	1955-2006	52	10.8	16.9	24.9	21.3	18.5
Tartous	34 52	35 53	5	1957-2006	50	13.0	17.5	25.5	21.7	19.4
Tel Abiad	36 42	38 57	348	1955-2005	51	6.6	15.6	28.0	18.3	17.1
Jaraplus	36 49	38 00	351	1957-2005	49	6.8	15.9	28.7	18.9	17.6
Aleppo	36 11	37 14	385	1955-2006	52	6.9	15.9	27.3	19.0	17.3
Atheria	35 22	37 47	460	1977-2006	30	7.7	17.1	28.4	20.0	18.3
Meslmieh	36 20	37 14	415	1955-2005	51	5.9	14.6	26.9	18.0	16.3
Idleb	35 56	36 37	451	1955-2005	51	7.4	16.1	26.5	19.7	17.4
Hama	35 07	36 24	305	1956-1993	38	7.9	16.2	27.3	19.6	17.8
Salamiyh	35 01	37 02	448	1955-2006	52	7.3	15.4	25.9	18.6	16.8
Al Rastan	34 56	36 44	390	1984-2001	17	8.2	16.4	26.5	20.0	17.8
Homs	34 46	36 43	483	1955-2006	52	7.7	15.5	25.4	19.0	16.9
Damascus Int. Air Port.	33 26	36 32	610	1956-2006	51	7.5	15.8	25.8	17.9	16.7
Mezzeh Air.Dam	33 29	36 13	730	1955-1992	38	8.2	16.1	25.9	19.1	17.3
Kharabo	33 30	36 27	620	1955-2005	51	7.3	14.8	23.8	17.2	15.8
Dara	32 36	36 07	543	1972-2006	35	9.2	16.3	24.9	19.6	17.5
Nabek	34 01	36 44	1329	1955-2006	52	4.2	11.7	21.6	14.6	13.0
Qunetara	35 49	33 08	941	1986-2006	221	6.9	13.6	22.6	17.6	15.2
Sweida	32 44	36 34	1015	1958-2006	49	7.9	14.7	23.2	18.5	16.1
Palmyra	34 33	38 18	400	1955-2006	52	8.4	18.3	29.0	20.6	19.1
Maskaneh	35 59	37 59	350	1978-1999	22	7.0	15.8	27.1	18.5	17.1
Deir Ezzor	35 17	40 11	215	1955-2006	52	8.5	18.9	31.6	21.3	20.1
Abuo Kamal	34 26	40 55	175	1959-2005	47	9.2	19.7	31.5	21.7	20.5
Raqqa	35 54	38 59	246	1958-2005	48	7.9	17.8	29.3	19.7	18.7
Al Tanf	32 29	38 40	712	1958-2000	43	7.5	16.6	26.9	18.8	17.5
Qoumishlie	37 02	41 12	449	1955-2006	52	7.8	16.6	30.4	21.0	19.0
Hassakeh	36 34	40 43	307	1957-2005	49	7.0	16.8	30.1	19.5	18.4



(a) Winter

(b)Spring



(d) Summer

(e)Autumn

(f)Annual

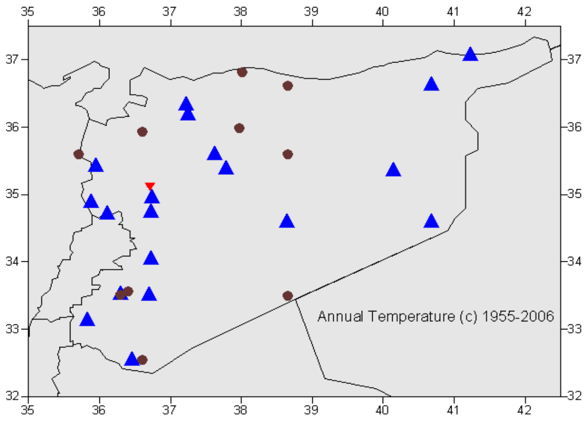


Fig. (4): Annual Temperature Trends for the period 1955-2006

● *denotes no trend* ▲ *significant increase* ▲ *insignificant increase*

▼ *significant decrease* ▼ *insignificant decrease and* ●*insignificant increase and decreases*

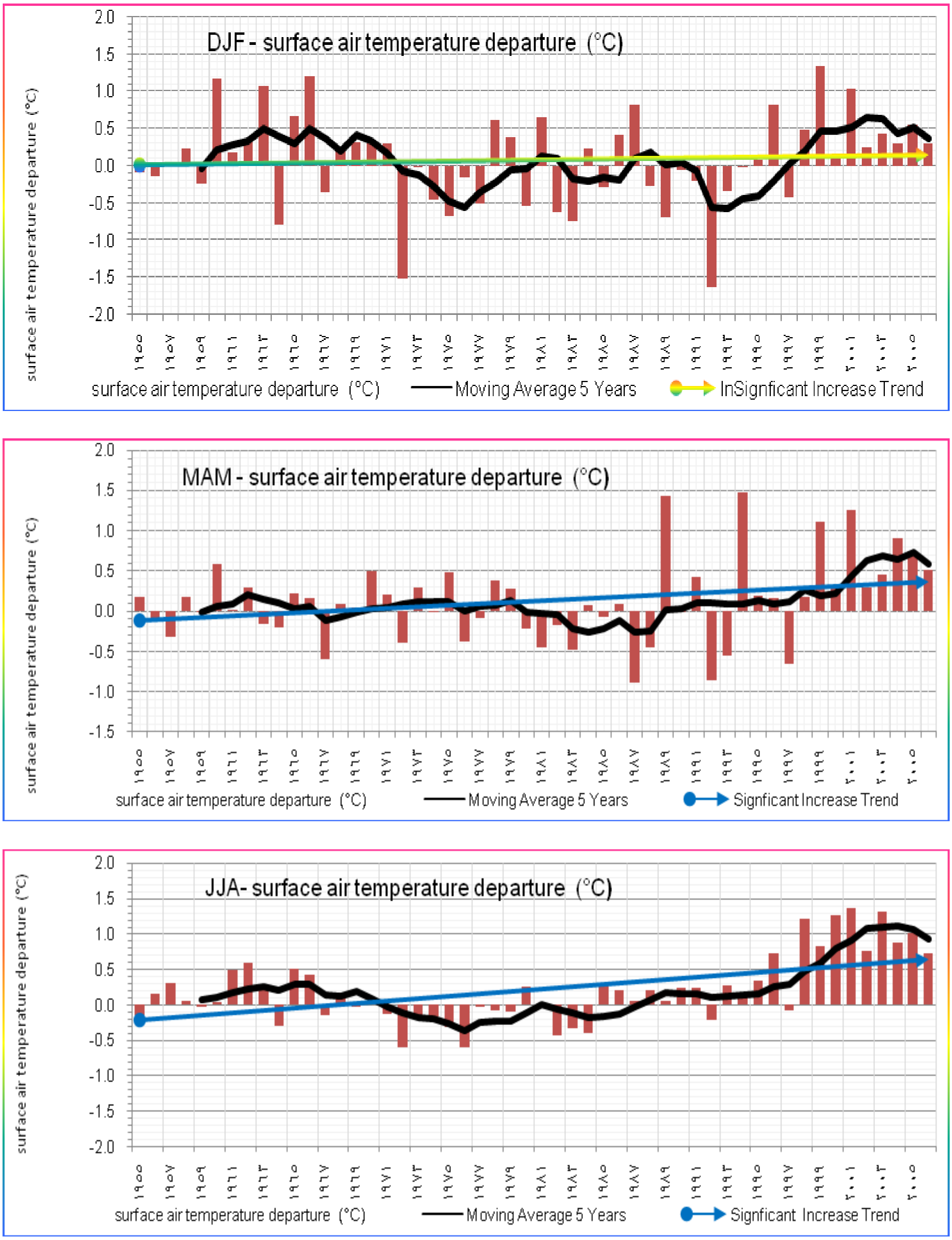


Fig.(5-a): Departures of the surface air temperature for 30 Syrian stations.

Plots are shown for December–February (DJF), March–May (MAM), June–August (JJA), September– November (SON) and December–November (annual). Departures are calculated from associated long-term record means.

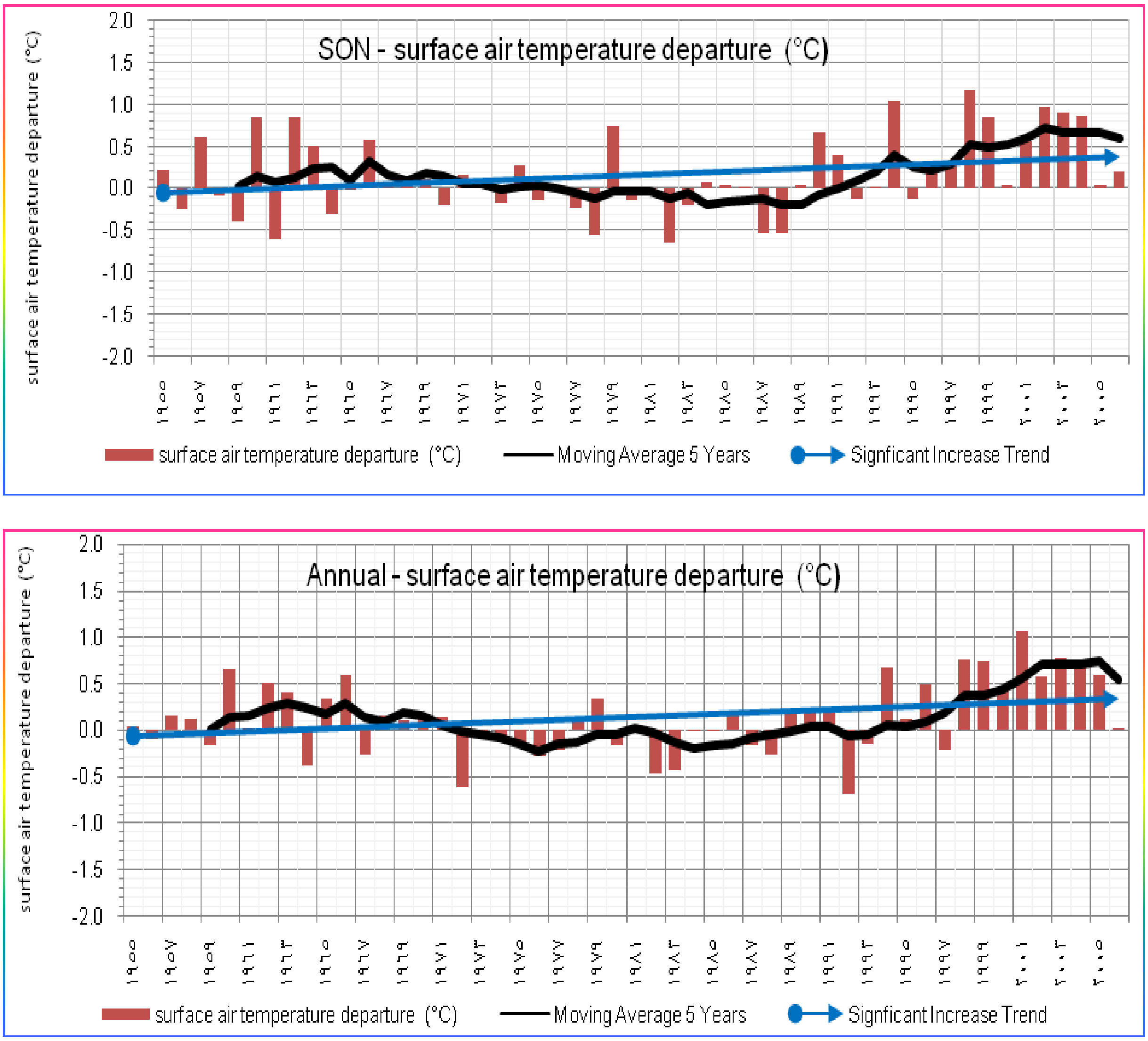


Fig.(5-b): Departures of the surface air temperature for 30 Syrian stations.
Plots are shown for December–February (DJF), March–May (MAM), June–August (JJA), September– November (SON) and December–November (annual). Departures are calculated from associated long-term record means.

2. Evaluation Current Climate Change Extremes Events And Indices

Report trends in extreme temperature and precipitin index which were computed (follow quality control and homogeny test).

For practical reasons, in this chapter of the study, not all indices are calculated on a monthly basis. Monthly indices are calculated if no more than 3 days are missing in a month, while annual values are calculated if no more than 15 days are missing in a year. No annual value will be calculated if any one month’s data are missing. For threshold indices, a threshold is calculated if at least 70% of data are present. For spell duration indicators, a spell can continue into the next year and is counted against the year in which the spell ends e.g. a cold spell in the Northern Hemisphere beginning on 31st December 2000 and ending on 6th

January 2001 is counted towards the total number of cold spells in 2001, Fig. (1) Distribution of Syrian Climate Station Used In Studies.

2.1 Temperature Indices

Trend index's were examined from 1965-2006 at thirteen station covering the climatic district (Rclimdix model 2004) in Syria.

Results indicate that there have been statistically significant and spatially coherent, trends in temperature index's that are related to temperature increase in the district.

2.1.1 Significant increase trend have been found in :

2.1.1.1 Annual maximum of daily maximum and minimum temperature. Figures 6, 7.

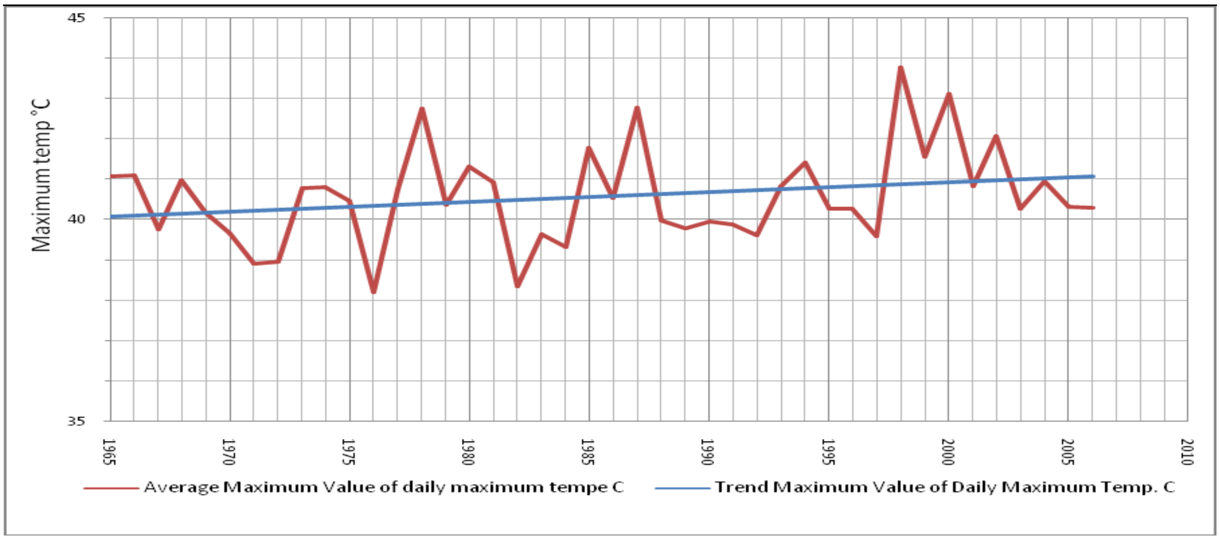


Fig.(6): Annual maximum of daily maximum of the surface air temperature

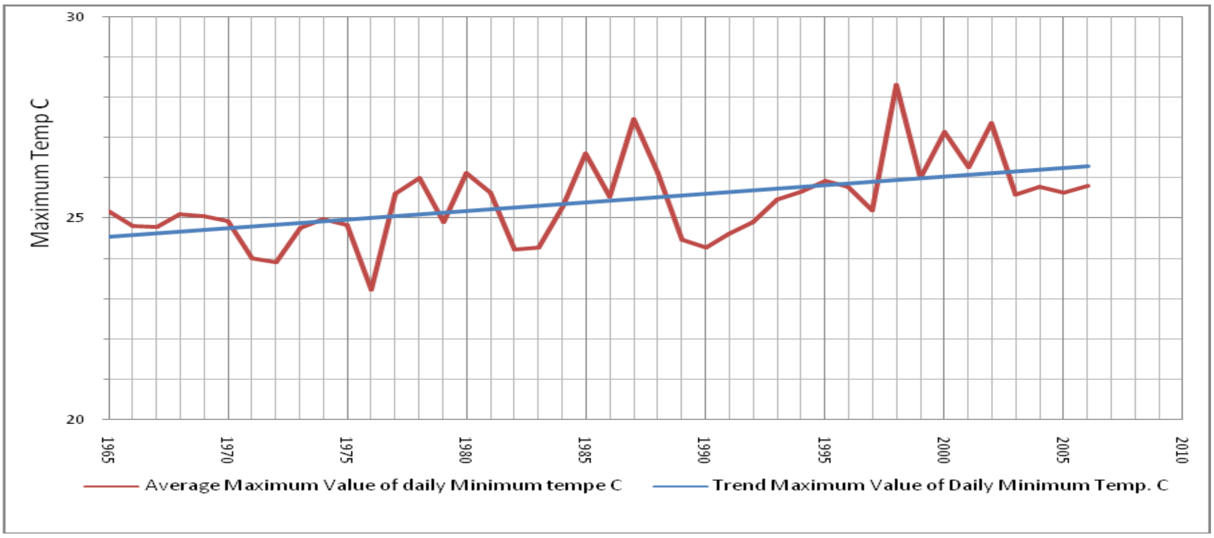


Fig.(7): Annual maximum of daily minimum of the surface air temperature

2.1.1.2 Annual minimum of daily maximum and minimum temperature. Figures 8, 9.

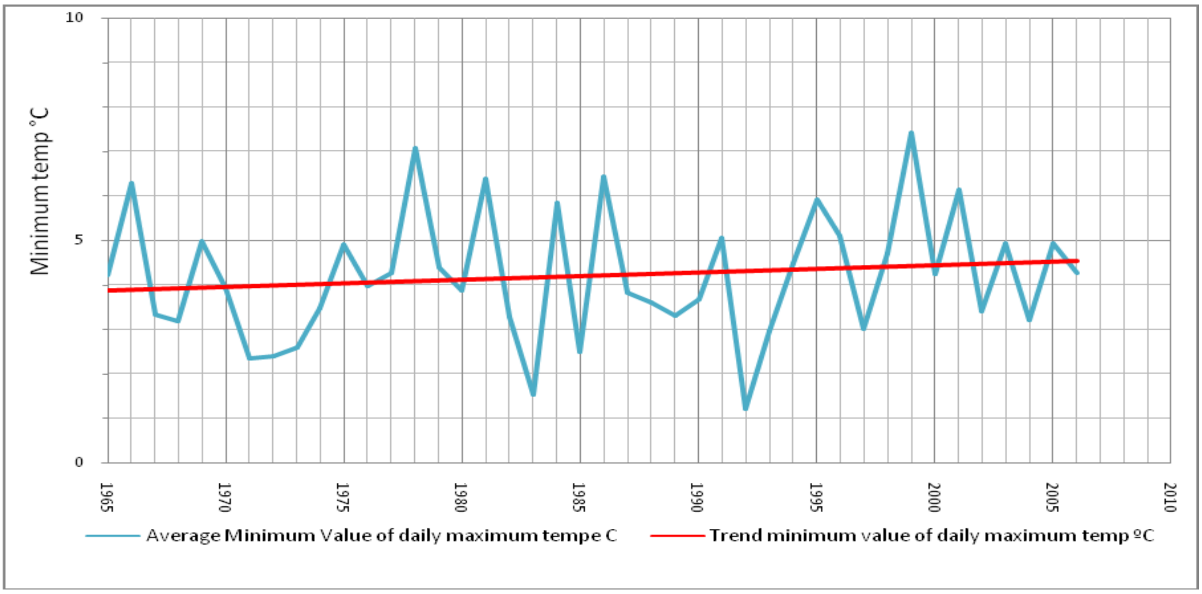


Fig.(8): Annual minimum of daily maximum of the surface air temperature

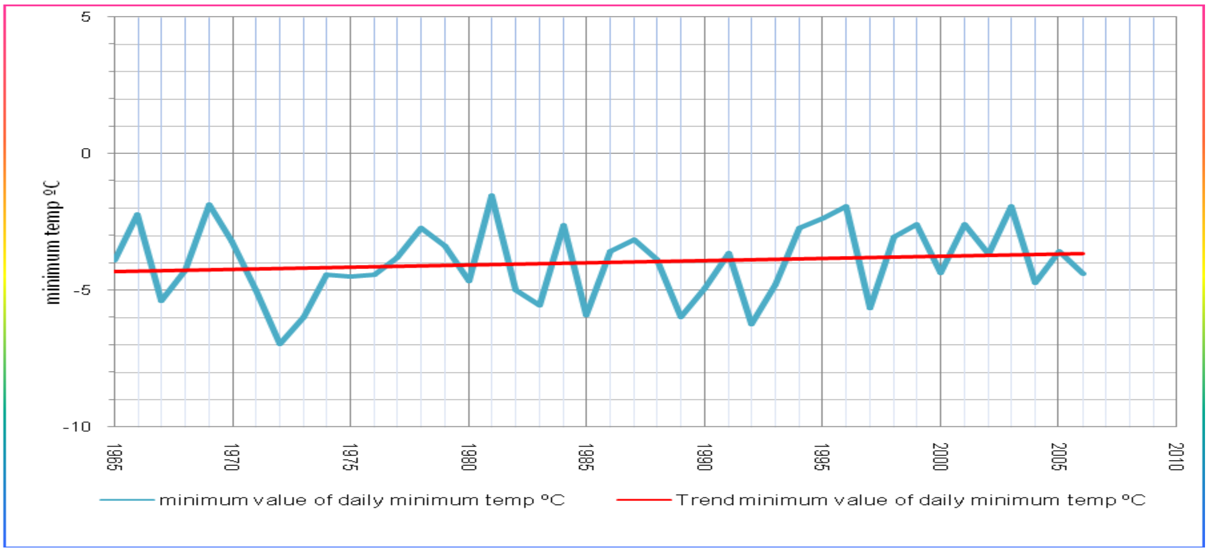


Fig.(9): Annual minimum of daily minimum of the surface air temperature

2.1.1.3 The Number of Summer night's: Figure 10.

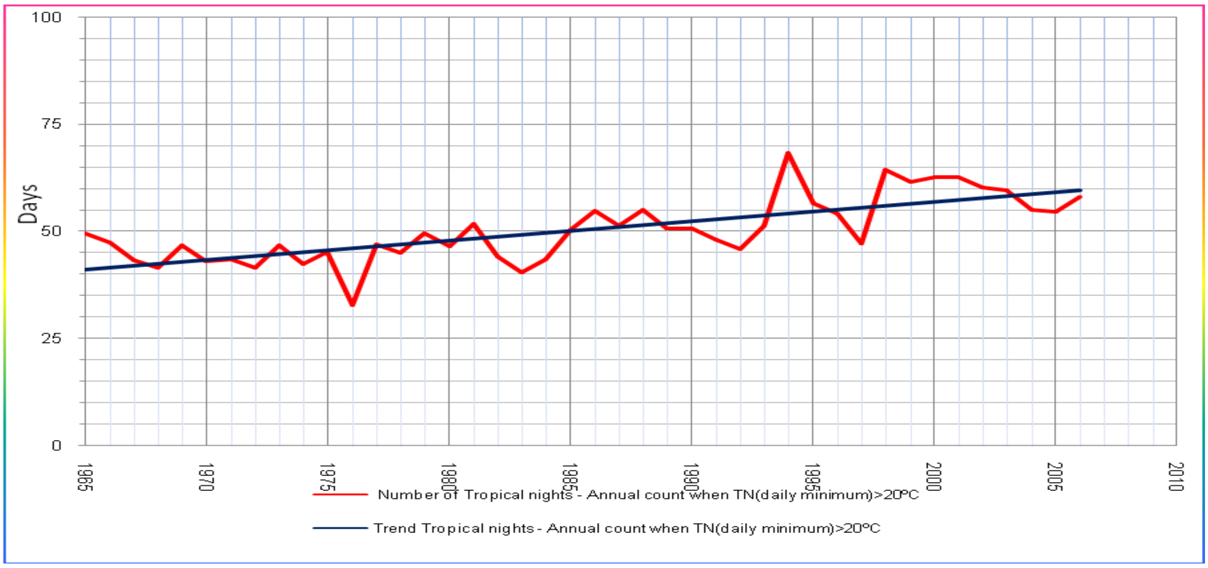


Fig. (10): Number of Summer nights [Tropical nights - Annual count when TN (daily minimum) > 20ºC]

2.1.1.4 The number of summer Days Figure 11.

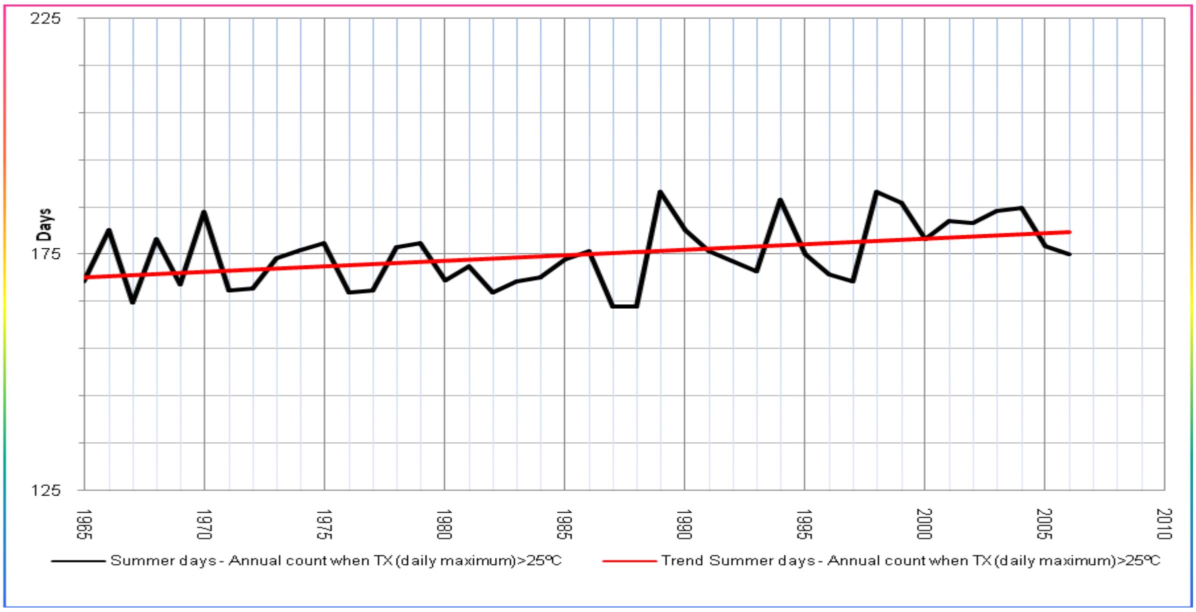


Fig. (11): Number of Summer days - Annual count when TX(daily maximum) > 25ºC

2.1.1.5 Warm days daily temperature has excided its 90th percentile, (regionally averaged analysis seriers (related to the mean 1961-1990) Annual Tx90p , TN90p. Figure 12.

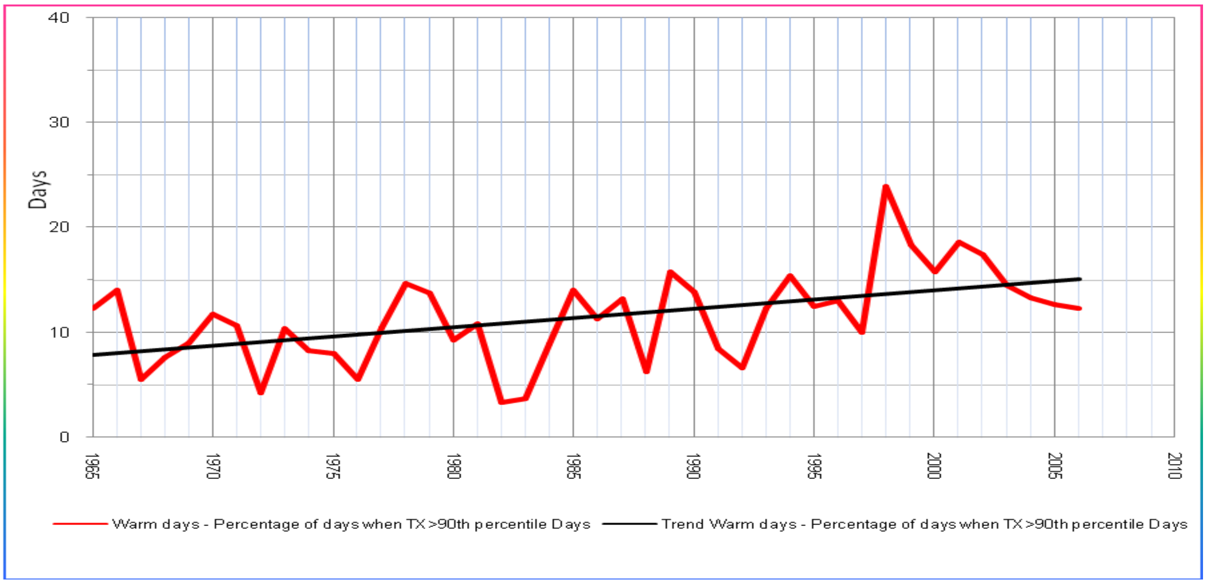


Fig. (12): warm day's daily temperature has excided its 90th percentile

2.1.1.6 Warm nights- Percentage of days when TN>90th percentile Days. Figure 13.

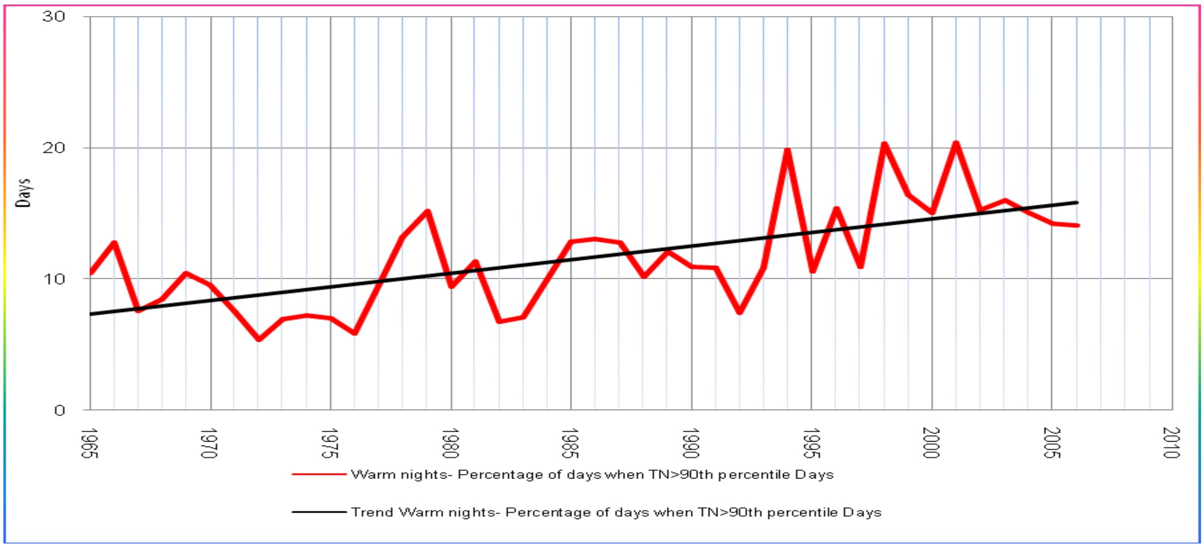


Fig. (13): Warm night temperature has excided its 90th percentile

2.1.2 Significant decrease trends have been found of

Days when daily temperature is below it 10 th percentiel (rergionally averaged analysis seriers related to the mean 1961-1990) Annual Tx10p, TN10p

2.1.2.3 Cool nights - Percentage of days when TN<10th percentile Days.Fig.14.

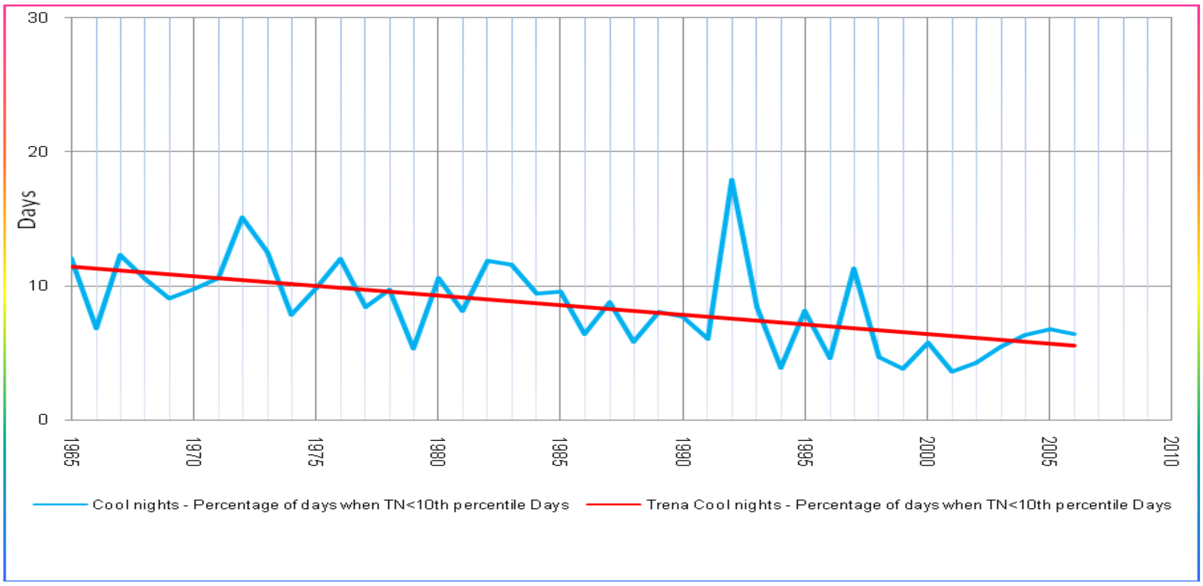


Fig. (14): Cool nights - Percentage of days when TN<10th percentile Days

2.1.2.2 Cool days - Percentage of days when TX<10th percentile Days.Fig.15.

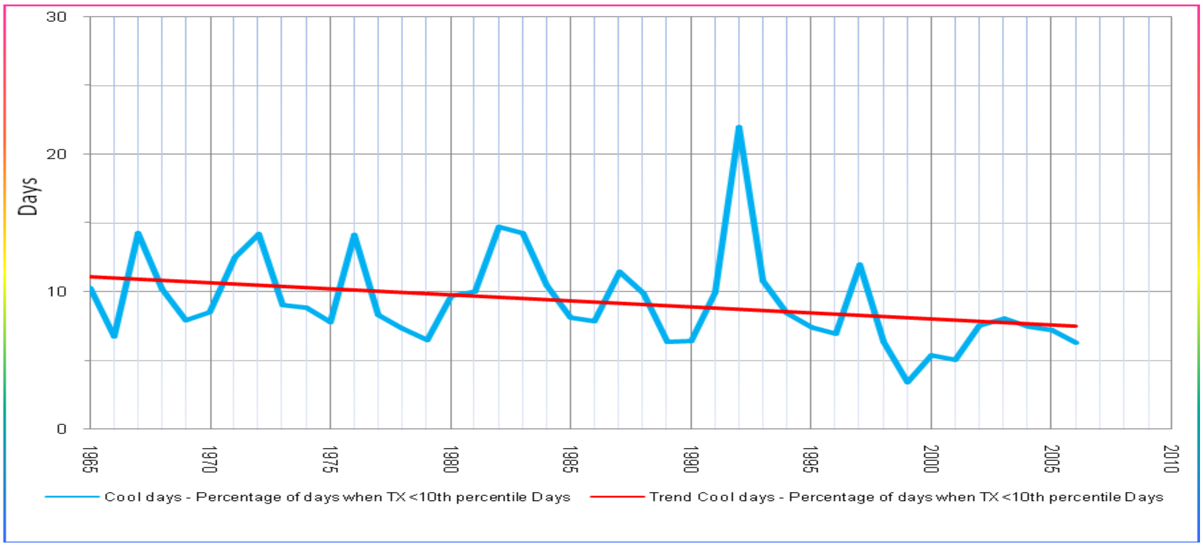


Fig. (15): Cool days - Percentage of days when TX<10th percentile Days

2.1.2.3 Daily temperature range.Fig.16.

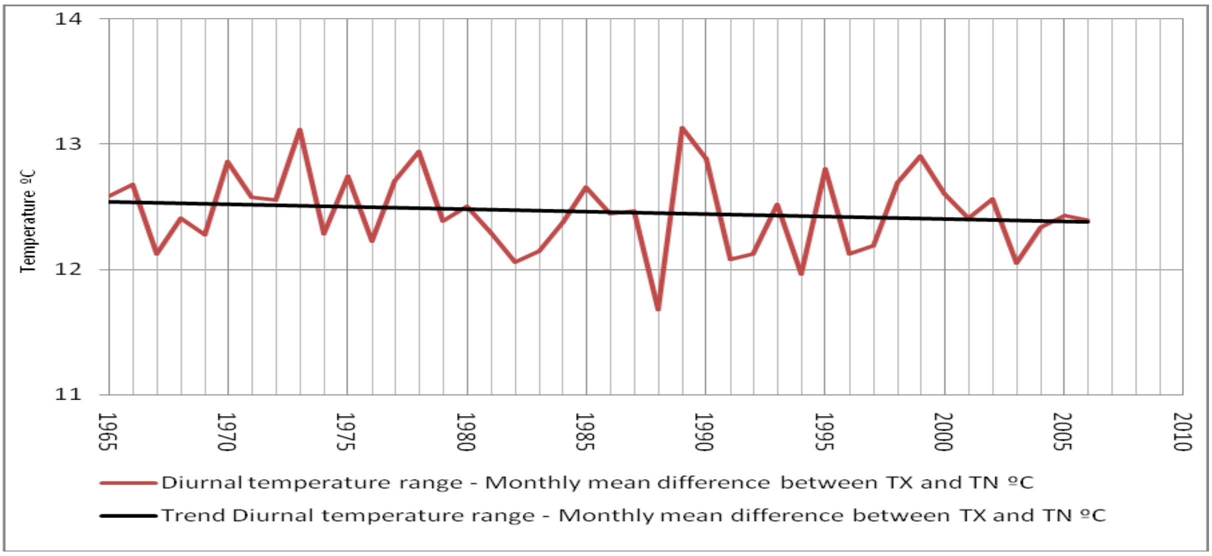


Fig. (16): Diurnal temperature range - Monthly mean difference between TX and TN ºC

2.2 Precipitation Indises

Trend in precipitation indexs inclouding: ***<u>Result:</u> All precipitation Idises are week in general and donts show spitial coherence .***

2.2.1 The number of day with precipitation (Annual count of days when Prec. >=25 mm)

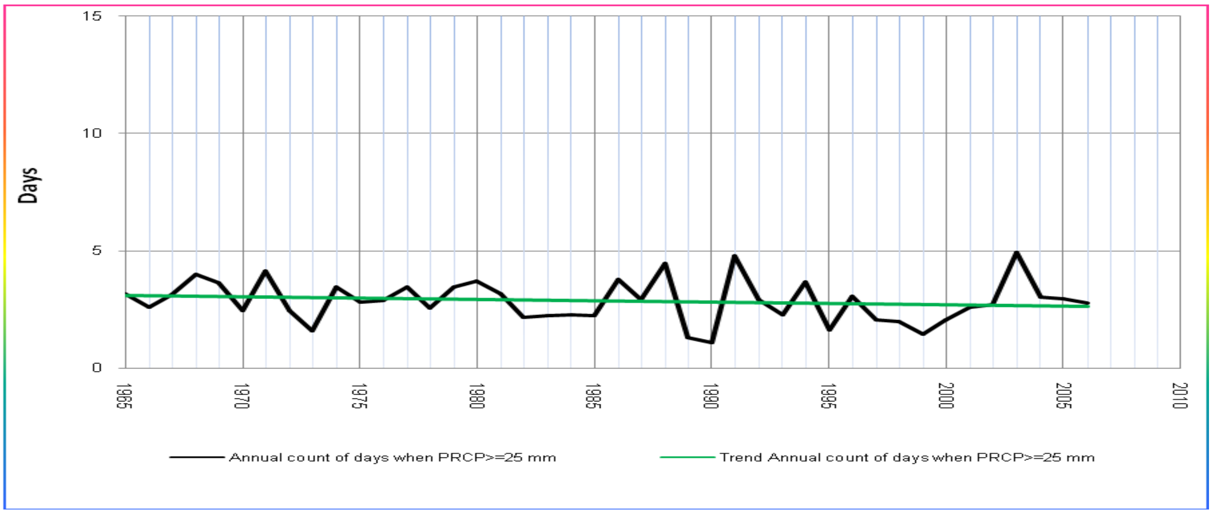


Fig. (17): Annual count of days when Prec. >=25 mm

2.2.2 The average precipitation Intensity:

[Simple daily intensity index Annual total precipitation divided by the number of wet days (defined as PRCP>=1.0mm) in the year mm/ day]. Fig.18.

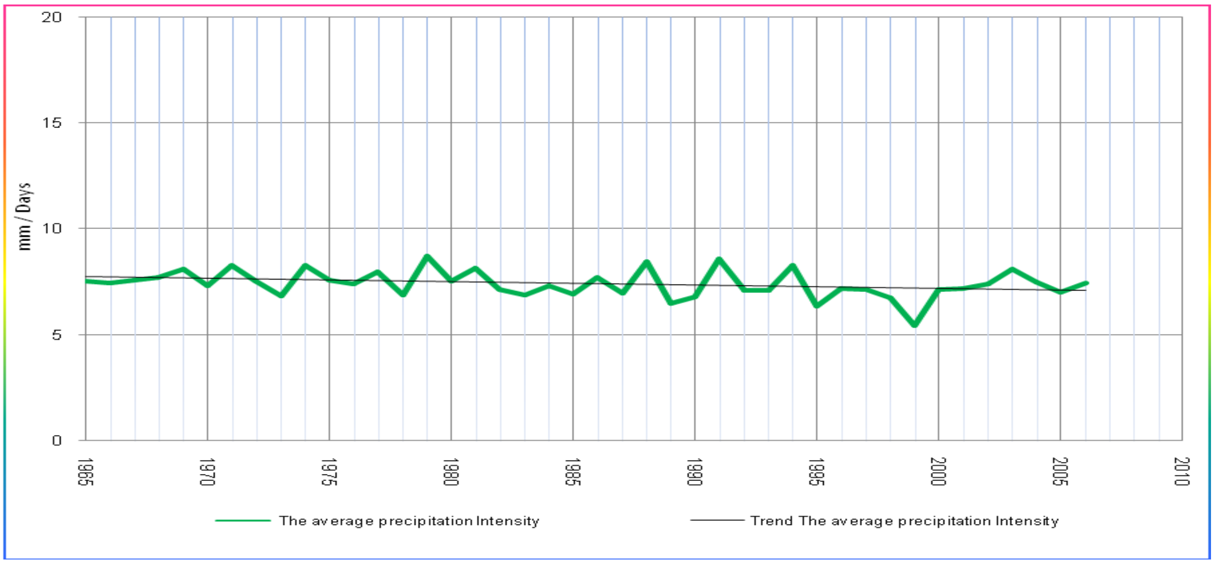


Fig. (18): The average precipitation Intensity

2.2.3 The max precipitation events:

(Monthly maximum one day precipitation amount mm).Fig.19.

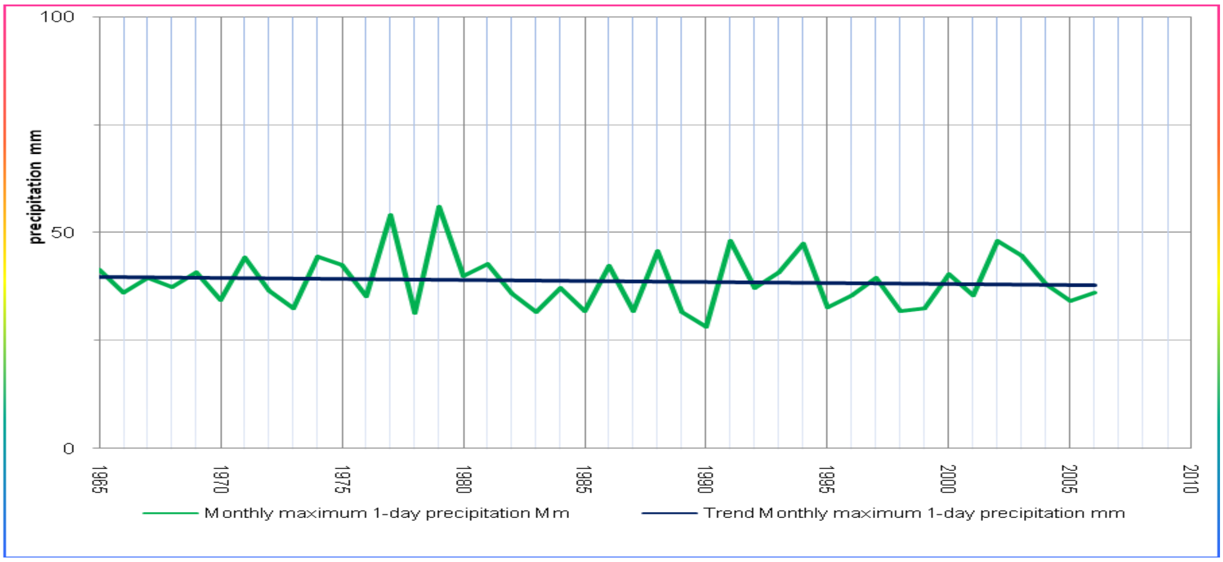


Fig. (19): Monthly maximum one day precipitation amount mm.

2.2.4 Average of annual precipitaion anomalise in wet days (RR>1mm).Fig.20

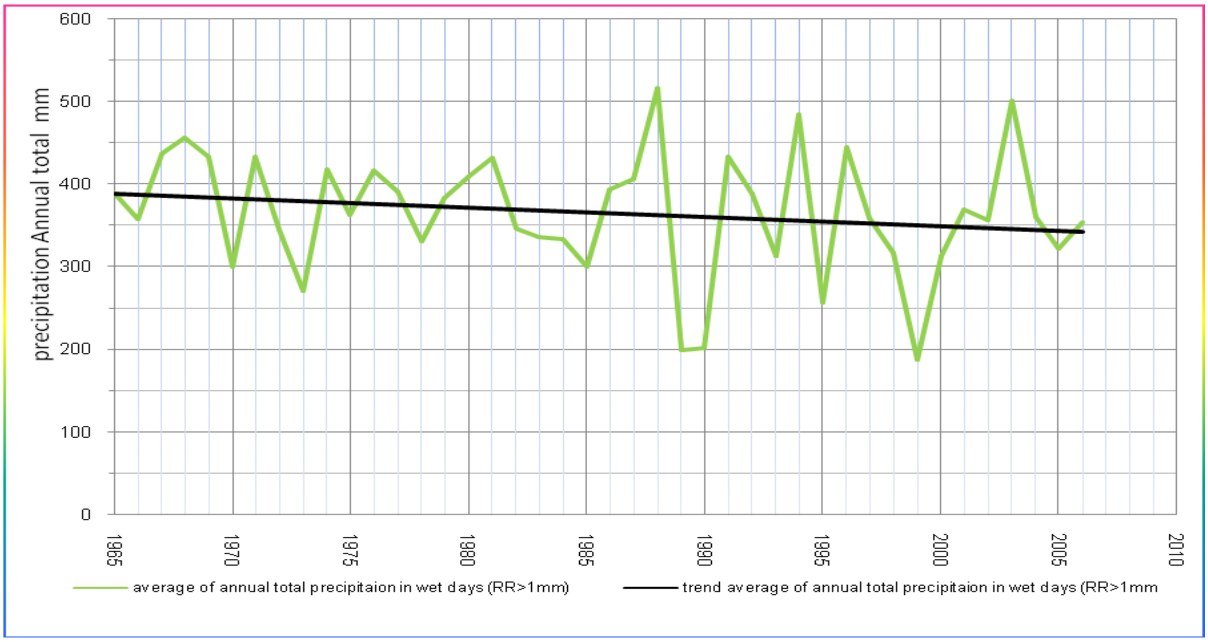


Fig. (20): Annual precipitation anomalies in wet days (RR>1mm)

3. Climate Change Scenarios (2041-2070-2100)

Climatic change scenarios were developed to predict temperature and precipitation values in 2041 and 2100 using two different models. MAGICC was used for 2041 prediction while predicted data by global models were retrieved From IPCC data base to predict for 2070-2100. These models are described below:

3.1 Application of MAGICC/ SCENGEN

In creating the climate change scenarios for Syria, software called Model for the Assessment of Greenhouse Gases Induced Climate Change MAGICC/ SCENGEN (version 4.1, September 2003), originally developed by the Climate Research Unit at the University of East Anglia, U.K., and was utilized.

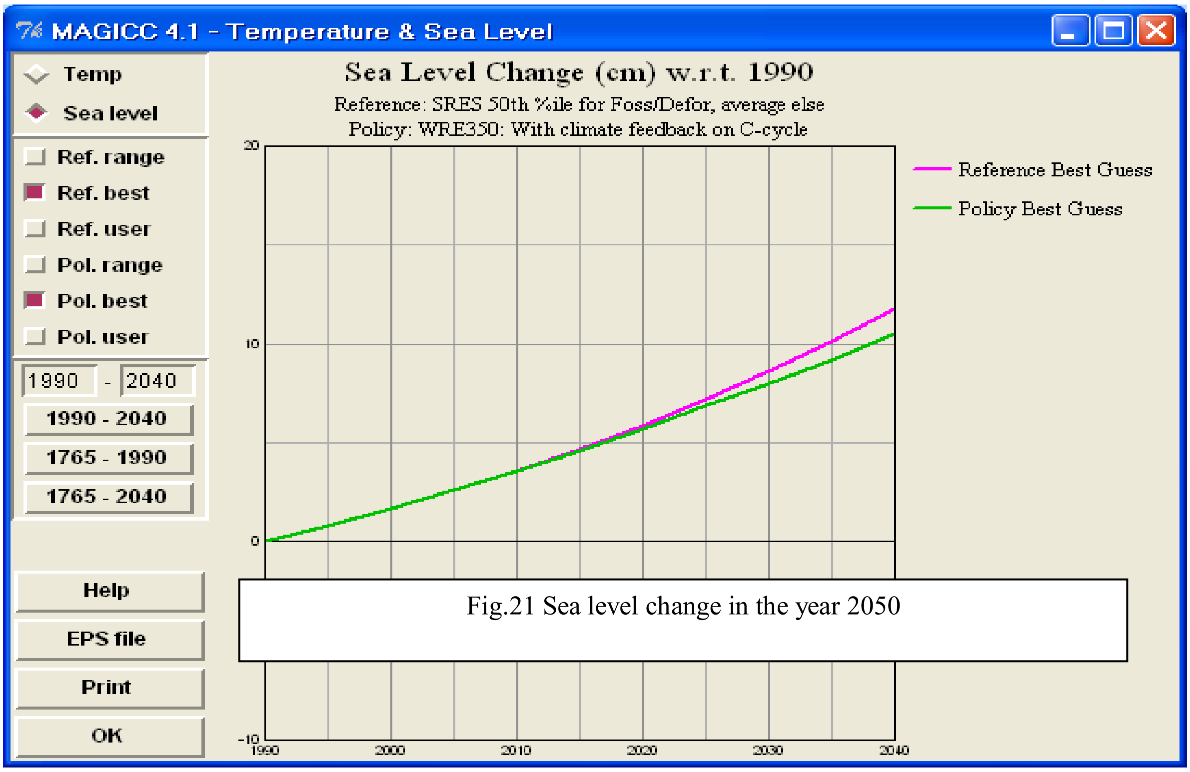
MAGICC, a coupled gas-cycle/ climate model, is the primary model that has been used in all IPCC assessments to produce projections of future global-mean temperature and global-mean sea level rise. The recent modifications to MAGICC were developed to update its science to that of IPCC Third Assessment Report (TAR). An important new feature in MAGICC-4.1 is the inclusion of climate feedback effects on its carbon cycle.

GSCENGEN, a climate scenario generator, uses the output from MAGICC to produce spatial patterns of the changes in climate parameters from an extensive database of Atmosphere/ Ocean General Circulation Models (AOGCM) data. The SCENGEN improvements allow, among other things, to produce area-average output for selected Regions for direct input to the impact components of integrated assessment models.

The method of using MAGICC/ SCENGEN begins by selecting the emissions scenarios. Out of the 47 scenarios available in MAGICC library (it includes now the Special Report of Emission Scenarios (SRES) having wider range of gases), two scenarios were selected: P50 as the "Reference" scenario, and WRE350 as the "Policy" scenario. P50, the median of SRES scenarios, is in use now instead of IS92a, which has been used with the old versions of MAGICC. IS92a scenario was used by many neighboring countries of Syria such as Lebanon Jordan, Saudi Arabia, Iran and others in their national communications.

The policy scenario WRE350 is also a SRES scenario having a CO2 concentration which stabilizes at 350 ppm in the year 2150. It should be mentioned here that the predicted global rise of sea surface level in the year 2041 was 11 and 12cm for policy and reference cases respectively. Fig. (21).

Output from MAGICC namely, global-mean time series of gas emissions, gas concentrations, temperature and sea level, for both reference and policy cases, were used to drive SCENGEN. In an initial trial run, all the 17 GCMs incorporated in SCENGEN library were used to produce seasonal and annual temperature (^{0}C) and precipitation (%) changes in the year, i.e. 50 years from the central year of the adopted baseline period. The aim of this trial was to select, based on a thorough comparison of output with baseline climatic trends, the best single or combination of GCM models to fit Syria climate peculiarities. The output of SCENGEN comes out as an array (Latitude-Longitude) of 5 x 5 deg. Grid for the whole globe. For the purpose of comparison and subsequent analysis, four grid cells that cover the Syria Lands were identified figure 21. The Extracted results for each of these cells are tabulated in seasonal and annual order in Table (3).



Sea Level Change (cm) w.r.t. 1990

Reference: SRES 50th %ile for Foss/Defor, average else

Policy: WRE350: With climate feedback on C-cycle

Fig.21 Sea level change in the year 2050

Table (3): Changes in temperature and Precipitation in each grid cell as predicted by GCM.

Zone **Model**	**1**		**2**		**3**		**4**	
	35 – 40 N		30 – 35 N		35 – 40 N		30 – 35 N	
	35 – 40 E		35 - 40 E		40 – 45 E		40 – 45 E	
	T	R	T	R	T	R	T	R
All(17)	1.7	-10.2	1.7	-11.3	1.8	-9.0	1.9	-8.5
BMRC98	2.0	-15.7	1.9	12.6	2.1	-17.3	2.2	-21.2
CCC199	1.9	-19.9	1.9	-14.9	2.5	-11.3	2.1	-1.1
CCSR96	1.7	-17.2	1.9	-11.4	1.8	-13.9	1.9	-8.7
CERF98	1.8	-17.1	1.8	-15.5	1.8	-15.8	1.9	-16.0
CSI296	2.3	-16.4	2.3	-23.0	2.3	-14.2	2.6	-34.8
CSM_98	1.5	-2.9	1.7	3.6	1.6	1.5	1.5	2.6
ECH395	2.1	-26.4	2.3	-37.1	2.3	-22.5	2.6	-23.2
ECH498	2.3	-5.3	2.3	-13.0	2.5	-5.6	2.5	-6.9
GFDL90	2.0	-3.3	1.9	-1.5	2.1	0.9	2.0	3.5
GISS95	1.6	-12.6	1.7	-13.9	1.7	-18.9	1.7	7.7
HAD295	1.7	-5.2	1.5	-11.3	1.7	1.6	1.8	0.8
HAD300	1.7	-9.6	1.5	-11.3	1.8	-9.7	1.6	-13.6
IAP_97	1.4	-10.5	1.3	-12.1	1.4	-8.2	1.4	-16.1
LMD_98	2.0	-9.5	1.7	-12.8	2.0	-6.1	1.7	-15.4
MRI_96	1.5	-5.8	1.5	-5.5	1.7	-6.8	1.7	-5.4
PCM_00	1.7	-2.3	1.7	-5.4	1.8	-8.7	1.7	-1.3
WM_95	1.4	3.2	1.6	5.5	1.4	4.0	1.7	3.9
MAX.	2.3	3.2	2.3	12.6	2.5	4.0	2.6	7.7
MIN.	1.4	-26.4	1.3	-37.1	1.4	-22.5	1.4	-34.8

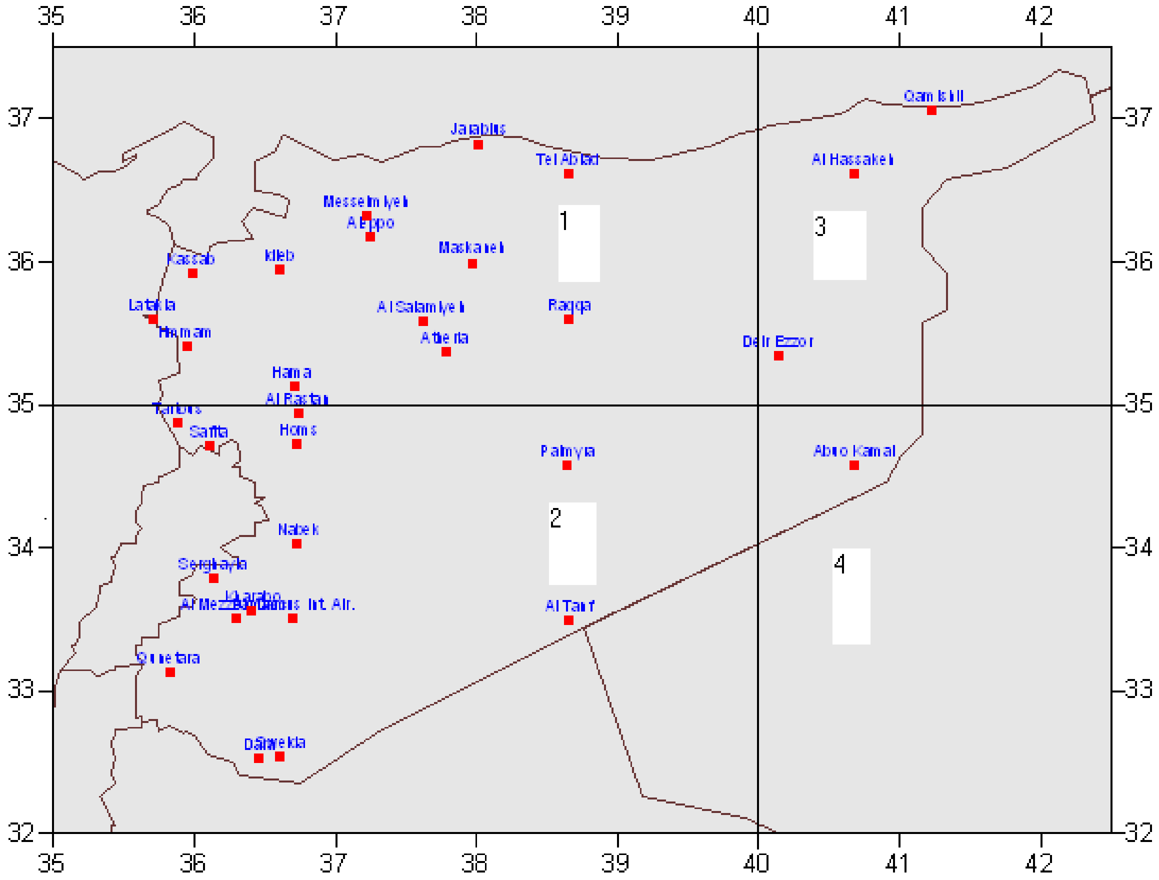


Figure (22): Grid cells covering Syria

Three GCM models were found to simulate very closely the climatic trend characteristics of Syria. These are (CCSR96, IAP-97), and (MRI-96). Results obtained from running the combination of these three models, for the reference (P50) and the policy (WRE-350) emission scenarios, are shown in table 4 for each of the four grid cells and given in seasonal and annual change order. Remarkable climate change features were concluded from these results, which included the following.

- The average warming in Syria for the year 2041 is higher than the global average for both the reference and the policy scenarios.
- The highest warming (2.0-2.1 ^{0}C) (cells 1 and 4), while the lowest (1.0-1.2 ^{0}C) occurs in Syria (All cells).

Table (4): Changes in Seasonal and annual mean temperature (^{0}C) and precipitation (%) from CCSR96, IAP_97 and MRI_96.

Zone Emission Scenario		1		2		3		4	
		35 – 40 N		30 – 35 N		35 – 40 N		30 – 35 N	
		35 – 40 E		35 - 40 E		40 – 45 E		40 – 45 E	
		T	R	T	R	T	R	T	R
Winter	Policy	1.0	-13.3	1.1	-16.2	1.0	-10.3	1.2	-13.6
	Reference	1.1	-14.4	1.2	-17.5	1.1	-11.1	1.3	-14.7
Spring	Policy	1.4	-3.3	1.4	-10.2	1.5	-8.9	1.5	-13.1
	Reference	1.5	-3.6	1.5	-11.0	1.6	-9.7	1.6	-14.2
Summer	Policy	1.9	-4.0	2.0	79.3	1.9	-6.3	1.9	62.5
	Reference	2.1	-4.3	2.1	85.7	2.1	-6.8	2.0	67.5
Autumn	Policy	1.5	-1.3	1.5	14.9	1.6	-0.7	1.6	7.3
	Reference	1.6	-1.4	1.6	16.1	1.7	-.08	1.6	7.9
Annual	Policy	1.4	-9.7	1.5	-8.0	1.5	-9.1	1.5	-9.9
	Reference	1.6	-10.5	1.6	-8.6	1.6	-9.8	1.6	-10.7
Policy (WRE 350) Global-mean dt:0.81 (^{0}C) **Reference (P 50%) Global-mean dt:1.1(^{0}C)**						Year 2041			

- The highest increase in precipitation occurs in summer and autumn in all Syria.

Table 5 shows the calculated average annual rainfall for all meteorological stations for the year 2041, using the average rate of change deduced from the model as follows:

$$\mathbf{AV\ 41 = AV\ 91\ (1 + RC/100)}$$

Table (5): Annual total rainfalls for the year 2041 from the model MRI_96

Station Name	Average 1961-1990 (mm)	Rate of Change (%)	Average Change (mm)	Average 2041 (mm)
Lattakia	802.0	-5.4	43.3	758.7
Hmmam	852.9	-5.4	46.1	806.8
Safita	1130.9	-5.1	57.7	1073.2
Tartous	872.4	-5.1	44.5	827.9
Tel Abiad	287.3	-5.4	15.5	271.8
Jaraplus	324.0	-5.4	17.5	306.5
Aleppo	329.5	-5.4	17.8	311.7
Atheria	186.6	-5.4	10.1	176.5
Meslmieh	330.8	-5.4	17.9	312.9
Idleb	504.5	-5.4	27.2	477.3
Hama	348.5	-5.4	18.8	329.7
Salamiyh	305.3	-5.1	15.6	289.7
Al Rastan	380.5	-5.1	19.4	361.1
Homs	433.4	-5.1	22.1	411.3
Damascus Int. Air Port.	142.2	-5.1	7.3	134.9
Mezzeh Air.Dam	200.3	-5.1	10.2	190.1
Kharabo	161.6	-5.1	8.2	153.4
Dara	265.6	-5.1	13.5	252.1
Nabek	120.1	-5.1	6.1	114.0
Serghayia	572.4	-5.1	29.2	543.2
Qunetara	610.2	-5.1	31.1	579.1
Sweida	357.7	-5.1	18.2	339.5
Palmyra	134.2	-5.1	6.8	127.4
Maskaneh	228.7	-5.4	12.3	216.4
Deir Ezzor	157.2	-6.2	9.7	147.5
Abuo Kamal	133.7	M,-5.0	6.7	127.0
Raqqa	210.5	-5.4	11.4	199.1
Al Tanf	105.0	-5.1	5.4	99.6
Qoumishlie	435.1	-6.2	27.0	408.1
Hassakeh	285.8	-6.2	17.7	268.1

3.2 Prediction for different scenarios using global modeling data

Since the grid interval to retrieve information using this approach is quite coarse, 5 degree latitude and 5 degree longitude, it was difficult to interpolate information at micro-level in Syria. Therefore efforts were concentrated in retrieving daily data for the district from (IPCC) databases. These databases are maintained by (IPCC) and are based on the simulation studies conducted using global climatic models. These databases store data at global level for different climatic scenarios up to the year 2100. Various climate change scenarios, as developed by the (IPCC) group, were reviewed and the main focus of the study for this Initial communication report was on A2 and B2 climate scenario families.

Under the scenario family A2, the world will be very heterogeneous. The main emphasis will be on the family values and preserving solutions traditions and cultural identities. The global population under this scenario will increase continuously with a less concern on economic development.

The B2 scenario family, on the other hand, describes a heterogeneous world with less rapid, and more diverse technological change but a strong emphasis on community initiative and social innovation to find local, rather than global solutions. It is a world with continuously increasing global population at a rate lower than A2, intermediate levels of economic development, and less rapid and more diverse technological change than other scenarios. While the scenario is also oriented toward environmental protection and social equity, it will also focus on local and regional levels of development.

In order to assess long-term impact globally in the next hundred years, global climatic models were used to simulate changes in temperature, precipitation, relative humidity, solar radiation, and wind circulation. For this study, long-term simulated records on precipitation and temperature were retrieved from the following four models with main focus on Hadley Centre Global model.

- ✓ Hadley Centre Global Model, U.K. known as Hadley model
- ✓ Global climatic model by National Center For Air Research (NCAR), USA Known as (NCAR) model
- ✓ Canadian Climatic Centre Model known as (CCCMA)
- ✓ Australian global model known as CCSIRO model

A2 and B2 scenarios are the main scenarios among all the scenarios developed by the (IPCC) and have been used by most of the global climatic models for climatic change predictions. These two scenarios also cover most of the predicted climatic changes in this century. It was therefore decided precipitation changes in Syria between 2010 and 2100 in reference to baseline values between 1961 and 1990.to concentrate on these two scenarios to study temperature and precipitation.

Using GCM run data stored in IPCC Data Centre, monthly time series data was retrieved for Latitudes 30 0 N to 380 N and Longitude 320 E to 440 E covering Syria. Data was retrieved from 1961 to 2100 for mean monthly temperature and precipitation for all grids covering the above ranges of latitudes and longitudes.

Using average of 1961 to 1990 values as baseline, the change in temperature and precipitation were estimated for the period 2010 to 2100 with respect to average values obtained from 1961 to 1990 as base values. These changes were then plotted on the map to see variation in the monthly temperature (Figure.22 to Figure .24. for A2 scenario and Figure.25 to Figure .27 for B2 scenario) and change in precipitation on monthly basis (Figure.28 to Figure.30 for A2 scenario and figure.31 to Figure.32 for B2 scenario). The findings are summarized in the following subsections:

3.2.1 Change in Temperature

Although analysis was conducted using all four models but only the results obtained For scenarios A2 and B2 using Hadley model are presented in this section.

3.2.1.1 A2 Scenario

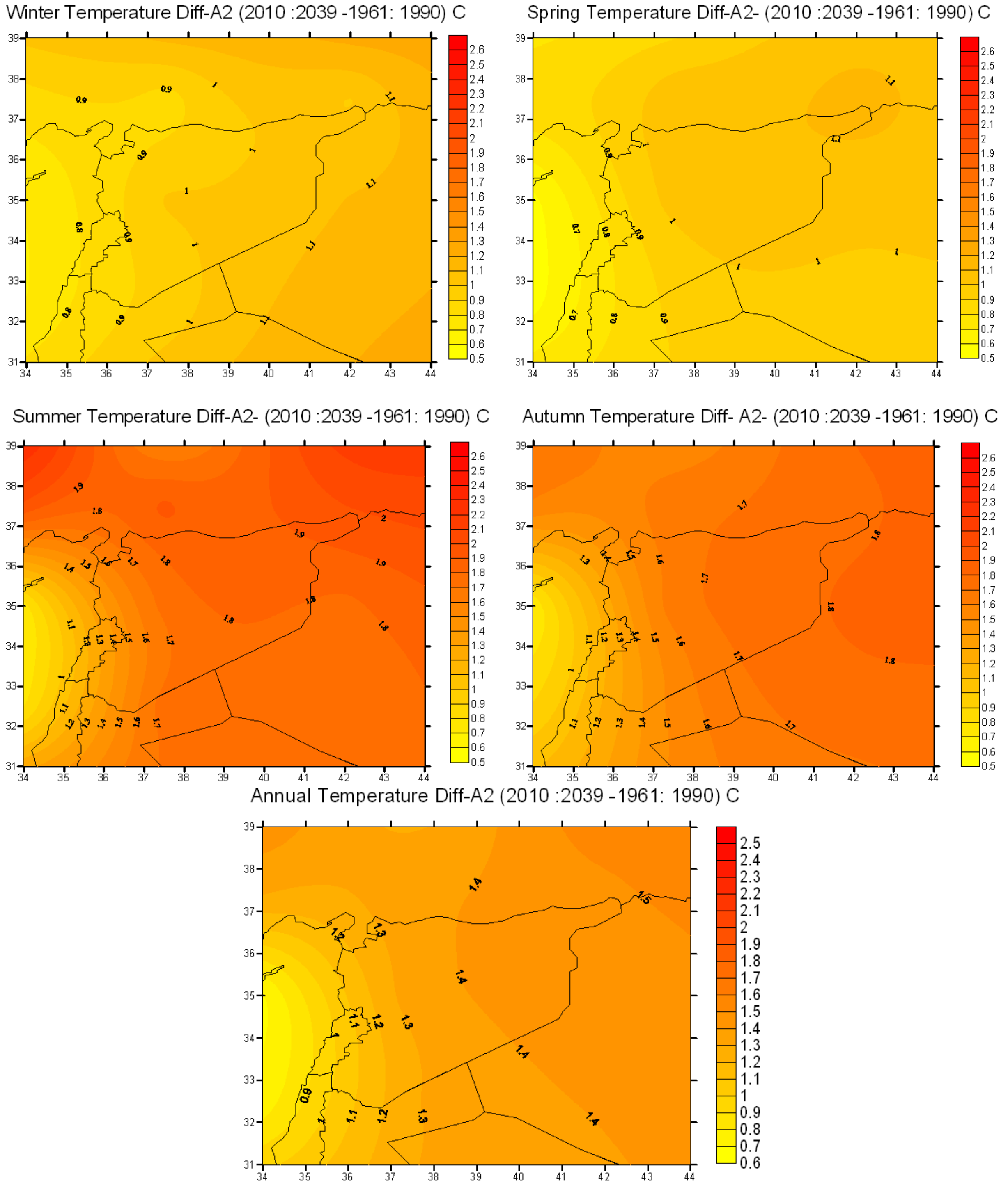
Based on the spatial variations on seasonal basis as shown in Figure.22 and Table.6 the Change in the temperature at various locations as predicted by the Hadley model for A2 scenarios are as follows:

Table (6): Seasonal and Annual Dry air temperature variation for the years 2039-2069-2099 with respect to normal average 1961-1990 from the model HADCM3

Years	Winter	Spring	Summer	Autumn	Annual
2010-2039	0.8 : 1.0	0.7 : 1.1	1.2 : 1.9	1.1: 1.7	**0.9 : 1.4**
2040-2069	1.8 : 2.2	1.8 : 2.6	2.6 : 4.4	2.2 : 3.0	**2.1 : 3.0**
2070-2099	3.3 : 4.1	3.3 : 4.7	4.4 : 7.0	3.9 : 5.0	**3.8 : 5.2**

3.2.1.1.1 A2 Scenario 2010-2039

- The minimum seasonal temperature increase is expected as 0.7 ^{0}C in Spring While maximum increase of 1.9 ^{0}C is expected in summer.
- In winter, temperature change varies from a minimum of 0.8^{0}C on the Western coast to a maximum value of 1.0 ^{0}C in East, Southeast and North East of Syria.
- In spring, increasing trend from Western (0.7 ^{0}C) to East (1.1 ^{0}C).
- In summer, increasing trend from Southwest (1.2 ^{0}C) to Northeast (1.9 ^{0}C).
- In autumn, increasing trend from West (1.1 ^{0}C) to Northeast (1.7 ^{0}C).



Winter Temperature Diff-A2 (2010 :2039 -1961: 1990) C

Spring Temperature Diff-A2- (2010 :2039 -1961: 1990) C

Summer Temperature Diff-A2- (2010 :2039 -1961: 1990) C

Autumn Temperature Diff- A2- (2010 :2039 -1961: 1990) C

Annual Temperature Diff-A2 (2010 :2039 -1961: 1990) C

Figure (23): Seasonal temperature changes for A2 scenario – Hadley Model-CM3

3.2.1.1.2 A2 Scenario 2040-2069

The spatial variations on Seasonal basis as shown in Figure.23 and Table.6 the change in the temperature at various locations as predicted by the Hadley model for A2 scenario are as follows between 2040-2069.

- The minimum seasonal temperature increase is expected as 1.8 0C in winter and spring while maximum increase of 4.4 0C is expected in summer.
- In winter, temperature change varies from a minimum of 1.80C on Southwest to a maximum value of 2.2 0C in North East of Syria.
- In spring, increasing trend from Western (1.80C) to Central and North (2.60C).
- In summer, increasing trend from Southwest (2.60C) to Northeast (4.40C).
- In autumn, increasing trend from Southwest (2.20C) to Northeast (3.00C).

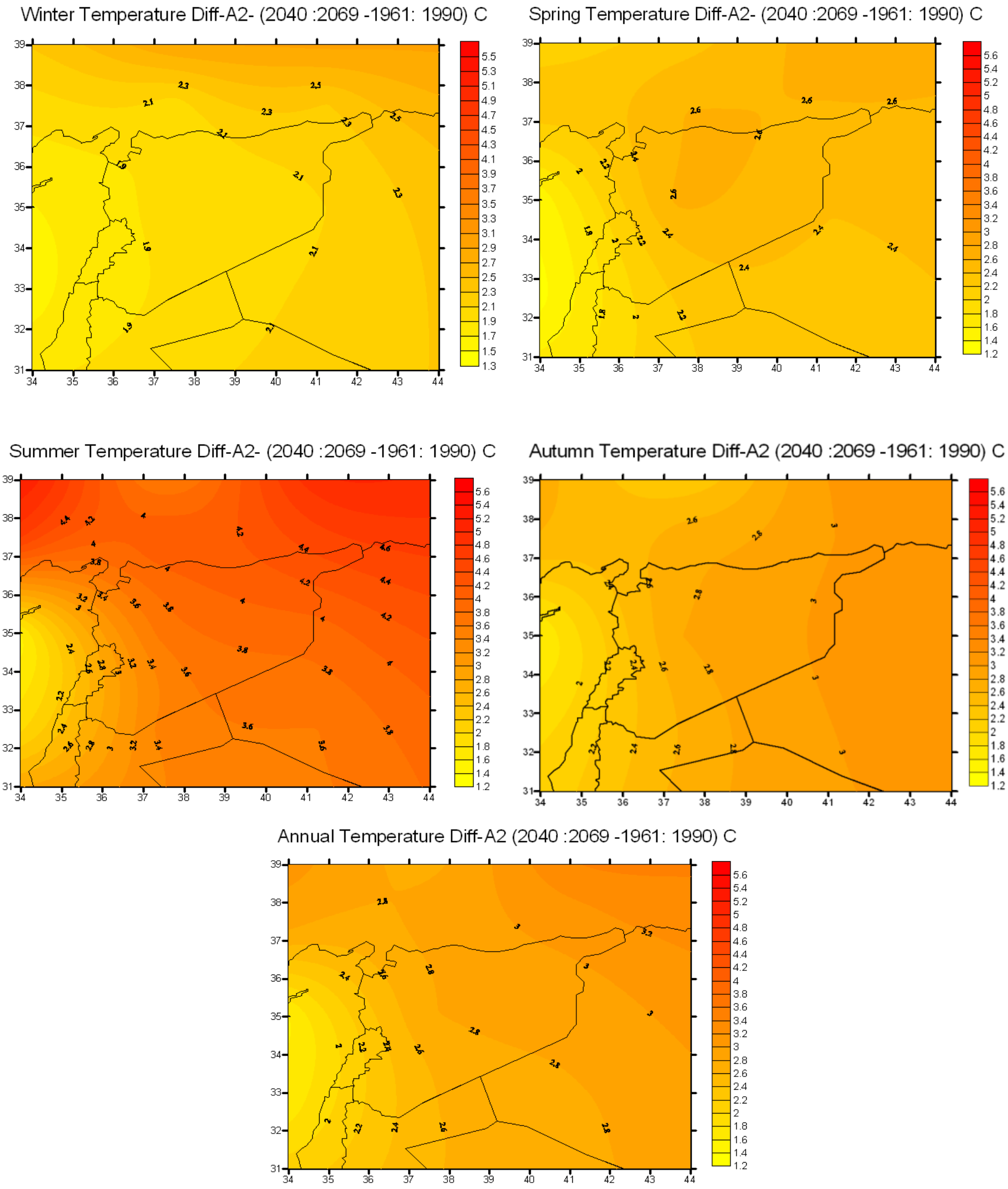


Figure (24): Seasonal temperature changes for A2 scenario – Hadley Model-CM3

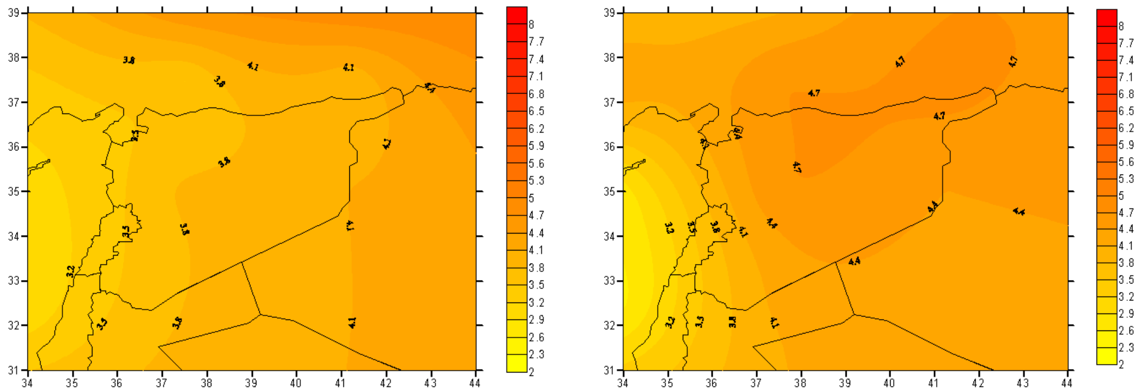
3.2.1.1.3 A2 Scenario 2070-2099

The spatial variations on seasonal basis as shown in Figure.24 and Table.6 the change in the temperature at various locations as predicted by the Hadley model for A2 scenario are as follows between "2070-2099".

- The minimum seasonal temperature increase is expected as 3.3 0C in winter and spring while maximum increase of 7.0 0C is expected in summer.
- In winter, temperature increase varies from a minimum of 3.30C on west to a maximum value of 4.1 0C in East of Syria.
- In spring, increasing trend from Western (3.3 0C) to Central and North (4.7 0C).
- In summer, increasing trend from Southwest (4.4 0C) to Northeast (7.0 0C).
- In autumn, increasing trend from Southwest (3.9 0C) to Northeast (5.00C).

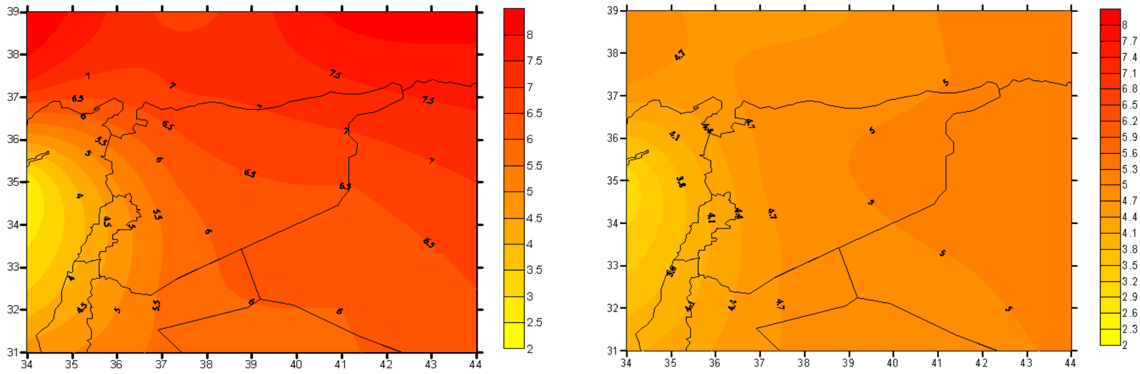
Winter Temperature Diff-A2 (2070 :2099 -1961: 1990) C

Spring Temperature Diff-A2- (2070 :2099 -1961: 1990) C



Summer Temperature Diff- A2-(2070 :2099 -1961: 1990) C

Autumn Temperature Diff-A2 (2070 :2099 -1961: 1990) C



Annual Temperature Diff-A2- (2070 :2099 -1961: 1990) C

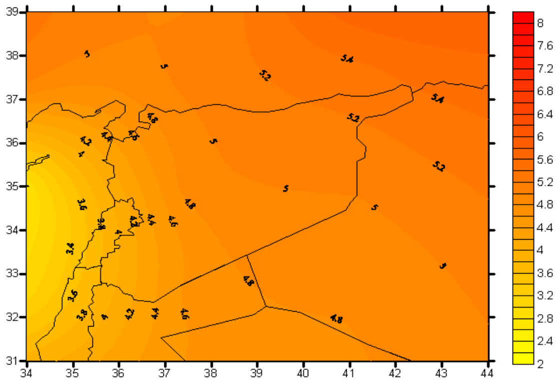


Figure (25): Seasonal temperature changes for A2 scenario – Hadley Model-CM3

3.2.1.2 B2 Scenario

Based on the spatial variations on seasonal basis as shown in Figure .25 and table .7, change in temperature at various locations as predicted by the Hadley model for B2 scenario are as follows for the period 2010-2039

Table (7): Seasonal and Annual Dry air temperature variation for the years 2039-2069-2099 with respect to normal average 1961-1990 from the model HADCM3

Years	Winter	Spring	Summer	Autumn	Annual
2010-2039	1.0 : 1.3	0.8 : 1.2	1.1 : 2.5	1.2 : 1.8	**1.1 : 1.7**
2040-2069	1.5 : 1.9	1.1 : 1.8	2.1 : 3.6	1.7 : 2.1	**1.6 : 2.4**
2070-2099	2.5 : 2.8	2.4 : 3.2	3.4 : 5.1	3.0 : 3.6	**2.8 : 3.8**

3.2.1.2.1 B2 Scenario 2010-2039

- The minimum seasonal temperature increase is expected as 0.8 ^{0}C in spring while maximum increase of 2.5 ^{0}C is expected in summer.
- In winter, temperature change varies from a minimum of 1.0 ^{0}C on the Southwest to a maximum value of 1.3 ^{0}C in North East of Syria.
- In spring, increasing trend from Western (0.8 ^{0}C) to Central and North (1.2 ^{0}C).
- In summer, increasing trend from Southwest (1.1 ^{0}C) to Northeast (2.5 ^{0}C).
- In autumn, increasing trend from Southwest (1.2 ^{0}C) to Northeast (1.8 ^{0}C).

3.2.1.2.2 B2 Scenario 2040-2069

- The minimum seasonal temperature increase is expected as 1.1 ^{0}C in spring while maximum increase of 3.6 ^{0}C is expected in summer.
- In winter, temperature increase varies from a minimum of 1.5 ^{0}C on the Southwest to a maximum value of 1.9 ^{0}C in North East of Syria.
- Spring, increasing trend from Western (1.1 ^{0}C) to Central and North (1.8 ^{0}C).
- In summer, increasing trend from Southwest (2.1 ^{0}C) to Northeast (3.6 ^{0}C).
- In autumn, increasing trend from Southwest (1.7 ^{0}C) to Northeast (2.1 ^{0}C).

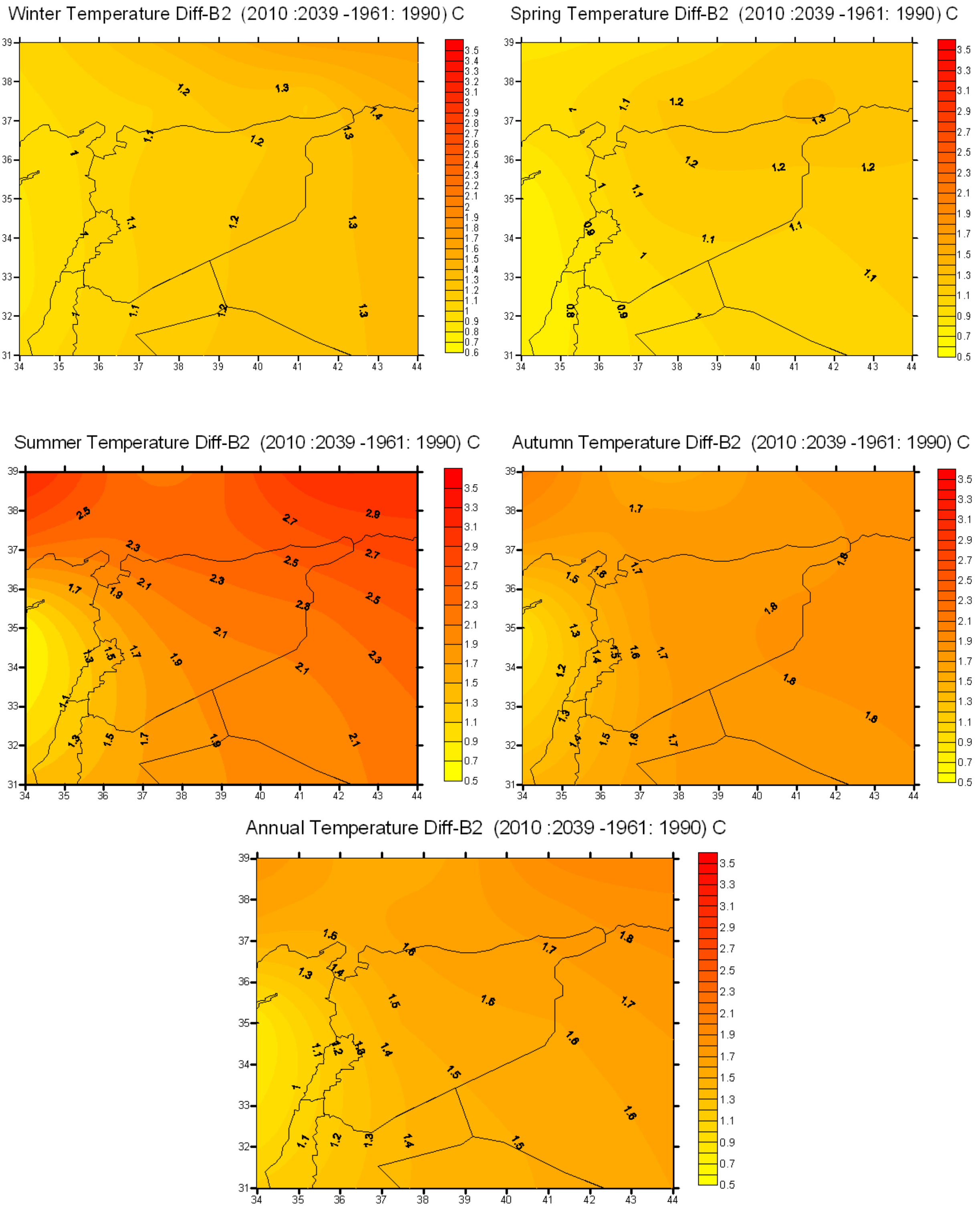


Figure (26): Seasonal temperature changes for B2 scenario – Hadley Model-CM3

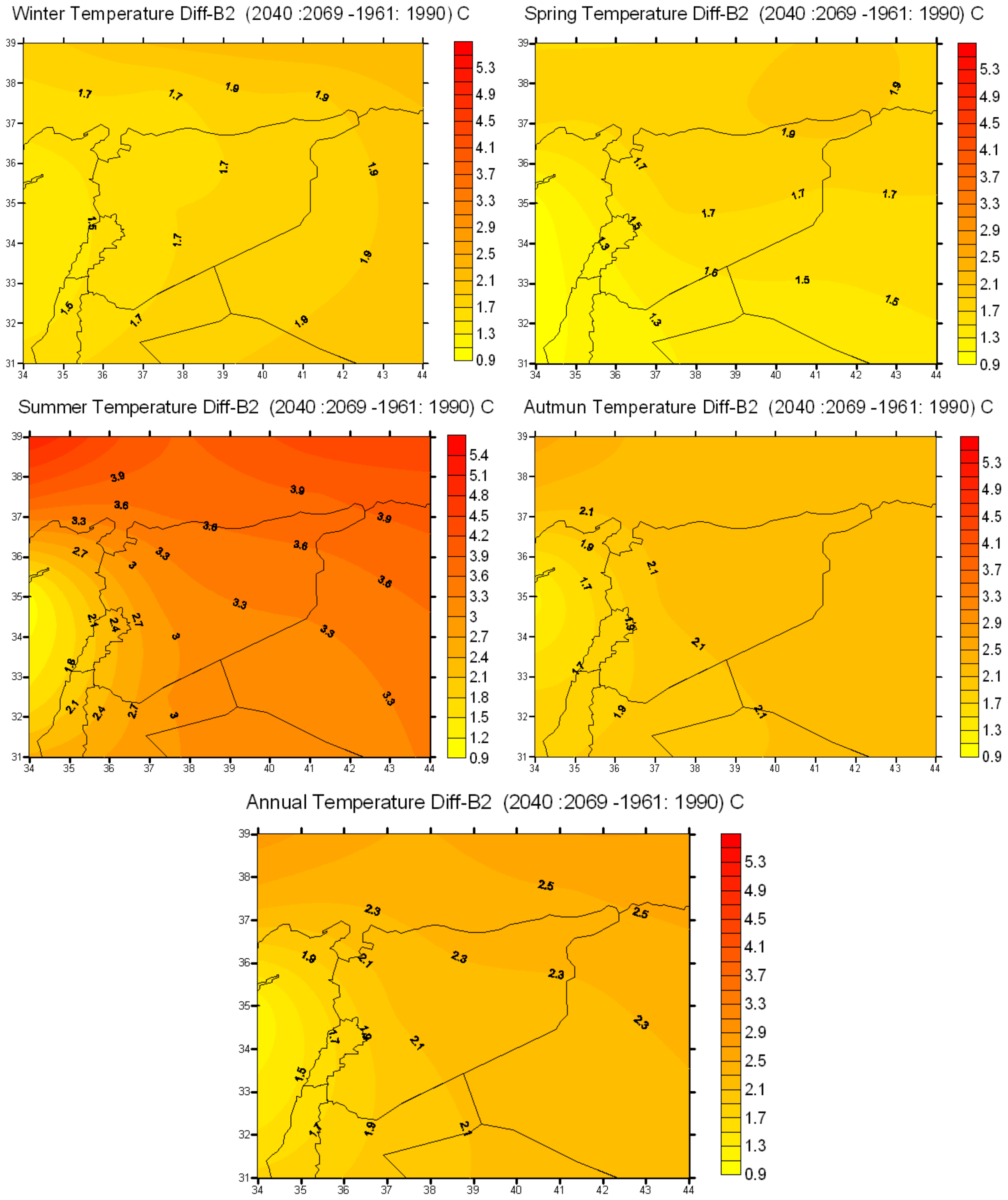
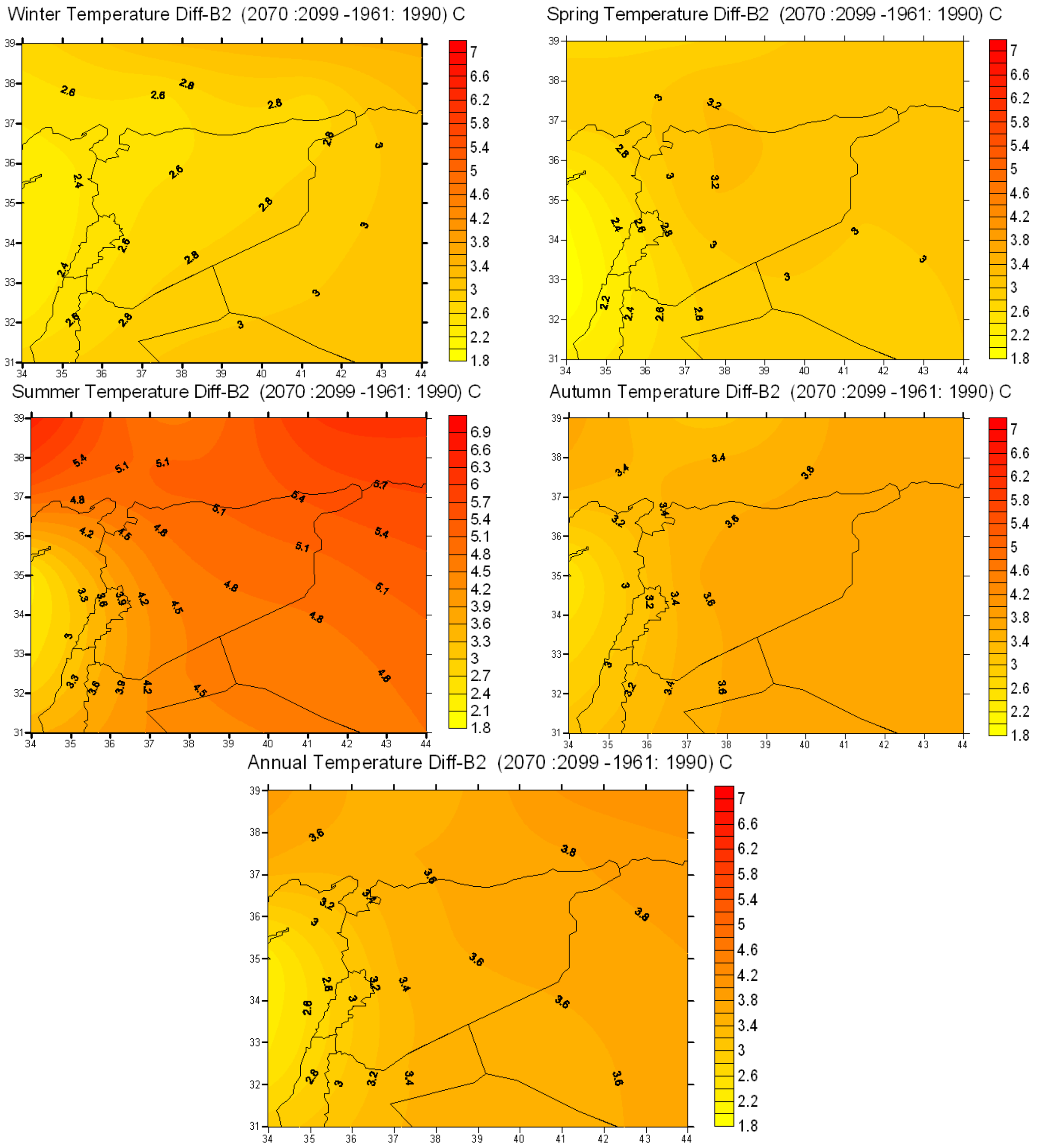


Figure (27): Seasonal temperature changes for B2 scenario – Hadley Model-CM3.

3.2.1.2.3 B2 Scenario 2070-2099

- The minimum seasonal temperature increase is expected as 2.4 ^{0}C in spring while maximum increase of 5.1 ^{0}C is expected in summer.
- In winter, temperature increase varies from a minimum of 2.5 ^{0}C on the Southwest to a maximum value of 2.8 ^{0}C in North East of Syria.

- In spring, increasing trend from Western (2.4 ^{0}C) to Central and North (3.2 ^{0}C).
- In summer, increasing trend from Southwest (3.4 ^{0}C) to Northeast (5.1 ^{0}C).
- In autumn, increasing trend from Southwest (3.0 ^{0}C) to Northeast (3.6 ^{0}C).


Winter Temperature Diff-B2 (2070 :2099 -1961: 1990) C

Spring Temperature Diff-B2 (2070 :2099 -1961: 1990) C

Summer Temperature Diff-B2 (2070 :2099 -1961: 1990) C

Autumn Temperature Diff-B2 (2070 :2099 -1961: 1990) C

Annual Temperature Diff-B2 (2070 :2099 -1961: 1990) C

Figure (28): Seasonal temperature changes for B2 scenario – Hadley Model-CM3

3.2.2 Change in Precipitation

Figure 28, 29 and 30 and table 8 present Seasonal changes in precipitation as predicted by Hadley Model between 2010 and 2100. The changes for scenario A2 are presented in Figure (31) while figure 33 shows changes for B2 scenario. The findings are highlighted in the following sections:

3.2.2.1 A2 Scenario

Table (8): Seasonal and Annual Precipitation variation for the years 2039-2069-2099 with respect to normal average 1961-1990 from the model HADCM3

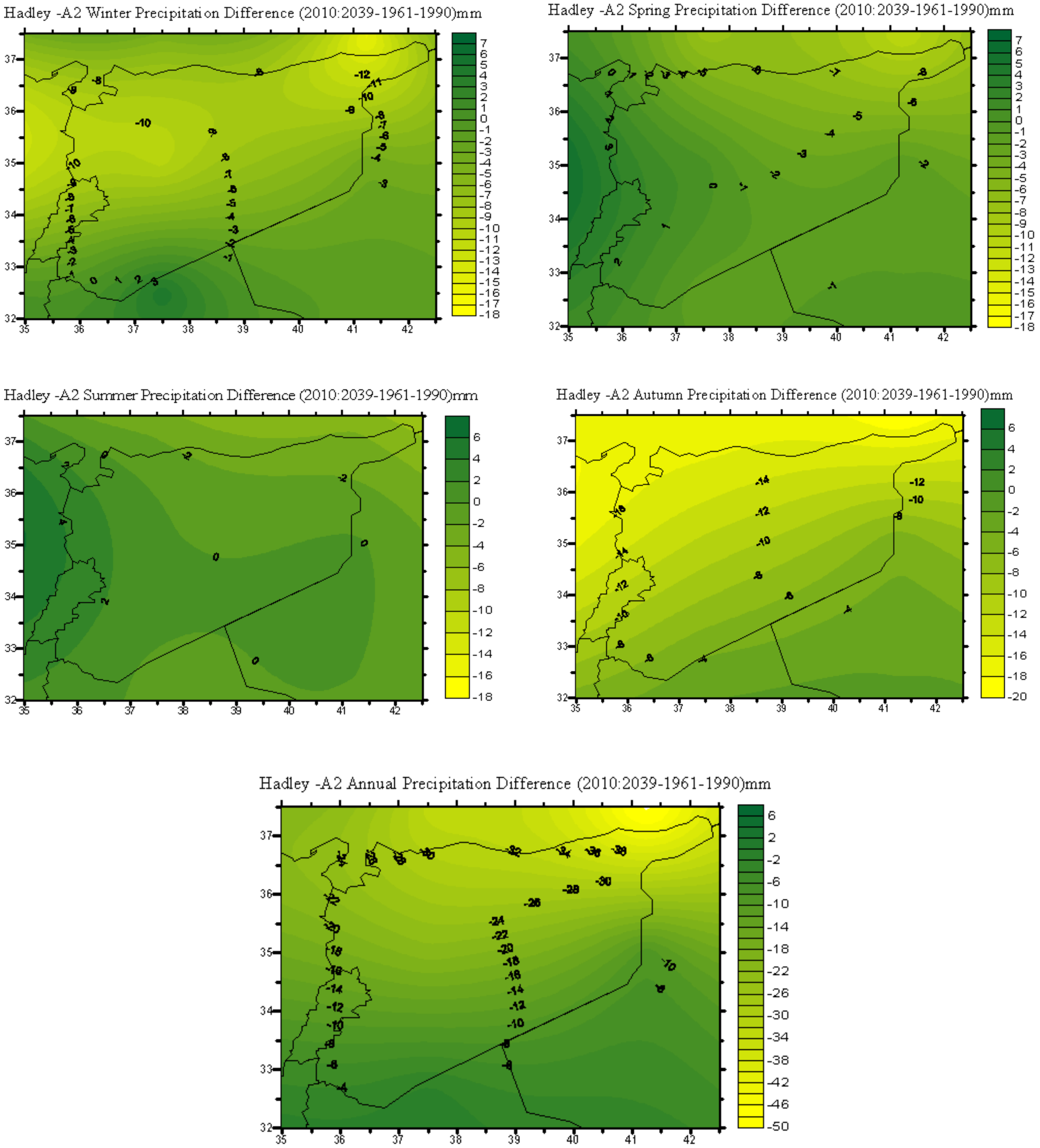
Years	Winter	Spring	Summer	Autumn	Annual
2010-2039	3.0 : -12.0	3.0 : -8.0	4.0 : -4.0	-4.0 : -16.0	**-2.0 : -40.0**
2040-2069	-6.0 : -22.0	-3.0 : -22.0	4.0 : -6.0	-4.0 : -28.0	**-20.0 : -60.0**
2070-2099	-16.0 : -34.0	-6.0 : -38.0	14.0 : -12.0	-6.0 : -40.0	**-6.0 : -34.0**

3.2.2.1.1 A2 Scenario 2010-2039

- In winter, southern region will experience an increase in the precipitation by 3 mm on average while the precipitation is expected to decrease in the northeastern and northwestern district near turkey by 12 mm. In the central and coastal district a decrease of 10 mm rain is expected.
- During Spring , there would be an decrease in the precipitation in the northern and northeastern district, which will decrease in the precipitation by 5 mm. in the western and internal district precipitation is expected to increase by 2 mm
- During summer, a 2 mm increases in the precipitation are expected affecting western coast and southern district. And decrease in precipitation expected in northeastern district.
- In autumn, an overall decrease in the total precipitation in the larger part of the country is predicted except a 5-16 mm decrease in the northeastern region bordering turkey.

3.2.2.1.2 A2 Scenario 2040-2069

- In winter precipitation is expected to decrease by 6.0 to 22.0 mm.
- During Spring , there would be a decrease in precipitation by 3 to 22 mm
- During summer, a 2 mm increases in precipitation is expected affecting western coast and southern district .And decrease in precipitation expected in northeastern district by 3 mm.
- In autumn, an overall decrease in the total precipitation in the larger part of the country is predicted except a 4-26 mm decrease in the northeastern district bordering turkey.



Hadley -A2 Winter Precipitation Difference (2010:2039-1961-1990)mm

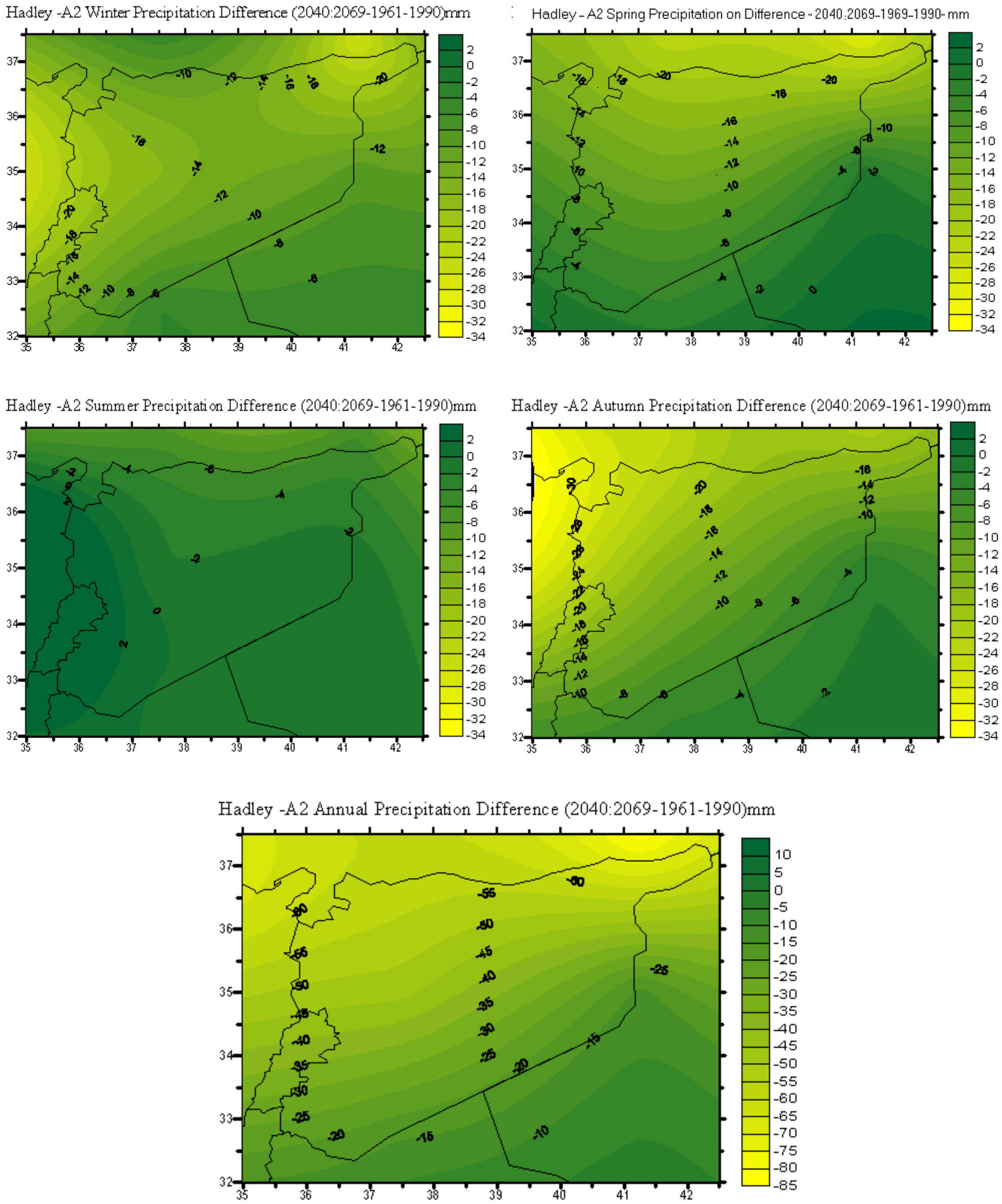
Hadley -A2 Spring Precipitation Difference (2010:2039-1961-1990)mm

Hadley -A2 Summer Precipitation Difference (2010:2039-1961-1990)mm

Hadley -A2 Autumn Precipitation Difference (2010:2039-1961-1990)mm

Hadley -A2 Annual Precipitation Difference (2010:2039-1961-1990)mm

Figure (29): Seasonal precipitation changes for A2 scenario – Hadley Model-CM3



Hadley -A2 Winter Precipitation Difference (2040:2069-1961-1990)mm

Hadley - A2 Spring Precipitation on Difference - 2040:2069-1969-1990- mm

Hadley -A2 Summer Precipitation Difference (2040:2069-1961-1990)mm

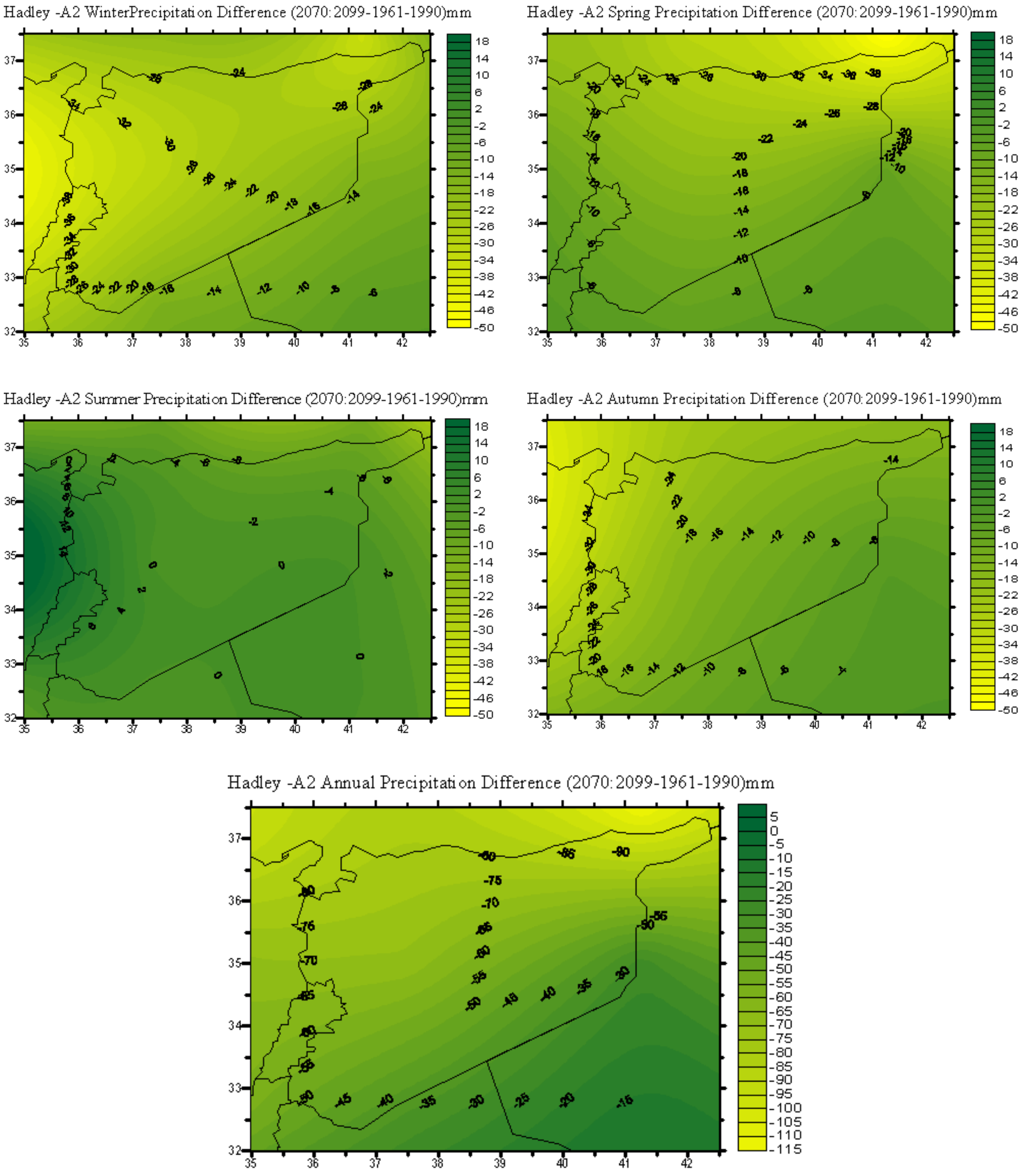
Hadley -A2 Autumn Precipitation Difference (2040:2069-1961-1990)mm

Hadley -A2 Annual Precipitation Difference (2040:2069-1961-1990)mm

Figure (30): Seasonal precipitation changes for A2 scenario – Hadley Model-CM3

3.2.2.1.3 A2 Scenario 2070-2099

- In winter the precipitation is expected to decrease by 16.0 to 34.0 mm.
- During Spring , there would be a decrease in precipitation by 6 to 38 mm
- During summer, a 14 mm increases in precipitation is expected affecting western coast and southern district .and decrease in precipitation expected in northeastern districts by 12 mm.
- In autumn , an overall decrease in the total precipitation in the larger part of the country is predicted except a 6 to 40 mm decrease in the northeastern district bordering turkey.


Hadley -A2 WinterPrecipitation Difference (2070:2099-1961-1990)mm

Hadley -A2 Spring Precipitation Difference (2070:2099-1961-1990)mm

Hadley -A2 Summer Precipitation Difference (2070:2099-1961-1990)mm

Hadley -A2 Autumn Precipitation Difference (2070:2099-1961-1990)mm

Hadley -A2 Annual Precipitation Difference (2070:2099-1961-1990)mm

Figure (31): Seasonal precipitation changes for A2 scenario – Hadley Model-CM3

3.2.2.2 B2 Scenario

Table (7): Seasonal and Annual Precipitation variation for the years 2039-2069-2099 with respect to normal average 1961-1990 from the model HADCM3

Years	Winter	Spring	Summer	Autumn	Annual
2010-2039	4.0 : -6.0	4.0 : -10.0	8.0 : -8.0	-4.0 : -20.0	**-8.0 : -44.0**
2040-2069	-11.0 : -18.0	7.0 : -7.0	9.0 : -5.0	-3.0 : -17.0	**-8.0 : -49.0**
2070-2099	-12.0 : -18.0	-6.0 : -28.0	10.0 : -12.0	-2.0 : -28.0	**-25.0:-75.0**

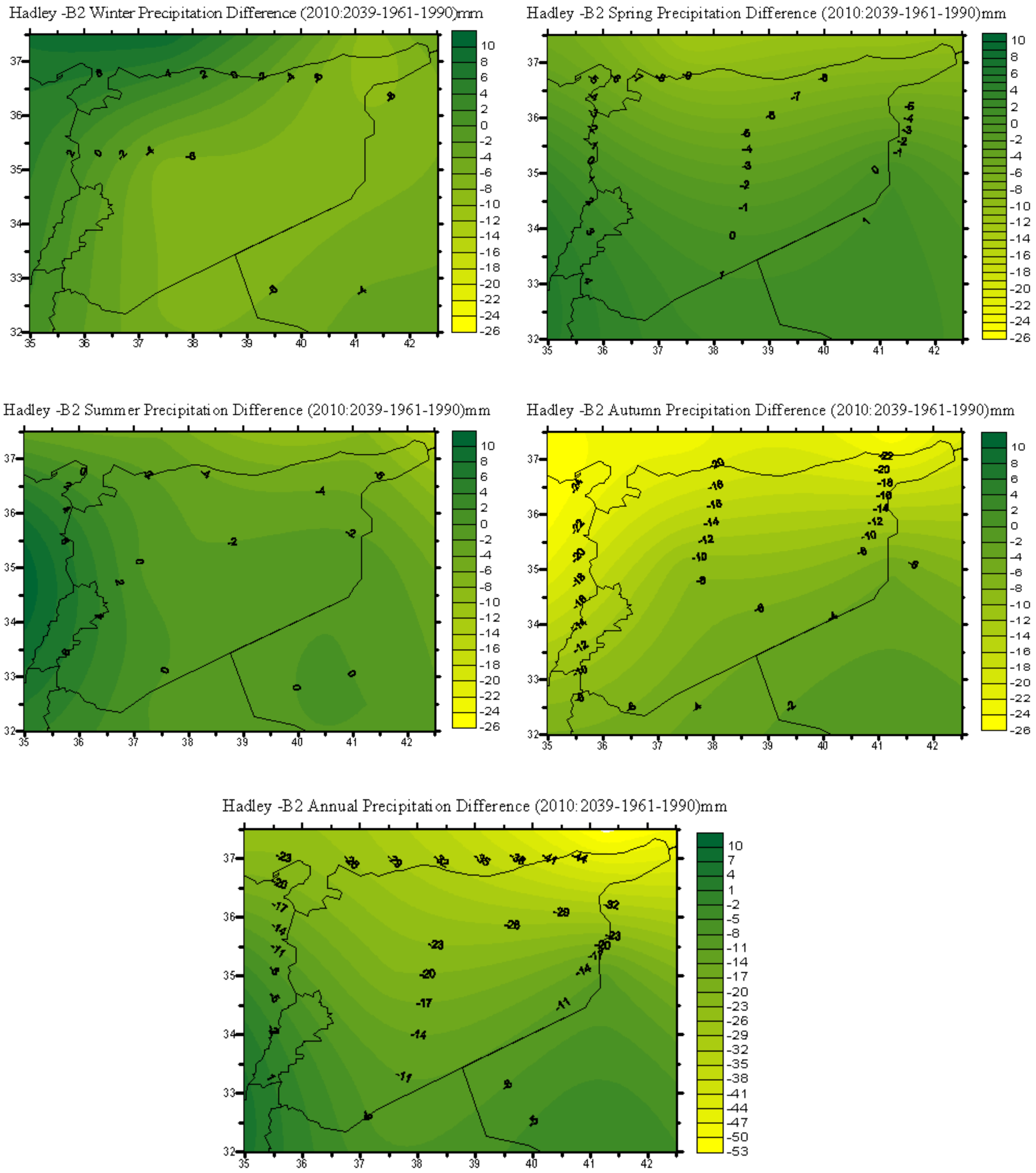
3.2.2.2.1 B2 Scenario 2010-2039

In winter precipitation is expected to decrease by 6.00 and increase by 4.0 mm.

- During spring , there would be a decrease in precipitation by 10 and increase 10 mm
- During summer, a 8 mm increases in the precipitation is expected affecting western coast and southern regions .and decrease in precipitation expected in northeastern districts by 8 mm.
- In autumn, an overall decrease in the total precipitation in the larger part of the country is predicted except a 4-20 mm decrease in the northeastern district bordering turkey**.**

3.2.2.2.2 B2 Scenario 2040-2069

- In winter precipitation is expected to decrease by 6.00 to 18.0 mm.
- During Spring , there would be a decrease in precipitation by 7 and increase 7 mm
- During summer, a 9 mm increases in precipitation is expected affecting western coast and southern districts .and decrease in precipitation expected in northeastern districts by 5 mm.
- In Autumn , an overall decrease in the total precipitation in the larger part of the country is predicted except a 3-17 mm decrease in the northeastern district bordering turkey.



Hadley -B2 Winter Precipitation Difference (2010:2039-1961-1990)mm

Hadley -B2 Spring Precipitation Difference (2010:2039-1961-1990)mm

Hadley -B2 Summer Precipitation Difference (2010:2039-1961-1990)mm

Hadley -B2 Autumn Precipitation Difference (2010:2039-1961-1990)mm

Hadley -B2 Annual Precipitation Difference (2010:2039-1961-1990)mm

Figure (32): Seasonal precipitation changes for B2 scenario – Hadley Model-CM3

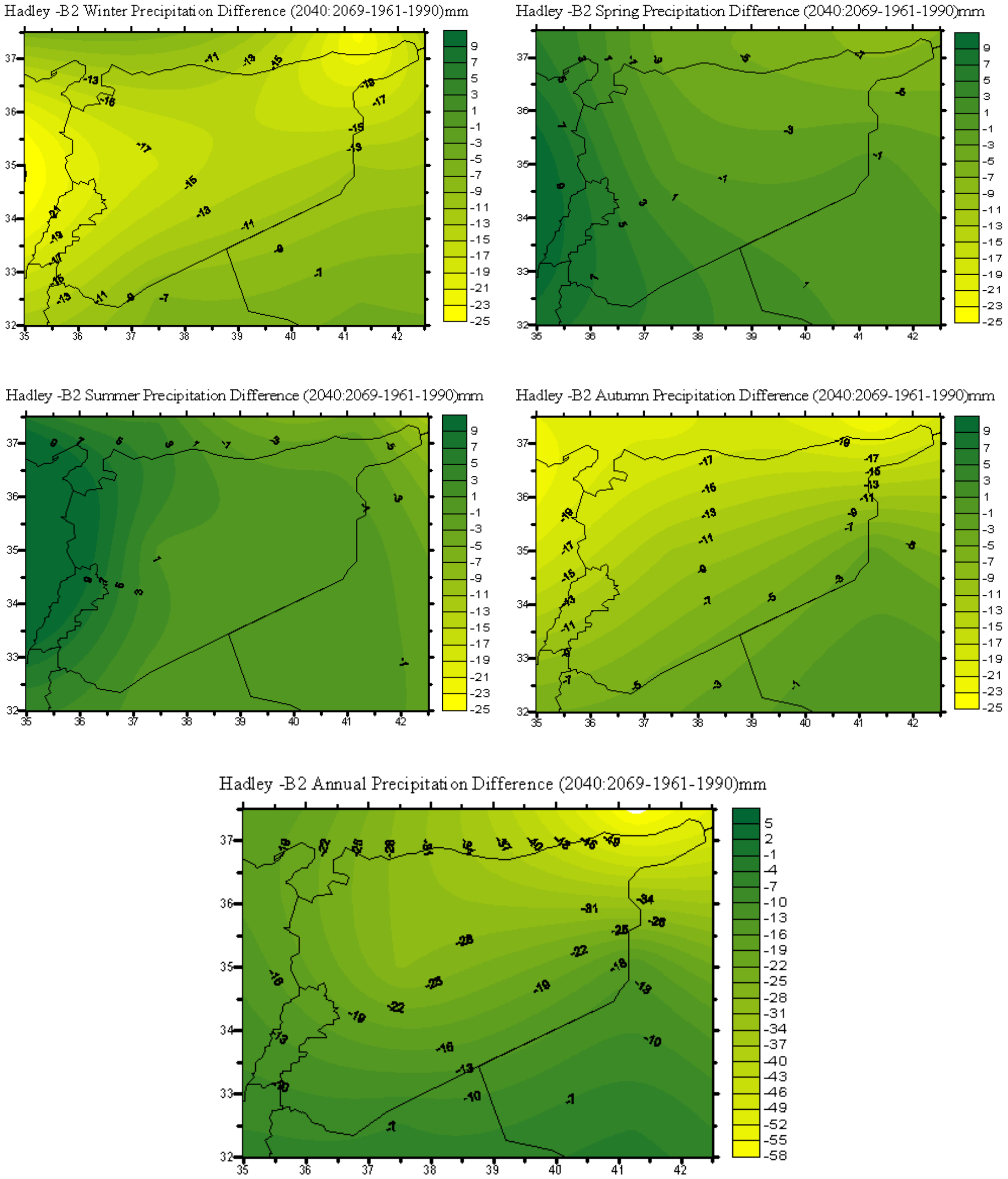
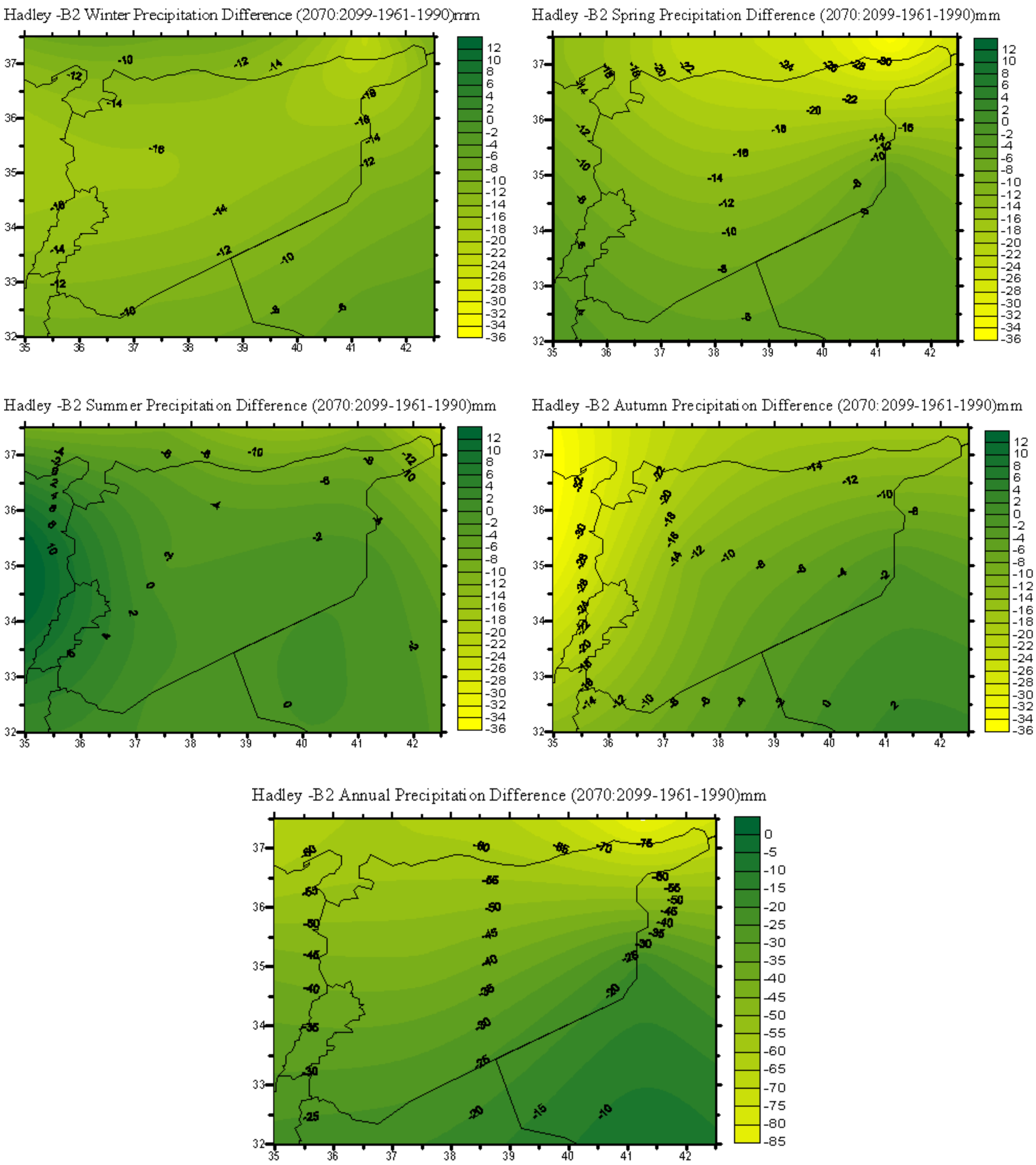


Figure (33): Seasonal precipitation changes for B2 scenario – Hadley Model-CM3

3.2.2.2.3 B2 Scenario 2070-2099

- In winter precipitation is expected to decrease by 12 to 18 mm.
- During spring, there would be a decrease in precipitation by 6 to 28 mm
- During summer, a 10 mm increases in precipitation is expected affecting western coast and southern districts .and decrease in precipitation expected in northeastern districts by 12 mm.

- In autumn, an overall decrease in the total precipitation in the larger part of the country is predicted except a 2-28 mm decrease in the northeastern district bordering turkey**.**



Hadley -B2 Winter Precipitation Difference (2070:2099-1961-1990)mm

Hadley -B2 Spring Precipitation Difference (2070:2099-1961-1990)mm

Hadley -B2 Summer Precipitation Difference (2070:2099-1961-1990)mm

Hadley -B2 Autumn Precipitation Difference (2070:2099-1961-1990)mm

Hadley -B2 Annual Precipitation Difference (2070:2099-1961-1990)mm

Figure (34): Seasonal precipitation changes for B2 scenario – Hadley Model-CM3

4. Assessment and Adaptation

4.1 Installations a Climate Change Information Center

Appropriate information of sufficient quality and comprehensives is essential for adequately completing a (GHG) inventory, vulnerability assessment, and mitigation analysis. At present information needed for these types of assessments are distributed among several different

Local agencies and is often difficult to acquire. A climate change information center would help to address informational challenges by centralizing key data in one place and under the oversight of the Executive Committee. Once established, the center would establish mechanisms for

- Data collection and reporting
- Training on methods and techniques of data collection
- Reporting and management, research to fill data gaps.
- The integration of climate change data needs into the normal reporting systems for relevant institutions.

The creation and maintenance of a well designed web-based information center should greatly facilitate access to climate change data.

4.2. Research Gaps and Needs

Despite the efforts and projects which have taken place in Syria in the field of Climate Change, there are still a lot of research gaps and needs that ought to be covered in the near future. Climate research needs to address three main issues:

- The science of climate.
- The likely impacts of climate changes.
- The policy mitigation and adaptation measures to be implemented.

Consequently, research gaps may be classified into the following main areas:

4.2.1. Research Related to the Science of Climate:

There is a need to upgrade Syrian capacity to better understand climate change and the exact nature of its impact through a dedicated programmer of scientific research aiming at the development of a regional Climate Change model.

4.2.1.1. Remote Sensing Sector:

Identified the following needs in the area of climate change:

- Up to date hardware and software.
- Capacity building in the field of modeling and prediction.
- Development of a common database on climate patterns.

4.2.2. The Meteorological Sector.

The Syrian Meteorological Department needs the following areas of research as its priorities:

- Global Climate Observing System.

- Global Terrestrial Observing System.
- Global Oceanographic Observing System.

Moreover, the Syrian Meteorological Department needs capacity building that Involves staff training on the use of satellites monitoring equipment, and networking With national and international universities, and the World Meteorological Organization (WMO).

4.2.3 Research Related to the Likely Impacts of Climate Change:

Although several studies had been conducted to assess the negative impact of Climate Change; there is a great need for further understanding of its likely impacts on Specific sectors in Syria.

- ✓ **Integrated Research:** Most of Climate Change assessment studies were one-dimensional and sectored; hence there is a great need for integrated research that assesses the average climate change Impact on the coastal zone, on water resources and human health.

4.3. Impact of Climate Change on Water Resources:

Both the General Environment Affairs and Climate Change Research, and the National Water Research Center, ***must start to the following issues as research Priorities:***

- ✓ Identification and assessment of various hydrologic, physical, Environmental, economical and social elements those are sensitive to climate change in the Water basins and evaluate their variation Over time.
- ✓ Simulating the impacts of climate change scenarios on the All River flow.
- ✓ Assessing quantitatively the water-related resource impacts in the water supply Al l basins.
- ✓ Identification of potential adjustments and adaptation measures to climate change.

Water Research needs

- Development of regional climate models for the Water basins.
- Link climate change models to hydrological models.
- Establish a local and regional climate and environmental network to:
  - Enable data collection, monitoring and assessing climate changes.
  - Likely impacts within Syria and in the neighbor's basin countries.

- Establish database for the data of the climatologically data including:
  - Rainfall, temperature, evaporation, and the evaporative demand of Crops.

- Examining regional circulation models for potential use.
- Study and assess sea water intrusion and the change of water quality in the shallow aquifers in the coastal areas.
- Encourage academic and on the job training of the subject and Provide the necessary professional assistance through technical, local and foreign consultants, short courses, seminars and workshops.

4.4. Water Resource Sector:

In order to develop adaptation and mitigation measures for the resource system, suggest the following proposals:

- ***Climatic Change Impacts on Water Resources Vulnerability Assessment***: The Main objective of this proposal is to establish and to strengthen technology Transfer and human resources development on climate change issues. Activities of The project include establishment of specialized computer centers, water quality Monitoring labs and equipment, and libraries, in addition to organization of Workshops and both long term and short term training on state of the art Technology and approaches related to climate change and water resources Vulnerability assessment.
- ***Technology Transfer of Monitoring and Evaluating the Global Sea Level Rise to the Coastal Research Institute:*** The main objective of the proposed Project is to upgrade the capabilities of the Coastal Research Institute through Technology transfer to meet the challenges imposed by the global rise in sea level. In this respect, advanced instrumentation for recording the phenomenon is Essential, as well as, up-to-date techniques for estimating the long-term relative, +4And absolute sea level changes and also predicting their impacts on the entire Region.

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