The Energy-Water-Security Nexus in the Jordan River Basin: A Sustainable Outlook for Strategic Resources?

Bonthius, C.[1,2], Moran, A.[2*], Rosner, K.[3,4], & Scholl, E.[2]

[1] Department of Geography and the Environment, The University of Texas at Austin,
[2] Robert S. Strauss Center for International Security and Law, The University of Texas at Austin
[3] Institute for the Analysis of Global Security
[4]Stockholm Environment Institute

*Primary contact: amoran@austin.utexas.edu

The Water-Energy-Security Nexus

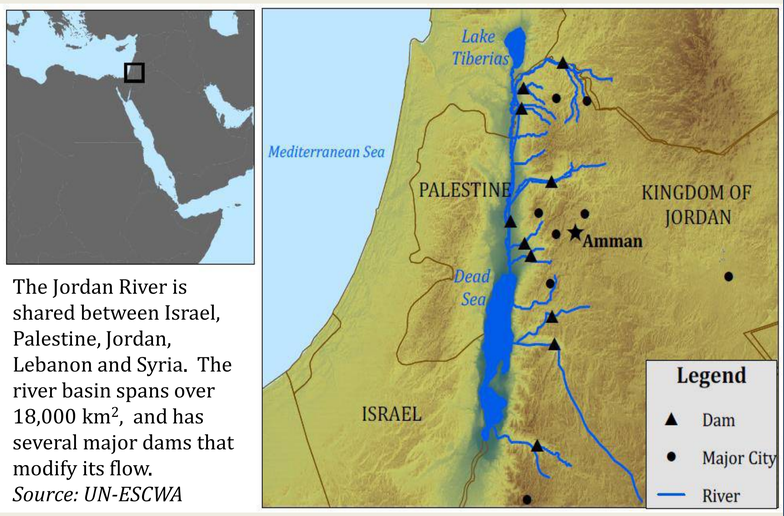
i) Water and energy are inextricably linked, as treating and distributing water takes energy and producing electricity requires water[1]

ii) The lack of either resource may hamper socioeconomic growth[2], strain domestic stability[3], and create transboundary tensions[4]

iii) Pressures, such as increasing population growth, climatic variability and sectarian conflict pose a threat to sustainably managing these strategic resources in an uncertain future

Area of Interest: the Kingdom of Jordan

- Jordan is the most water stressed country in the Middle East with a current water deficit of approximately 150 million m^3 [3 5]
- As a stakeholder in transboundary river basins, Jordan is vulnerable to environmental and geopolitical disturbances in the region
- Jordan is one of the largest recipients of refugee populations from regional conflict epicenters, which adds pressure to already strained water and energy sectors
- Active projects, such as the Disi Aquifer Project and the Red-Dead Sea Project, aim to increase and improve access to water and energy for Jordan



The Jordan River is shared between Israel, Palestine, Jordan, Lebanon and Syria. The river basin spans over 18,000 km^2, and has several major dams that modify its flow.
Source: UN-ESCWA

Major Objectives

The objectives of this research are threefold:

i) Understand how the Kingdom of Jordan is coping with its interrelated water and energy challenges

ii) Locate areas of water and energy deficiencies, and examine the underlying causes of underutilized and inefficient resource consumption

iii) Recommend solutions to sustainably address water and energy stress under future scenarios of increasing pressures on resource needs

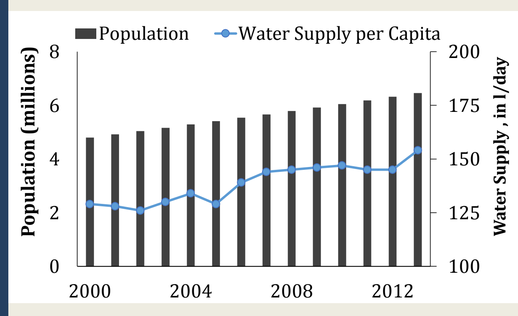
Methods

This research synthesizes information from across various fields. A **data-driven** approach allows for the coupling of **geospatial and quantitative data** with **qualitative assessments** of Jordan's energy-water nexus.

Resource Use

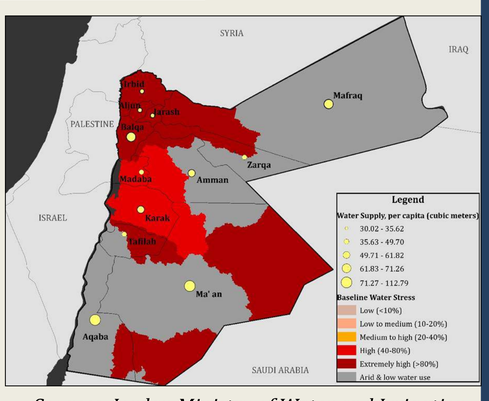
Water

Though Jordan's per capita water supply has increased, despite a growing population, it still does not meet demand. Significant water loss (66% in some areas) due to old infrastructure is an issue throughout the country.



Left: Per capita water supply has increased due in part to a growing use of treated water for municipal supply. *Source: Jordan Ministry of Water and Irrigation; World Bank*

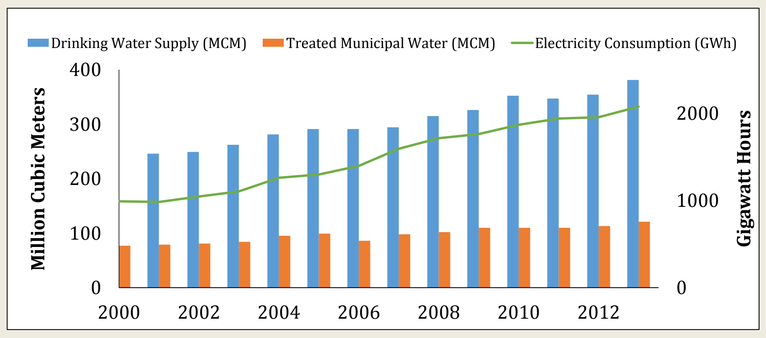
Right: The entire country of Jordan is considered to be under high or extremely high water stress. Average per capita water supply is approx. 60 liters per day. The regions of Irbid, Mafraq and Amman have experienced the greatest population growth, which has strained resources.



Sources: Jordan Ministry of Water and Irrigation; World Resources Institute

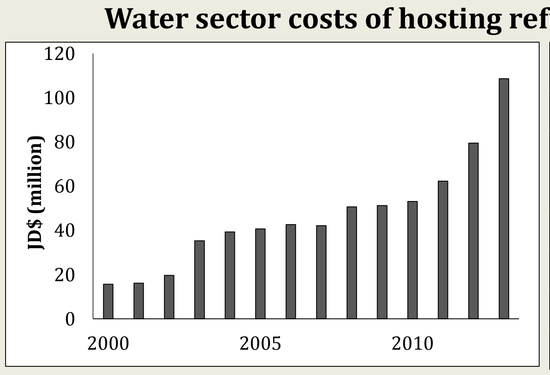
Energy

Jordan's water sector consumes a large amount of energy to transport, treat and distribute water. The country has invested in energy-intensive technologies, such as water treatment and desalinization, to augment its water supply.



Top: The water sector's energy need has increased to treat municipal water for use *Bottom:* Jordan has increased spending on the water sector's energy needs to provide water to refugees. *Sources: Jordan Ministry of Water and Irrigation; World Bank*

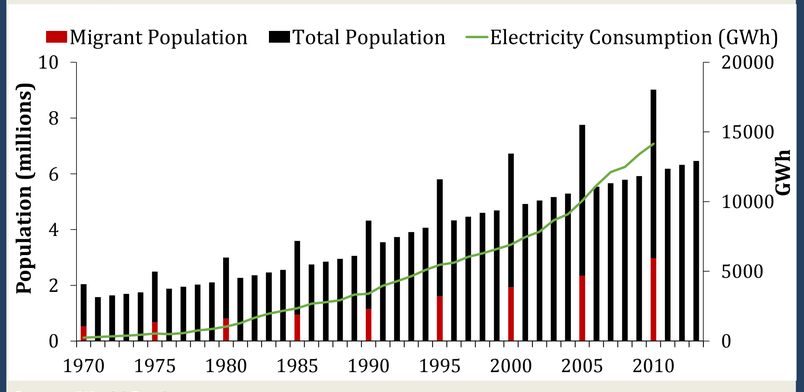
Water sector costs of hosting refugees



Financial Costs
Capital Costs
Operations & Management
Economic Costs
Over-Pumping
Crisis Management
Opportunity

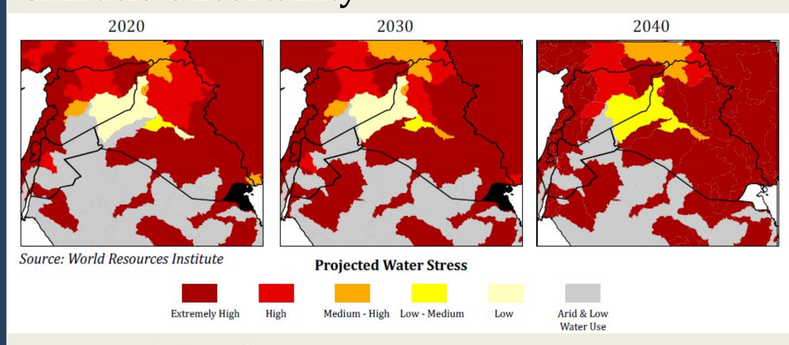
Pressures

Refugees



Source: World Bank

Climatic Uncertainty



Source: World Resources Institute

Regional Conflict

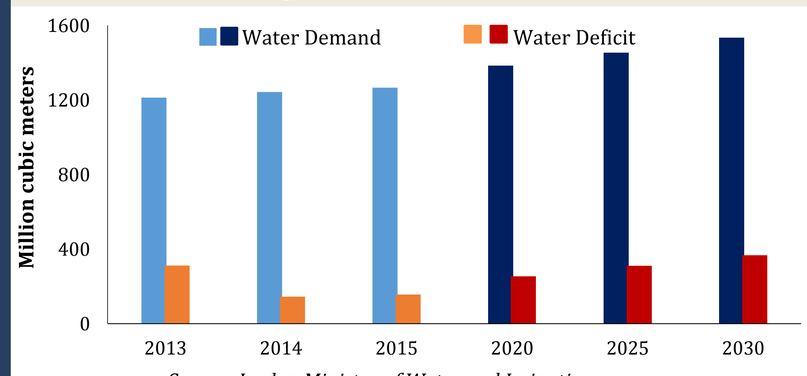
Water and energy resources and infrastructure as a:

Stressor	Tool	Target
• Shortages • Drought	• Intentional flooding	• Bombing of pipelines

Assessing Sustainability in the Water-Energy-Security Nexus

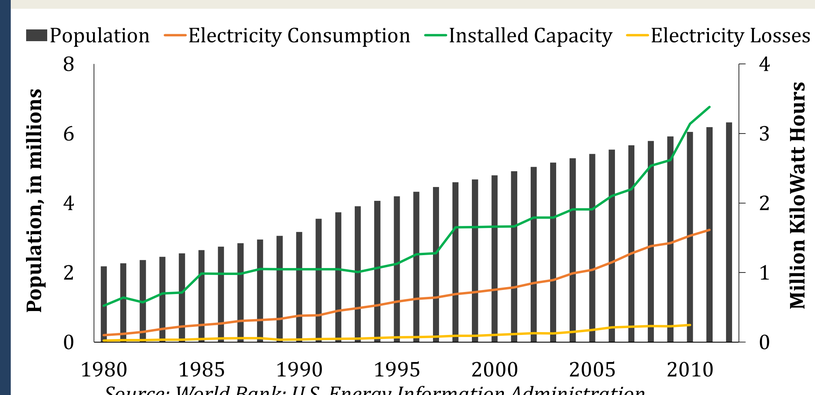
Sustainability in the water and energy spheres may be assessed as separate indicators to evaluate their individual outlooks. However, given the interrelated nature of these resources, a metric that accounts for their interdependence may better assess water and energy's coupled relationship.

Water Availability and Deficits



Source: Jordan Ministry of Water and Irrigation

Energy Capacity and Consumption



Source: World Bank; U.S. Energy Information Administration

Integrating Watts and Water: a Conceptual Framework

A comprehensive metric for evaluating sustainability in the energy-water nexus should include at least four main components:

• What is the proportion of available water used to produce electricity, and vice versa?	• What type of water (ground, surface, treated, etc) is used? • What fuel is used?
Quantity	**Source**
Location	**Sector**
• Do resource deficits in resource need or availability overlap?	• What sectors or populations are disproportionately affected by resource shortages?

Towards a Sustainable Future

- Pursue projects that augment water supply
- Increase efficiency in water and energy production and distribution
- Integrate planning between energy and water sectors in strategic planning
- Strengthen transboundary relationships to enhance regional resource sustainability and resilience

References

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