

## WEF (Water-Energy-Food) Nexus Research Team

### Research group activity and applications

Status | Project | Contact

Ongoing | WEF Nexus Tool | [Rabi H. Mohtar, Texas A & M](#)

The global community faces unprecedented risks that are directly linked to how we currently understand and manage resources. Sustainable solutions to these challenges require understanding the interlinkages between water, energy, and food as the primary systems that form a nexus affected by external factors (growing population, changing economies, international trade, governance, health, environment, climate change). Our WEF Nexus Research Team is committed to integrative thinking that builds upon the interconnectedness of the water-food-energy systems to enhance collaboration at all levels: stakeholders to policy makers. To this end, our team works to: develop and deploy WEF Nexus Analytic tools at different scales; develop improved thermodynamic modeling to better account for greenwater; and to assess the feasibility and implications of non-traditional (treated waste) water. The goal is to achieve a better understanding of the interlinkages between water, energy, and food in order to support decision-makers in identifying sustainable resource management strategies. To this end, we have developed a holistic platform (WEF Nexus Tool 2.0©) which continues to evolve.

### Primary Objectives of the WEF Nexus Team ([wefnexus.tamu.edu](http://wefnexus.tamu.edu))

- 1) **Develop and deploy Water-Energy-Food (WEF) Nexus Analytic Platforms and Tools** to provide a basis for sustainable resource management strategies based on quantification of specific resource (water, energy, land, financial, societal) requirements:
  - quantify inter-linkages for the resources nexus
  - develop tradeoffs and protocols for their assessment
  - enable assessment of sustainability of water, energy and food systems
  - apply W-E-F scenarios across ecological and socio-economic zones
  - identify inter-linkages between energy, water, food systems
  - provide a dynamic model to enable decision-makers and stakeholders to systematically integrate policy preferences based upon comparative scenarios and their respective resource requirements.

*The WEF Nexus Tool 2.0 can be accessed at: [www.wefnexustool.org](http://www.wefnexustool.org)*

- 2) **Develop better thermodynamic modeling**, including scalable models, for **Green Water Accounting**. Soil thermodynamics and soil structure are affected by local practices that are not currently integrated into hydrological processes at the landscape scale. Hydrologic models and tools are effective at providing the data needed for watershed level events, but, the thermodynamic state of the soil water medium constitutes the local physical conditions of development for all biological and geochemical processes within the soil medium. It is still not well defined and characterized. This situation limits modeling and coupling the different

processes in the soil medium. Because these are thermodynamically linked to the soil water cycle, improved thermodynamic modelling will allow more effective accounting for green water resources.

A description of the model is available at: <http://www.tandfonline.com/doi/abs/10.1081/E-EAFE2-120049111#.VMAQSEdOSSo>

- 3) **Assess the feasibility of non-traditional water for irrigation and for helping to bridge the water gap:** economic, technical, soil quality, health impact at the lab and field scales. Understanding the implications of soil property changes that result from repeated wastewater applications is essential. Reducing reliance on fresh water by allowing an additional safe, global water resource for food production is essential to our future water-food-energy security.

### Sample Applications

**Nexus Analytics** – help identify and quantify interlinkages between water, energy, and food systems. **Our team has developed a framework and tool** that captures technical and scientific inputs while also incorporating inputs from decision making circles reflecting specific strategies, costs and trade-offs. The **WEF Nexus Tool** output quantifies elements of the scenario, including water requirements, local energy, carbon emissions, land, and financial requirements, as well as those elements those related to import (energy consumption, carbon emissions). It *offers a dynamic model for systematic integration of resources during the planning and decision making process.*

**The tool provides** an opportunity to resolve current and foreseen bottlenecks, while answering critical questions related to energy, water and food securities through trade-off analysis. The comprehensive framework reflects the multidimensional and interdisciplinary nature of resource management projects. The underlying generic framework represents the quantitative relations and interconnections between the three systems.

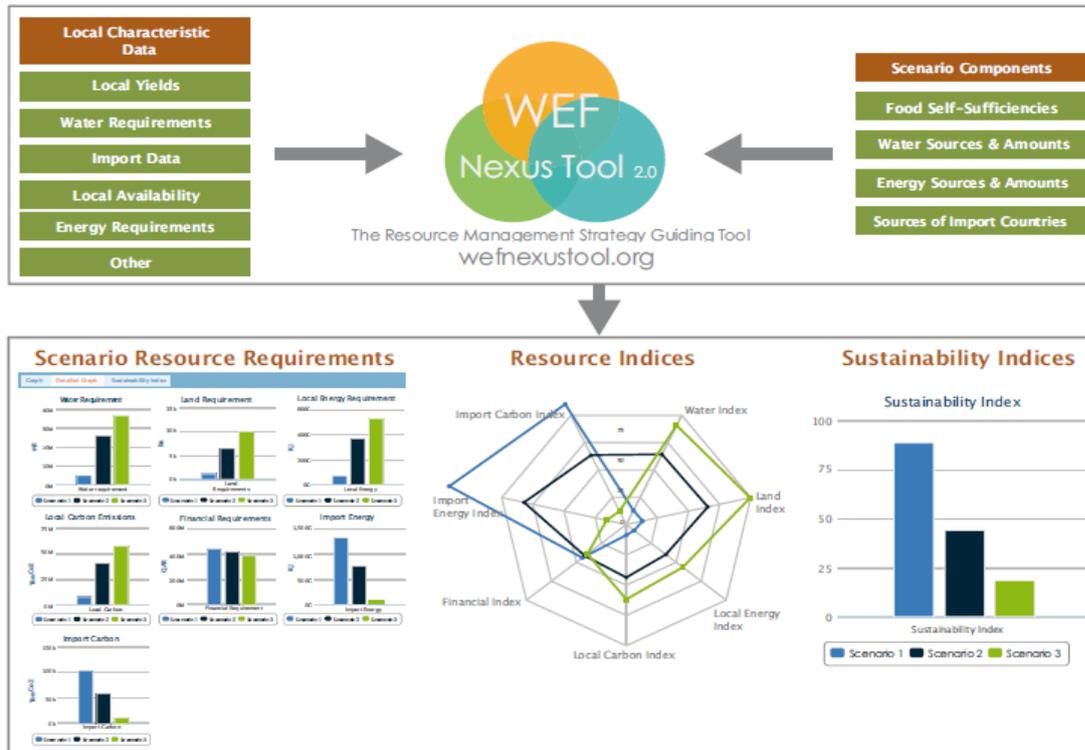


Figure 1: WEF Nexus Tool Structure (Mohtar and Daher, 2014)

**Application 1- Bridging the Water Deficit: a Texas case study** - The 2012 State Water Plan for Texas indicates an anticipated water gap of 40% by the year 2060, with supply demand deficit of 8.24 billion m<sup>3</sup>. **Effectively bridging the water gap** in Texas requires multiple solutions that vary with the region, and depend upon resource availability versus need, as well as the type of water consumption activities happening in each zone. Questions arise such as:

- can we better utilize green water to reduce stresses?
- Can we use New water in energy and agriculture?
- what will work where?

**Application 2- Integrative planning for sustainable growth and food security: a Qatar case study** - Qatar is enjoying a period of rapid economic and population growth catalysed by the abundance of its oil and gas reserves. Yet, Qatar’s harsh environmental conditions (severe water scarcity and aridity), severely limit local food production such that Qatar imports more than 90% of the food it consumes. Such high reliance on food imports to supply the local market involves high risk, yet, a decision to increase local production requires a comprehensive understanding of the interconnected water-food-energy systems and of the trade-offs between them. Integrative planning is essential to ensure sustainable growth, while eliminating unintended, negative consequences. Qatar aims to meet 40% of its food demand with local supply in the coming decade (Gulf Times, 2014): major resources will need to be employed to support this goal, including water, energy, land, and financial.

The WEF Nexus team conducted a sensitivity analysis for the resources involved and concluded that land requirement is the one most sensitive to increases in food production (Daher and Mohtar, 2014). This is primarily due to low local yields in light of environmental conditions hostile to efficient agriculture production. Qatar receives an average of 80mm/year of rainfall, and water withdrawals were recorded at 455% of total renewable water resources in 2005 (Aquastat, 2014): tapping the ground water to execute the food security plan is not an option. Part of the Qatar’s food security plan involves using solar-desalination to provide water for agriculture. A preliminary assessment conducted by Daher and Mohtar using the WEF Nexus Tool, showed the need for 206% more water to enable an increment of 25% in food self-sufficiency for eight selected food products (Mohtar R.H. and Daher B., 2014).

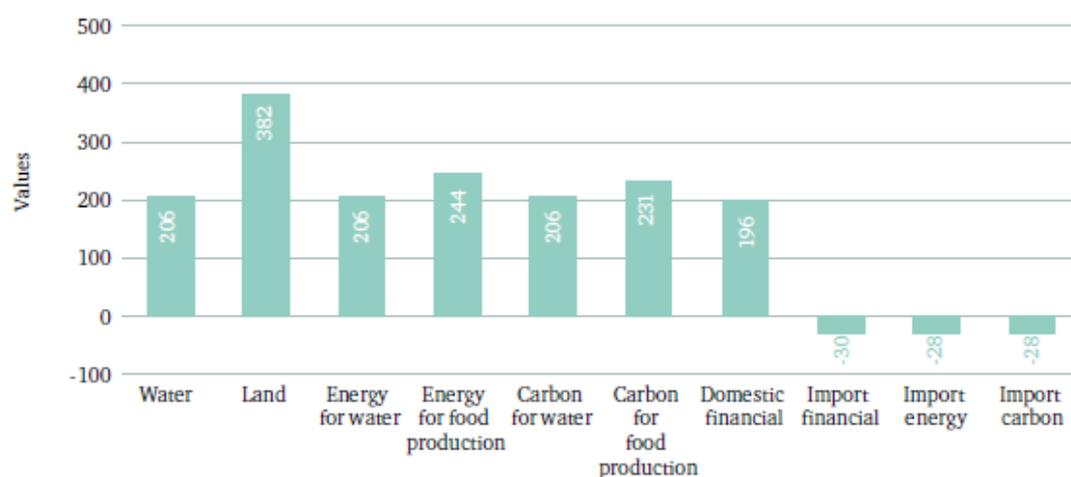


Figure 2: Percentage change in resource needs for a 25 per cent increase in the self-sufficiency of eight food products (Mohtar R.H. & Daher B., 2014)

**Application 3- Water-Fracking-Transport Nexus:** While fracking contributes to energy security and economic growth opportunities, it also carries short and long term social and environmental impact on local infrastructure (roads and lifelines). Our nexus study explores ways to maximize the advantages of this industry while minimizing unintended negative consequences?

### References

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nexus dialogue on  
**WATER INFRASTRUCTURE SOLUTIONS**  
building partnerships for innovation in water, energy and food security

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