



The Research and Policy Forum on Climate Change and Environment in the Arab World

at the

Issam Fares Institute for Public Policy and International Affairs, AUB

presents

***"Climate Change, Water and the Policy-Making Process
in the Levant and North Africa"***

A closed workshop with leading water experts from the Levant

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I - Context;

I-1 : General overview ;

Syria occupies the Eastern coast of the Mediterranean sea. The surface area of the country is about 185.518 Km² of which 32.2% is arable land (six million ha.), and 45% steppe and pasture lands. The country is divided into 14 governorates with a total population in 2007 of about 20.7 million (Fig. 1).

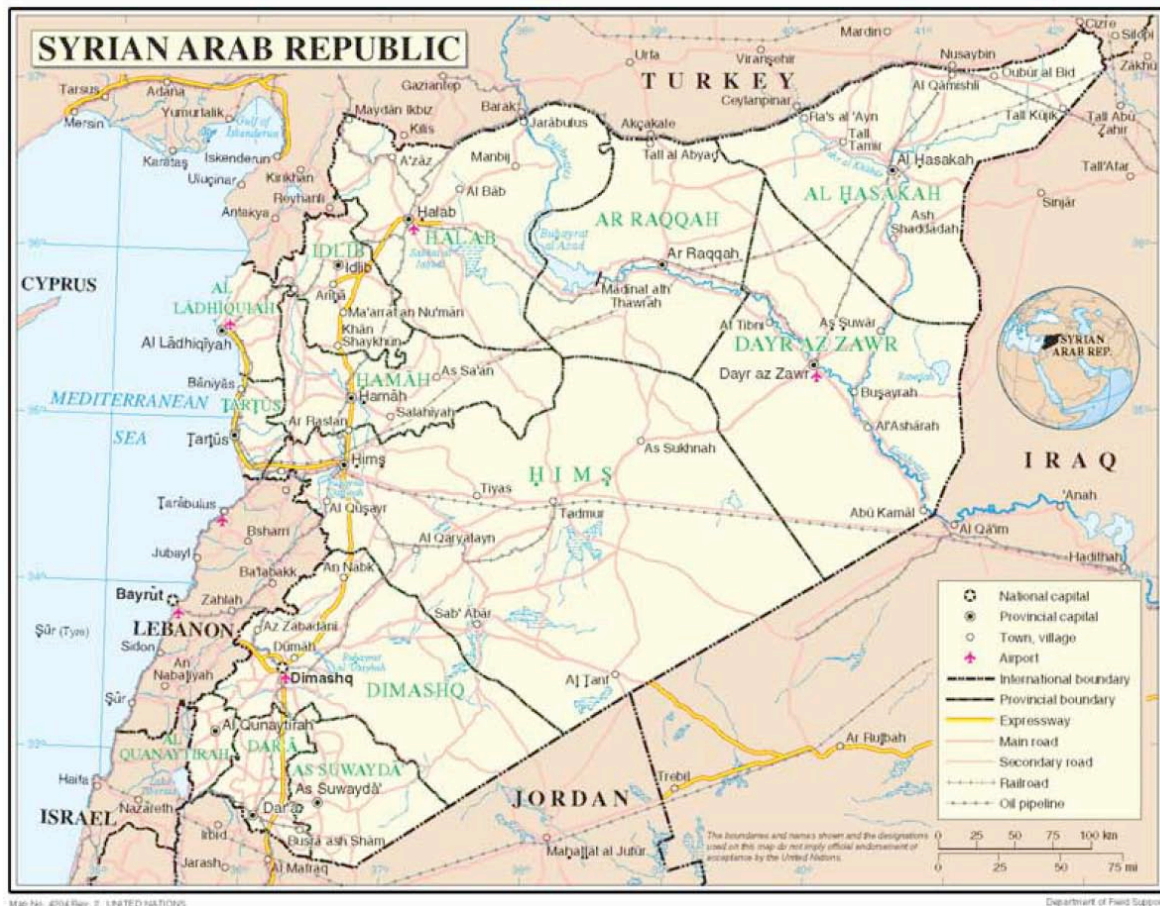


Fig. 1 : General map of Syria (Ref; UN drought Appeal report 2008)

The annual growth rate has decreased from 3.35% in the 1970s to about less than 3% during the last five years (Fig.2). The population density has increased from 34 inhabitant in km² in 1970 to about 102 in 2007 (Fig. 3).The percentage of urban population has increased very fast from about 43.5 in the seventies to about 53.5 in 2007 (Initial national communication report, 2009).

With a general population of 20.7 million inhabitants, the total rural population in 2006 was estimated at 8.808 millions (42.5%). Rural population, especially in the north and north-eastern region, are among the poorest in Syria. According to UNDP report on poverty in Syria, 2005, in 2003-2004, almost two million individuals in Syria (11.4% of the population) could not obtain their basic life needs. The north eastern region, (both rural and urban, has the greatest incidence, depth and severity of poverty (UN Drought appeal report 2008).

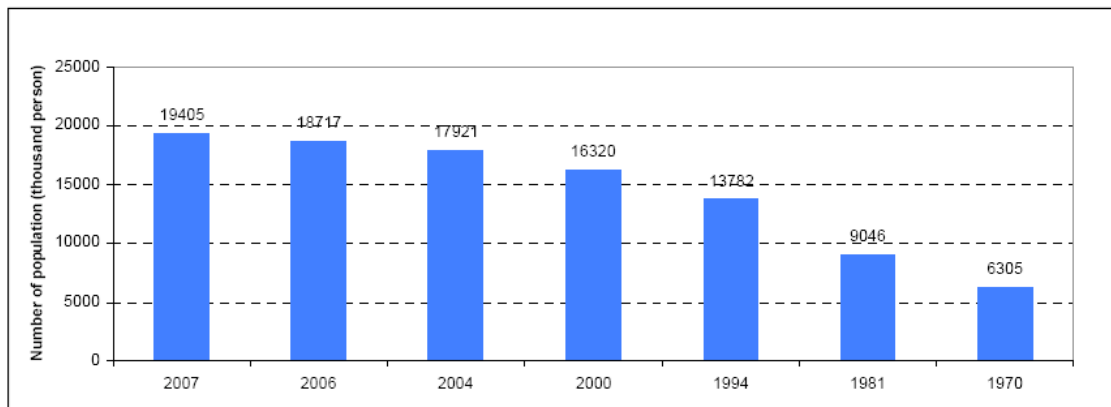


Fig. 2 : Population growth rate development between 1970 -2007 in thousand persons . (Ref. Syria initial national communication to UNFCCC 2009)

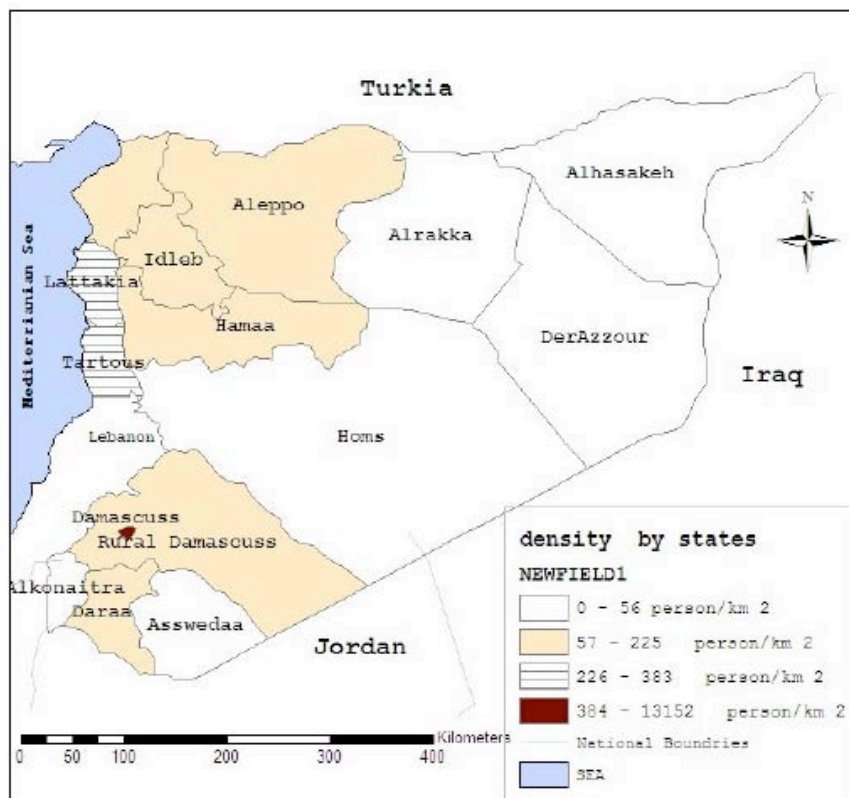


Fig. 3 : Density of population in different governorate(Ref. Syria initial national communication to UNFCCC, 2009).

The pastures and grass land constitute the main part of Syrian territory .45% of the country can be considered as pastures ,32% fertile lands ,20% arid lands and 3% as forest (Syria initial national communication to UNFCCC, 2009).

The irrigated area represents only 21.6% of the arable land (1.3million ha), while the rest depends purely on rainfall .In recent years, agricultural production has contributed over 26% of the gross domestic product (GDP).

Crop	Cultivated area ('000 ha)		Yield (kg/ha)		2007yield as % of 2006 value	Production		2007 production as % of 2006 value
	10-year average	2007/ 2008	10-year average	2007/ 2008		10-year average	2007/ 2008	
Wheat	1,744	1,486	2,373	1,440	60.7	4,151	2,140	51.6
Barley	1,356	1,433	666	182	27.3	786	261	33.2
Lentil	136	136	947	251	26.5	130	34	26.2
Chickpea	87	76	723	367	50.8	63	28	44.4

Table 1; Crop production ,cultivated area and yield for the ten year average and for the 2007 / 2008 cropping season (UN drought Appeal report 2008).

I-2 Syrian Climate;

Syria is considered as an arid to semi arid country .Two third of its area is considered as arid to very arid (Fig. 4) .

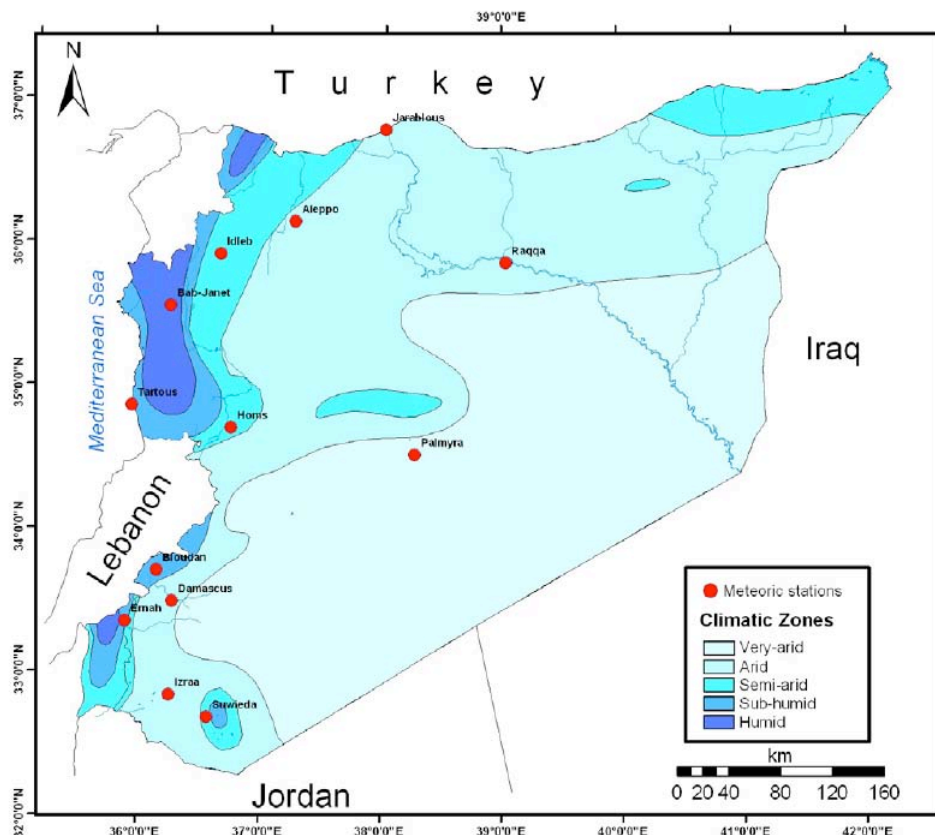


Fig. 4 : Climatic zones of Syria

The climate of Syria is of Mediterranean type with continental influence, i.e. cool wet winter and warm dry summer, with relatively short spring and autumn seasons. The Mountainous area along the coast and at the borders between Lebanon and Syria (Anti-Lebanon Mountains) has a direct impact on rainfall distribution,. These mountains constitute a barrier preventing wet depressions from the Mediterranean sea to arrive to the interior lands. So most of the rain falls along the coast and on the top of these mountains. Only the deep and strong depressions cross the mountainous and arrive to the interior plains of Syria. Accordingly, the highest precipitation is along the coastal lands and decreases towards the east (Fig.5).

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).The climate in Syria is often subject to high variability due to the influence of different air mass circulation .

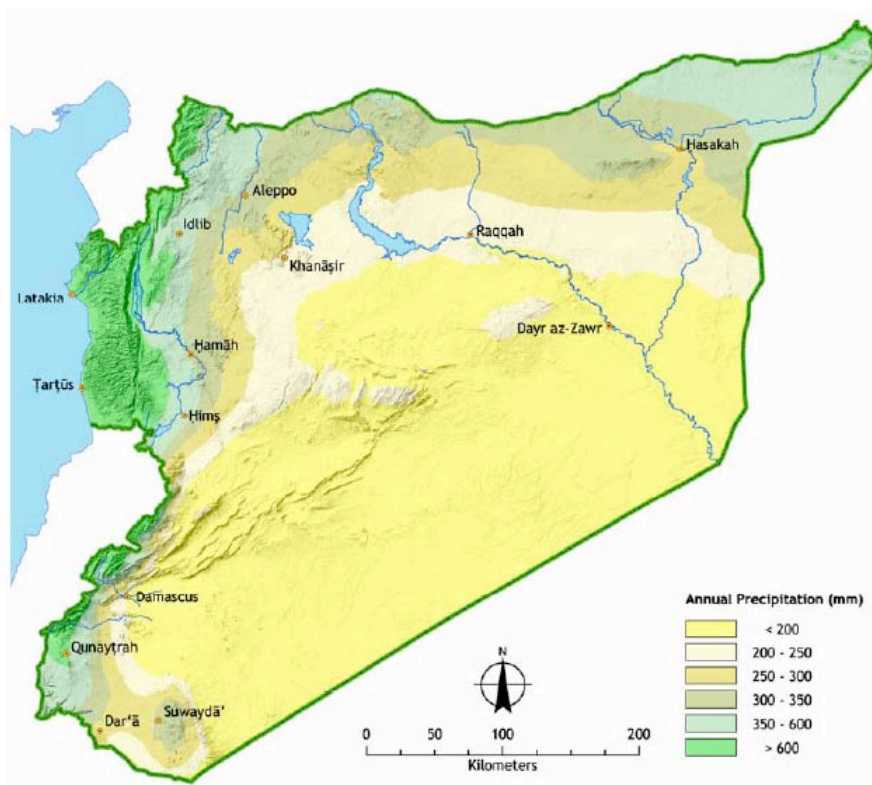


Fig. 5 : Average annual precipitation distribution in Syria (Meslmani , 2008)

II - Evidences of Climate change;

The Intergovernmental Panel on Climate Changes (IPCC) is one of the most renowned publishers of internationally acclaimed research on global climate change. Its recent Technical Paper on Climate Change and Water (IPCC Working Group II, 2008) outlines some general statements that are relevant for the Middle East region – such as, “many semi-arid and arid areas (for example, the Mediterranean basin) are particularly exposed to the impacts of climate change and are projected to suffer a decrease of water resources due to climate change (high confidence)”.

Middle East being the world’s most water-stressed region, climate change – which is projected to cause sea-level rise, more extreme weather events such as droughts and floods, and less precipitation – will contribute to even greater water stress in the region.

Alpert et al. (2008) analyzed the results of regional climate modelling of the Eastern Mediterranean region, and found:

- that the average temperature over the Mediterranean area has increased by 1.5–4 °C in the last 100 years.
- Precipitation over most of the Mediterranean shows a dominant negative trend in the last 50 years.
- There is a tendency toward extreme events.
- A trend towards drier as well as wetter years in the future.

The drought events also expected to increase. Weib et al., 2007¹ found that future climate predictions in the Middle East for the next 100 years foresee droughts that are 10 times more frequent.

Within the framework of the first national communication report in Syria to UNFFCCC (2009), two parameters have been selected to assess climate variation trend in the country , precipitation and air temperature . It was found that for the period of the study 1955 -2006 , there was some indication about a certain variability or shifting for both parameters. Generally speaking, Mann-Kendall trend test showed a coherent area of significant change in precipitation of both winter and autumn seasons. Winter precipitation in northern and north eastern zones of Syria showed a sign of decrease for the last five decades (Fig. 6(. For surface air temperature, the result of Mann-Kendall trend analysis showed a widespread increase in summer temperature in all stations in the country with prominent increase in coastal and western regions (Fig. 7(.

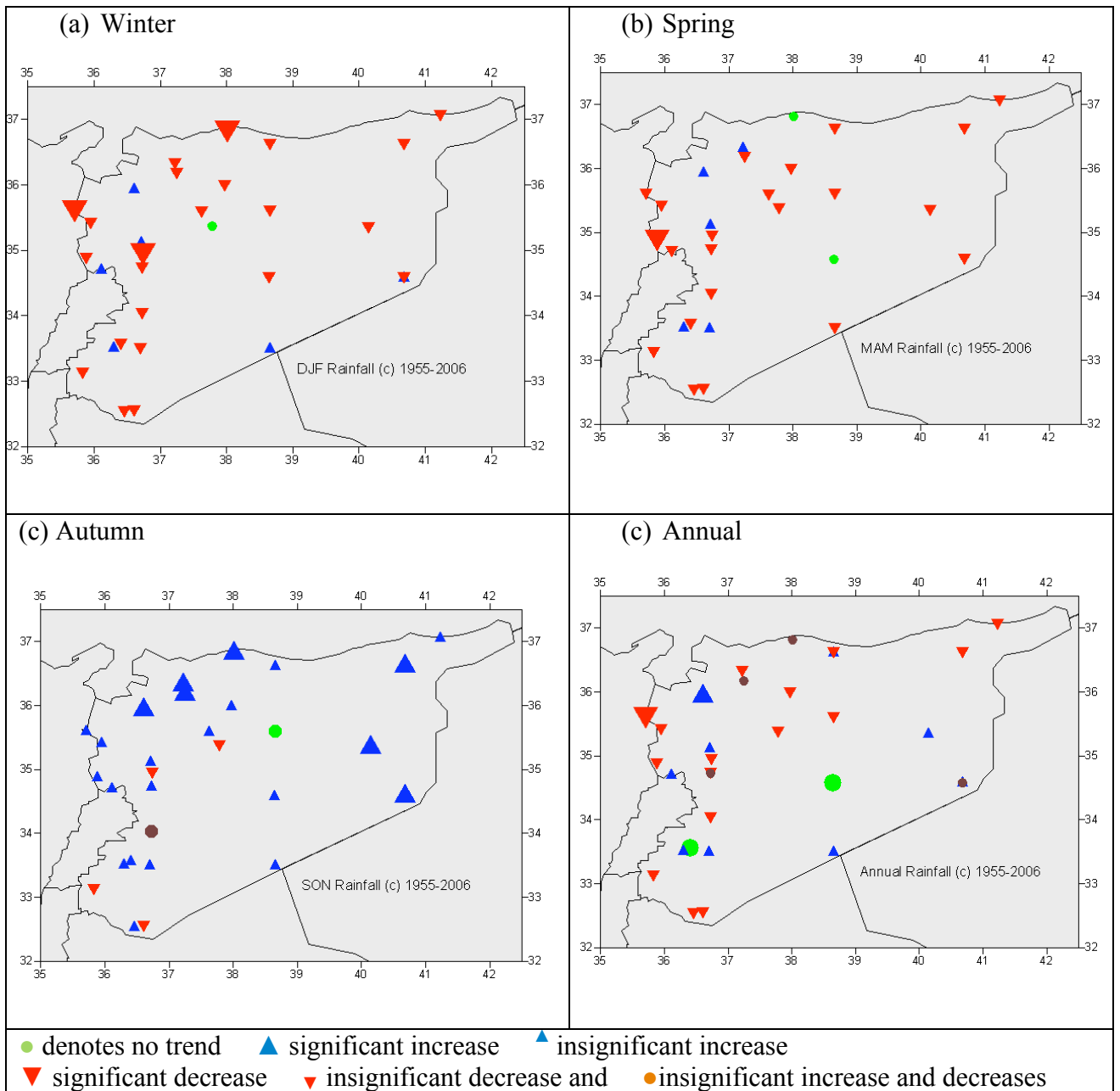


Fig.6. Seasonal and Annual Precipitation Trends for the period 1955-2006

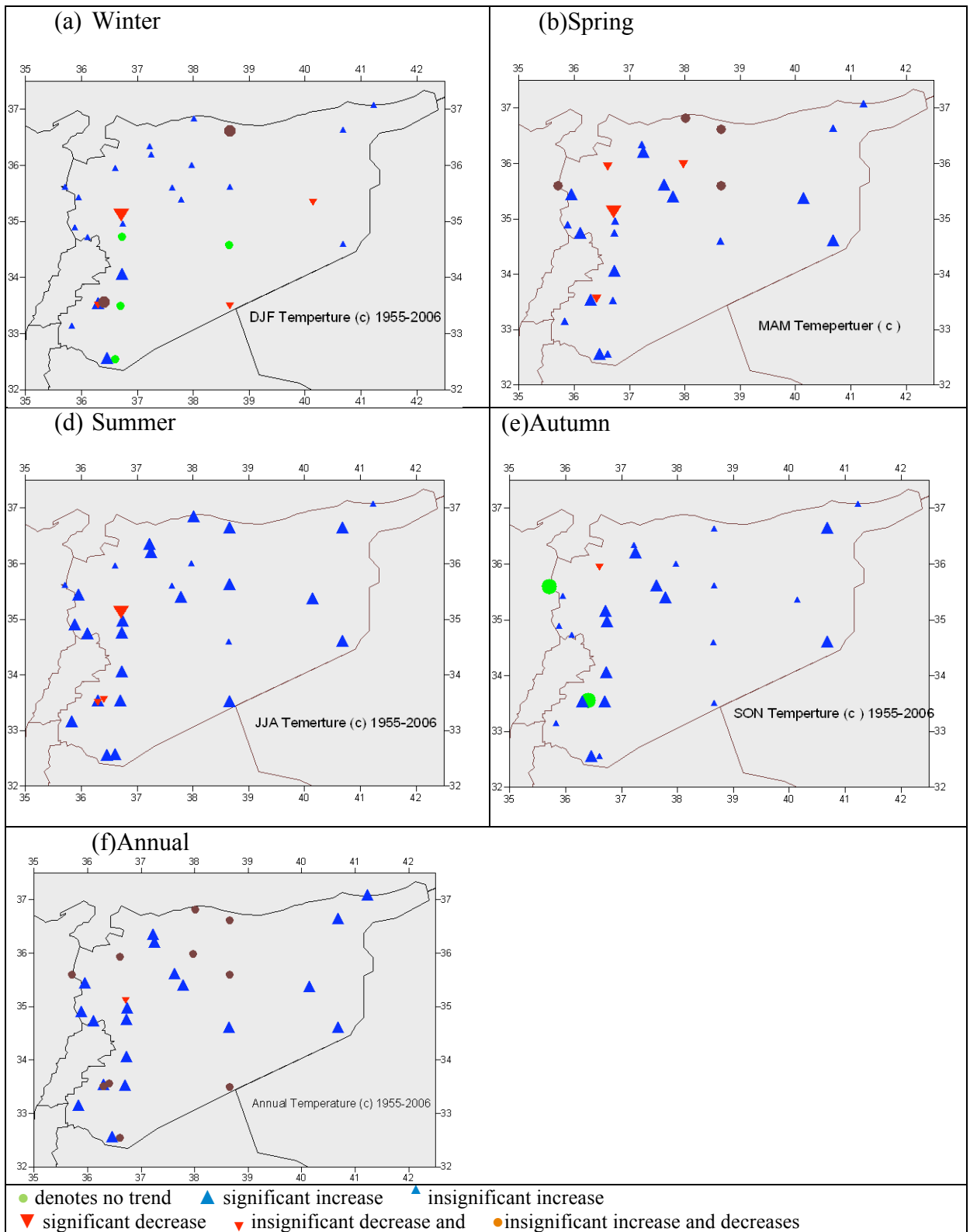


Fig .7. Annual Temperature Trends for the period 1955-2006

The analysis of temperature indices of extreme events showed significant increase trends (e.g. annual daily maximum and minimum temperature) while The analysis of precipitation indices of extreme events showed a decrease

(e.g. number of days with precipitation over 25 mm ,average precipitation intensity ,max precipitation) .

Within the same report 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 using GCM run data stored in IPCC Data Centre (Mawed et al, 2008). These changes are presented in table2 and 3 , for temperature and precipitation respectively. The spatial variation in the temperature and precipitation are plotted on the map (Fig. 8 ,9 .)

The results of A2 scenario indicated that the annual precipitation is expected to decrease by 6- 34 mm over the country with more sever decrease expected over the northern east fertile crescent. The same trend was observed also for temperature spatial change with a maximum expected increase in temperature reach 3.8 degree at 2099.

Table 2 :Seasonal and Annual Dry air temperature variation for the years 2039, 2069 and 2099 with respect to normal average 1961-1990 from the model HADCM3 according to A2 Scenario

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

Table 3 : Seasonal and Annual Precipitation variation for the years 2039-2069-2099 with respect to normal average 1961-1990 from the model HADCM3 according to A2 Scenario

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

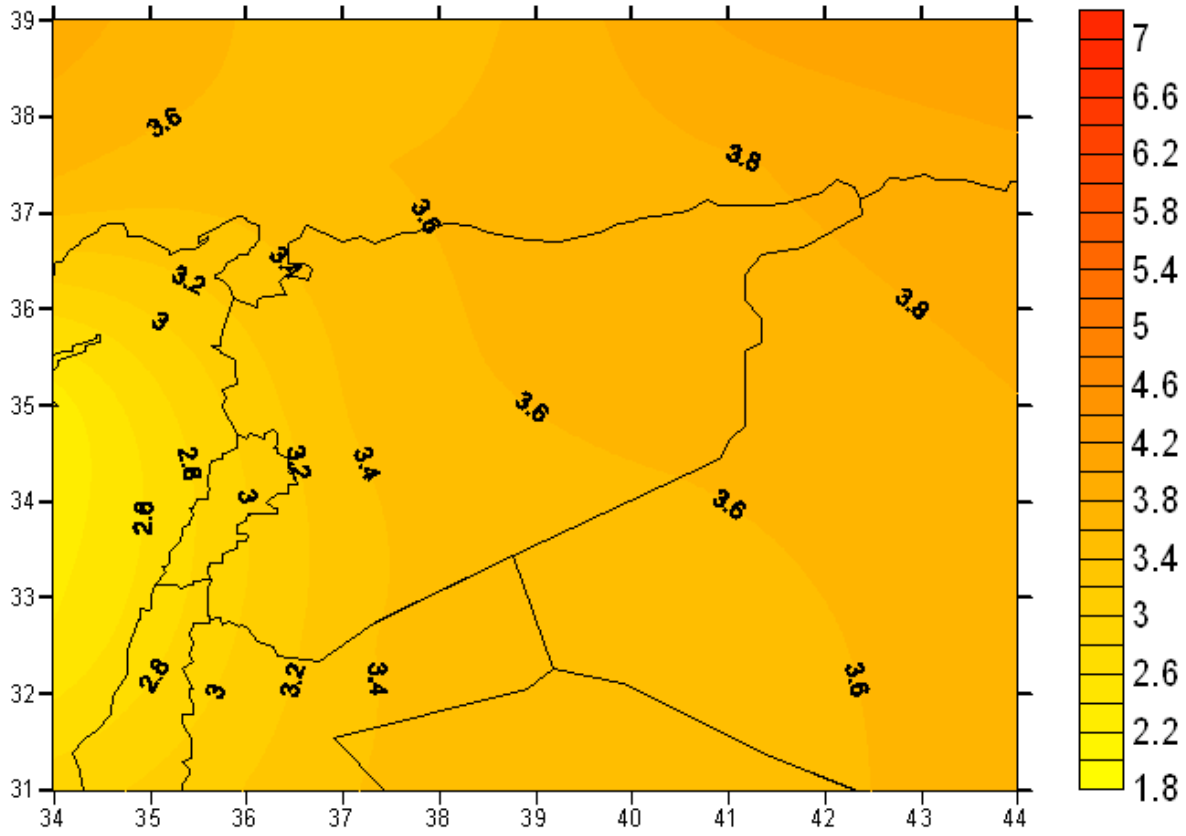


Fig. 8 : Annual temperature difference (2039-2069-2099) (Syrian first national communication to UNFFCCC (2009) .

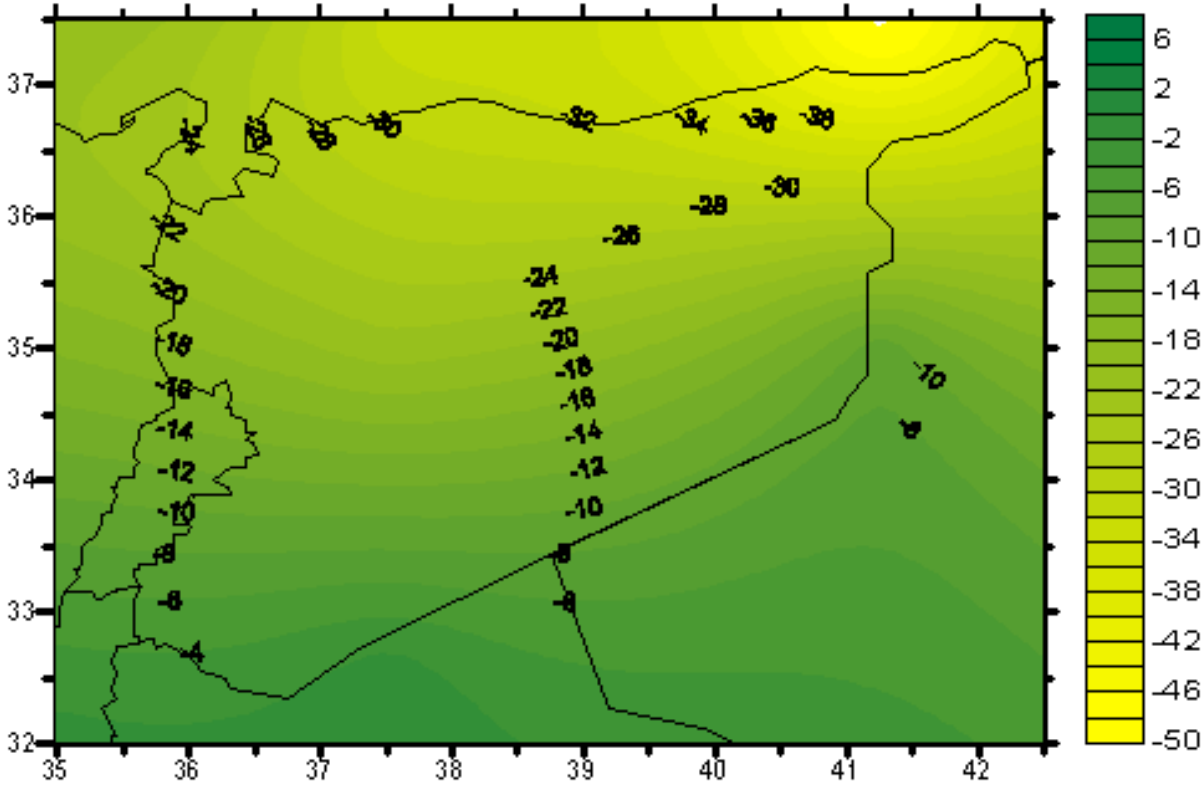


Fig. 9: Annual precipitation changes for 2010 -2039 (Syrian first national communication to UNFFCCC (2009) .

III- Climate change impacts ;

The assessment of the of climate change impacts are usually of broad nature and requires details and comprehensive survey .In this study we will focus on the main sectors which are the more vulnerable to climate change in Syria , water and agriculture .

As previously described ,Syria is considered as an agriculture country where about 45 % of the population live in the rural area and for which this sector is contributing 26% of the gross domestic product (GDP)..So any change in precipitation, change in surface air temperature ,frequency of droughts or intensity of precipitation will have a direct impacts on the country .

III-1 : Climate change Impacts on water resources ;

1- Available water resources in Syria :

Water resources in Syria are under a heavy and increasing stress. Any alteration in climatic patterns that would increase temperatures and reduce rainfall would greatly exacerbate existing difficulties. These changes in climate will be amplified in the water environment.

Syria is divided into seven hydrological basins (Fig.10). The main water user is the agricultural sector which consumes from 94% (Tigris & Khabour basin) to 71% (Barada & Awaj basin) (Fig11).



Fig.10: Hydrological basins of Syria.

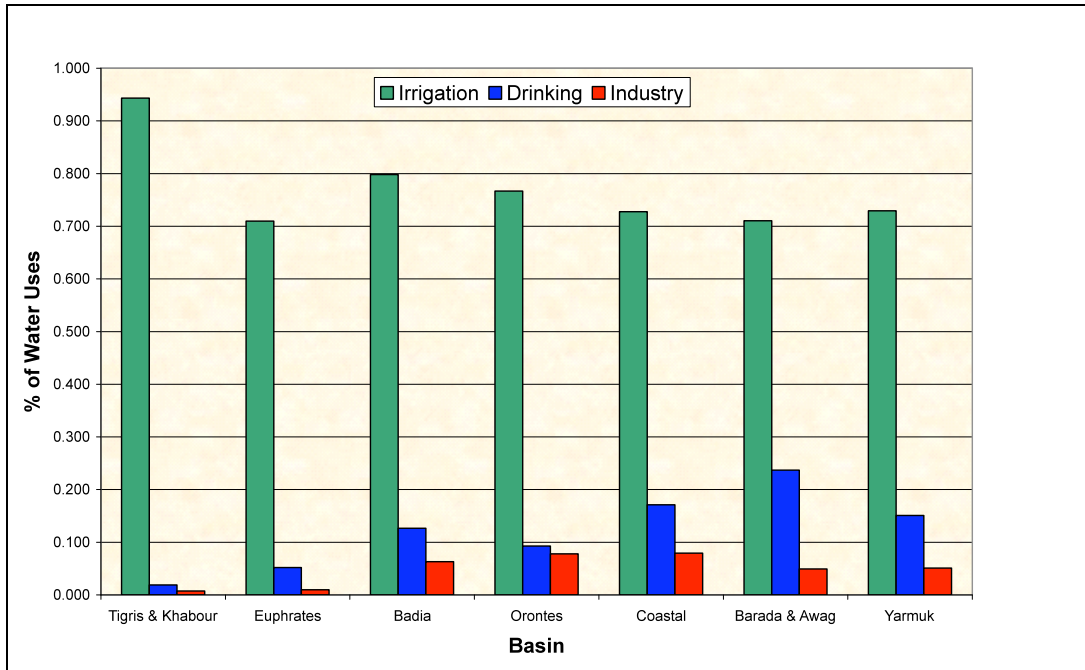


Fig. 11: Proportionality of water usages among different sectors (Kayal, 2006).

The available water resources of the country is estimated around 15200 Mm³/y, about 2000 Mm³/y can be added from treated sewage water and irrigation drainage, which make the total water resources around 17200 Mm³/y. This means that the per capita available water resources is about 860m³/y which is below the international water poverty standard of 1000 cubic meters. However, most of the basins suffer from water shortage and the situation expected to worsen in 2026 due to growth of demands with the exception of Coastal basin which has a positive water balance. The average overall water deficit of Syria (Kayal, 2006) from 1995-2005 was (651) Mm³/y and is expected to increase to (2077) Mm³/y in 2026-2027 due only to population and development growth. (Fig.,12) .

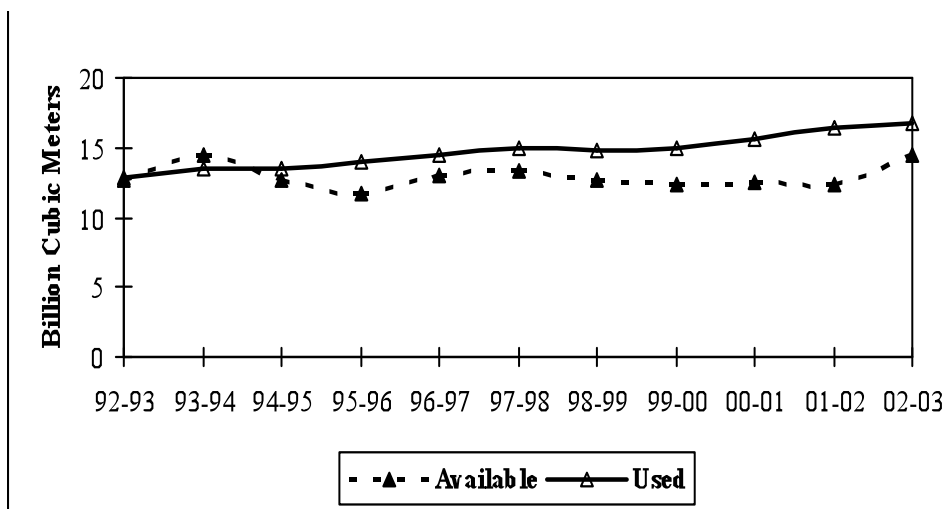


Fig.12 : Water resources availability and water use in Syria (MAAR –IFAD 2004)

Syria is depending in more than 75% of the total water resources on five main rivers shared between neighboring countries (Euphrates ,Tigris ,Yarmok ,Orontes and Nahr El Kabir Janobi) There are only one official agreement regarding Orontes basin (between Lebanon and Syria) .

For Euphrates there is a protocol of under standing between Turkey and Syria for delivering 500m³/s/day of which 52% is delivered to Iraq after the official agreement signed between both countries .For Yarmok and Nahr El Kabir Janobi and Tigris nothing up to now is done .Even for Euphrates the protocol is not officially adopted by the Turkish government and the Parliament ,so it could not be considered as a final agreement .

In case of climate changes impacts , challenges in managing these shared water will be increased and may cause conflict .In that context and since climate change induced water scarcity increases, frequent drought occurrence and increasing in temperature and consequently increasing in water demand , the access to adequate water supplies in different countries sharing these rivers would increase .Climate change preparedness urge the concerned countries for finalizing the agreement regarding the sharing of these rivers and becomes a vital component as a national integrated water resources management .

2- Assessment of climate change impact on Surface water (case Study: Euphrates River)

Syria has about 16 rivers and tributaries flowing in the country , five of which are shared with other countries and constitute about 75 % of the total surface water resources of the country which is estimated at 10923 Mm³/ y which shows the necessity of an improved transboundary water agreements that take climate change into account, in order to avoid conflicts e.g. due to increasingly frequency and severity of droughts.

Syria obtains 36% of its renewable annual resources from the Euphrates. The Euphrates River basin has a north-to-south precipitation gradient with humid highlands in the north and the arid plain of Mesopotamia in the south. In the highlands, precipitation is over 1,200 mm/year- and in the south the annual average rainfall is about 100mm (Zaitchik et. al, 2005) In portions of the Euphrates basin that are marginal for dryland production, the difference of one or two rain events can mean the difference between crop success and crop failure.

The model-derived climate sensitivity of the Euphrates, Upper Tigris and Greater Zab river discharges (Smith et al. 2000) shows that for Euphrates River, an increase or decrease in precipitation by 25% raises or lowers the discharge profile while keeping its shape unchanged. The annual discharge rises to 40655 M cm or drops to 15751 M cm /y compared to the reference value of 27048 M cm. This is a 50% rise and a 42% drop, nearly twice the imposed percentage change in precipitation. Knowing that regional modeling studies expected a reduction of rainfall in mid 21st century (Evans, 2008) around 40-50 mm in the upper Euphrates and Tigris basin (Fig.13) which is

about 7% of average rainfall, it is expected to have about 11% drop in Euphrates river discharge.

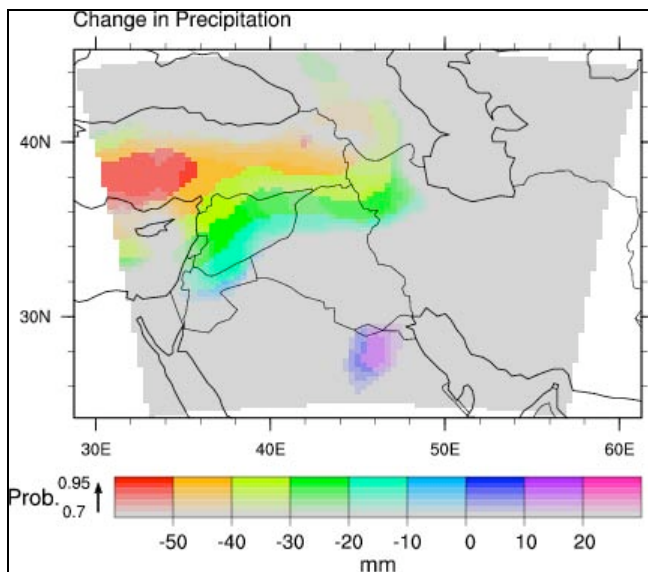


Fig.13: Demonstrates an Evans plot of the change in precipitation by amount (hue) and significance (sat). The probability (significance) of the change is calculated as a t-test between the precipitation now and the precipitation simulated in mid 21st century (Evans, 2008)

Other studies (Lehner et al, 2001 and EEA, 2004) also expected around 10 to 25% reduction in river runoff in the upper Euphrates and Tigris basin (Fig.14) in 2070 versus 2000 which prove the previous argument.

Kitoh et al. (2008) present even more pessimistic results in their projections of rainfall and stream-flow in the 'Fertile Crescent' of the Middle East. They found that The annual discharge of the Euphrates River will decrease significantly (29%–73%), as will the stream-flow in the Jordan River. Thus countermeasures for water shortages will become much more difficult.

In other hand, an imposed change in temperature changes both the shape and magnitude of the Euphrates discharge. A 5 degree warming increases evapotranspiration thus lowering the discharge curve dramatically, dropping the annual discharge from 27048 M cm to 16329 M cm (~60%). The warming also eliminates the spring peak by preventing the over winter storage of water in the mountain snow pack (Smith et al. 2000)

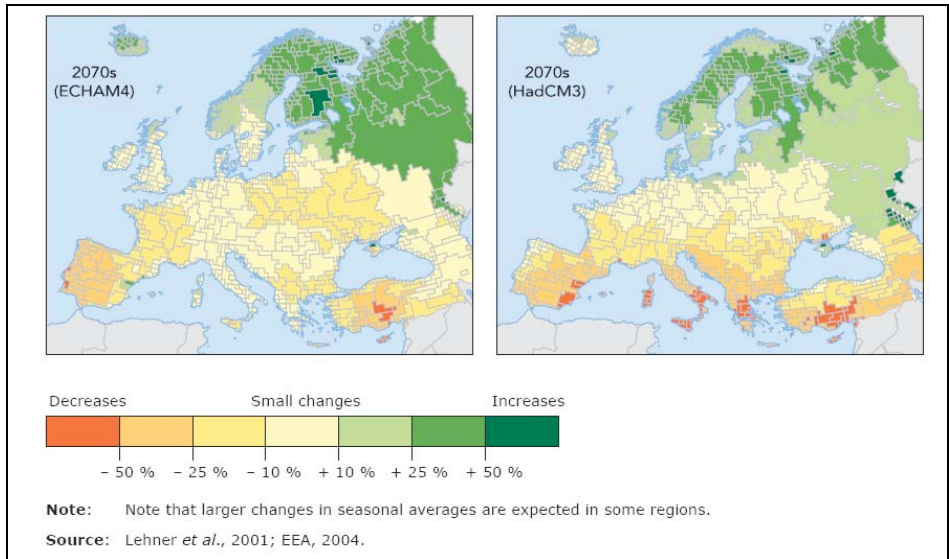


Fig. 14 : Change in average annual river run-off in Europe 2070 versus 2000

The climate change projection for Turkey (First national communication on climate change for republic of Turkey,2007) shows that major reduction changes in snow water equivalent may occur in the stream flow for the rivers basin in Turkey (including Euphrates and Tigris). The figures expected up to 100 mm reduction in snow water equivalent (Fig.15) at Euphrates upper stream (Onol, B. & Semazzi, F. 2006). This will lead to reduced flows in late summer when water is scarce and demand is greater. Similar sensitivities to temperature change are seen in the Upper Tigris. Also, reducing snow melt flowing through dams will decrease the potential of hydropower production .

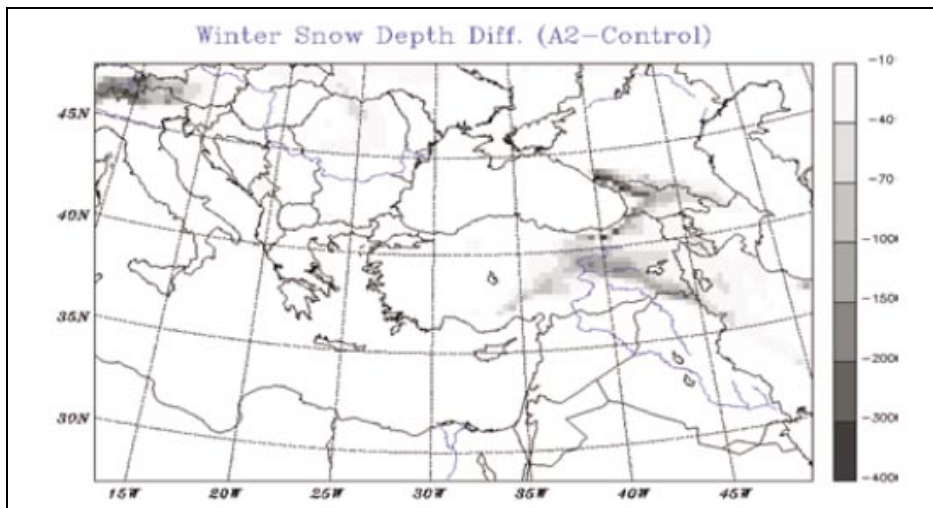


Fig.15: Climate change prediction for Turkey: Changes in snow water equivalent (in mm) affecting Euphrates and Tigris basins (Onol, B. & Semazzi, F. 2006).

These reductions in flow discharge will affect several sectors which rely on Euphrates river flow. The large irrigation projects on the river basin will be badly affected since it consumes the largest portion of the water (71%,

table1). Improving the irrigation efficiency is therefore very crucial to mitigate the impacts of climate change.

3- Assessment of climate change impact on Ground water

Groundwater is very important source of water in Syria. It's important increased considerably during drought events. The appraisal report of the Syrian North Eastern Region rural development Project (NORTH EASTERN REGION RURAL DEVELOPMENT PROJECT, 2007) showed that in year 2001 which come at the end of three successive drought years witnessed a 21% increase in the number of drilled well, equivalent to about 167000 wells, where only 42% of them are licensed. The overall water deficit in Syria showed a considerable increase in the percentage of used water to available water in the drought years (1999-2001) as it shown in table4. In year 2001-2002, the deficit was 16% more than the ten years (1992-2002) average value.

date	1992-1993	1993-1994	1994-1995	1995-1996	1996-1997	1997-1998	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	average
(consumed water/available water)%	101%	93%	107%	119%	111%	112%	116%	121%	124%	132%	115%	114%

Table4: percentage of consumed water to available water (Abed Rabouh, 2007)

Further decreases in groundwater levels are projected because of the lower recharge which is (partly) caused by a shorter length of the recharge season and the drop in water retention as snow. Recent studies (Döll and Flörke, 2005) projected a change of groundwater recharge between present-day (1961 to 1990) and the 2050s (2041 to 2070) to be more than -30% (Fig.16)

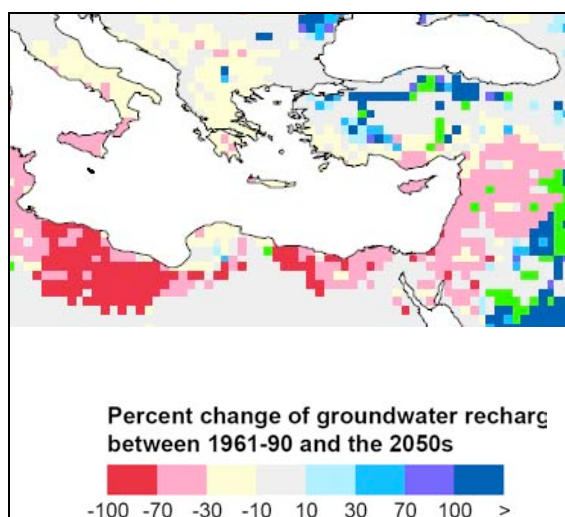


Fig16. Percentage changes of 30 year averages groundwater recharge between present-day (1961 to 1990) and the 2050s (2041 to 2070) (Döll and Flörke).

3-1 - Case Study:(Barada spring)

Most of springs in Syria are karst spring such as Fiegh, Barada, Sen, Ras EIEin and others. Modelling of such system is very complicated especially with the heterogeneity in karst and scarcity of data.

The karst spring of Barada constitutes an important resource for the drinking water supply of Damascus city (Fig 17). The study of this spring is essential for understanding the functioning of the aquifer, especially since pumping groundwater becomes very important with the growth of the population supplied primarily by the spring of Fiegh.

The hydrogeological conceptual model of Barada Spring is based on the recharge of the karstic system by rainfall and snow melting. The infiltrated water is divided in two parts: a flow through the conduits (fast flow) and a slow flow fed by groundwater stored in the epikarst, infiltration- and phreatic zones, and narrow karst features which delay the flow. Consequently, the conceptual model contains two reservoirs, one for the slow discharge corresponding to the low flow stage and one for fast flow mainly feeding the flood flow (Fig.18).

The infiltration water is shared between these two parts according to the sharing coefficients X_1 and X_2 allocated to each reservoir. The model is running using rainfall time series as the system input. The model will simulate the discharge time series and is well appropriated to model karst spring hydrograph.

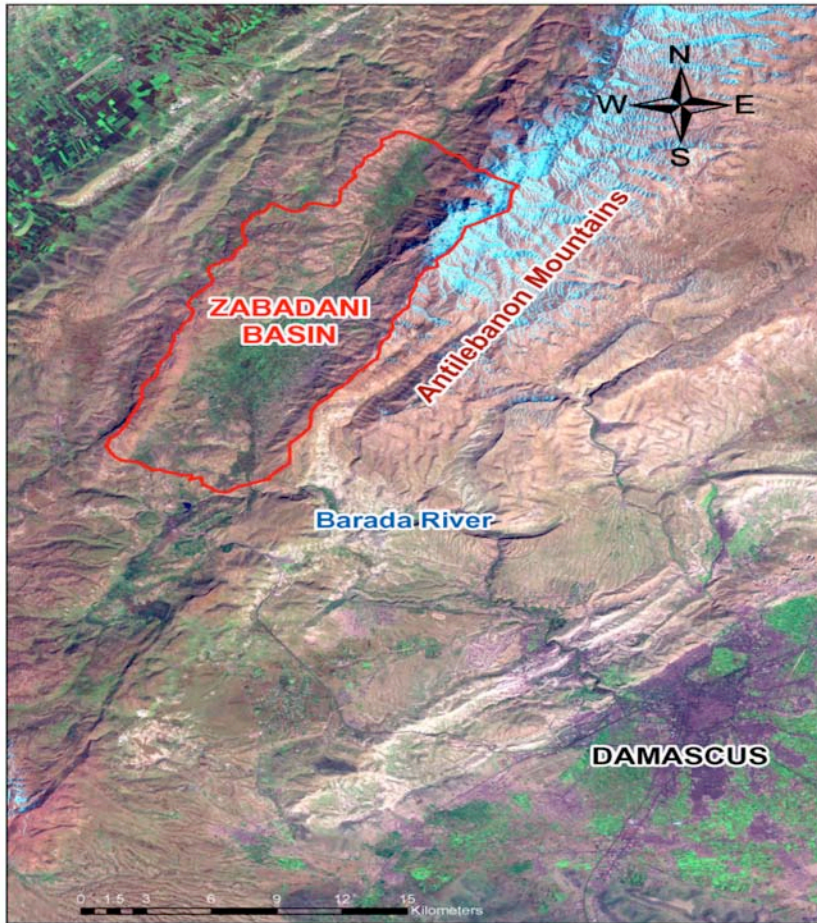


Fig.17 : Location of Barada Spring

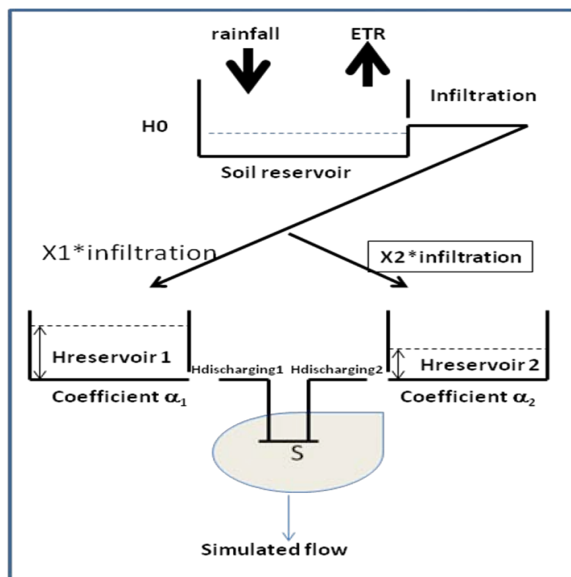


Fig. 18 : General structure of karst spring model.

The model (Streamflow simulator, 2007) developed by ACSAD and BGR of the Barada karst system was applied. The model had been calibrated according to the daily rainfall data (from 1985 to 2007) for four stations: Madaya, Zabadani, Serghaya and Bloudan, and flow rates of the spring. Two sets of parameters were obtained for the periods before and after the beginning of pumping respectively. The model gave very satisfying simulation results for the pumping period (Fig.19).

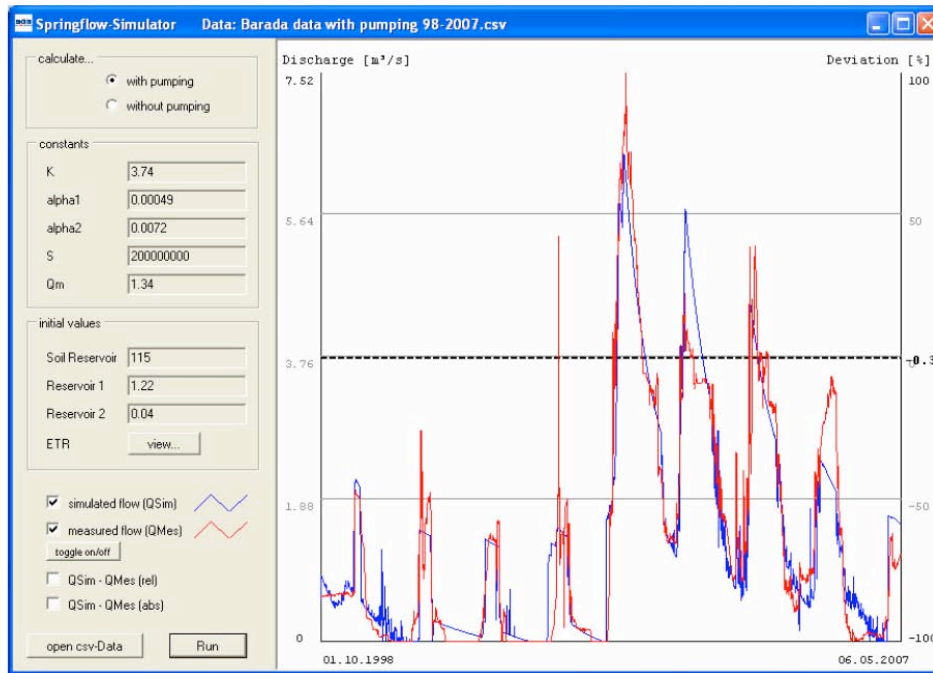


Fig. 19 : Calibrating results, Calculated (Blue) and measured (Red) values for Barada spring discharge. The values on the left bar are the calibrated parameters.

The model is used to predict the impact of climate change on Barada spring discharge. An annual decrease in rainfall of 5.1% at 2040 (according to the result of MRI-96 projection model for Syrgaya Station, national communication report in Syria to UNFFCCC 2009) accompanied with in the same annual pumping of 2007 was applied using the same pattern of rainfall of year 2006-2007. The model result is shown in figure 20, where the continuous decrease in spring discharge is clear. The low flow period of the spring disappears gradually and the spring discharges mainly in peak time. The model expected a decrease of 37% in annual discharge in 2093 (Fig.20).

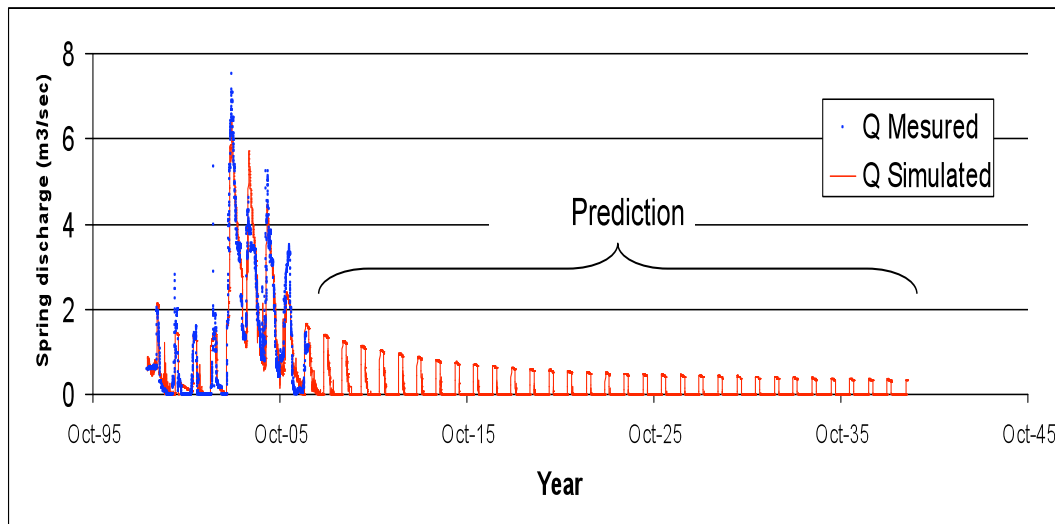


Fig. 20: Simulated spring discharge after 2007 according to the model assumptions (red line is the simulated result).

With Barada & Awaj basin having the highest proportion of drinking water (24%) among the other basin, the domestic sector will be the most vulnerable. Damascus city has done considerable improvement in its drinking water network and more work is planned for Damascus countryside. Groundwater quality is deteriorating in Damascus plain due to over-irrigation, over-fertigation, and pollution from domestic & industrial waste and adds more pressure on fresher water of Barada and Fiegh springs. Adequate conservation of groundwater is required by reducing irrigation from groundwater using treated water and improving irrigation efficiency. Protecting groundwater quality from all types of pollution (domestic, agriculture, and industrial) is also high priority.

Defining protection zones for the springs "especially those used for providing drinking water" is very important to preserve these fragile sources from different kind of pollution. The tendency to increase pumping from springs' adjacent areas to meet the increase in water demand should be guided according to detailed hydrogeological and environmental studies .

4- Gaps in knowledge regarding climate change :

- Several gaps in knowledge exist in terms of observations and research needs related to climate change and water. Observational data and data access are prerequisites for adaptive management, yet many observational networks are shrinking.
- There is a need to improve understanding and modeling of changes in climate related to the hydrological cycle at scales relevant to decision making.

- Information about the water-related impacts of climate change is incomplete, especially with respect to water quality, aquatic ecosystems, groundwater, including their socio-economic dimensions.
- need for down-scaling atmospheric models
- As climate changes evolve, national governments would have to operate under higher risks and uncertainties, although, governments are always making decisions in an area of relative risk and uncertainty. Awareness and understanding of climate change on national and international water resources is increasing, but no one really knows the magnitude and significance of the risks and uncertainties, especially where regional and basin-wide changes are taking place .

III-2 ; Climate change impacts on the agriculture sector ;

Syria's economy has traditionally been dominated by the agriculture sector which employs about 25-30% of the labor forces (national communication 2009) .Nearly 70 % of the cropped area (about 5.5Million h.) depends on rainfall and is considered as rain fed agriculture (Fig. 21, areas with rainfall less than 350 mm/y) and table 5 .The main cultivated crop in these areas are barely and wheat. Any change in rainfall pattern or temperature will have a direct impact on the productivity of rain fed areas and consequently on the economy of the country .

Therefore, Syria has placed great emphasis on developing and stabilizing agricultural production by expanding irrigation facilities, even that the climatic conditions are not very favorable for that .

A total area of 1.4 million hectare is under irrigation in Syria, according to official agricultural statistics for 2004. Sixty percent of this area is irrigated by 191 600 private wells.

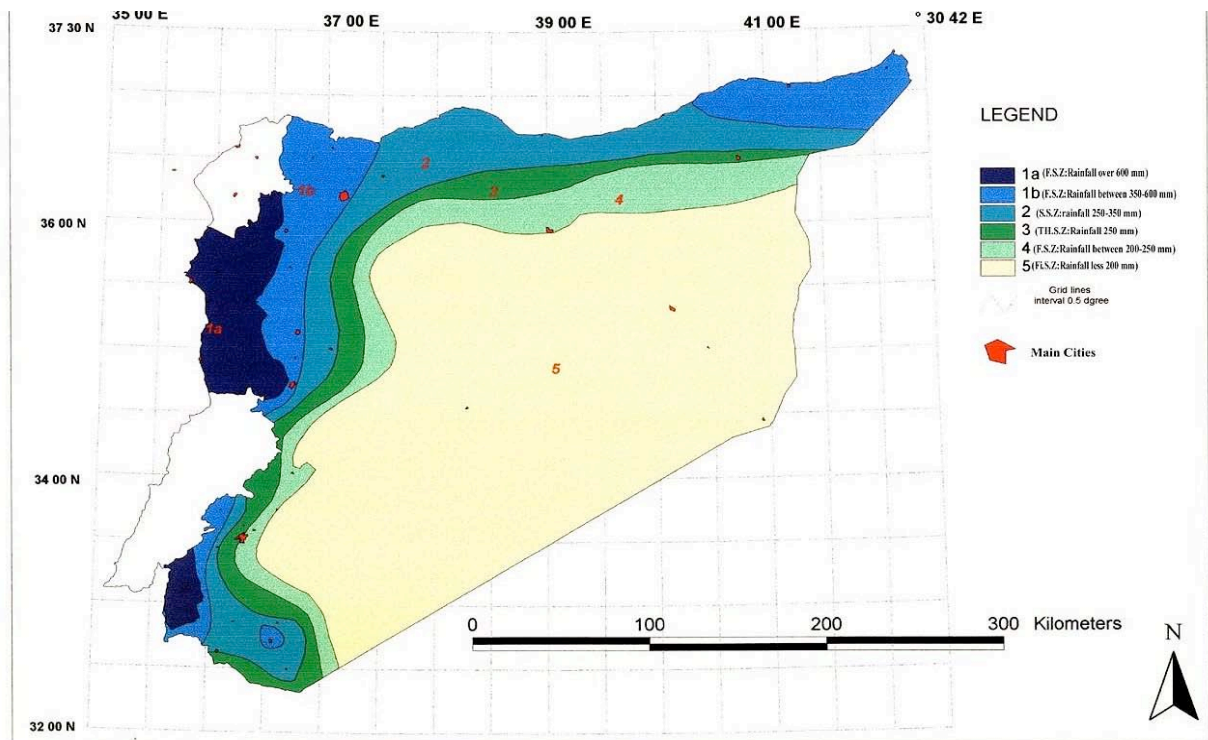


Fig. 22: Agro-climatic zones of Syria ,known as stabilization zones (FAO)

Table 5 : Classification of agro climatic zones (UNDP 2008).

Stabilisation zones	Annual rainfall (mm)	Area (hectares)	Cultivated plants	Percent of the total country area
1	Over 350	2,701,000		14.6
1a	Over 600		Field crops	
1b	350 – 600		Wheat, legumes and summer crops	
2	250 – 350	2,475,000	Barley, wheat, legumes and summer crops	13.3
3	250	1,303,000	Barley and legumes	7.1
4 (Marginal)	200 – 250	1,830,000	Barley	9.9
5 (Desert and steppe)	Less than 200	10,209,000	Prohibited cropping	55.1

Nearly about 58% of these wells are illegal (has increased from 25% in 1999) The remaining irrigated areas (40%) are irrigated from surface water resources and managed by both public (60%) and the private sector(40%), Overall, the irrigated areas have increased with an impressive average annual growth rate of nearly 10%, from 0.65 million h. in 1985 to 1.4 million h. in 2004 (about 26% of the cultivated area in Syria), mostly through expansion of groundwater irrigation (Fig.23) (official agricultural statistics for 2004)



Fig. 23; Trends in irrigation development in Syria (MAAR ,IFAD ,2004)

The expected increase in temperature and decrease in rainfall will have impact on crop water requirements ,crop water use efficiency, crop growing season and water availability .

As an example of the impact of climate change, is the drought that has affected the country during the year 2007 - 2008 where the wheat production has decreased by 78.9% in most of the areas and was close to null in rainfed areas (Fig. 24) . The average yield in irrigated areas fell by 31% due to the shortage of available water for irrigation (UNDP 2008) .

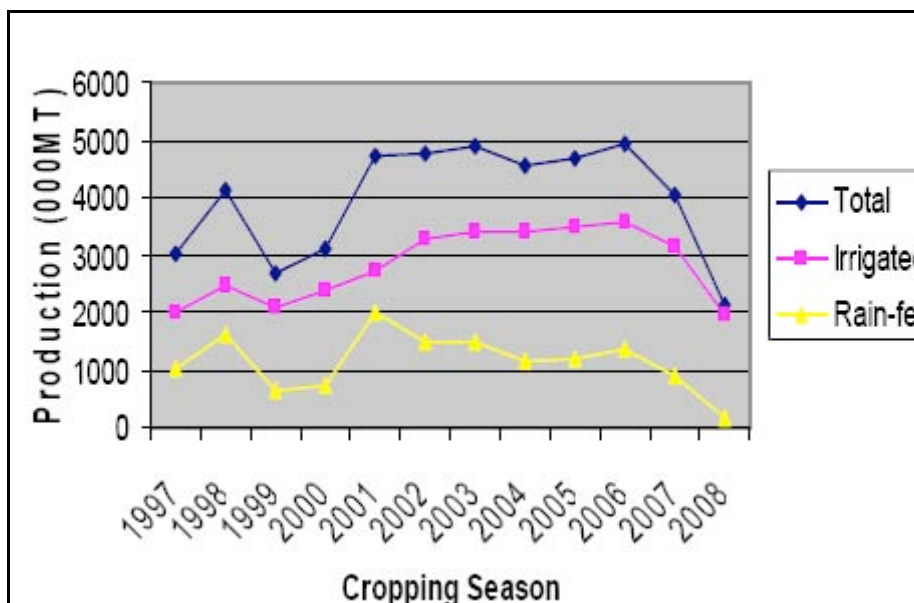


Fig. 24: Wheat production 1997 -2008 (UNDP 2008)

A study done within the Syrian initial national Communication to the UNFCCC (vulnerability assessment and adaptation report, 2009) using mathematical model to assess the impact of predicted climate change on wheat production. Wheat is considered as a strategic crop in the country (it occupies 34% of the cropped area in the country and where 55% of its production is coming from irrigated areas). The results have shown that the increase of temperature by about 1 degree and decrease in precipitation by 4-10 mm will lead to an increase of crop requirement from 563 to 617 mm .This means an increase by about 10% in water use .If no irrigation water is added this will lead to an decrease in productivity by 15.6% (from 3.5 to about 2.95 t /h). The same model has also been applied for rain fed wheat production and the results showed that the water requirement will increase by 10%.This means a loss of production by about 21%.

III-3 : Climate change impacts on Range lands :

Syria's range lands constitute about 55.1% of country area and known under the name of Badia . It is the area where about 20 Million of cheeps and about 26000 camels are breeding . It is by nature a very fragile eco -system and is facing various problem of land degradation ,desertification due overgrazing ,un-appropriate land use ,frequent drought and low forage productivity. It is expected that climate change will introduce new threats to herders and livestock owner and range land ecosystem .

IV- Institutions and researchers involved in climate change and related issues ;

Several institutions are involved in climatic related issues in Syria for which the role and responsibility are the following ;

IV-1 : Secretary of state for the environmental affaires : The ministry has a regulatory, coordination and research functions and is responsible for activities such as:

- (i) identification of the environmental problems facing the country
- (ii) stipulation of the environmental policy and preparing the necessary national strategy, action plans and programmes for implementation,
- (iii) enhancing public awareness on importance of environmental concerns and protection;
- (iv) research and scientific studies to mitigate the impacts of environmental problems ;

- (v) preparing draft laws, regulations and procedures for environmental protection and development, within the framework of the general policies of the Government;
- (vi) monitoring activities of private and public establishments to verify their conformity with the environmental standards and specifications.

The ministry is assuming responsibility of follow up all the international agreements regarding environmental issues including convention for combating desertification ,climate change , biodiversity.. etc . Regarding climate change issues, the Ministry is in charge of the preparation of Initial National Communication to UNFCCC. which is funded by GEF and UNDP and now under publication . Under the ministry there is the General commission for environmental affaires which is considered as the technical tool of the ministry and is in charge of the protection and conservation of the environment in the country (water ,chemical ,awareness ,biodiversity ,land .) . It is also in charge of the enforcement of environmental laws.

A center for environmental studies has been established within the ministry of environment to follow up the conditions of environment in the country (air and water pollution) and develop legislations. However, its contribution in scientific researches including climate change still limited .

IV-2 : Ministry of Irrigation (Mol): It has the overall responsibility for management of water resources in the country in terms of;

(a) Policy formulation and studies regarding the water resources development including water quantity and quality and water allocation among sectors,

(b) Collection of data, monitoring and issuing water permits both for surface and groundwater use ,

(c) Planning, construction, operation and maintenance of most of the hydraulic structures and facilities, such as dams, canals, and pumping stations.

In order to meet the future challenges in an era of water scarcity, Mol has gone through a major organizational restructuring. At the central level, Mol is responsible for policy decisions, planning and budgeting and operates through the General Commission of Water Resources (GCWR) which is a new body within the Mol . It has replaced the six General Directorates of the basins. A Directorate of Water Resources has been established within administrative boundary of each governorate, under the overall responsibility of GCWR and would work closely with the local authorities.

A water information center has been established ten years ago with the assistance of Japanese agency (JAICA) for collection ,analysing monitored data and submit reports to decision makers regarding the status of water resources in the country . However, the centre does not conduct any scientific researches neither for climate change nor other topics .

IV-3 :Ministry of Agriculture and Agrarian Reforms (MAAR): Has the responsibility for on-farm water management and basic extension and research services to farmers. The overall coordination between the MAAR and Mol is through the State Planning Commission (SPC). MAAR is also responsible for all development activities related to agriculture, livestock, forestry and fisheries.

MAAR operates through a number of sectoral directorates at the central and provincial levels . The agricultural researches are conducted by the General Commission for Scientific Agricultural Researches (GCSAR). The Directorate of Natural Resource Management (DNRM) at GCSAR is responsible for nation-wide research on crop water requirement, on-farm water management and irrigation technologies.

Within the ministry, the national centre for agriculture policies has been established in 2000 with the technical assistance from FAO and Italy for drawing agriculture policy and strategy. The objective is to assist the ministry in developing the agriculture policy for the country based on related data and information and to follow up drought events to define appropriate policy for mitigation .

A separate project for establishing an early warning system for drought has been implemented with the assistance of FAO (2004-2005) with the objectives of defining areas and population threaten by drought ,coordinate efforts for drought mitigation ,define indicators for drought monitoring , increasing awareness and capacity building of concerned institutions and staff .

IV-4 : General Directorate of Meteorology ;It has the responsibility of climate monitoring in the country through supervising many climatic stations distributed all over the country (30 SYNOP stations ,100 climate stations ,500 rainfall stations) .The collected climatic data is processed by their staff and made available to different users with a fixed prices for each of climatic parameters .Its main task is collecting of climate data without conducting any research or studies .This directorate is affiliated with the ministry of defense .

IV-5 ; Ministry of higher education and scientific research ;

The ministry is supervising the education of different public and private universities (in total 5 public and about 15 private) . A general commission for scientific research has recently been established within the framework of the ministry .It is charged to conduct research in different fields of applied science . Limited researches on climate change have been conducted by Public universities .Private universities share in researches is minimum since most of them have recently been established .

The Syrian prime minister issued a degree on 2007 to establish **the higher committee for water** which include seven ministers (minister of irrigation, local administrative, agriculture, Housing, interior, foreign affairs and industry) and headed by the PM. The tasks of the committee are to draw the national

water policy and strategy and approve of implementation procedures in addition to follow up the shared water resources subject.

Moreover, the Syrian parliament has two permanent committees one for Irrigation & agriculture and the other for environment to look after their relative issues

IV-6 : Other institutions involved in environmental issue including climate change ; The role of NGO's and other local associations is still very limited ..Most of these organizations are concerned with awareness raising in environmental issues ,such as pollution of rivers , cleaning of public gardens and natural parks ,air pollution and protection of old parts of the cities .They have organized general workshops on hot spot issues ,such as water crisis and climate change .

IV-7 : Regional and international organizations working in Syria ;

- **The Arab center for the studies of Arid Zones and Dry lands (ACSAD)** ; ACSAD is a regional organization working within the League of Arab states with the aim to ensure sustainable agriculture development in the Arab Region. ACSAD has initiated several activities concerned with climate change in Syria and the Arab region .A climate unite has been established to collect different climate data on selected station in the Arab countries .ACSAD is looking to develop its capacity for conducting research studies and applying simulation models for climate change and down scaling the global climate model to a the sub regional scale .

- **The International Center for Agriculture Research in Dry Areas (ICARDA)** : It is an international organization which affiliated with the CGIAR . ICARDA is conducting several projects in Middle East and Mid Asia regions in agriculture development, one of their project deals with drought monitoring .

JICA, GTZ, BGR, TNO are the main international organizations and institutes which working in the field of developing water sector in Syria.

As a conclusion of this paragraph ,we can say that researches on climate change are still very limited in the country ,and there is a need for more work to build up a strategy on how to deal with this issue .The projects which have been initiated by foreign funds such as the project on drought monitoring faced difficulties after ending the project.

Most of the governmental bodies and concerned institutions deal with climate change as a subject of less importance regarding other day to day issues, More studies and researches are required especially from ministry of agriculture and ministry of irrigation to develop adequate strategy for mitigation of climate change impacts and adaptation .

V ;Analysis of the current status of climate change in research programs

V- 1 : Governmental policies ,

As it was described in the previous paragraphs , it is clear that climate change is inadequately included in research programs in different concerned national institutions .However, some of the actions and studies have been undertaken by different institutions and governmental agencies in the context of environment conservation(water ,agriculture ,desertification, range land degradation) which can be considered as a mitigation policies for climate change .

The water sector is already under stress in the country due to limited available water resources, frequent drought, high water demand due to high population growth rate and prevailing agriculture policy. A new water policy has been adopted by the ministry of irrigation based mainly on water demand management rather on water supply management This means increasing productivity and reducing unproductive losses (mainly in irrigation).It is now approved that there will not be any extension in irrigated areas up to the year 2027. The water allocated for agriculture sector will be maintained at a certain volume and the efforts would focus on vertical development of this sector by changing crop pattern ,introducing modern irrigation techniques reducing water loss and reallocating water to crops with higher economic value.

The national water strategies in Syria are articulated by the 5-Year Development Plan. The present Tenth Five-years Plan (2006 -2010) places special importance on water security as an essential ingredient of sustainable development. While water is utilized as a mean for ensuring food security, efforts will be made for its development, protection and rational use as a vital and strategic wealth. The Plan places emphasis on;

- (i) improving the efficiency of irrigated agriculture through rehabilitation and modernization of irrigation systems;
- (ii) optimal use of surface water resources, especially in the Euphrates and Tigris basins;
- (iii) improved groundwater management and effective control of irrational use of groundwater resources;
- (iv) protection of the environment through preventing pollution and treatment of sewage water.

The water strategy also includes a number of institutional measures to address challenges related to scarce water resources improvement and prevention of rapid deterioration of the water quality. These include: organizational restructuring, capacity building and strengthening capabilities of MOI at local, governorate and national levels.

From the previous strategy ,we can conclude that the first concern for the country is , improving water use efficiency in irrigated agriculture (since

this sector consume more than 80 % of the total water used in the country So any amelioration in water use efficiency in this sector will impact positively on the availability of water and food security of the country . But as a consequent of this strategy these measures can also help the country to deal with future natural water crises resulted from expected climate change, drought events ,.

However, implementation of climate change adaptation strategies within national water resources strategic plans is poor; this strategy should be multi-disciplinary in nature and will require interaction and horizontal coordination between multiple levels of Government institutions and the involvement of stakeholders, civil society, business sectors and the public. The challenge facing managers of water resources is to ensure such high level of coordination among concerned sectors and water stakeholders .

Regarding agriculture policy the government maintain its control on the strategic crops such as wheat and cotton putting more emphasis on water saving in irrigation and improving irrigated agriculture .

All these measures are indirectly help to mitigate climate change impacts ,but as it was mentioned no clear research policy is adopted .

V-2 : Media coverage : Climate change is seen by the media as a subject of hot spot .So in selected occasion like for example the day of environment some article are published in the local newspapers describing the climate change phenomena and its impacts . Most of these articles are translated from foreign newspapers. The same as well at the TV national channels .

Some of the articles for example tried to explain the Kyoto protocol and the role of different countries for its implementation and the benefits of each country from the fund allocated by the international agencies in the matter of mitigation and adaptation .Others talked about sustainable development and renewable energy .Some articles have explained in detail the impact of climate change on the socioeconomic conditions in the country ,such as water resources ,agriculture , animal resources and forest ,desertification and land degradation ,frequently considered as a consequences of climate change, ,even the dust storms that strike the cities in the North Eastern region of Syria.

Recently and for raising public awareness about climate change some activities have been conducted within the framework of the project for preparing the first national communication report such as the preparation of small documentary film about climate change and how the local population look to this phenomena .It was found that by questioning people most of them are not aware about climate change and green house effect and they do not have any idea about it .This reflect to which extents efforts are needed for raising public awareness about this issue .

Within the same project activity , a drawing contest about climate change and green house phenomena (Fig.25) has been announced for the young in the occasion of the Arab Environment day (14 th. of October) .

All of these actions are still sporadic and occasional and there is a need for systematic policy for increasing public awareness.

مبادرة إعداد البلاغ الوطني الأول للتغيرات المناخية
INITIAL NATIONAL COMMUNICATION

بمناسبة الاحتفال بيوم البيئة العربي الموافق
14 تشرين الأول / أكتوبر 2008، وتحت شعار:
بيئة شبابية

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Fig. 25 . Type of awareness campaign

V-3 ; Civil society knowledge and activities ; As it was previously mentioned the role of civil society is still very limited in the country .It is concentrated on some activity regarding the protection of environment ,water pollution , cleaning of river and cities ,preserving the old cities .In almost all the major cities in Syria many associations have been established .They organize workshops about different subjects of the environment including climate change, where well known key speakers are invited to give lectures ..

V-4 : Legislation ,laws related to climate change ;

Many legislation and regulation regarding the environmental issues have been issued in the country which are indirectly related to climate change adaptation either for water management ,desertification ,increasing efficiency of water

use in irrigation ,water legislation and water tariff . In the following a summary of these laws;

1. **The Government has launched a national programme to promote modern irrigation** and assist farmers to convert from inefficient traditional on-farm irrigation systems to advanced efficient modern systems. Legislative Decree No 91, enacted on 29 September 2005, provides the legal base for: (a) establishment of a Fund for financing this programme with a capital of Syrian pound 52 billion,;

2. (b) the Fund's capital would be deposited in an special account at the Agricultural Cooperative Bank (ACB) to be used for the purpose of the Programme;

3. (c) the Funds source of financing would be the Government's Budget, donations, gifts, grants, interests on current accounts, fines and interests from delayed payment of loan instalments by the beneficiaries;

4. (d) the Fund would be administered by a Board of Directors under the Minister and a Director.

5. **The Water Law (No 31) was ratified by the Syrian Parliament** on 20 October 2005 and issued as presidential decree on 16th of November,2005.. the decree provides the legal base for improved water resources management and protection. The decree promote the establishment of water users' associations to participate in water management. **The new Water Law recognizes water from all sources (ground and surface) as public property** and subject to regulation by the Government. The right to use surface or groundwater is acquired through the issuance of water use license by MOI. The license for groundwater wells would specify discharge and maximum depth and require instalment of water measuring device on each pump. License for new irrigation wells would only be issued subject to commitment by the applicant to install modern on-farm irrigation system. License would be valid for a period of one year and its renewal is subject to availability of water in the basin. Sever penalty for non-compliance with the provision of license is foreseen. Violations related to improper use of water would be regarded as criminal act.

V I: The way forward to alleviate impacts of climate change ;

Half of the Syrian population live in rural areas and largely dependent on agriculture for their livelihood .The agriculture sector is the main water consumer in the country (more than 80%) and is contributing by 30 to 32% to the GDP , providing works to about 50% of the population and employs 32% of the Syrian labor forces of the rural population. Being the most sector depending on natural resources such as water which is very vulnerable to climate change, add more pressure on the socio-economic conditions in the rural areas. .For example during the drought of 1998-1999 , the mortality rates for mature ewes and lambs were dropped by 10% and 25% respectively and the reduction in wheat and barley production was estimated at 2.9 billion Syrian pounds (ESCWA 2005).

Despite these facts and that the rural population is the most vulnerable to any change in natural conditions and the poorest in the country, no assessment has been done to define to which extent the country population is vulnerable to climate change and little is done to initiate climate change research programs .

Implementation of climate change adaptation strategies within national water resources strategic plans is multi-disciplinary in nature and will require interaction and horizontal coordination between multiple levels of Government institutions and the involvement of stakeholders, civil society, business sectors and the public. An urgent multidisciplinary action program is therefore needed to define adaptation measures .This program is intended to help the country to overcome the impacts of climate change and to prepare the appropriate policies for alleviating these impacts .This program can include the following topics ;

VI -1 ; Adoption of integrated and sustainable development policy ;

Incorporating or integrating adaptation to climate change into planning processes is a necessary strategy for sustainable development over the long term. Climate change impacts do not happen in isolation; impacts on one sector can adversely or positively affect another; sectors can be affected directly and/or indirectly by climate change and indeed sometimes a change in one sector can offset the effects of climate change in another sector .

The sustainable development and management of water resources requires a coordinated efforts between the different water users, since the water resource is considered as the pivot for all economic activities and is expected to be the most vulnerable to climate change, some steps have been taken to improve the coordination (i.e. the higher committee for water) but still more is needed. A good example is the coordination occurred between the water and agriculture policies in allocating water for different crops (reduction of cotton cultivated areas for saving water which was decided recently) ,

The agriculture sector is using about 80% of the total water used in the country , but the low water use efficiency, which is around 30% (more than 80% of all irrigated areas are still using traditional flood irrigation) and low water productivity in this sector presents an enormous challenge to sustainable water management .

Water demand management requires major improvement in the agriculture water productivity. The Integration approach of land and water management across different economic sectors in the country is a pre- requisite for ensuring cooperation between the different ministries ,authorities ,research and other concerned institutions.

The forthcoming challenge—due to climate change—will be to also manage the social, political, and institutional processes of balancing the water use interests of present generations vs. future generations (Fig. 26).

The two axes of this diagram (finance, and water) present the two key facets of IWRM. The vertical axis describes to what degree a country is managing its water in a financially sustainable manner. The horizontal axis describes how far a country is managing its water in an environmentally sustainable manner. Of the four possible outcomes, conceptually only one (the upper right box) will lead to sustainable outcomes, or the IWRM ideals. In the other three boxes, failures in policy, or in the implementation of policy, result in countries falling short of the IWRM ideals.

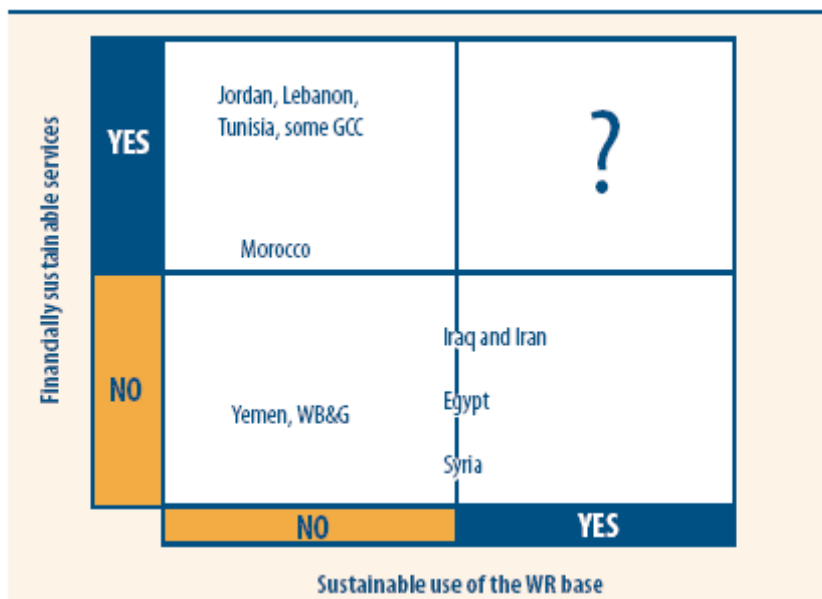


Fig. 26 : Status of water management in different Arab countries (UNESCO)

VI -2 :Monitoring and information management :

Knowledge management and information are increasingly becoming the key factors for ensuring sustainable management.

In Syria most of the available data regarding water and climate from the existing monitoring networks are, either not continuous in time and space or with limited accuracy due to lack of data quality control.

Climate data are dispersed within different institutions , such as the Ministry of Agriculture ,Ministry of Irrigation ,National Meteorological Administration. Each of these institutes has their own climatic monitoring network. Sharing the information between different institutions is limited and inefficient, and usually few months late . Such issue make the data quality control very difficult . For monitoring drought for example ,.meteorological services play a key role ,but as it was mentioned, the data are sparse and most climatic stations are located in predominantly agriculture areas and usually not located in more

arid and less populated areas such as the Badia which is the most vulnerable area to drought .

Coordination between concerned institutions is also very weak and there is no information sharing mechanism adopted for the country ..Such issues would certainly impede the capacity of the country to deal with climate change impacts ,such as drought ,floods .. .

Within the ministry of irrigation a water resources information center was created 5 years ago with the technical assistance of Japan (JAICA) . The center in principal should centralize all the water monitoring data collected by the network belonging to the ministry of irrigation .

At present only two of 7 basins of the country are connected to the center ,Barada and Awaj and coastal basins .The other basins will be linked in the future .But a lot of efforts are still needed for upgrading the center ,improving the quality of the data received by the center from different networks ,applying a data control mechanism . Data processing is vital to improve the knowledge and draw plans accordingly. This important loop presented in figure 27 is still weak .

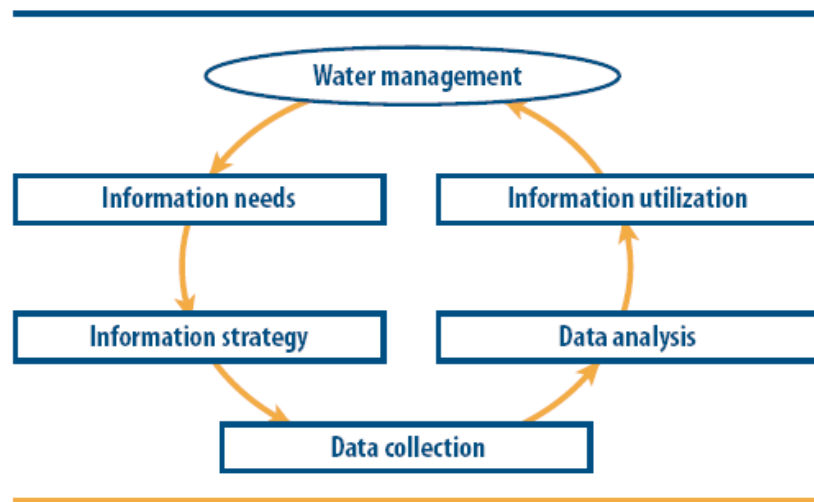


Fig. 27 : The information cycle (UN/ECE 2000)

Building Information system and enhance information exchange are a prerequisite conditions for successful climate change adaptation action plan. Since climate change affects all the socioeconomic sectors, its preparedness action plan requires multidisciplinary approach, institutional arrangements and inter-agencies communication and information exchange .Decision makers should have access to a reliable data and should be informed about the results of the different scenarios of their actions .

VI -3 :Institutional capacity ;

A key dimension of climate change impact assessment is the presentation of the results which is considered an effective tools in increasing understanding

and awareness of climate change risk such as hazards mapping which highlights geographic areas at risk (drought or floods ...) .Geographical information system (GIS) and remote sensing are particularly suited for such issues.

A change from reactive to proactive strategy i.e to adopt a proactive approach to minimize the effect of climate change is an important step the governmental institutions should take. For example , for the drought events which is one of the worst natural disasters the country is frequently facing there is no drought early warning system which is an essential component of drought preparedness plans and policies, and the investigation. Meanwhile the country is exposed since mid of the last century to a frequent drought events as it was the hydrological year 2007-2008 where the average precipitation was about 50% of the annual average for the country .Despite these facts and that about 55% of the country (The Syrian Badia) is the most environmentally vulnerable to drought the country is lacking of multi disciplinary strategy for drought monitoring and mitigation plans. The same as well regarding climate change assessment and impacts .

The country does not have an institutions that could act as a central coordination unit for data collection , analysis and dissemination of results or findings .

However, an agriculture policy center has been created recently within the ministry of agriculture with the assistance of FAO and Italian government which deals at limited level with drought monitoring , but unfortunately , its work is not well known at the national level and there is minimum coordination with other institutions dealing with water issues .

A commission has also been recently formed under the auspice of the Prime Minister for dealing with some natural disaster (focusing mainly on earthquakes) ,but no real actions has been taken regarding the climate change impacts .

More training are required for data processing, reporting and results presentation.

VI -4 : Regional cooperation ;

Coordination and exchange of data and information within the region can be of great help for the country for complementing the existing data , filling the gaps and even exchange the experience .There are some regional network such as the Network coordinating by ICARDA(NEMEDECA) and (ADMANET) in ACSAD for early warning of desertification .

The cooperation or the involvement of the country in different existing networks are improving slowly , mainly because the relevant data and information are some time classified in the country as confidential and therefore need more efforts to be released .

Networking usually provides opportunities to share experiences and lesson learned and help in predicting the climate change events ,since all the Eastern Mediterranean countries (Levent countries) are projected to the have the same climate change . There are already some regional network which were established in the region , such as the Network coordinating by ICARDA(NEMEDECA) and (ADMANET) in ACSAD for early warning of desertification

Mitigating climate change impacts necessitate also the enhancement of regional cooperation ,since this phenomena will have an impacts on all the countries of the Eastern Mediterranean region or even more .Cooperation with other countries through bi- lateral or regional cooperation by establishing a regional networks with the assistance of regional and international organizations would help to streamline the information, exchange knowledge and experience and lesson learned and increasing capacity building .It also provides opportunities to share data, information and fill the gaps in data .

VI -5 : Research on climate change;

Usually in developing countries research impacts on policy and even policy draws on research .Or Syria is lacking any kind of programs in this field .The existing national research centers are mainly dealing with how to save water in agriculture .But from the climate change point of view and its impacts there is nothing done up to now .The major constraint is the access to the data and information ,as it was mentioned previously most of the data ,reports are considered confidential for the students or different institutes .

The scientific research in this field constitute a basic element for defining water policy and strategy which can be harmonized with climate change issue.

It is widely recognized that dissemination of research results to policy makers in appropriate formats is the most factor in order to facilitate policy influence . For example developing some scenarios for the country about the impacts of climate change on different issue such as ,food ,water environment ,poverty will have certainly a great influence on decision makers and consequently on national water policy .

Research priorities must include building better data series with a better geographical coverage, priorities for water research to support adaptation.

VI -6 : Finalizing the shared water resources agreements;

As it is known ,Syria is depending in more than 75% of the total water resources on five main rivers shared between neighboring countries(Euphrates ,Tigris ,Yarmok ,Orontes and Nahr El Kabir Janobi) There are only one official agreement regarding Orontes basin shared by Lebanon and Syria (Table 6).

For Euphrates there is a protocol of under standing between Turkey and Syria for delivering 500m³/s/day of which 52% is delivered to Iraq after the official

agreement signed between both countries . For Tigris a recent agreement has been signed between Turkey ,Syria and Iraq after which Syria can utilize the river water to irrigate about 150000 h in the North Eastern part of the country.

For Yarmouk there is certain coordination and an agreement for building a dam on Yarmouk ,but can not be considered as a final agreement .For Nahr El Kabir Janobi nothing up to now is done .Even for Euphrates the protocol is not officially adopted by the Turkish government and the Parliament ,so it could not be considered as a final agreement .

In case of climate changes impacts , challenges in managing these shared water will be increased and may cause conflict .In that context and since climate change induced water scarcity increases, frequent drought occurrence and increasing in temperature and consequently increasing in water demand , the access to adequate water supplies in different countries sharing these rivers would increase .Climate change preparedness urge the concerned countries for finalizing the agreement regarding the sharing of these rivers and becomes a vital component as a national integrated water resources management .

It is urgently needed for Syria to finalize the agreement regarding the shared water resources with all neighboring concerned countries .Syria is also urged to claim her rights, at the international level, in the water resources of the occupied Golan heights from which Israel is covering about 30% of its water needs .

Water conflict	Issue	Countries involved	Outcome
River Tigris	Irrigation in Syria with Tigris waters	Syria, Iraq, Turkey	No formal agreements as yet
Shatt al Arab River	Boundary demarcation	Iran and Iraq	1974 agreement by which the river is recognized as the boundary
River Euphrates	Sharing river for irrigation	Syria and Iraq	1990 agreement to share waters 42:58 between Syria and Iraq
River Orontes	Sharing river for irrigation	Syria, Lebanon, Turkey	Lebanon gets 80mcm, Syria 430 mcm. Turkey gets adequate water for irrigated lands.
River Jordan	Sharing river for irrigation, urban, and industrial use	Jordan and Syria	Syria retains flow from springs above 250m. Maqarin Dam flows used by Jordan but 70% of power generated allocated to Syria

Source: Hadadin 2008, 79–81.

Notes:

Mashreq = Eastern countries of the Arab Region.

In border-creator situations, as the water or the externalities are shared, the tendency is to share (often equally) the costs of mitigating measures. For example, the Baltic countries saw clear advantages of sharing the benefits and the costs of protecting the Baltic Sea from land-based pollution.

Table 6; Disputes and agreements on shared rivers in Mashrek countries

VI -7 : Assessment of socioeconomic impacts of climate change ;

Several publications have substantially highlighted that agriculture and the rural economy are important elements in the Middle East including Syria (UNESCO -2009) .Since agriculture claims the largest share of the workforce

in Syria with a high proportion of the poor depending on this sector for their livelihood ,it is important to conduct further research to assess the extend of climate change impact on the livelihood of rural population and to define an adaptation measures and strategy for alleviating the impacts. This issue, should be taken as an urgent matter due to its direct impact on stability in the country. The rural population who will be affected the climate change will find them self without any work and then they immigrate to the big cities looking for work adding more social, economic and environmental difficulties in urban areas,

VI - 8 : Reuse of treated water :

The development of non conventional resources such as desalinated water and reclaimed wastewater is increasingly relevant .The volume of water treated and reused is still very limited in the country (550 Million m³ / y ref?) This is due mainly to the delay in starting building treatment plants in the country .Since treated water is considered by most of the countries in the world as an renewable source of water which can help to alleviate water stress ,more efforts should be taken by the country to develop research on reusing treated water in different sectors ,mainly agriculture .

VII – General conclusions and recommendations:

Climate change could potentially significantly affect current water vulnerability and security situations in the country . There are many predicted and observed changes attributed to global warming and climate change . Some of the changes are increased temperature ,altered patterns of precipitation ,sea level rise and a diminishing ice and snow cover .A change in temperature and rainfall modifies the distribution of vegetation which in semi arid areas is strongly sensitive to climate induced variability .This situation will affect directly the food production and indirectly the political stability in the country .

From the previous sections we can conclude that the country needs a coordinated efforts to mitigate the climate change impacts and preparedness measures ,including a sound research program to assess these impacts and evaluate to what extend the country will be affected by developing some scenarios .

- All predictions indicate that climate change will reduce the overall amount of rain by 20% and will increase its variability making it much harder to manage.
- Climate change studies indicate that Syria and Eastern Mediterranean countries will experienced extreme weather events. Changes in precipitation, combined with rising atmospheric temperature and reduced snow cover. this will have impacts on water quality and quantity, requiring water managers to incorporate climate change in their water policy .
- Limited water supplies due to climate change would restrict present agricultural productivity and threaten the food security in Syria .Changing

crop types and introducing more efficient irrigation systems can provide significant win-win options for water conservation to offset the projected impacts of climate change in the country .

- Water policy should focus on demand management rather on supply management .This means more efforts are needed regarding the enforcement of water legislation , awareness ,integration of land and water management through the implementation of integrated water resources management concept (IWRM).
- Implementation of climate change adaptation strategies within national water resources strategic plans will require interaction and horizontal coordination between multiple levels of government institutions and the involvement of stakeholders, civil societies, private and public sectors.
- Climate change has its predicted impacts on shared water resources in the region, inter and intra-regional conflicts could be sparked by competition over varying and declining natural resources with up-stream countries . a final agreement regarding all share water resources must be achieved .
- Development of regional cooperation with the other countries of the region will facilitate exchange of data, experiences, lesson learned . and helping in capacity building of national institutions
- A national water strategy depends heavily on data and information sharing. The establishment of an early warning system is urgently needed for the country .It will aid in supervising and managing the water data collection ,data processing ,assessment of climate change impacts and vulnerability .Dissemination of early warning findings to key policy and decision makers is critical to effective climate change preparedness .
- There is also an urgent need to create a central institutions or a task forces at the national level charged with assessing, monitoring ,supervising a climate change early warning system and developing a climate change preparedness plan. This unit should also take in charge the development of research program focusing on climate change issue and coordinate the efforts at the national and regional level . This unit should has the technical capacity (in both qualified human resources and modern equipments) for conducting studies , research ,synthesize existing information (previous and actual), developing long term climate change planning , preparing scenario, developing indicators to assess various characteristics of climate change, assess vulnerability of national economy at different levels including the poor, and defining national strategy and priorities for mitigating climate change impacts. For example developing indicators for assessing different characteristics of drought, such as intensity, frequency, spatial extent, socioeconomic impacts ...
- Since climate change is a multidisciplinary issue by nature ,strategies should be integrated into national policies affecting water supply ,water use, land use agriculture and environment policies . The implementation of the

integrated water resources management concept (IWRM) which was recently developed as an approach for ensuring optimal management of water resources can help for defining a new water policy for climate change preparedness and mitigation.

- Building partnerships among scientific institutions, civil society, international and bilateral donor agencies, and national policymakers, so that the nature and consequences of emerging hydrological risks are understood, and appropriate mitigating measures are taken.
- Develop investment programs to build regional resilience to climate change.

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