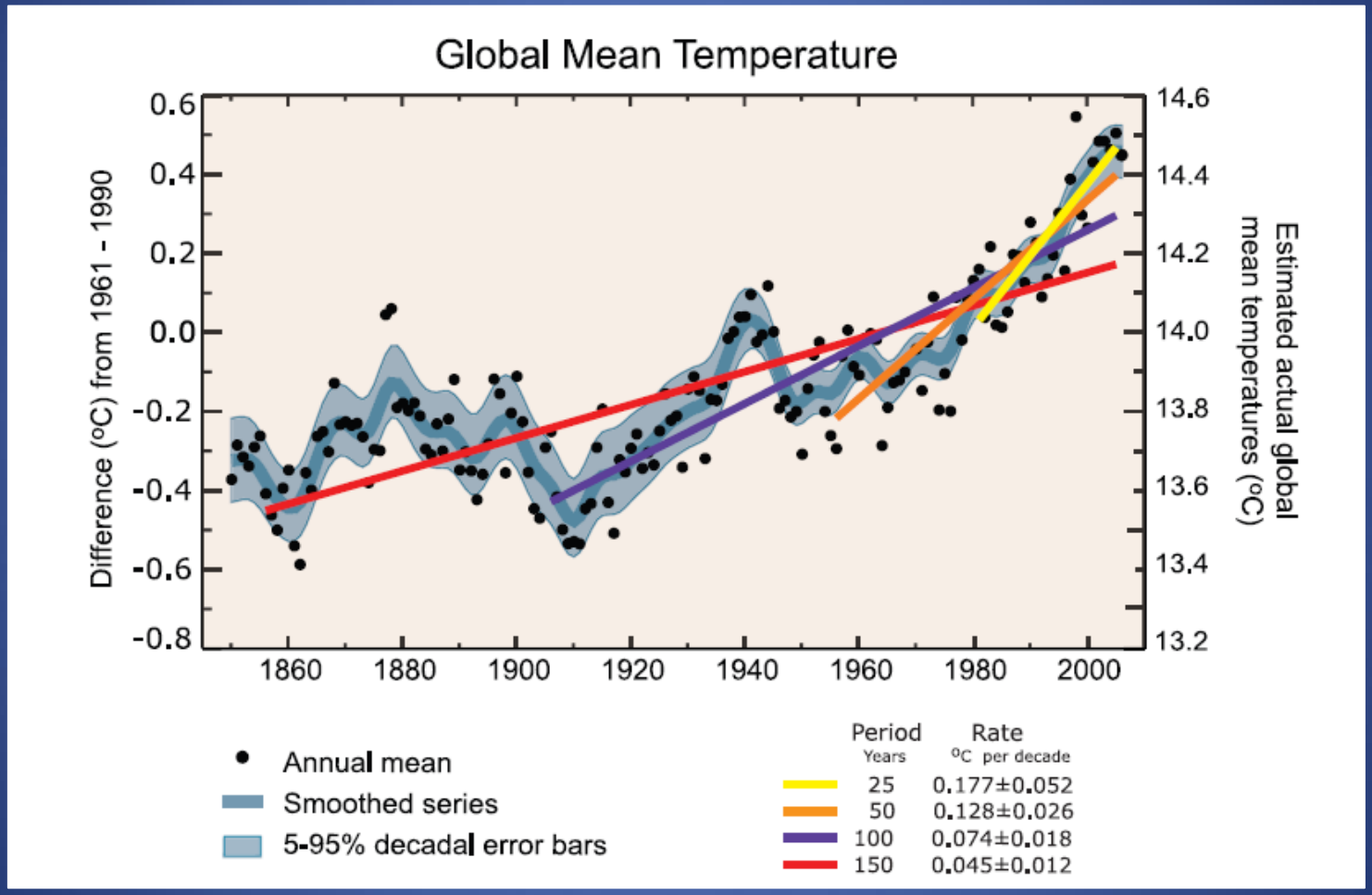
Expected Impact of Climate Change on Population and Livelihood in Arid and Semi Arid Areas: Case Studies from Palestine

Rabi, A.; Carmi, N.; Abu Jamus, S;
Jibreel, O and Abu Saadah, M.

Water Problem in Palestine

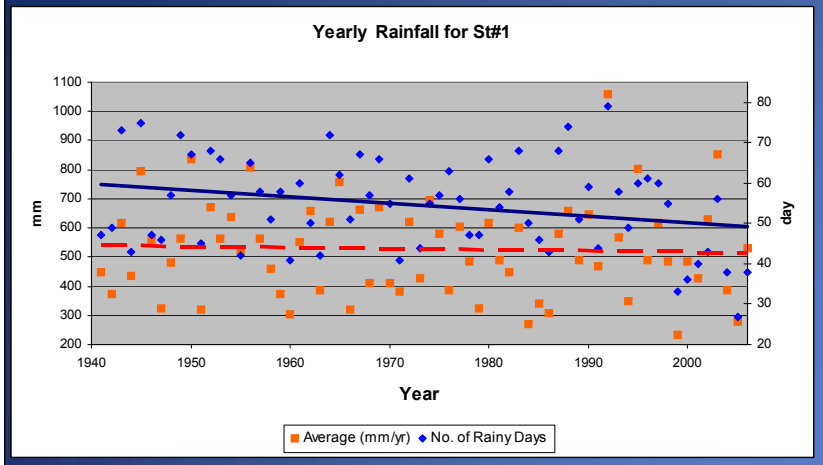
- Palestine is a **semi-arid** area with very limited water resources.
- Additional stress on water resources:
  - **Growth rate** is one of the highest worldwide; 3.06% in West Bank and 3.7% in Gaza while world average is 1.14%.
  - **Political conflict**; destruction or pollution of water resources in addition to limited accessibility.
  - Potential impact of **climate change**; which , to date, is not addressed in water resources management and planning.

Global Temperature Trend Analysis

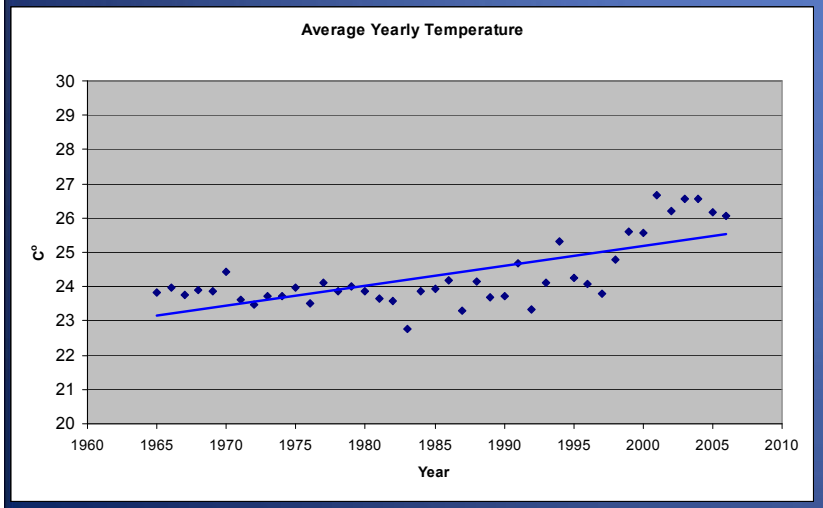


Source: IPCC, 2007

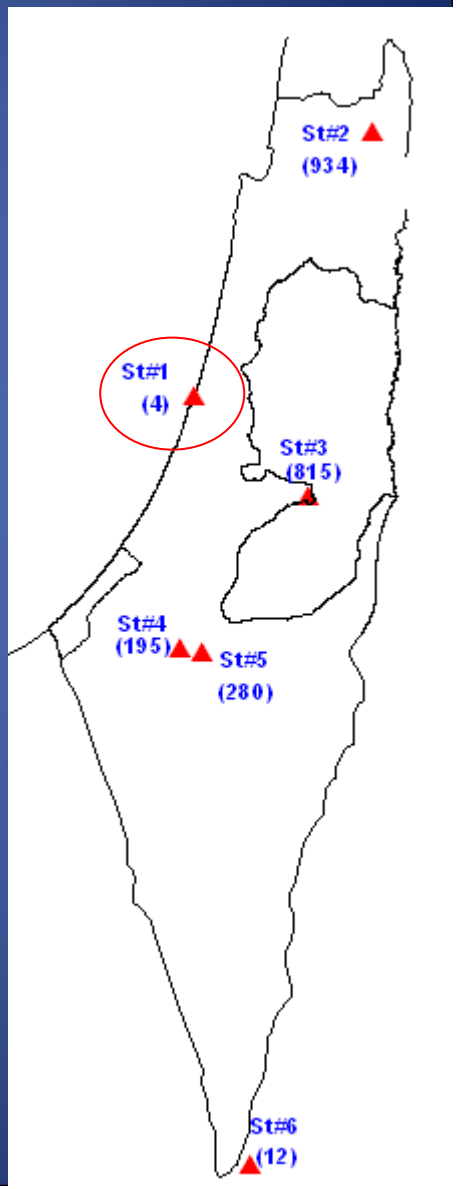
St#1



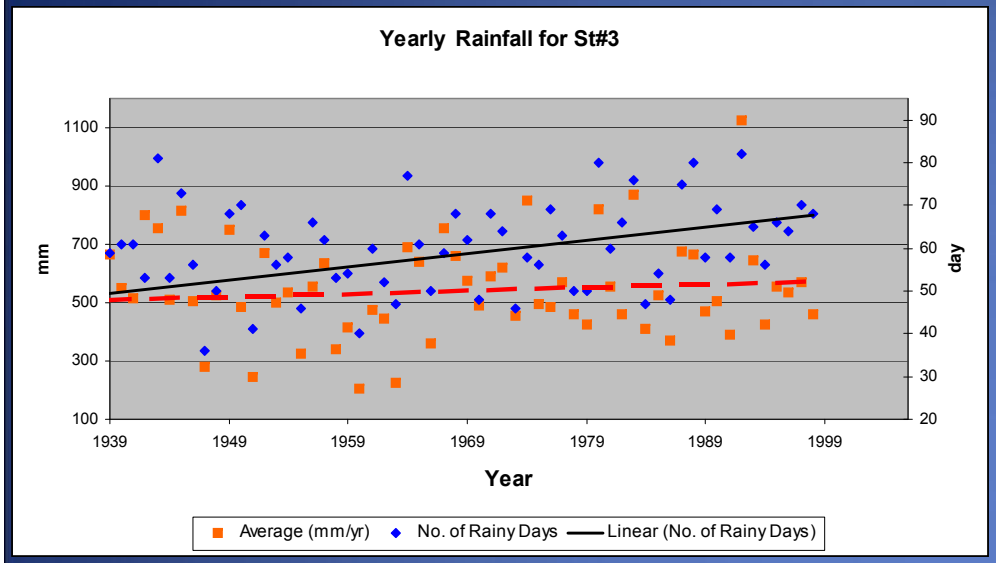
- Period: 65 years
- Mean annual average rainfall= 526 mm/yr
- Mean annual average rainy days= 60 days
- Change in rainfall trend= -22.4 mm (decrease)
- Change in rainy days trend= -10 days (decrease)



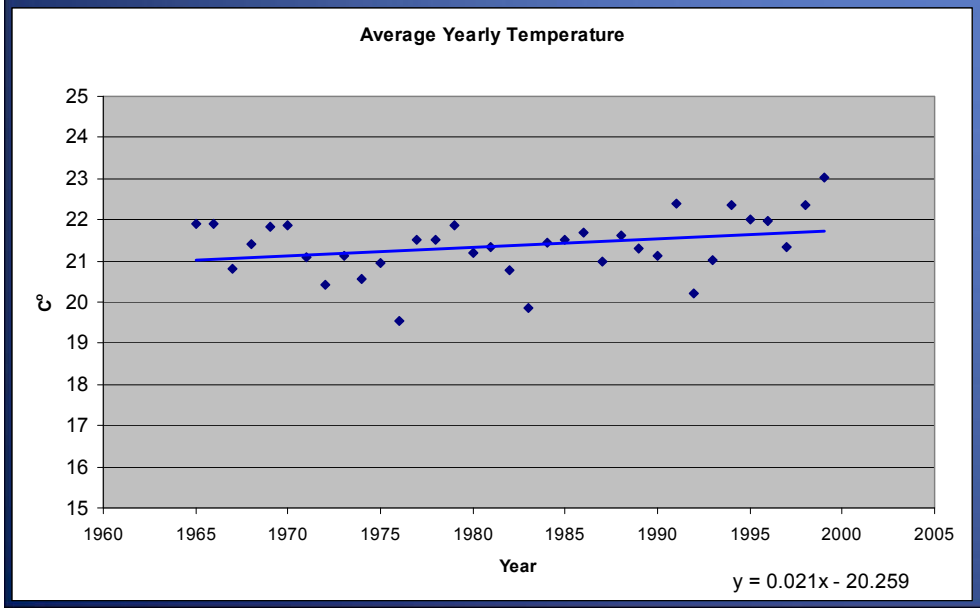
- Period: 41 years
- Mean annual average temperature= 24.3 C°
- Change in temperature trend= 2.3 C° (increase)



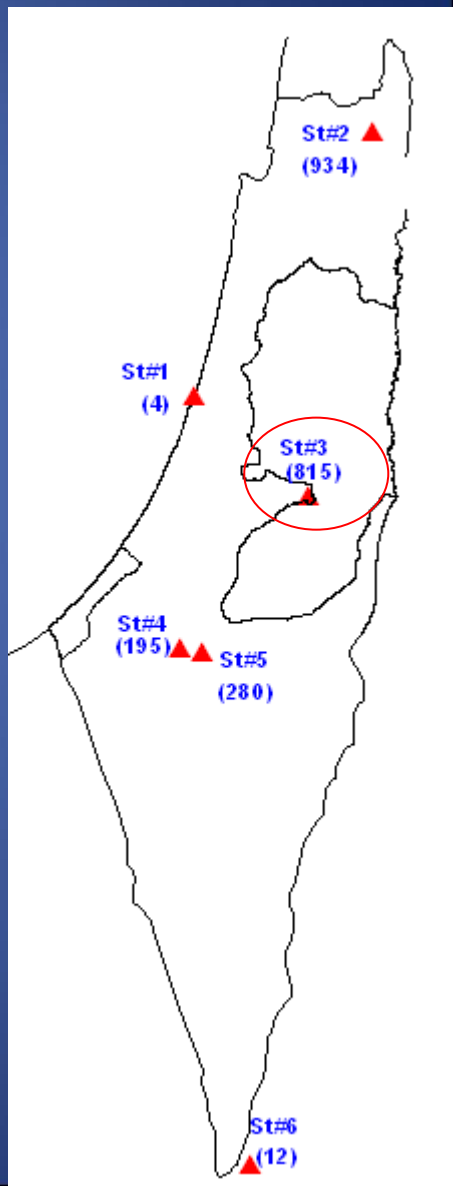
St#3



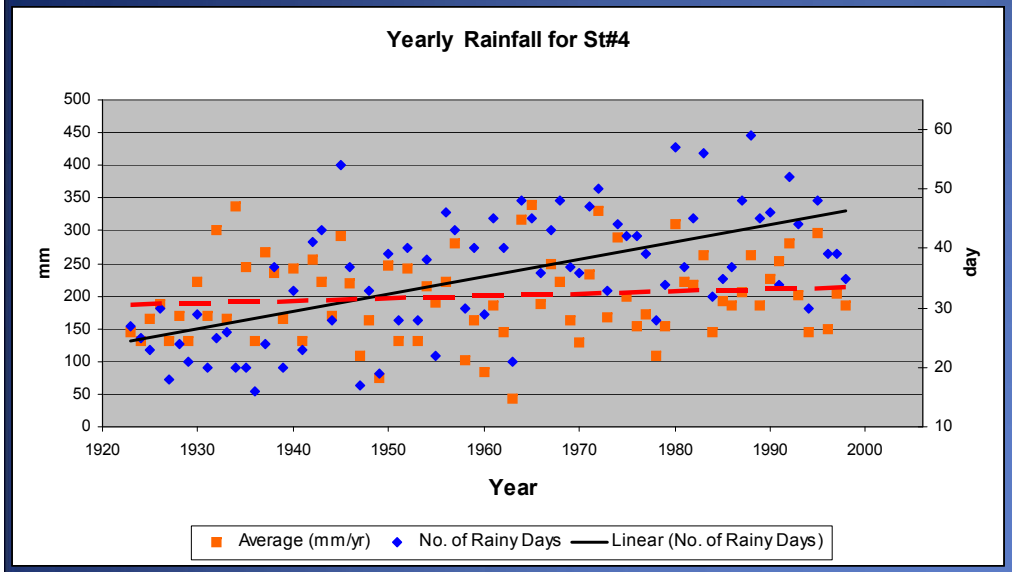
- Period: 97 years
- Mean annual average rainfall= 522.7 mm/yr
- Mean annual average rainy days= 54 days
- Change in rainfall trend= 106 mm (increase)
- Change in rainy days trend= 30 days (increase)



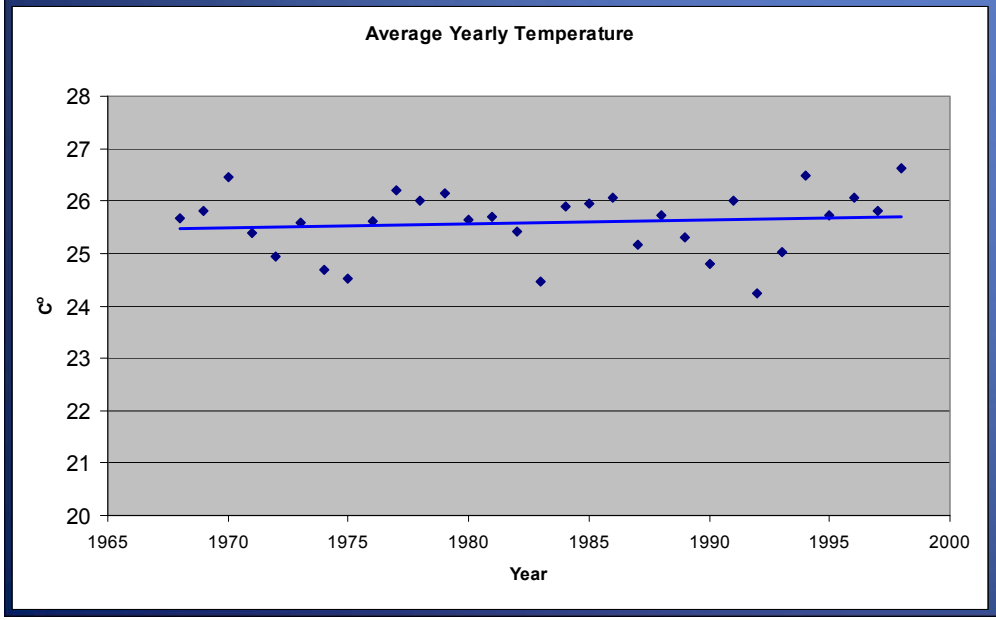
- Period: 34 years
- Mean annual average temperature= 21.4 C°
- Change in temperature trend= 0.7 C° (increase)



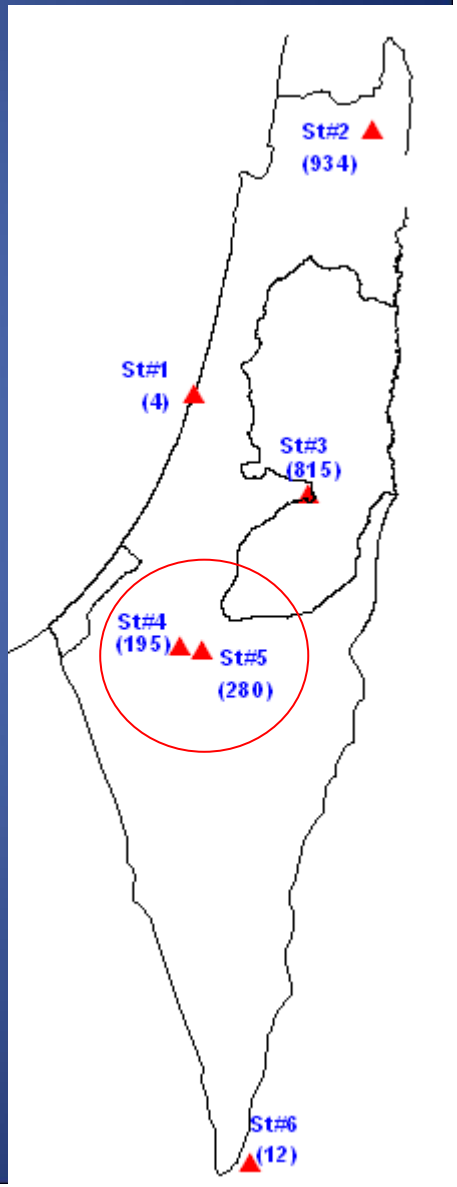
St#4 & St#5



- Period: 75 years
- Mean annual average rainfall= 198.5 mm/yr
- Mean annual average rainy days= 35 days
- Change in rainfall trend= 28 mm (increase)
- Change in rainy days trend= 22 days (increase)



- Period: 30 years
- Mean annual average temperature= 25.6 C^{o}
- Change in temperature trend= 0.2 C^{o} (increase)

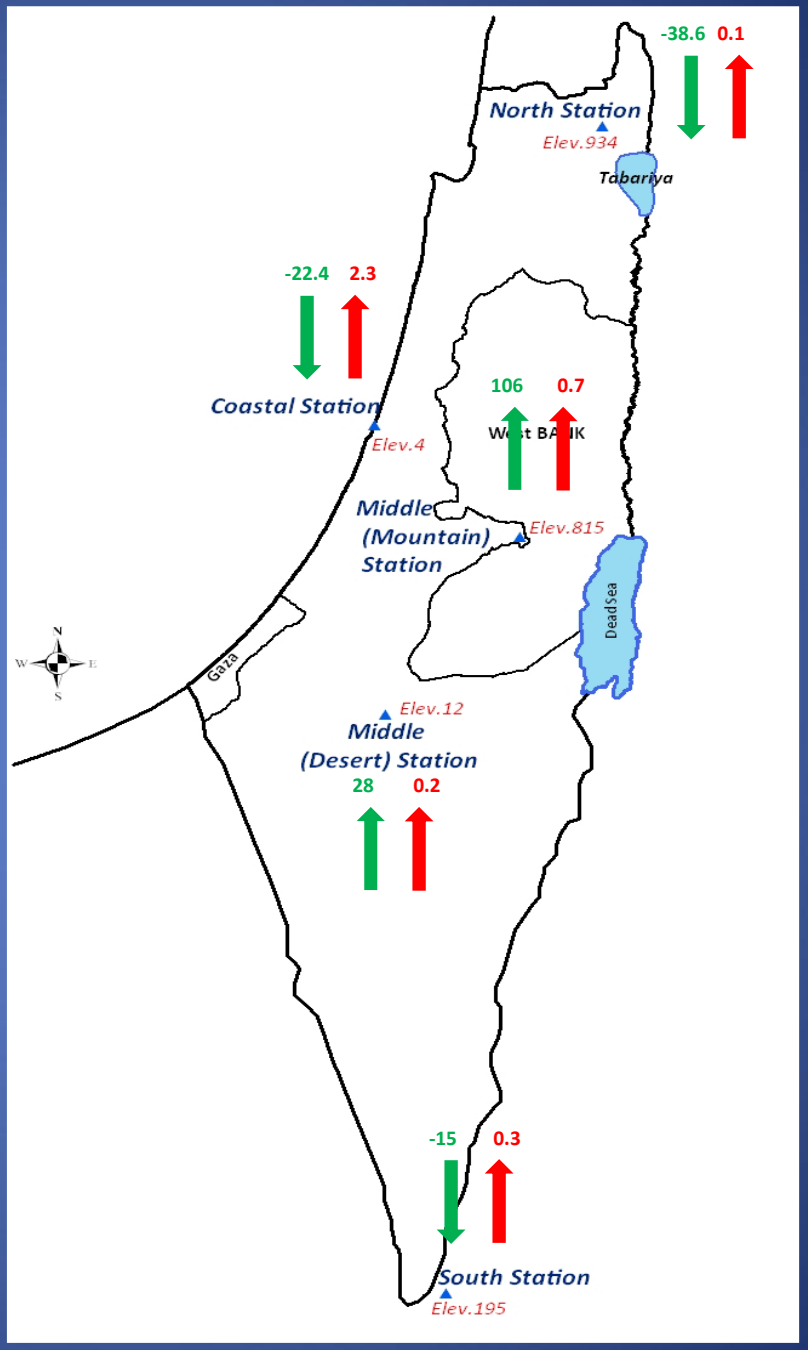


Temperature & Precipitation Trend Analysis for the late 20th century

Where;

Refers to Temperature change in °C

Refers to Precipitation change in mm



Source: Abu Sa'da, 2007

Water Supply & Demand in West Bank

Year	Supply (MCM/year)	Demand (MCM/year)			Deficit (MCM/year)
		Municipal	Industrial	Agricultural	
2005	159	135	11	168	155
2010	159	156	25	190	212
2015	159	181	30	208	260

- Agriculture is the biggest consumer of water.
- Supply is assumed to be constant over the years.
- Water demand is estimated based on population growth as the fundamental factor.

Source: PWA, 2007

IPCC 4th Assessment Report

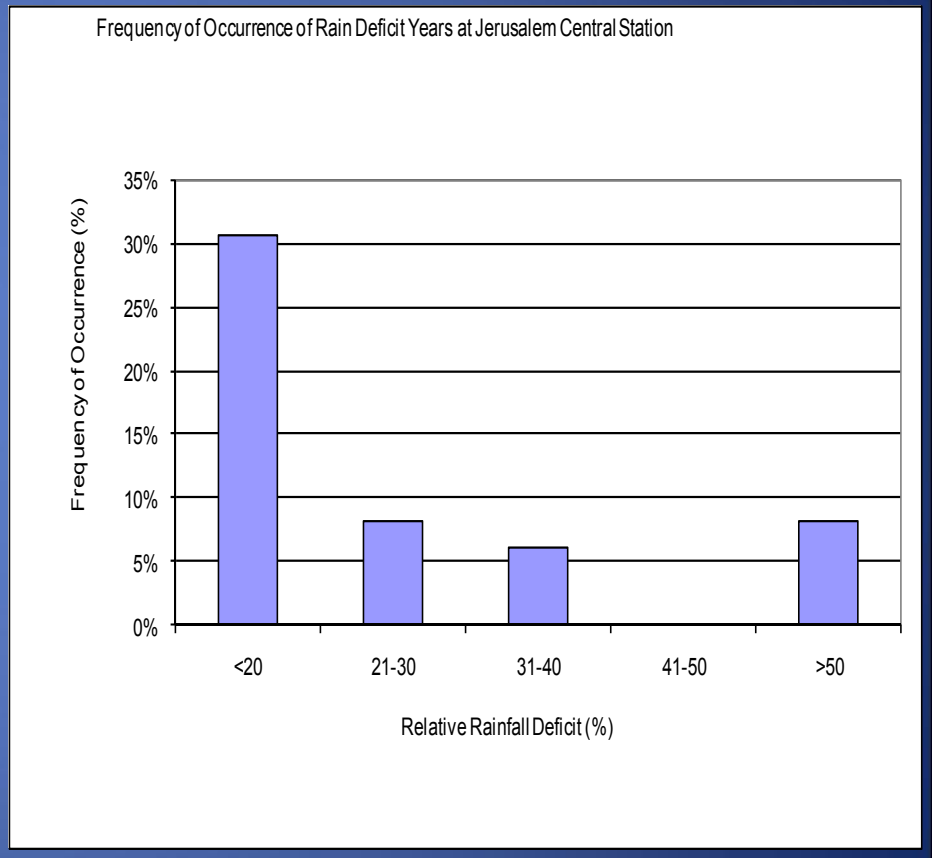
For the Mediterranean:

- Warming is *likely* to be in summer.
- Annual precipitation is *very likely* to decrease.
- The annual number of precipitation days is *very likely* to decrease.

Terminology	Likelihood of the occurrence
Likely	> 66% probability
Very likely	>90% probability

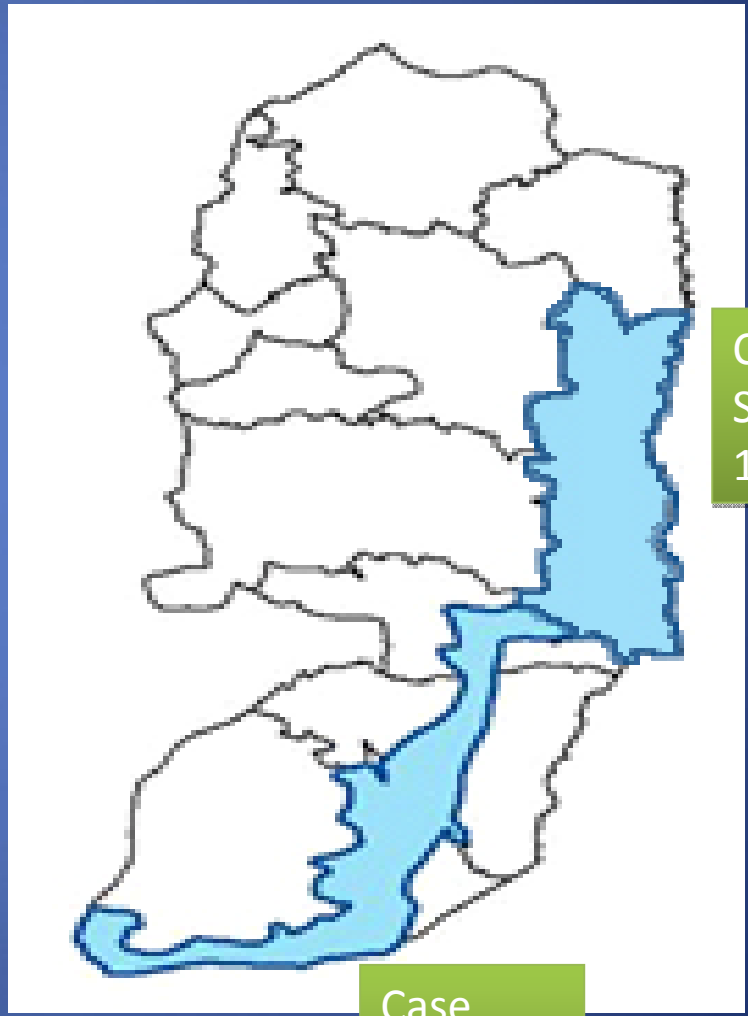
Drought Phenomena

- The frequency and duration of drought in the region is not fixed over time.
- The time between two occurrences of drought can be described as random variable.
- Drought has non-uniform return periods.



Case Study Areas

- Both areas are characterized by an arid and semi arid nature.
- The area of case study 1 is mainly cultivated with irrigated agriculture (citrus, dates and vegetables) and is a plain area that lies as low as 200 m below sea level
- The area of case study 2 is hilly with steep slopes with elevations up to 800 m ASL. Most of the area in case study 2 is not cultivated and considered as range land used mainly for grazing while some parts are classified as nature reserves.



Case Study 1: Details

Main Objective:

To evaluate the potential impact of climate change on agricultural water demand.

Specific objectives:

Identify the observed trends and future predictions (Temperature and precipitation).

Determine reference evapotranspiration **(ET_o)**, crop water requirement **(CWR)** and irrigation water requirement **(IWR)** under different suggested climate change scenarios

Selection of study area:

Jericho district

Selection of computer model to be used:

CROPWAT computer model; decision support system developed by the Land and Water Development Division of FAO

Jericho District Socio-economic profile

- 17% of HH income is used to purchase water
- 71% of population is less than 30 years
- 15% of population immigrate seasonally
- Unemployment lowest in WB at 9.1% (PCBS, 2008)

Formulation of Scenarios

	T	T+1	T+2	T+3
Reference evapotranspiratio (ET_o)	…..	…..	…..	…..
Crop water requirement (CWR)	…..	…..	…..	…..
Irrigation water requirement (IWR)	…..	…..	…..	…..

	P-20%	P-10%	P	P+10%	P+20%
Reference evapotranspiratio (ET_o)	…..	…..	…..	…..	…..
Crop water requirement (CWR)	…..	…..	…..	…..	…..
Irrigation water requirement (IWR)	…..	…..	…..	…..	…..

	T	T+1	T+2	T+3
P-20%	…..	…..	…..	…..
P-10%	…..	…..	…..	…..
P	…..	…..	…..	…..
P+10%	…..	…..	…..	…..
P+20%	…..	…..	…..	…..

First: Impact on Reference Evapotranspiration (ET_o)

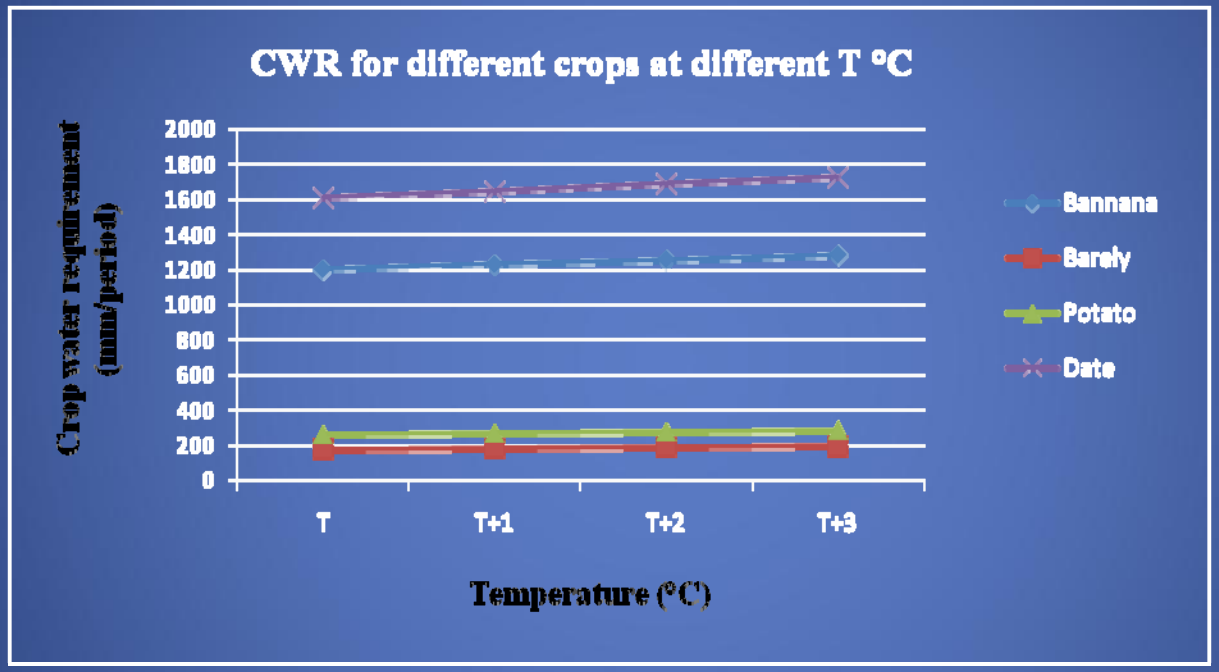
Average change rate (%) of ET_o with temperature increase:
Calculated using Penman-Monteith equation

	T+1°C	T+2°C	T+3°C
ET_o change rate	2.6%	5.3%	8%

Second: Impact on Crop Water Requirement (CWR)

Average change rate (%) of CWR with temperature increase;

CWR = Et_o *K_c



	T+1°C	T+2°C	T+3°C
CWR change rate	2.7%	5.4%	8%

Third: Impact on Irrigation Water Requirement (IWR)

Annual IWR for the total area under consideration;

∑ IWR for each crop x corresponding area

IWR= CWR – effective rain

	P-20%	P-10%	P	P+10%	P+ 20%
IWR (MCM/year)	21.05	20.24	19.95	19.66	19.38
Change rate %	5.53	1.47	0.00	-1.44	-2.84.

Fourth: Irrigation Water Demand Under Hypothetical Climate Change Scenarios

Deficits:

	T	T+1	T+2	T+3
P-20%	1.104	1.685	2.285	2.881
P-10%	0.294	0.877	1.469	2.065
P	0.00	0.581	1.172	1.763
P+10%	-0.286	0.291	0.880	1.470
P+20%	-0.566	0.010	0.596	1.181

As T & Ppt decrease , IWR I deficits ncrease

•Values are expressed in MCM/Year

Policy Recommendations: case study one

- Further efforts needed to **improve the predictions** of future irrigation water requirement for agriculture in Palestine; studies that consider the climate change impact on rain-fed and greenhouses agriculture and studies to cover the whole agricultural areas in Palestine.

- Climate change should be addressed in **water resources management and planning,** for development of future water resources in Palestine, as one of the factors affecting water supply and demand.

- **Adaptation measure** should be considered to cope with climate change potential impacts on water demand and supply.

Case Study 2: Socio-economic Profile

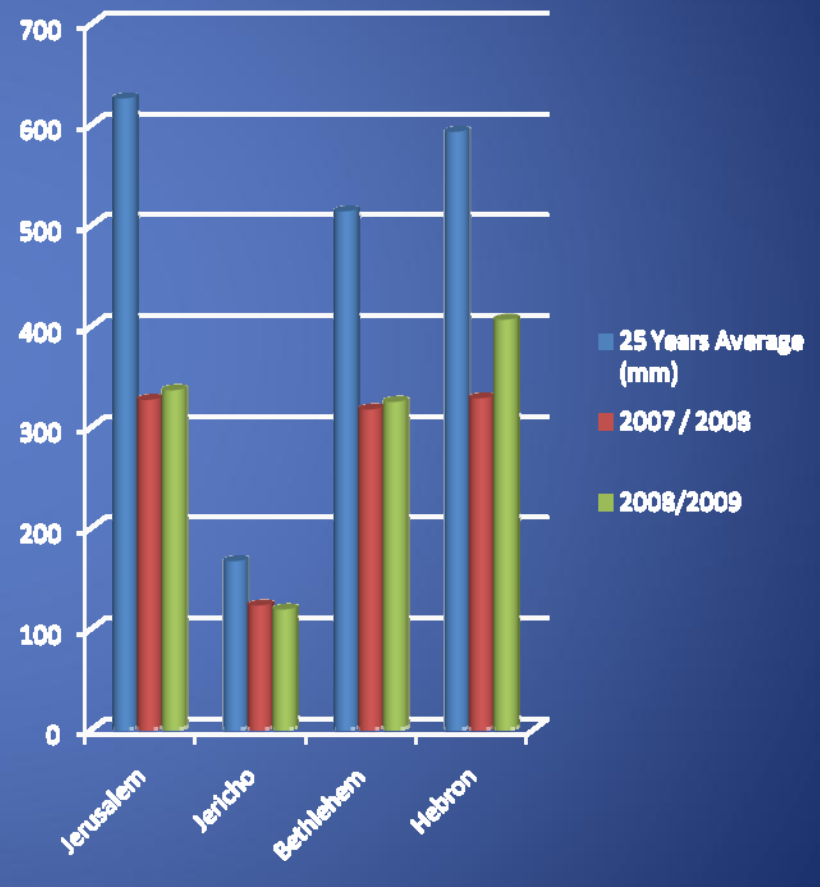
- Daily per capita income is <0.8$
- Poverty Rate is 22.5% (vs 13.1 WB)
- Average family size is 8.6 and 76% is young
- Almost74% of people rely on Livestock
- Population Growth is 3.3%
- Unemployment rate 24% (vs 15.6 in north)
- 40-50% of HH income goes for food
- 21% of HH income goes to purchase water
- Cultivated field crops are 66% ,25% and 9% barley ,wheat and legumes respectively
- Unconnected to electrical , water or sanitation networks hence electrical generators, water tankers and cesspits and septic tanks.

Objective -Case study 2

- To assess the impact of drought on livelihood (mainly water availability for domestic, agriculture and livestock) of marginal and vulnerable communities and to strengthen the sustainable coping mechanisms of the people in those areas.

Drought in the Study Area

- The area has encountered meteorological drought
- Rainfall was 30 -40% below average
- This has caused agricultural drought

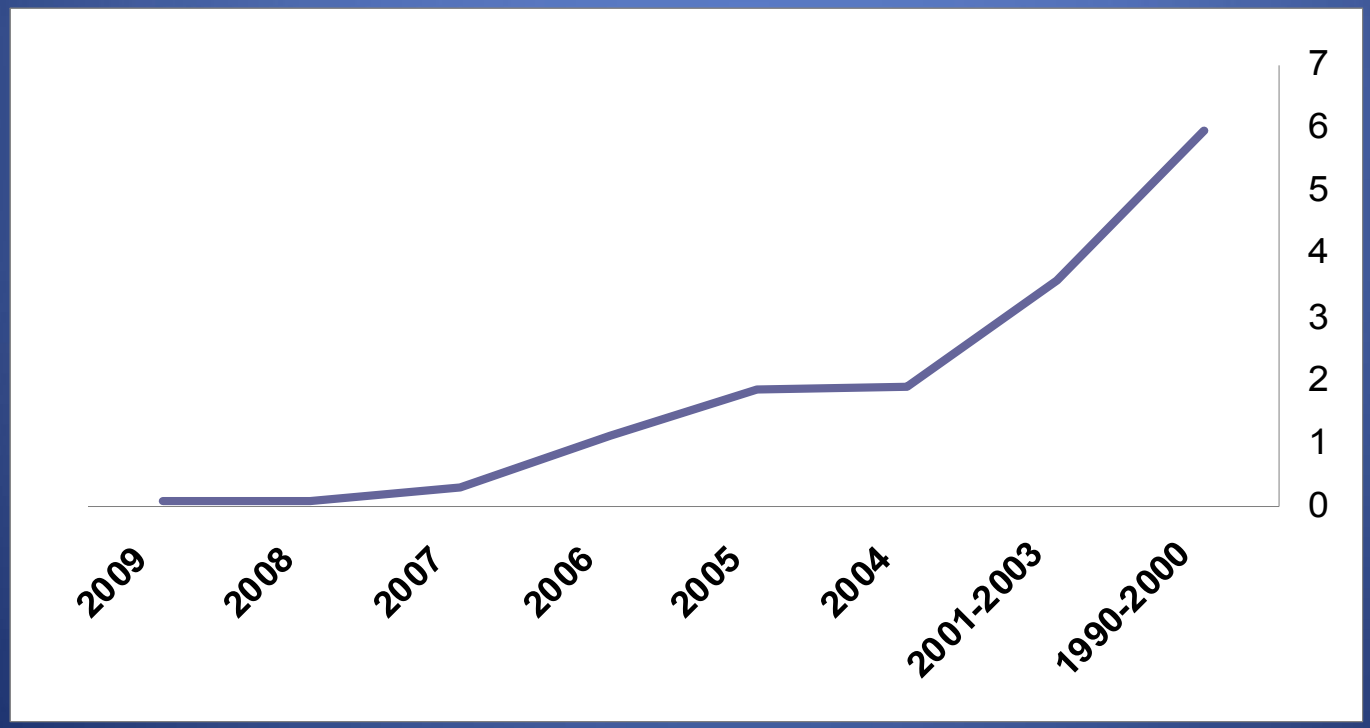


Impact of Agricultural Drought

- The change in Rainfall and its characteristics indicated above clearly shows the rainfall spatial and temporal variability, and the change in the number of rainy days and length of dry and rainy seasons. This has affected the livelihood of people and reduced the natural rangeland production.
- Areas previously cultivated with wheat and barley used as fodder diminished leading to further unemployment and increasing the costs of raising livestock

Impact of the successive drought

- Deterioration and retrogression of rangeland productivity



Range Land Deterioration

- The range land deterioration enhanced the unpalatable shrubs domination
- Lack of field crops seeds
- Extinction of some grass species
- Overgrazing
- More purchase of animal feed

Impact on livestock- main source of income

- Increased livestock mortality rate with 10% at least
- Decrease the quantities of the produced milk with 48%
- Delaying the breeding season for one month at least
- Increase the demand of the water consumption since there's the lack of the grasses and relying in the grains feedings
- Reduction in the flock sizes – livestock sold to afford buying water tankers

Socio-economic impacts

- Outbreak of certain diseases- 32% live in concrete houses only, rest in tents or metal roof shelters.
- Less water collected and Increased water costs
- Internal Migration reaches 40% in some communities
- Social instability
- Reduction in percentage of population relying on raising livestock
- Change in profession-shift from farming
- Less expenditure on basics affecting household nutritional levels.

Policy Recommendations

- It is important to re-assess the potential water resources (ground and surface) and consider the new change in the precipitation and temperature.
- Adopt more appropriate plans to eliminate internal migration from the vulnerable areas, invest in infrastructure, health and education services as well as WATSAN services.
- Develop an alternative plan for both irrigated agriculture as well as dry land farming. More drought resisting varieties, less water requiring crops, etc.
- Develop plans to regenerate the grazing areas and to maintain the current pattern of land use in those areas.
- Develop appropriate means to increase the water availability and accessibility to the vulnerable areas, mainly storage of surface water.