Adaptation of the Water Sector to Climate Change

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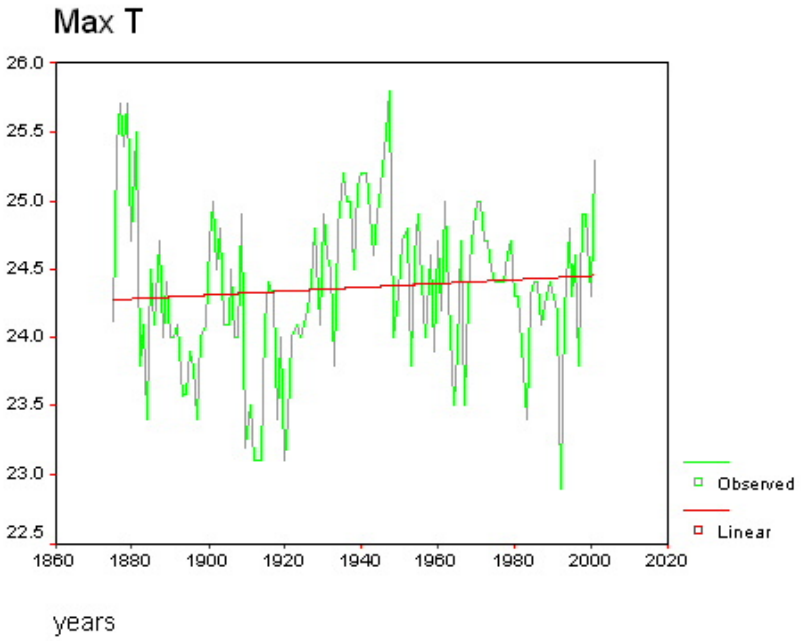
Some Observed Effects - Region

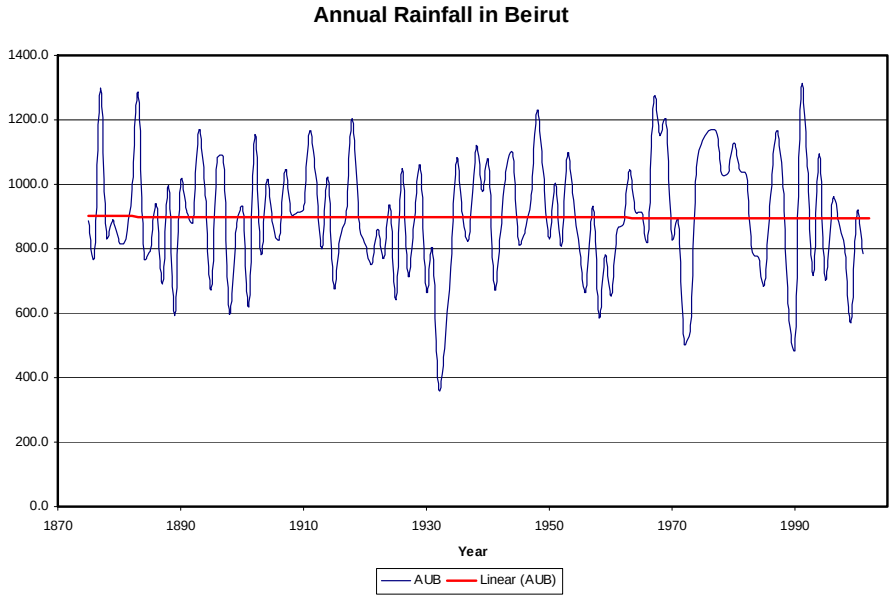
- Increasing summer temperatures and decreasing winter temperatures.
- Increased dust storms affecting crops, human health, economic activity, and tourism
- Observed changes in the timing, form, and intensity of rainfall: decreased snowfall in Lebanon's mountains, and severe thunderstorms or unprecedented floods in Saudi Arabia, in Gaza, in Turkey, and along the Nile river
- A severe drought from 2006-2009 that spanned central Turkey and Syria
- Rising sea levels, observed throughout the eastern side of the Mediterranean basin, and the northern coastline of the Nile Delta (where land subsidence is a key factor)
- Low or empty dams and water storage facilities noted in Turkey, where half of the dams serving Ankara and Istanbul were empty, prompting the installation of a $600 million emergency water diversion system
- Longer and more intense seasons for forest fires observed in Turkey and elsewhere.

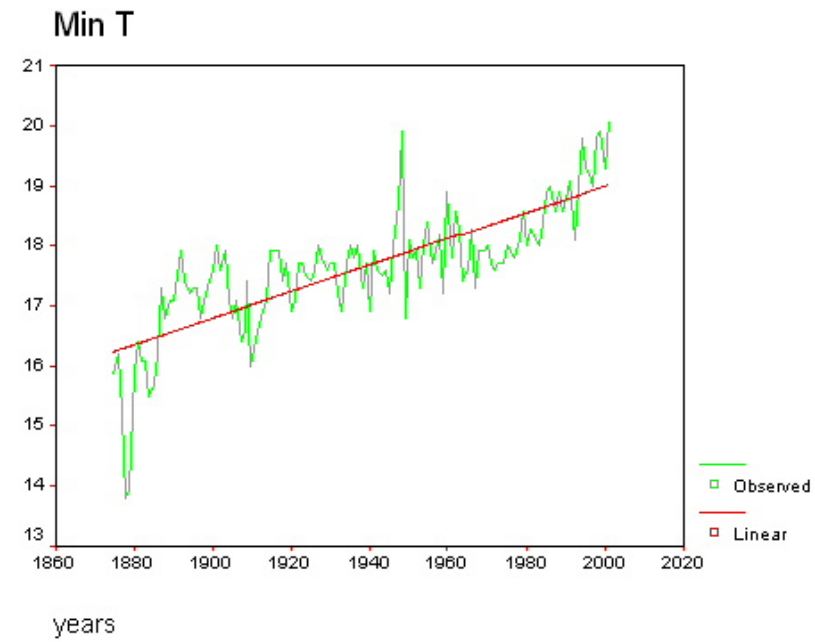
Some Current Numbers - Lebanon

- Population in 2004 is estimated at 4.29 million
- Population growth rate ~ 1.0%
- Proportion of total population in urban areas ~ 83%.

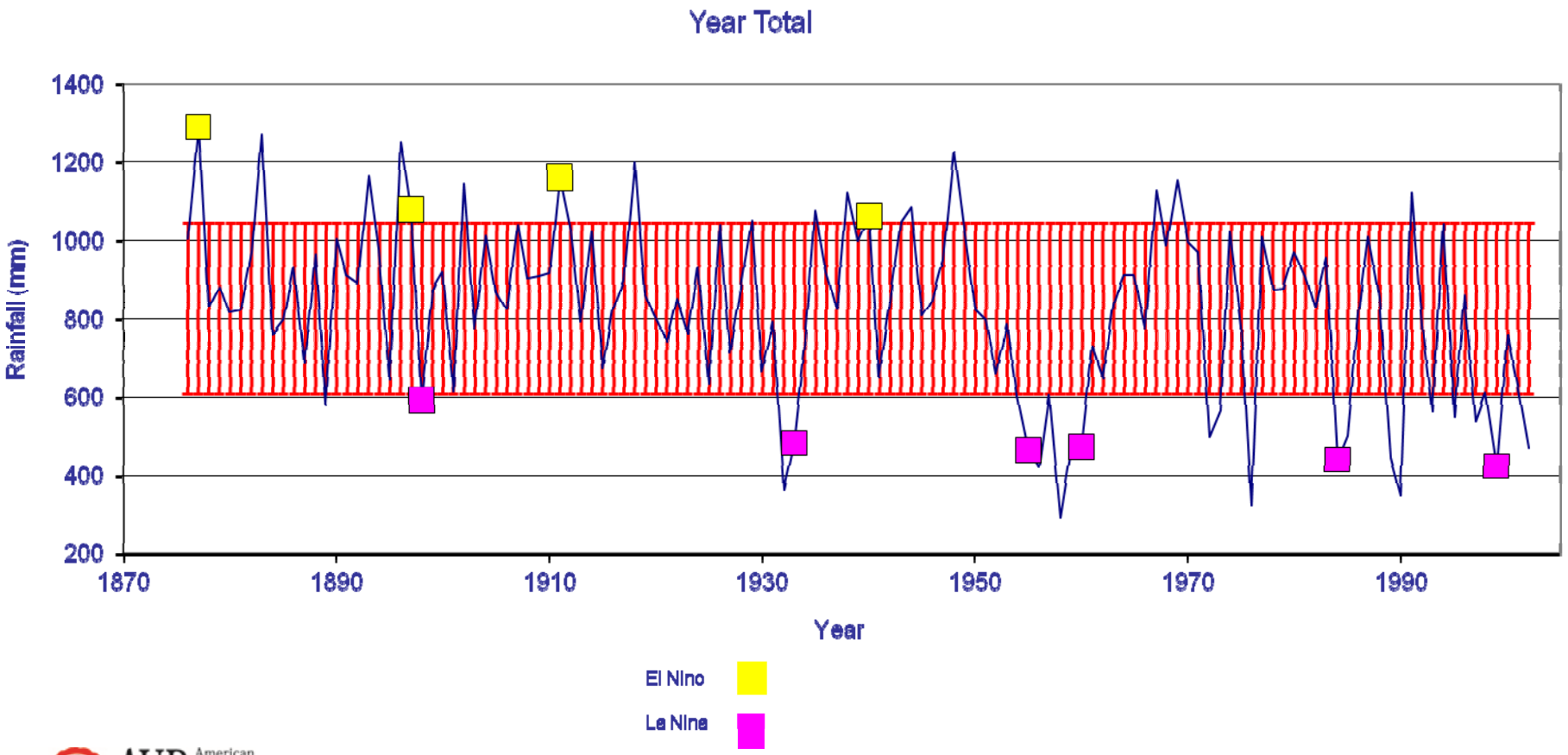
Some Current Numbers – Beirut, Lebanon





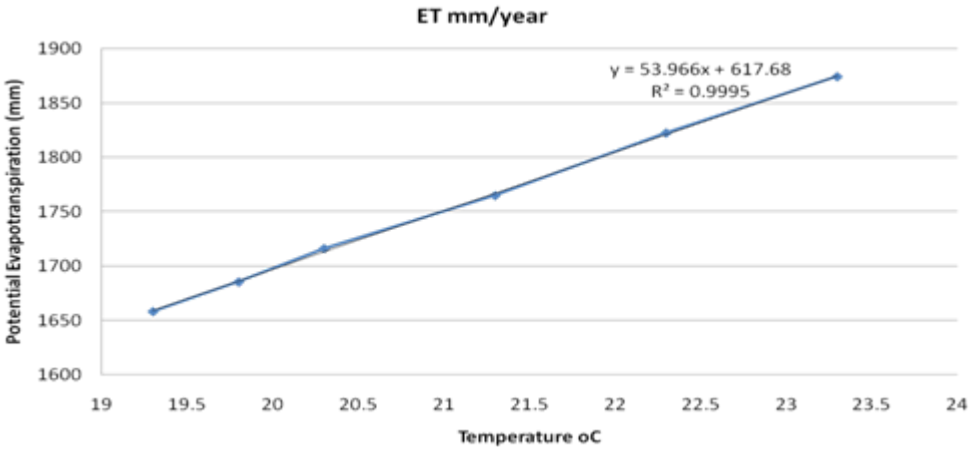


Effects of ENSO on Precipitation

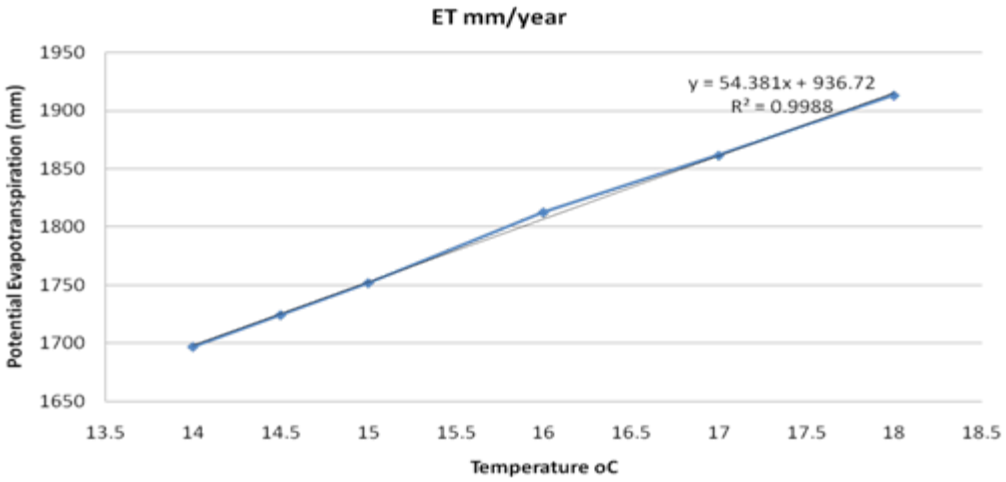


Anticipated Impacts on Water Resources

increase in evapotranspiration



Coast



Inland

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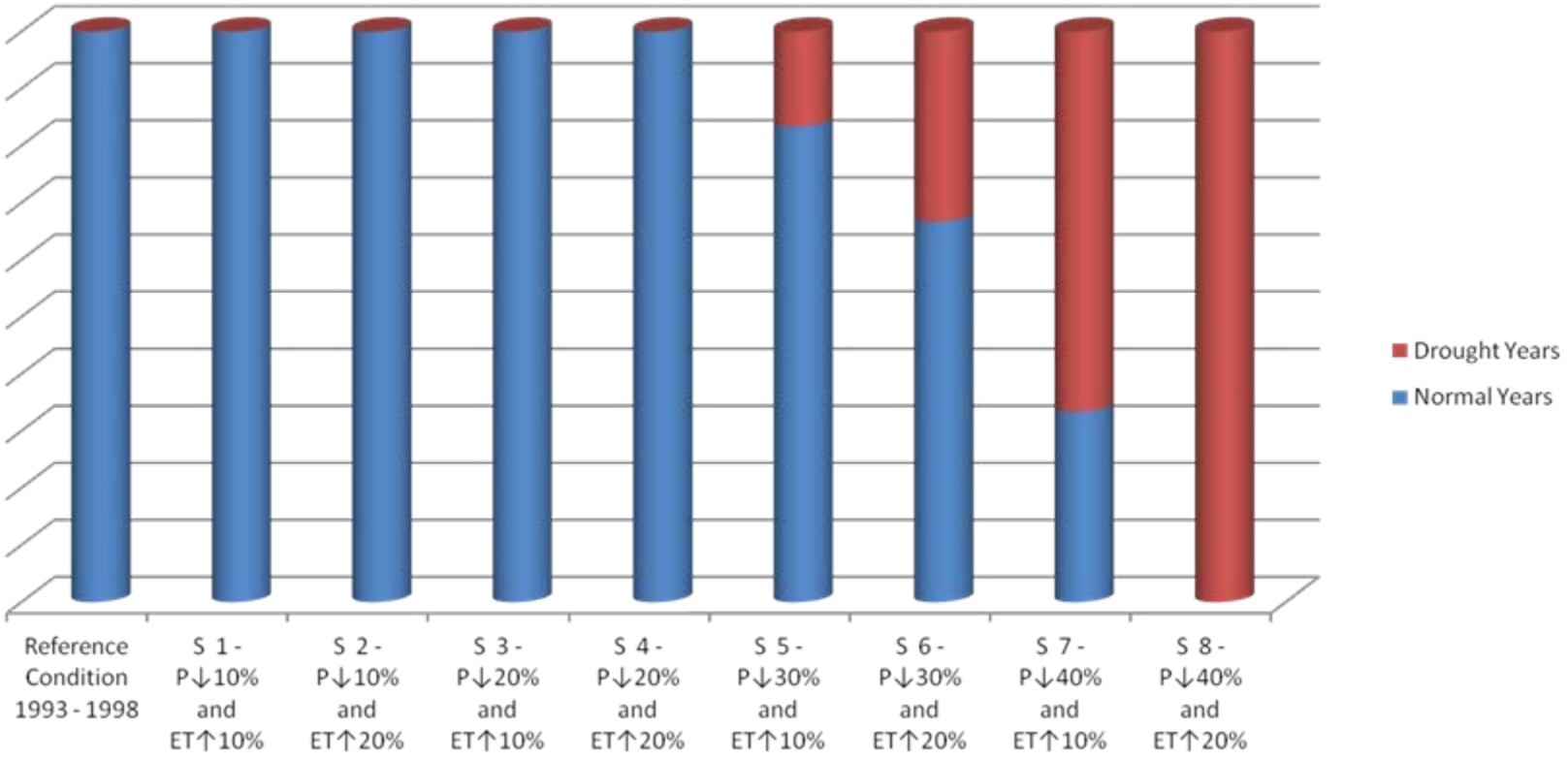
Anticipated Impacts on Water Resources

increase in the occurrence and frequency of droughts



Anticipated Impacts on Water Resources

Hermel Stream Flooding

Al Kabir Flooding

Hasbani Flooding

Litani Flooding


TOYOTA
Chez
COCO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	Hydrometeorological Disasters			Floods			Damages $ million
	Number of Disasters Reported	Total Affected	Victims per year per 100,000 inhabitants	Number of Disasters Reported	Total Affected	Victims per year per 100,000 inhabitants	
1974 – 1978	ndr	ndr	ndr	ndr	ndr	ndr	ndr
1979 – 1983	2	43	0.3	1	1	0.1	na
1984 – 1988	1	1500	9.7	1	1	9.7	16
1989 – 1993	1	104,100	647	ndr	ndr	ndr	204
1994 – 1998	ndr	ndr	ndr	ndr	ndr	ndr	ndr
1999 – 2003	2	500	2.7	1	1	na	na

Hydrometeorological Disasters: floods, landslides, avalanches, storms, droughts, wildfires, extreme temperatures

Floods: floods, landslides, avalanches,

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Source: CRED, 2004

Consequences of Climate Change

- increase in forest fires leading to:
  - decrease in ground cover
  - increase in erosion
  - decrease in infiltration → decrease in groundwater recharge

- reduction in surface and ground water quality
  - higher temperatures reduce dissolved oxygen levels
  - reduced streamflow and lake levels ⇨ less dilution of pollutants;
  - increased frequency and intensity of rainfall ⇨ more pollution and sedimentation due to increased runoff

- sea level rise leading to
  - intrusion of seawater into coastal aquifers
  - Interference with sewage and stormwater sea outfalls/networks in coastal areas.

Consequences on Urban Areas

- Disruption in supply of:
  - Water
  - Food
- Reduction in air quality
- Reduction in water quality
  - Groundwater: Sea water intrusion
  - Surface water: Reduced mixing
- Infrastructure failures:
  - Stormwater and sewage networks
  - Electricity networks
  - Transportation network
  - Increase in coastal erosion
- Stress on public health:
  - Increase in respiratory and vector borne diseases
- Stress on Social Services:
  - Increase in internal migrations
  - Associated unemployment
  - Disruption of school days

Consequences to No Action

- Reduction in national productivity due to illnesses, breakdowns of services, etc.
- Conflict over diminishing resources – internal and external
- Migration – from rural to urban areas with the associated pressures on infrastructure and social services
- Immigration – to better adapted countries, namely the West.

Some Adaptation Measures in the Water-Related Sectors

- Water Resources:
  - Improved urban demand management (new technologies, regulations on new construction and retrofitting, etc.)
  - Demand management in agriculture
  - Improved storage capacity
  - Alternate water sources
  - Virtual water
- Water quality:
  - Wastewater treatment
  - Restriction on access to groundwater
- Infrastructure failures:
  - New technologies
  - Urban green spaces
  - Structural interventions (dikes, breakwaters, flap gates, etc.)
  - Zoning

Some Adaptation Measures in the Water-Related Sectors

- Restrict and control access to groundwater
- Force the use of water saving devices in all new developments and retrofit construction and implement metering
- Control leaks in conveyance and distribution networks to limit UFW to around 20%
- Structure tariffs to attain full cost recovery – introduce incremental block rates to ensure equity
- Encourage the participation of the private sector with the aim of building up the capacity of the public sector – here today gone tomorrow!
- Integrate water resource management into the country's and the region's development plans so that water availability controls development and not the other way round.

Some Adaptation Measures in the Water-Related Sectors

- Improve agricultural water use:
  - Irrigation:
    - conveyance efficiency from source to farm
    - application efficiency, e.g. sprinkler and drip methods
    - New management techniques, e.g. supplemental and deficit irrigation
  - Crop production:
    - Introduce new crops and plants that are drought-tolerant and are suited to the dry/hot environment and to saline water
    - Focus agricultural production on cash crops
    - Shift crop growing areas to regions that have more rainfall or available water
  - Rely on local scientific research for development of above
  - Make use of virtual water principle in assessing agricultural production costs

Some Adaptation Measures in the Water-Related Sectors

- Adaptation in Urban Areas
  - Infrastructure failures:
    - New technologies
    - Urban green spaces
    - Structural interventions (dikes, breakwaters, flap gates, etc.)
    - Zoning
  - Water quality:
    - Wastewater treatment
    - Rainwater harvesting
  - Improved storage capacity
    - Reservoirs (preferably closed)
    - Hill lakes
    - Groundwater recharge
    - Dams
  - Alternate water sources
    - Desalinization
    - TSE

Thank you