

Climate Change: Impact on Water Resources in the MENA Region

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Highlights

- ✘ Water and climate change.
- ✘ What shapes climate in the MENA region?
- ✘ Projected impact on hydrologic variables.
- ✘ Potential impact of climate change on water resources.
- ✘ Water resources adaptation options.

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Water and climate change

- ✘ Water is the single most important issue in addressing the impact of climate change.
- ✘ Water is a limiting factor for the socio-economical development in the MENA region.
- ✘ The MENA region is chronically water deprived due to naturally limited and unevenly distributed supplies, high and rapidly growing demand, and poor water quality.
- ✘ By accentuating all these factors, climate change is expected to exacerbate water scarcity conditions in the MENA region.

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Water Poverty

Renewable water per capita in many countries in the MENA region are well below the threshold of 1000 m³/capita.

| Country | Average Annual Precipitation (mm) | Total Renewable Water Resources (1000 MCM) | Renewable Water Resources (m ³ /capita) | | |
|-----------------------|-----------------------------------|--|--|---------------|---------------|
| | | | 1997 | 2015 | 2025 |
| Iraq | 154 | 63 - 100 | 2,963 - 4,628 | 1,832 - 2,938 | 1,359 - 2,000 |
| Israel | 630 | 1.50 - 2.57 | 280 - 435 | 190 - 356 | 140 - 311 |
| Jordan | 94 | 0.75 - 1.35 | 168 - 229 | 78 - 133 | 70 - 91 |
| Lebanon | 827 | 2.00 - 3.94 | 766 - 1,287 | 336 - 979 | 262 - 809 |
| Palestinian Authority | 350 | 0.20-0.22 | 72 - 92 | 43 - 56 | 34 - 36 |
| Syria | 252 | 15.00 - 21.48 | 1,160 - 1,438 | 759 - 948 | 535 - 609 |

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Skyrocketing Water Demands

Water demands are expected to surge propelled by growth in population and living standards.

| Country | Recent and Projected Total Water Demand | | Breakdown by Sector (2025) | | |
|-----------------------|---|--------|----------------------------|------------|-------------|
| | 2000 | 2025 | Municipal | Industrial | Agriculture |
| Iraq | 54,972 | 74,310 | 4,750 | 3,560 | 66,000 |
| Israel | 1,960 | 3,116 | 997 | 206 | 1,906 |
| Jordan | 1,257 | 1,760 | 700 | 160 | 900 |
| Lebanon | 1,650 | 3,069 | 876 | 693 | 1,1500 |
| Palestinian Authority | 495 | 1,290 | 800 | 70 | 420 |
| Syria | 17,130 | 23,555 | 2,825 | 1,300 | 19,430 |

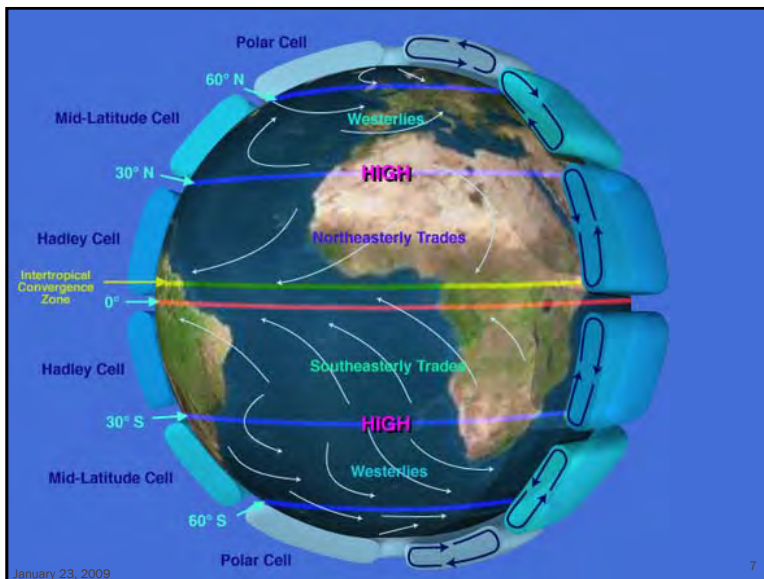
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What shapes climate in the MENA region?

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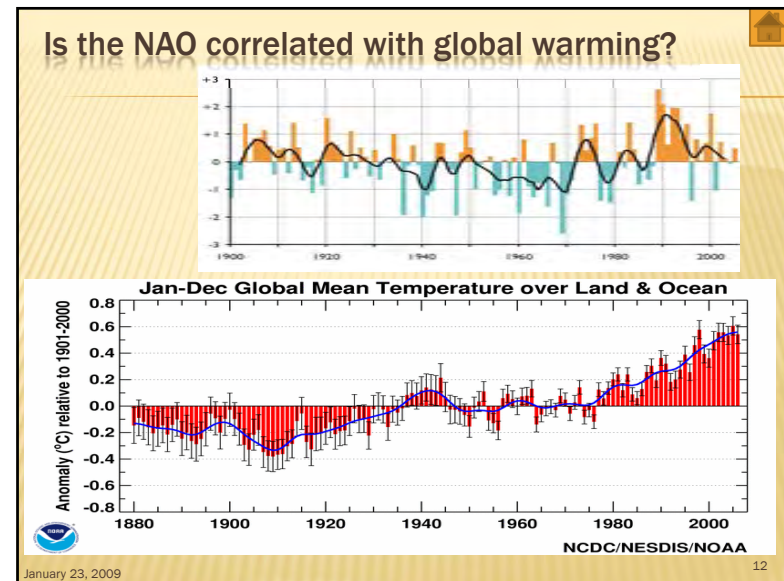
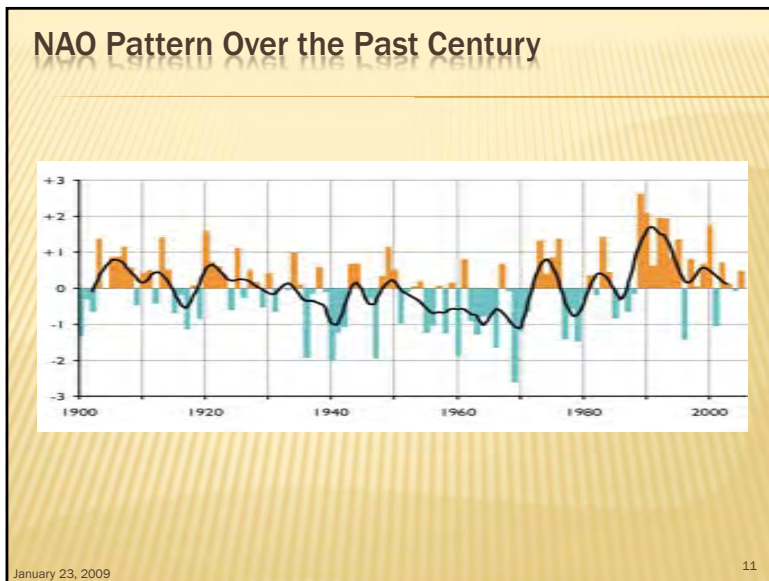
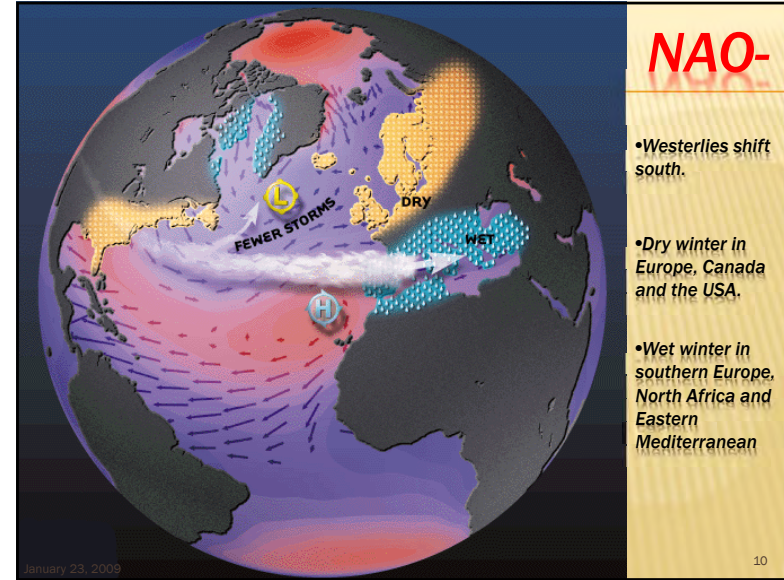
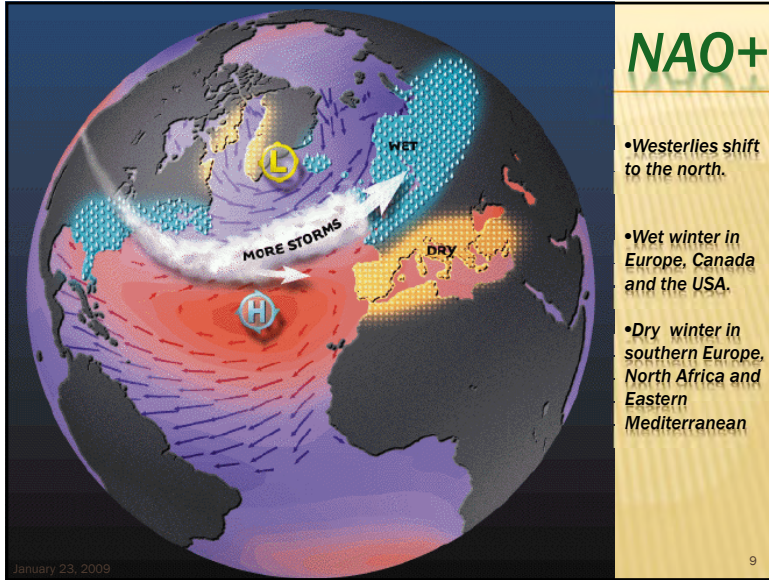
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What shapes climate in the MENA region?

- ✗ Most of the MENA region lies in a transition zone between the Westerlies in the north and the subtropical Monsoon system to the south.
- ✗ A southerly shift in the Westerlies increases precipitation in the northern MENA and is accompanied with lower precipitations in the southern regions (e.g. the Nile's headwaters) due to weakened Monsoon system; and vice versa.
- ✗ This process is highly influenced by a global climatic phenomenon known as the North Atlantic Oscillation (NAO), driven by the atmospheric pressure difference between the polar low and Atlantic subtropical high.

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Projected Impact on Hydrologic Variables (IPCC 2008)

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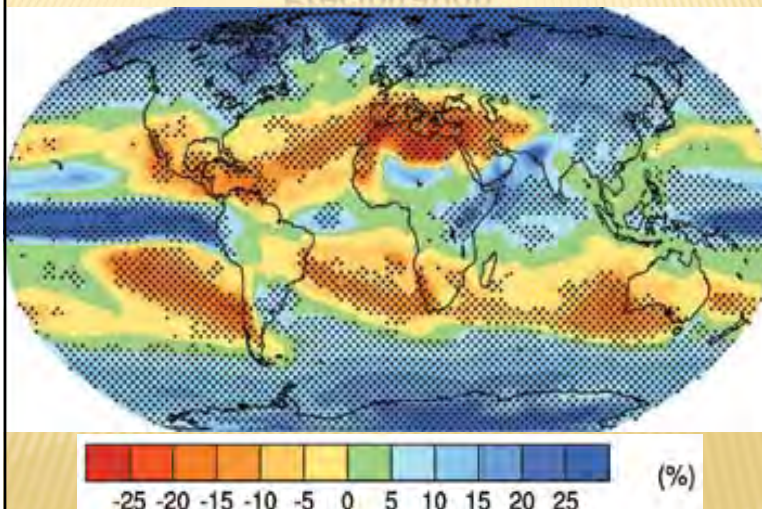
Projected Impact on Hydrologic Variables (IPCC 2008)

- ✦ Changes are annual means for the SRES A1B scenario for the period 2080–2099 relative to 1980–1999.
- ✦ Fifteen-model mean % changes in precipitation, soil moisture content, runoff, and evaporation
- ✦ Regions are stippled where at least 80% of models agree on the sign of the mean change.
- ✦ Soil moisture and runoff changes are shown at land points with valid data from at least ten models

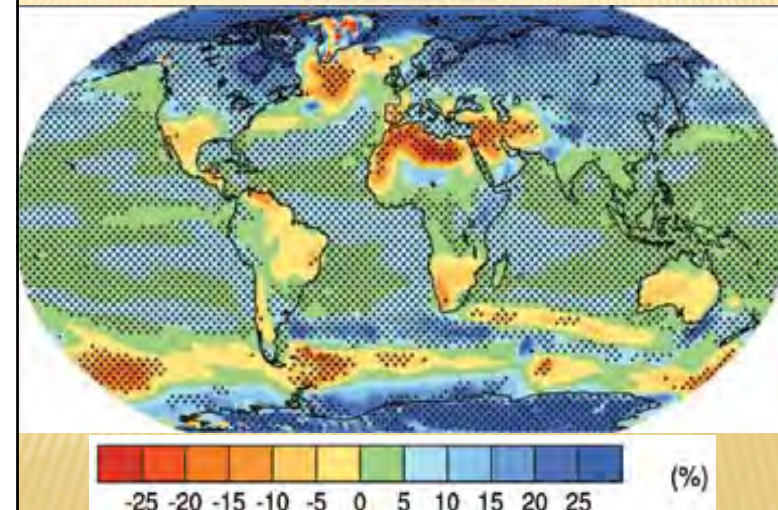
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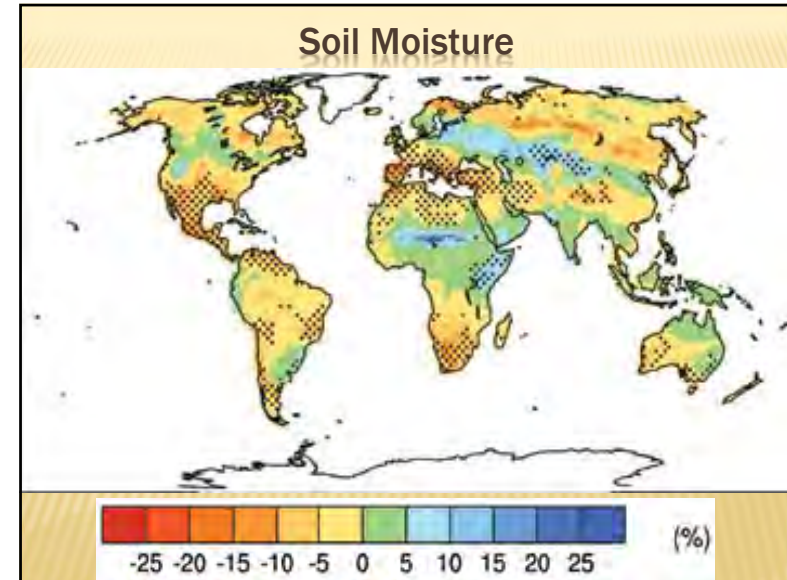
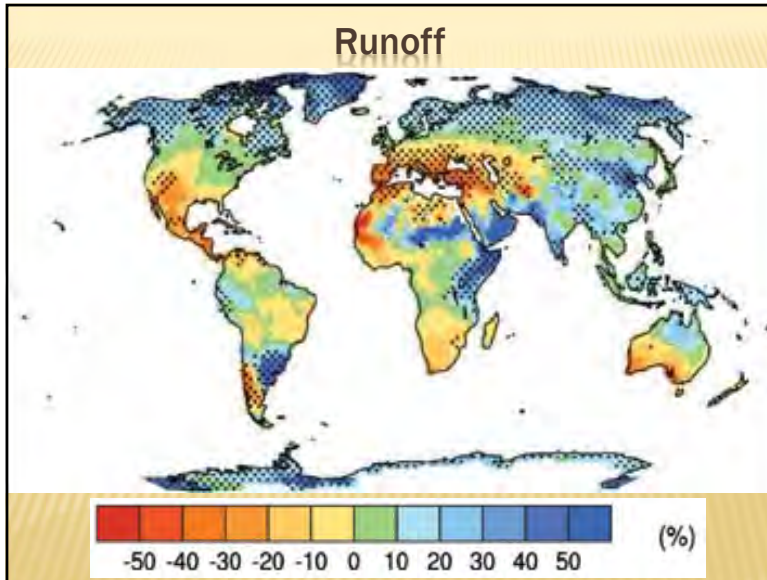
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Precipitation



Evaporation

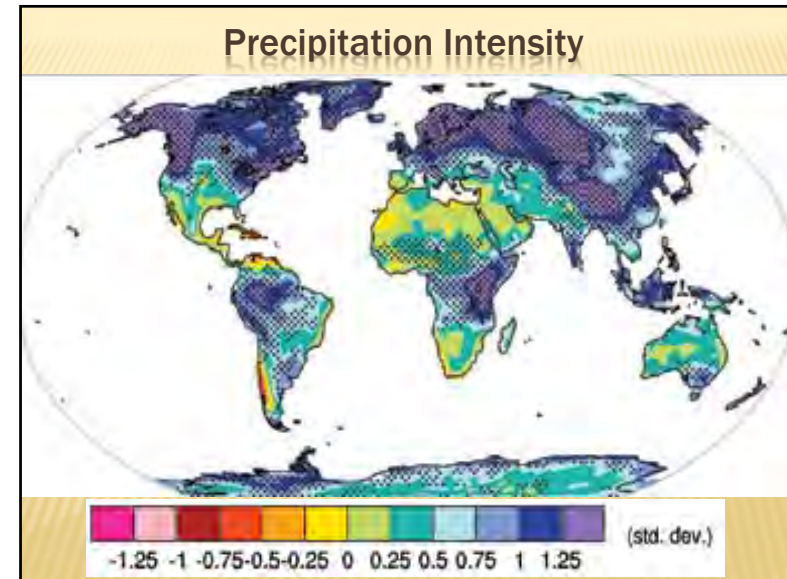


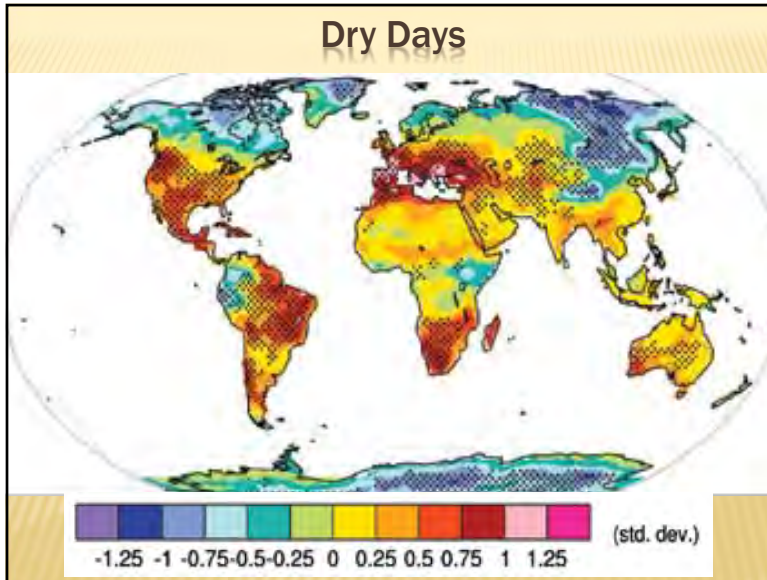


Projected impact on precipitation intensity and dry days

- ✘ Precipitation intensity is defined as the annual total precipitation divided by the number of wet days.
- ✘ Dry days is defined as the annual maximum number of consecutive dry days.
- ✘ Stippling denotes areas where at least five of the nine models concur in determining that the change is statistically significant.
- ✘ The changes are given in units of standard deviations

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Potential Impact of Climate Change on Water Resources

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Impact of climate change on water resources in the MENA region

- ✘ The Northern more humid regions of the MENA region will receive less precipitation and face warmer weather. (the Westerlies will drift northwardly)
- ✘ Consequently, all river systems, with the exception of the Nile, will receive less water exacerbating water scarcity.
- ✘ The Monsoon system is expected to become more dominant bringing more precipitation to the Nile's headwaters.

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Impact of climate change on water resources in the MENA region

- ✘ Floods will intensify and become more frequent, which results in:
 - + Increasing the risk to life, buildings and infrastructure,
 - + pollution of water resources
 - + loss of top soil
 - + sedimentation of reservoirs.
 - + difficulty in capturing runoff.

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Impact of climate change on water resources in the MENA region

- ✘ The frequency, duration and extent of droughts will increase, aggravating the scarcity problem and drive the desert frontier northward.
- ✘ Higher evapotranspiration rates will accelerate losses from natural lakes and reservoirs and reduce effective precipitation.
- ✘ Reduction in soil moisture (green water) will impact rain-fed agriculture and increase demand for irrigation.
- ✘ Higher temperatures will increase urban water demand.

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The potential impact of climate change on water resources

- ✘ Snow will arrive later, disappear sooner and moves higher, reducing the value of this strategic and natural storage of water.
- ✘ This is particularly problematic for Lebanon, where a significant portion of water originates as snowfall.
- ✘ Higher CO₂ levels are expected to improve plant's water efficiency and increase productivity.

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Consequences of higher sea levels

- ✘ Aggravation of the sea water intrusion problem in coastal areas (e.g. Beirut).
- ✘ Increase in the erosion of beaches and damage to onshore structures due to boosting of wave action.
- ✘ Reduction in the efficiency of coastal urban drainage systems and power plants due to loss of hydraulic gradient between outlets and sea level.
- ✘ Combined with expected increase in the frequency and intensity of extreme rainfall events may lead to substantial increase in coastal urban flooding.
- ✘ Loss of coastal land (potentially a serious problem for Egypt, where the low-lying Nile Delta houses millions of people and support major agricultural activities).

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Water Resources Adaptation Options

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Water Resources Adaptation Options

- ✘ Even under the most optimistic scenarios, elevated CO₂ levels are expected to last for centuries.
- ✘ Adaptation is generally a no-regret approach since its options have dual benefits.
- ✘ Adaptation to manage water resources in the MENA region under potential climate change is a win-win situation since they will leverage efforts in dealing with existing water issues. E.g. drought management, demand control, etc.

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Water Resources Adaptation Options

- ✘ Developing water storage and transfer capacity to deal with long-term and more frequent droughts, and the expected loss of natural snowpack storage. (e.g., the 800 conveyor and Beirut-Awali Conveyor, Bisri Dam).
- ✘ Water demand management including effective water pricing, education, leakage control and investment in water efficiency technologies.
- ✘ Regulation of water pumping in coastal areas to control sea water intrusion.

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Water Resources Adaptation Options

- ✘ Water reuse.
- ✘ Recharge of aquifers.
- ✘ Sectorial transfer (agriculture to urban & industrial).
- ✘ Improve water drainage systems, especially in coastal urban centers to mitigate the impact of increased flooding.

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Research Efforts: Develop a water resource planning model for Lebanon

- ✘ A simulation GIS-based model will be developed to represent natural water resources, man-made features (dams, wells, etc.), water demand centers (urban, agriculture, industrial) and environmental constraints.
- ✘ The potential impact of climate change on Lebanon's water resources and its capacity to meet water demands will be evaluated through simulating and assessing several alternative climate change scenarios.
- ✘ The simulation model will be used to explore alternative adaptation options that could include enhancing water supply capacity, demand management, and water reuse.

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