



Food and Agriculture Organization
of the United Nations

Water-Energy- Food Nexus Webinar series

Topic: **Understanding the nexus
and nexus challenges:
Examples from NENA**

Presenters: Domitille Vallee,
Annette Huber-Lee, Youssef Almulla
and Francesco Fuso-Nerini

2 February 2021



Set limits-Defining
the safe boundary
conditions for water
sustainability



WATER

Productivity
Efficiency, and
Sustainability

in the NENA countries





Webinar series objectives

- Give a deeper understanding of the water-food-energy (WEF) nexus, including how it is defined and its importance
- Navigate approaches for identifying both nexus challenges and solutions to those challenges, and what types of tools may be developed to find robust solutions
- Use case studies of current efforts and best practices to manage the water-energy-food (WEF) nexus in NENA countries and beyond for sustainability and resilience of people and ecosystems





Webinar series

No.	Date	Title
1	2 Feb 2021	Understanding the nexus and nexus challenges: Examples from around the world
2	15 Feb 2021	Tools and Methods to find Nexus Solutions: Examples from Jordan and Morocco
3	2 Mar 2021	A Water-Energy-Food Nexus approach for evaluating the sustainability of the Mediterranean Diet: The Case of Lebanon
4	16 Mar 2021	The WEF Nexus on the ground: practical applications from the Maghreb and West Africa
5	30 Mar 2021	Selected experiences with WEF Nexus decision-making: applications in Jordan and Morocco
6	tbd	tbd



Understanding the nexus and nexus challenges: Examples from NENA

Annette Huber-Lee, SEI

Youssef Almulla, KTH

Francesco Fuso-Nerini , KTH



Objectives for today

- Deepen understanding of the nexus and learn about one analytical approach to explore the nexus
- See applications of identifying nexus challenges in selected cases in the NENA region:
 - Souss-Massa, Morocco;
 - Jordan;
 - The North Western Sahara Aquifer System (NWSAS).
- Start brainstorming possible nexus challenges in your country





Overview

- What is the nexus and what value does it bring?
- Methodology used in the FAO 2030 water sustainability project
- Show case the implementation of the methodology on selected case studies





Agenda

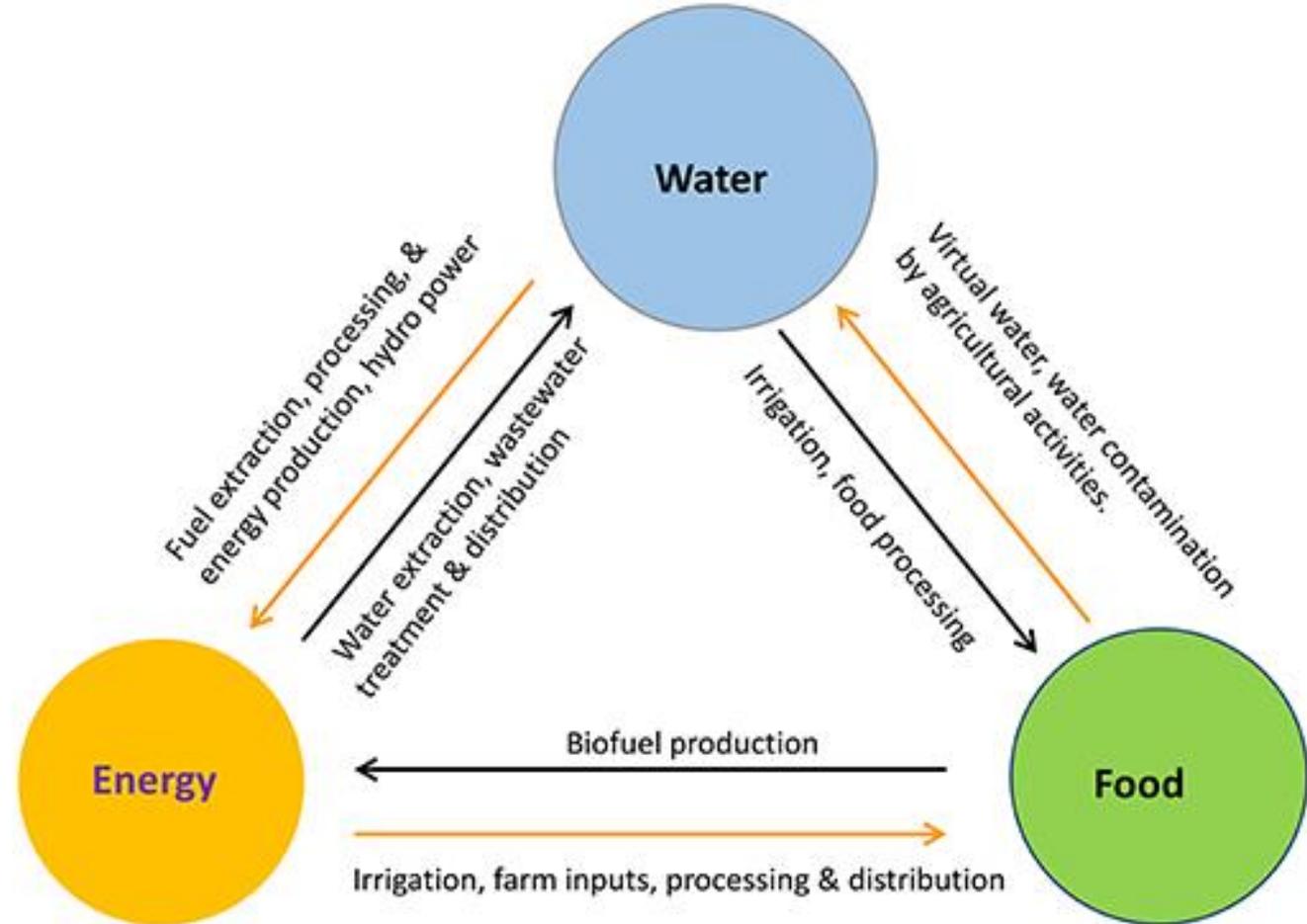
Topic	Speaker/Moderator	Duration
Value of the nexus	Annette Huber-Lee	10 min
Methodology used for the FAO project		10 min
Nexus challenges for Morocco and Jordan	Youssef Almulla	10 min
Example from North Western Sahara Aquifer System		15 min
Break out groups	All	15 min
Report back and Q&A	Francesco Fuso-Nerini	15 min



What is the nexus and what value does it bring?

What is the WEF nexus?

- Water, food and energy systems are highly interlinked
- Taken together, they are often referred to as “the nexus”



Mentimeter

The WEF nexus and Sustainable Development Goals (SDGs)



SDG cross-impact methodology

“If progress is made on target x, how does this influence progress on target y”?

-  Positive reinforcement
-  Consistent (not – or +)
-  Negative reinforcement

Not all interactions are negative

Selected SDG targets (influenced targets)

	1.3	1.5	2.2	2.4	3.4	3.8	4.1	4.4	5.4	5.5	6.5	6.6	7.2	7.3	8.4	8.5	9.4	9.5	10.1	10.7	11.1	11.2	12.1	12.5	13.1	13.2	14.1	14.4	15.2	15.5	16.4	16.6	17.11	17.13	SUM			
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Drivers for nexus studies

Scarcity

- Especially of water, secondarily of energy/food
- Scarcity in one system tied to activity in another system or causing impacts in another system
- Scarcity leading to economic losses for consumers

Threats

- Infrastructure and other development with impacts that cross systems
 - Hydropower
 - Irrigation
 - Biofuels plantations
- Climate change
 - Decreased availability of water
 - Reliance on hydropower, rainfed agriculture



Nexus for more coherent sectoral policies

- Why a Nexus Approach? We need to break the “silos” that keep sectoral policies separated and sometimes incongruent.
- Policy coherence* can help break down the silos
- What does “policy coherence” mean?
 - ❖ Inter-sectoral exchange of communication
 - ❖ Active coordination and due consideration of different interests
 - ❖ Synergy and co-operation towards common objectives

*Weitz, Nina, Claudia Strambo, Eric Kemp-Benedict, and Måns Nilsson. "Closing the governance gaps in the water-energy-food nexus: Insights from integrative governance." *Global Environmental Change* 45 (2017): 165-173.





Are nexus inter-linkages clear to policy makers?

- To a limited extent, on **already known issues** (e.g. hydropower vs irrigation):
 - **broader benefits** of intersectoral/regional cooperation often **remain unclear or unexplored**
- But some are **often overlooked**, most notably:
 - the **cross-sectoral impact** of sectoral policies
 - the **transboundary and regional impact** of a national policy
 - the **role of ecosystems**: their effective capacity to support multiple demands and the true potential of nature-based solutions





Value of nexus assessments

- Facilitating **inter-sectoral dialogue**: joint prioritization of issues, elaboration of solutions and synergetic action
- Initiating, broadening, revisiting regional **cooperation** frameworks (energy, agriculture, environment)
- **Policy insights** from modeling on key questions e.g. **optimization of resource use** (land, water/dams for food and energy production) and **infrastructure** (hydro, flood & droughts) in long-term planning
- Joint identification of cross-sectoral and transboundary **nexus solutions** e.g. synergetic RE projects, sustainable rural development, etc. and discussing necessary **nexus investments**



Water sustainability and the nexus

Methodology for this FAO project



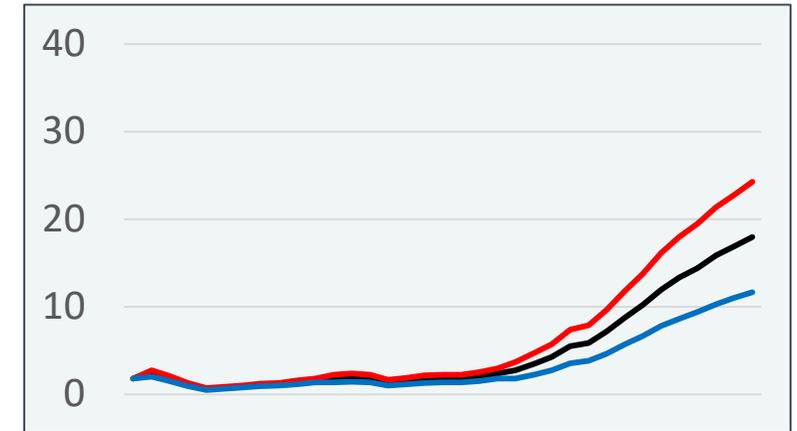
Combining methods

- Two methods were applied in this project:
 - **Robust Decision Support (RDS)**
 - **UNECE Nexus Methodology**
- Both methods are participatory
- RDS emphasizes deep uncertainty in planning and co-development of scenarios and models
- UNECE emphasizes engaging stakeholders in qualitatively identifying the linkages between sectors and possible solutions. Quantitative models are often used to quantify the benefits of cooperation and nexus thinking approach.

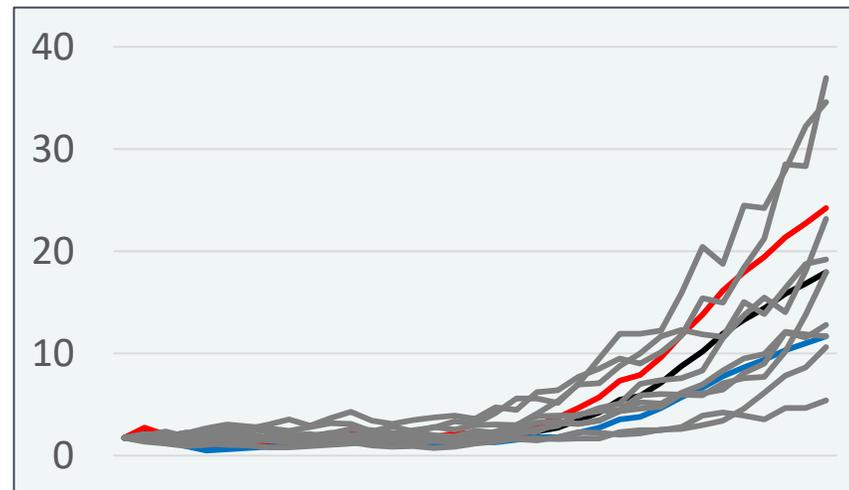


Conventional planning can be problematic

- 3 scenarios – high, medium, low
 - Often fails to consider probabilities and extreme outcomes



The future may not be well-behaved



Any given projection is almost certainly wrong

Nexus assessment process in Jordan and Morocco

PROBLEM FORMULATION AND MODEL DEVELOPMENT

Identify stakeholders who will participate

With stakeholders, define issues to address

Co-develop inputs to water-energy-food models with stakeholders

SCENARIO DEVELOPMENT AND ANALYSIS

With stakeholders, develop future scenarios

Conduct model runs to quantify future scenarios

Use data visualization tools to help stakeholders analyze model results and assess the effects of possible actions

Agree on priority actions



Applications of the nexus approach on selected cases in the NENA region:

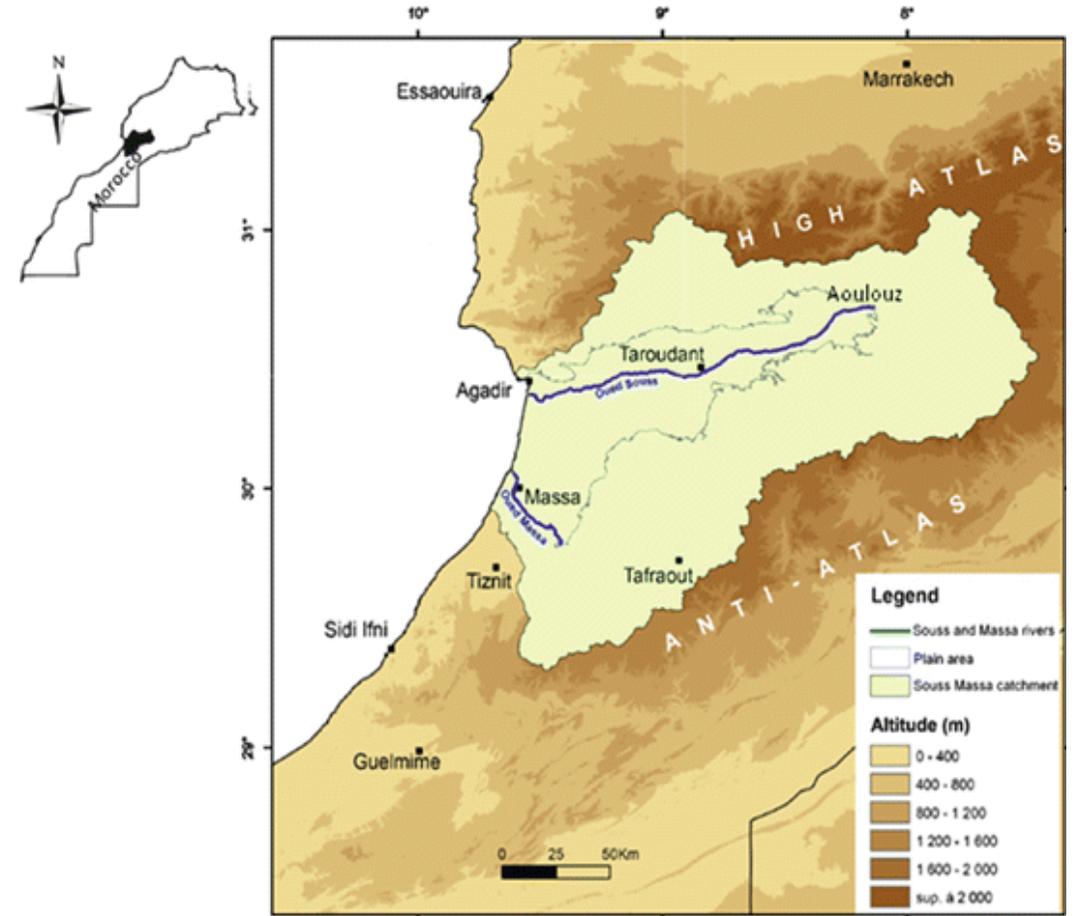
- **Sub-national level: Souss-Massa, Morocco;**
- National: Jordan;
- Regional: The North Western Sahara Aquifer System (NWSAS).



Background:

Souss-Massa:

- is a province situated in the mid-western part of the Kingdom of Morocco.
- It spans over 27,000 km², is home for 2.56 million inhabitants, of which 55% live in rural areas.
- The region produces about 7% of Morocco's total GDP with agriculture, tourism and fishing being the main economic drivers.
- Agriculture employs 46% of the region's workforce.



Sectoral perspectives / issues:

- **Agriculture centered**

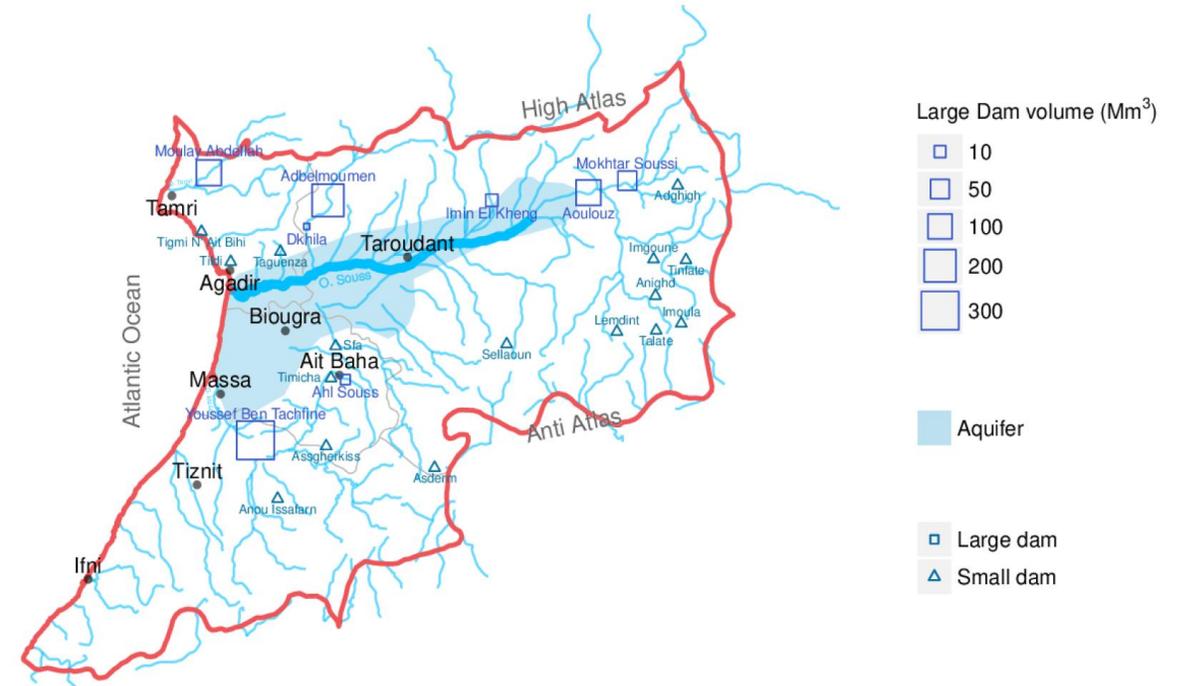
- Increased agricultural demand
- Inefficiencies in the irrigation system

- **Energy Centered**

- Energy for pumping and post harvesting
- Energy for desalination

- **Water centered**

- Water scarcity and salinification
- Water table draw-down



Water resources in Souss-Massa River Basin





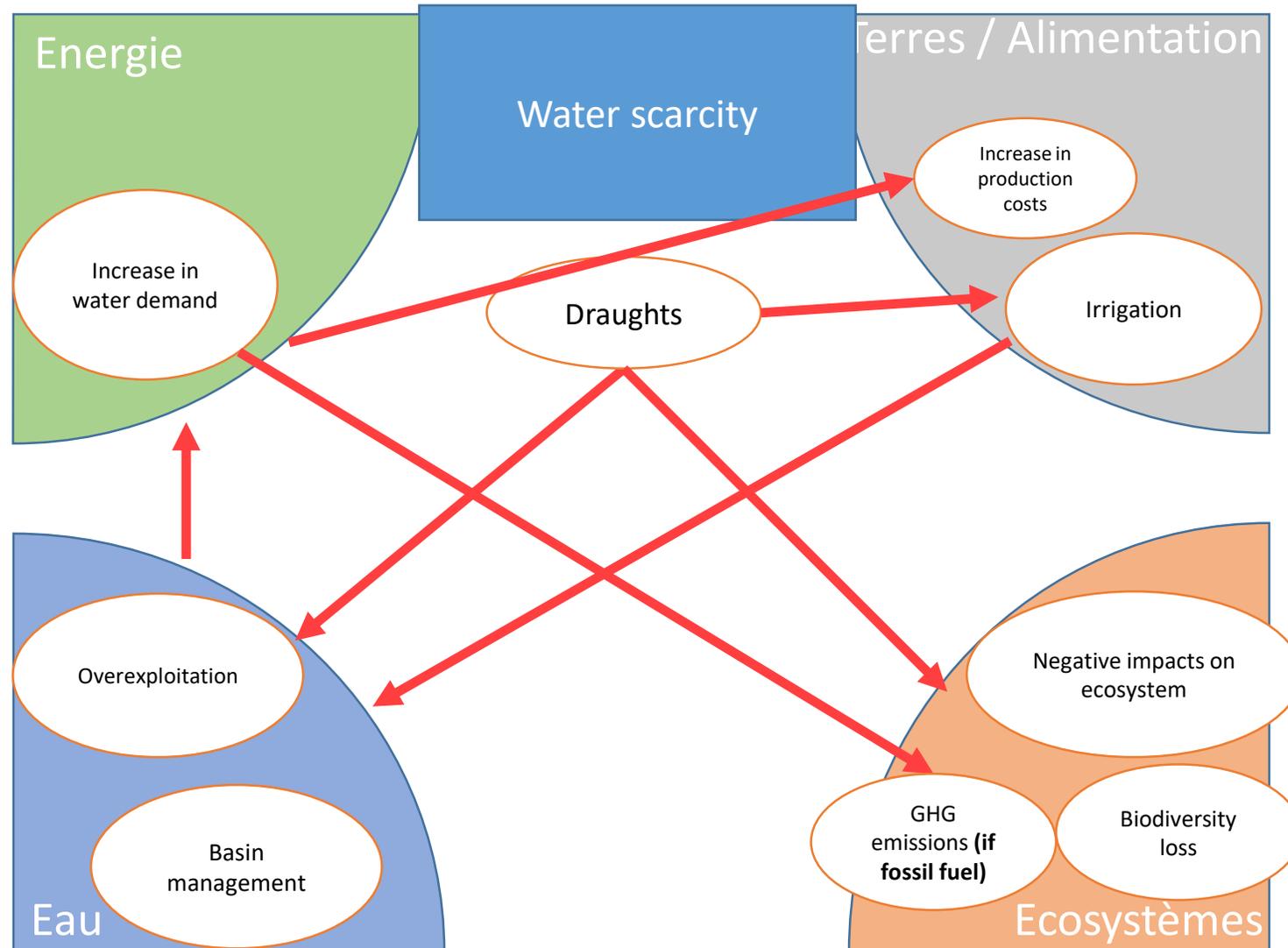
Nexus challenges identification



How to move from sectoral issues to nexus challenges?

- Participatory nexus workshops;
- Mapping of the nexus challenges;
- Jointly prioritizing the key challenges.



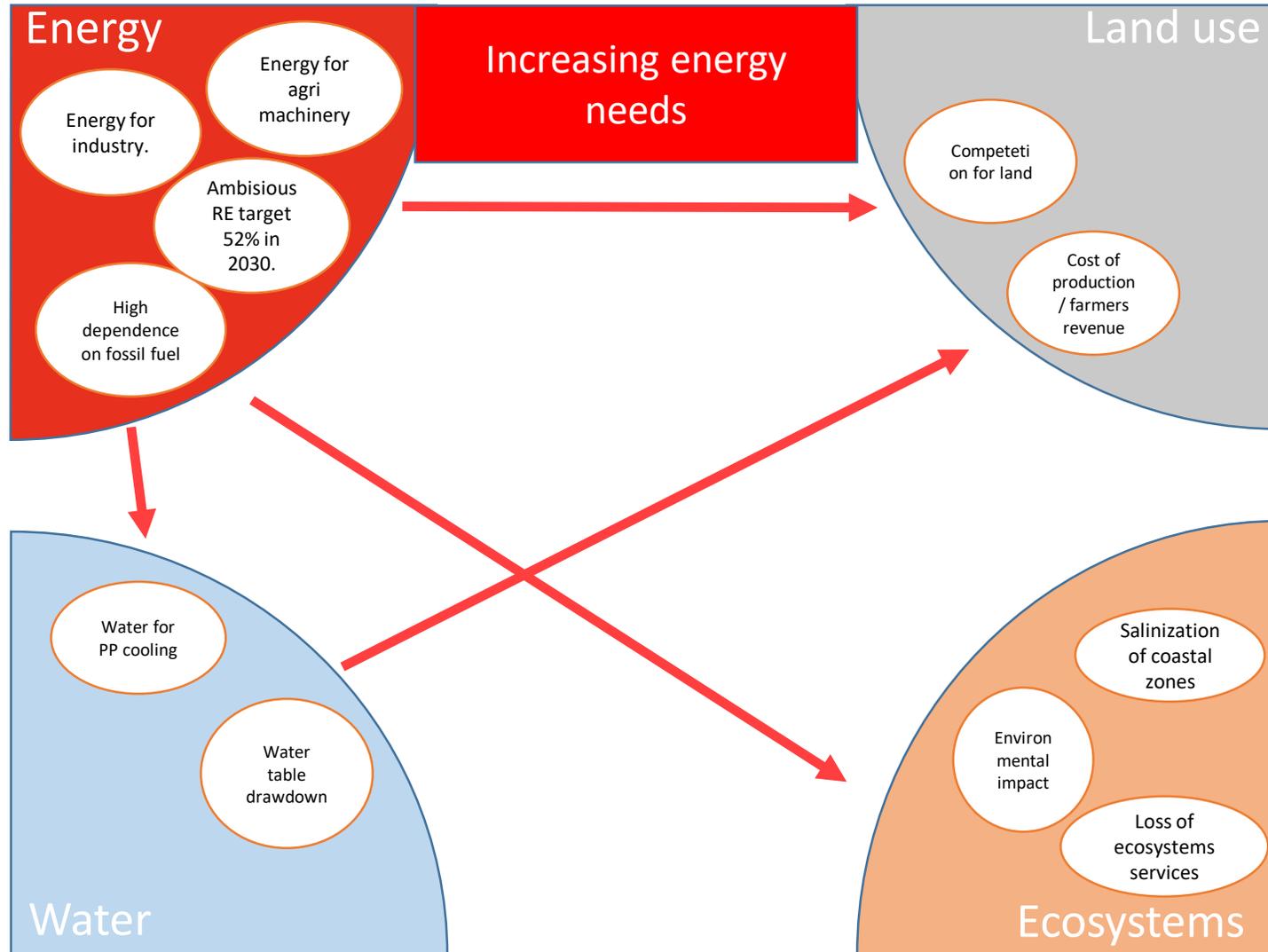


Walk them through the example

Sectoral issue/challenge:

Nexus implications on other sectors.



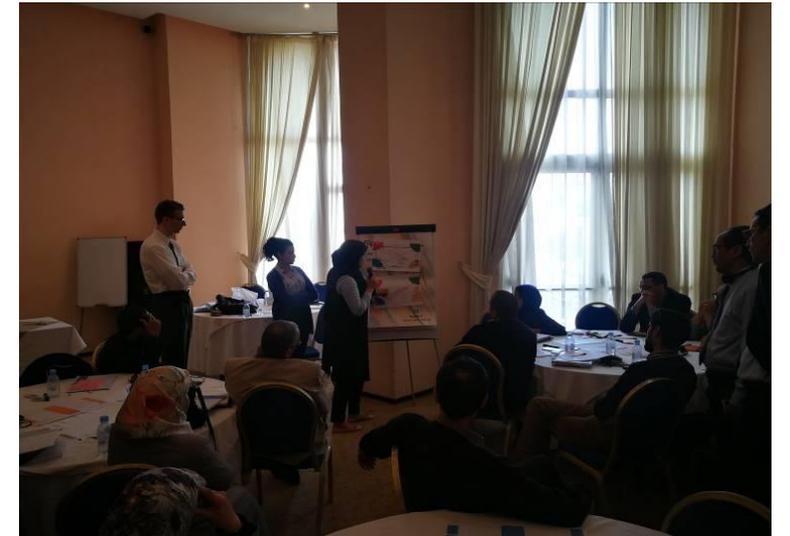
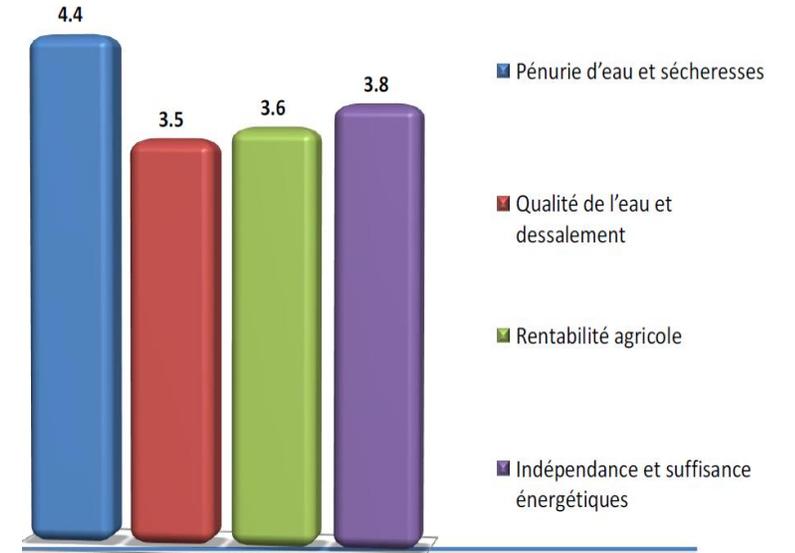




Key nexus challenges:

Key nexus challenges in Souss-Massa:

1. Water scarcity and droughts,
2. Energy sufficiency and independence,
3. Agricultural productivity,
4. Water quality and the need for desalination.





Applications of the nexus approach on selected cases in the NENA region:

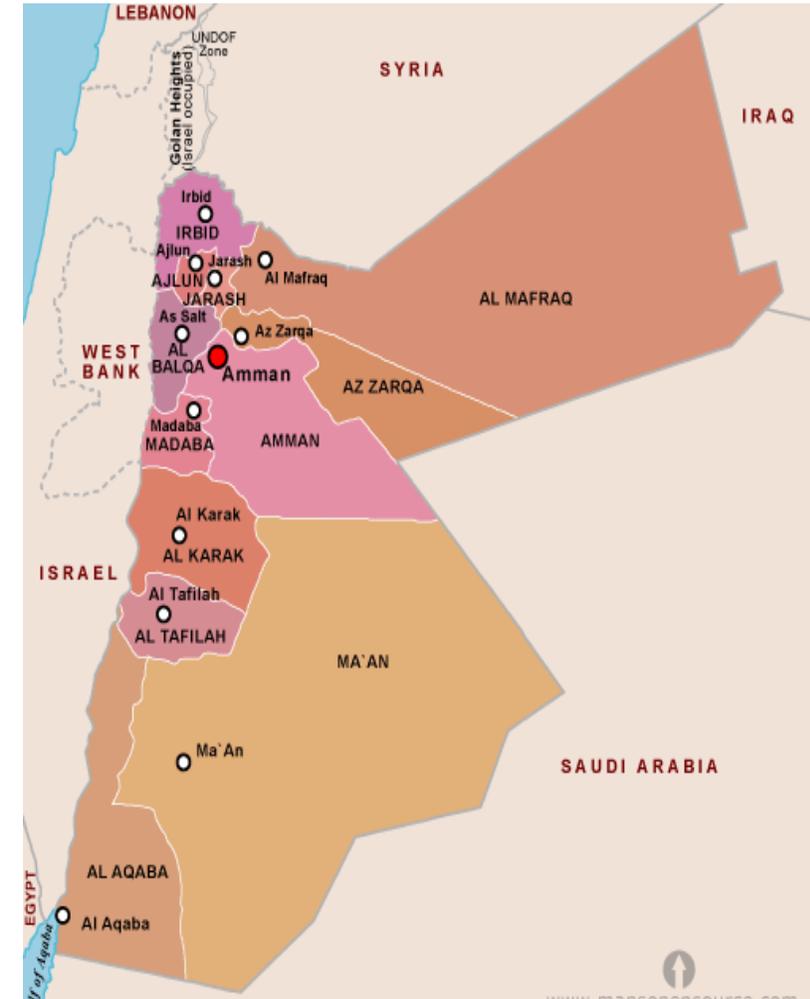
- Sub-national level: Souss-Massa, Morocco;
- **National: Jordan;**
- Regional: The North Western Sahara Aquifer System (NWSAS).





Background

- The Kingdom of Jordan has an **area of 89,342 km²** (1), of which approximately 0.6% is water.
- With total population of **9.7 million people**, of which **91% live in urban areas**.
- Jordan is one of the countries in the world with the **lowest water availability per capita** (6).
- Approximately **0.5% of households** suffer from **food insecurity** and an **additional 13%** are considered to be **vulnerable to food insecurity** (2).
- **Fossil fuels imports** account for more than **40% of the government's budget** (7) or about **20 %** of Jordan's **GDP** (8).





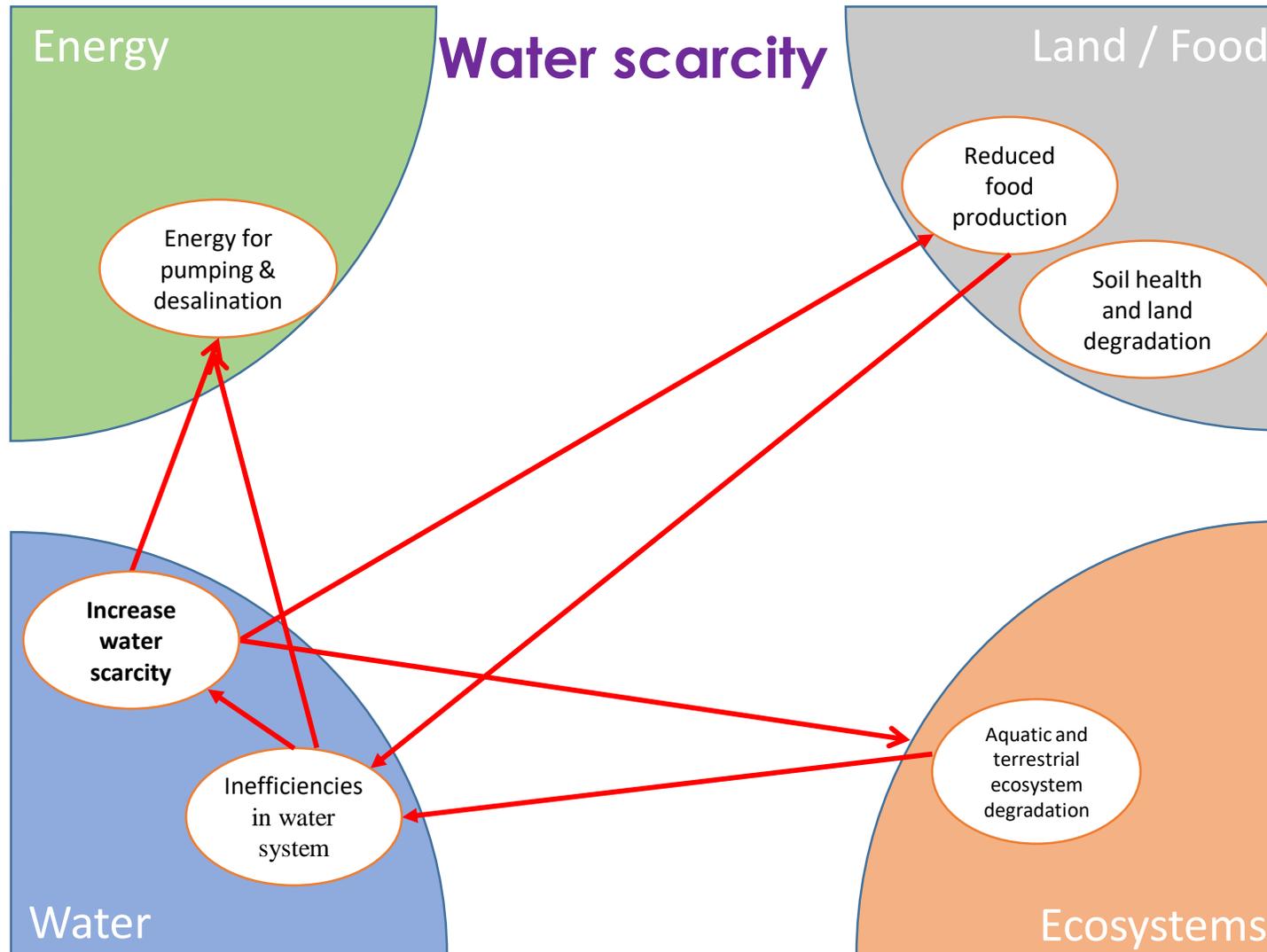
Nexus challenges identification

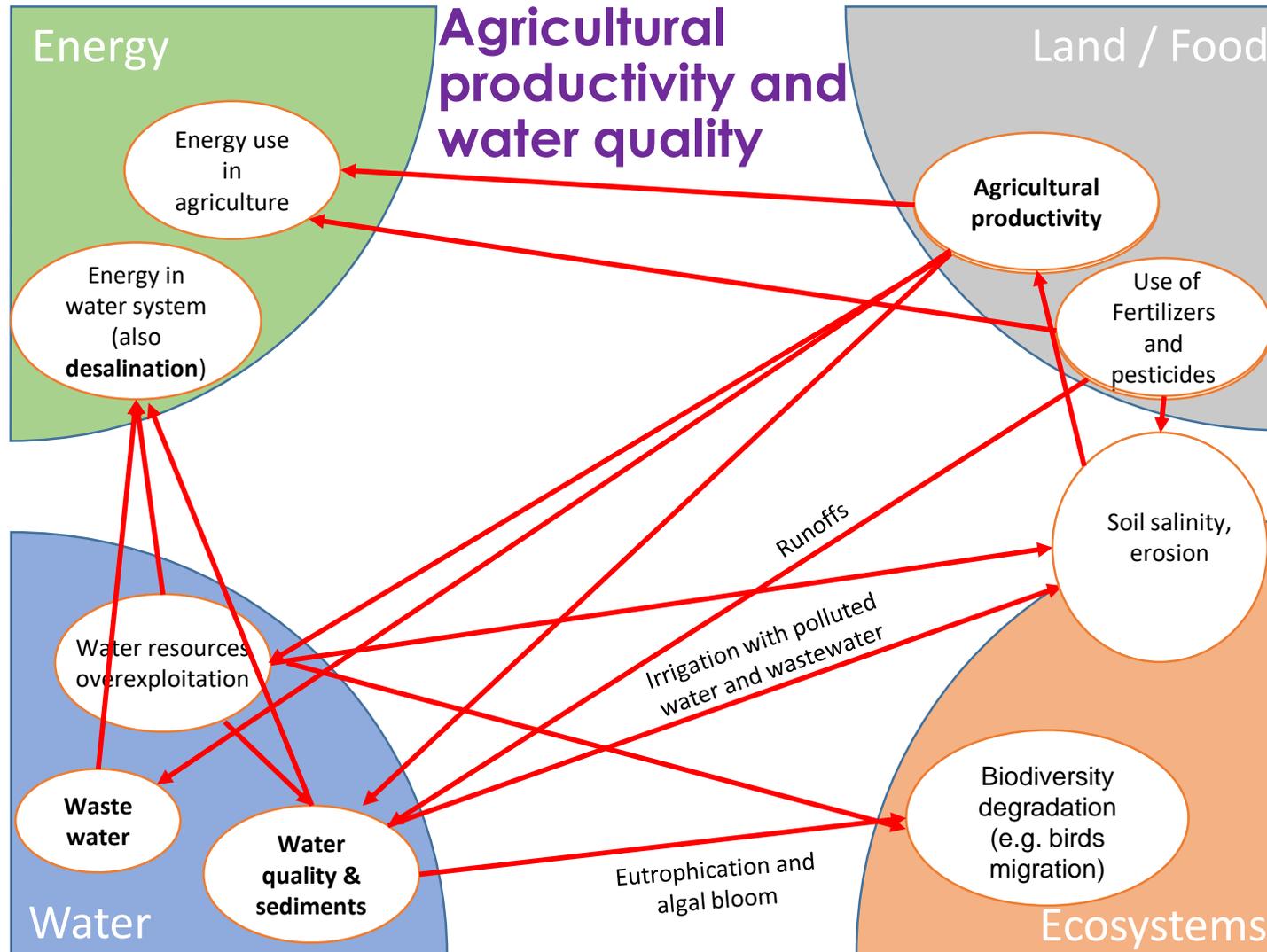


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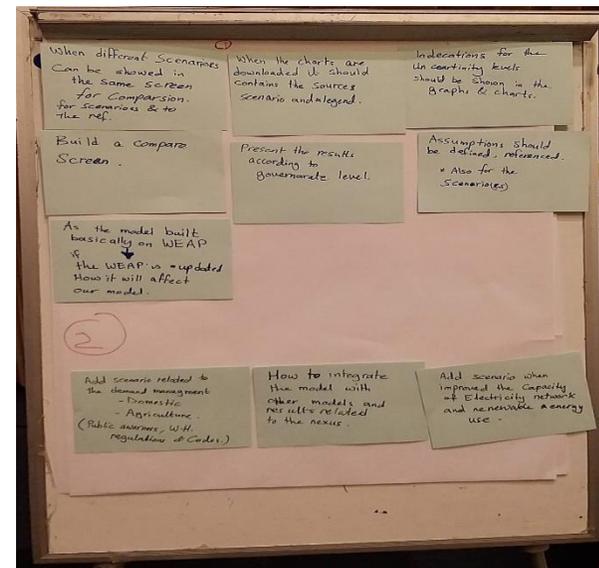




Key nexus challenges:

key nexus challenges in Jordan:

1. Water scarcity and droughts
2. Agricultural productivity
3. Water quality
4. Shift to energy independence





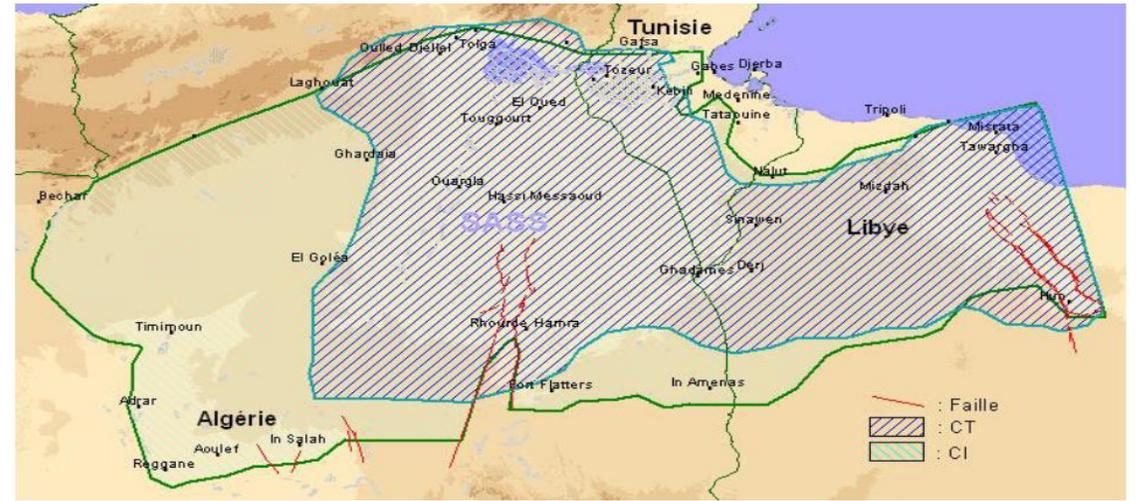
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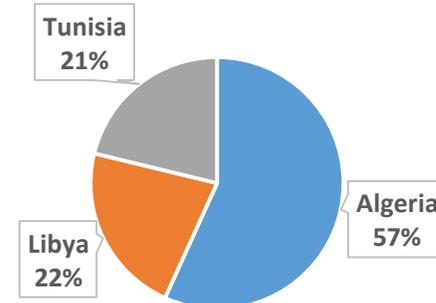
Background

- The North Western Sahara Aquifer System (NWSAS) shared between: Algeria, Tunisia and Libya.
- The NWSAS hosts a population of 4.8 million inhabitants. Around 70 percent of them live in urban areas.
- The NWSAS qualifies as a fossil aquifer due to its very limited water recharge, estimated at 1 billion m³/year out of the basin's 60,000 billion m³ fossil water reserves.
- Current withdrawals from the aquifer exceed three times its recharge capacity (3.171 billion m³ in 2016).



	Algeria	Tunisia	Libya
Country area (km ²)	2,381,741	163,610	1,759,540
Country area in the basin (km ²)	700,000	80,000	250,000
Share of national territory in the NWSAS (%)	29	49	14
Share of NWSAS (%)	68	8	24

Population in the NWSAS (2014)





Sectoral perspectives:

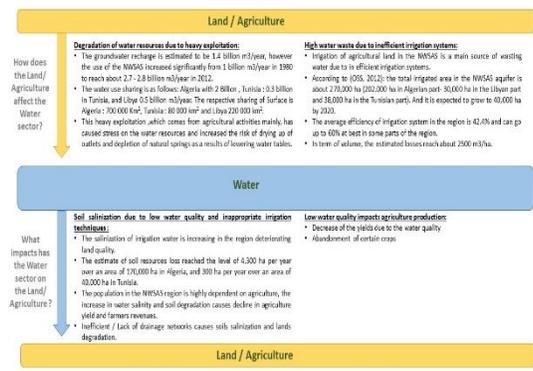
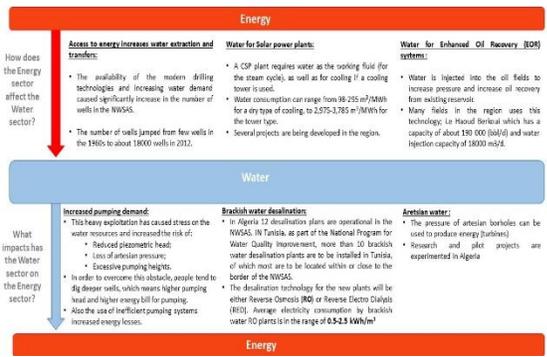
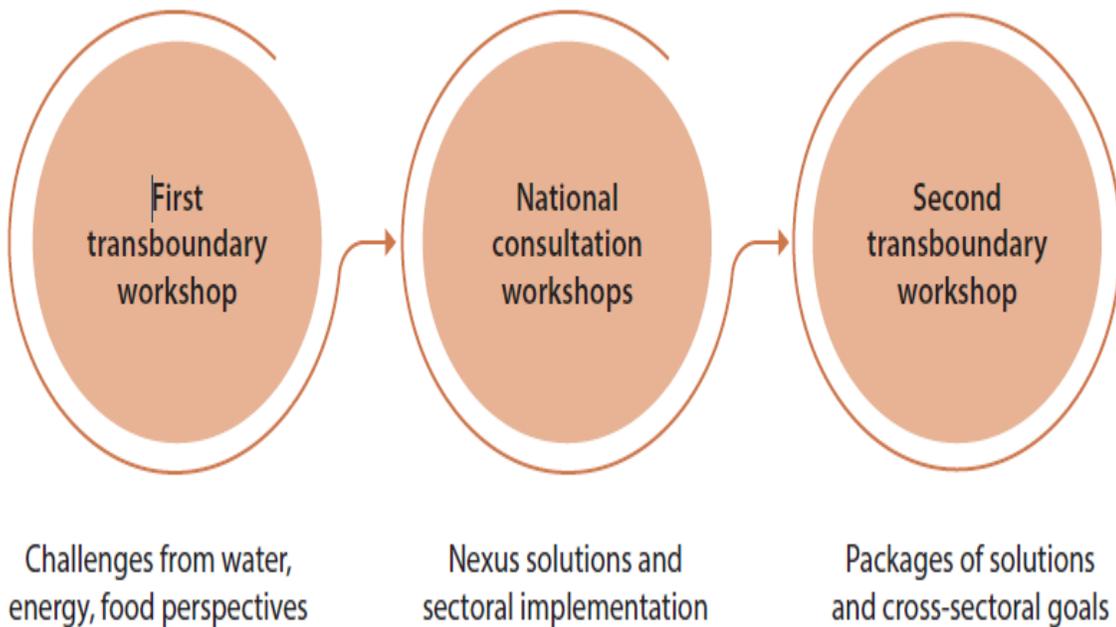
Common challenge	Water perspective	Energy perspective	Food perspective
NWSAS aquifer degradation compromising development	W1. Reducing vulnerability and dependence of economic activities on groundwater resources	E1. Managing increasing energy demand and reducing excessive pumping	F1. Managing increasing water demands and reducing irrigation losses
	W2. Managing the increasing risk of saline intrusion from chotts	E2. Supplying future demand for energy to be used in water treatment (brackish water, wastewater)	F2. Managing salinisation of water and soil in agriculture
	W3. Addressing ecosystem degradation and its impacts on public health	E3. Securing supply of electricity in rural areas	F3. Coping with the social impact of natural resource degradation

Source: Outcome of regional and intersectoral dialogue at the First regional NWSAS nexus workshop in Algiers (2017).



Nexus dialogues and key challenges

Key steps within the nexus assessment participatory process in the NWSAS (2017-2019)



Source: [29]





Summary of intersectoral impacts

	Water sector	Energy sector	Food sector	Environment sector
Water resources		Higher water withdrawals also driven by cheap, subsidized energy	High water demands and pollution from agriculture (driven by diets and markets)	Impact of steady environmental degradation (and lack of awareness) on water resources availability for all uses
Energy resources	Increasing energy demands for pumping and conveyance		Increasing energy demand for multiple uses and new demands (e.g. water desalination and treatment)	Higher energy demand for pumping due to the drying up of natural springs
Food resources	Lower yields due to soil salinisation (due to use of saline water) and where water is difficult to access	Challenges in food production in remote areas where energy access is difficult or expensive		Lower productivity aggravated by low awareness of environmental issues and climate change
Ecosystems	Consequences of groundwater depletion and degradation on ecosystem functioning and biodiversity	Greenhouse gas missions from fossil-fuels based energy systems; local pollution from diesel pumps” to “Greenhouse gas emissions from fossil-fuel based energy systems; local pollution from diesel pumps	Impact of agricultural practices (e.g. poor drainage) on soil quality and land use: shift away from traditional varieties (demand for e.g. <i>deglet nour</i> date)	





Three levels of analysis:

- **Qualitative analysis:** experts work and consultation with stakeholders
- **Quantitative analysis:** GIS-Based model developed by experts and supported by stakeholders.
- **Participatory consultation workshops:** consolidation of finding, ownership, taking responsibility for actions.





The 15 nexus solutions:

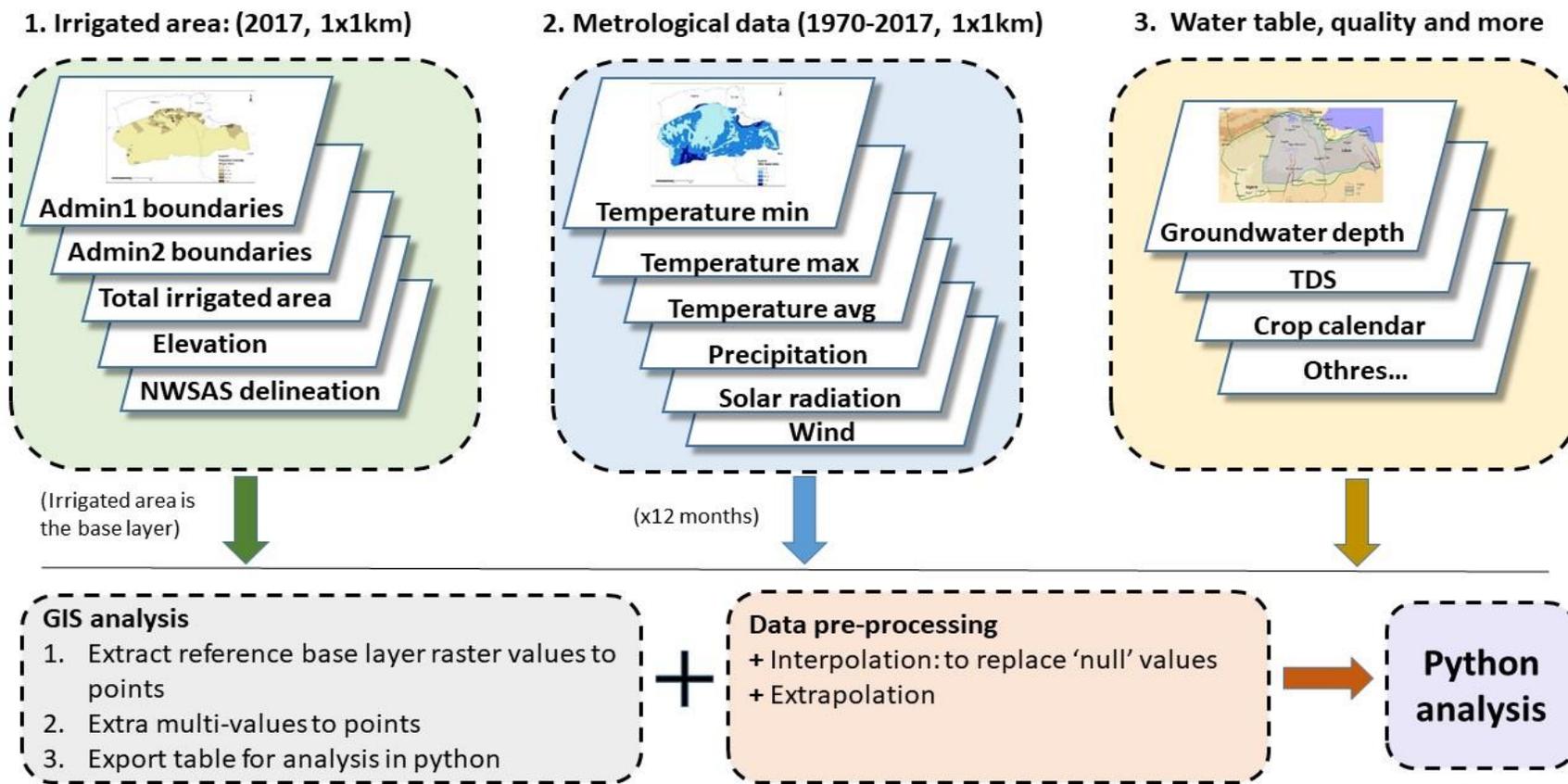
1. Enhance local water management, including revitalising participatory models in oases and enhancing the enforcement of existing laws on water conservation.
2. Reinforce transboundary cooperation for sustainable groundwater resource management.
3. Set up dedicated policies and related incentives for wastewater reuse in agriculture and urban areas.
4. Strengthen water demand management, including through water-saving programmes.
5. Upscale the use of non-conventional water resources through desalination and wastewater and drainage water treatment.
6. Enhance mechanisms for the coordination of energy development with other sectoral plans, to anticipate trade-offs and build on intersectoral synergies.
7. Develop a sustainable programme for diversified, multipurpose renewable energy and sustainably upscale small-scale solar irrigation.
8. Improve the reliability of the electricity grid in rural areas, thereby enhancing the integration of renewable energies for remote and multiple uses.
9. Set up agricultural policies oriented towards rational, sustainable, and productive agriculture.
10. Valorise local products and strengthen programmes for a more balanced diet while involving young people and women in the economic and social development of the oases.
11. Promote the circular economy including agroecological practices, through ad hoc economic measures and social instruments.
12. Enhance innovative practices and techniques for sustainable soil and crop management and invest in their upscaling and dissemination.
13. Increase awareness of the trade-offs and synergies between different sectors in public institutions.
14. Consider environmental needs in the water balance of the aquifer.
15. Systematise environmental and social impact assessment for all new infrastructure (large and small scale).





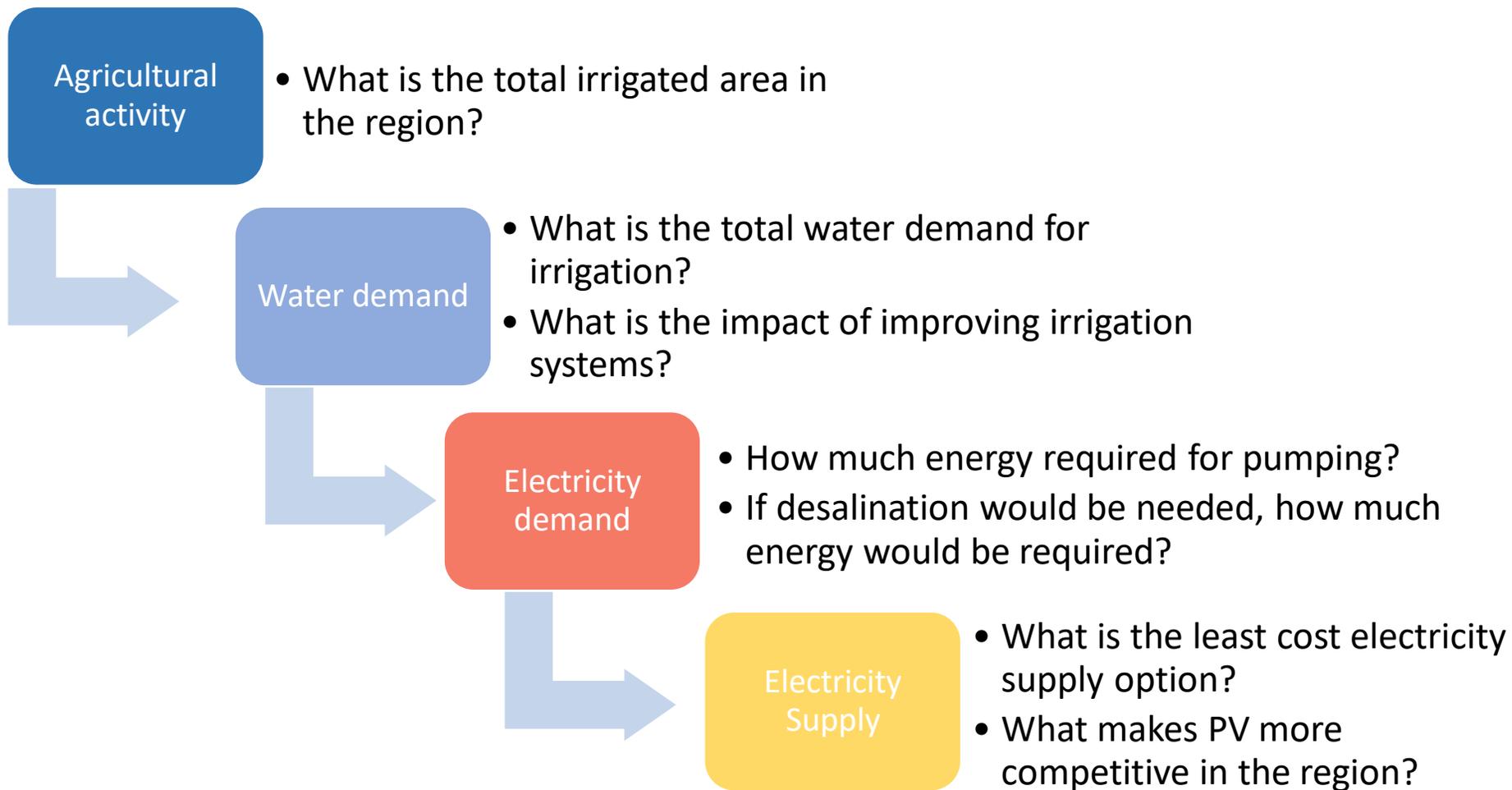
Implementing actors/solutions	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Algeria															
Ministry of Water Resources	L	L	L	L	L	S	S					S	S	S	S
National Agency for Water Resources	S	L	S	S	S								S	S	
National Office for Irrigation and Drainage	S	S	L	L	L		S		S		S	S	S		
National Agency for Integrated Water Resources Management	S	S	S	S	S		S		S		S	S	S	S	
Hydrographic Basin Agencies	S	S	S	S	S		S		S			S	S	S	
National Agency for Dams and Transfers		S		S									S		
Algerian Water Authority	S	S	S	S	S								S		
The National Department of Sanitation		S	S	S	S								S		
Directorate for Agricultural Hydraulics – Ministry of Water Resources	L	S	S	S	S		S		S		S	S	S		
Directorate of Water Resources of the Wilayas	S	S	S	S	S		S					S	S		
National Advisory Council for Water Resources	S	S	S	S	S	S							S	S	
Water users' associations	S	S	S	S	S		S	S	S		S	S	S		
Ministry of Industry, Energy and Mines		S				L	L	S				S	S	S	S
Department of Renewable Energy – Ministry of Environment and Renewable Energy			S		S	S	L	S			S	S	S		
National Agency for the Promotion and Rationalisation of Energy Use		S	S		S	S	S	S			S	S	S		
National Company of Electricity and Gas						S	S	L					S		S





Approach: To develop an open source GIS-based model that informs integrated planning in the NWSAS.

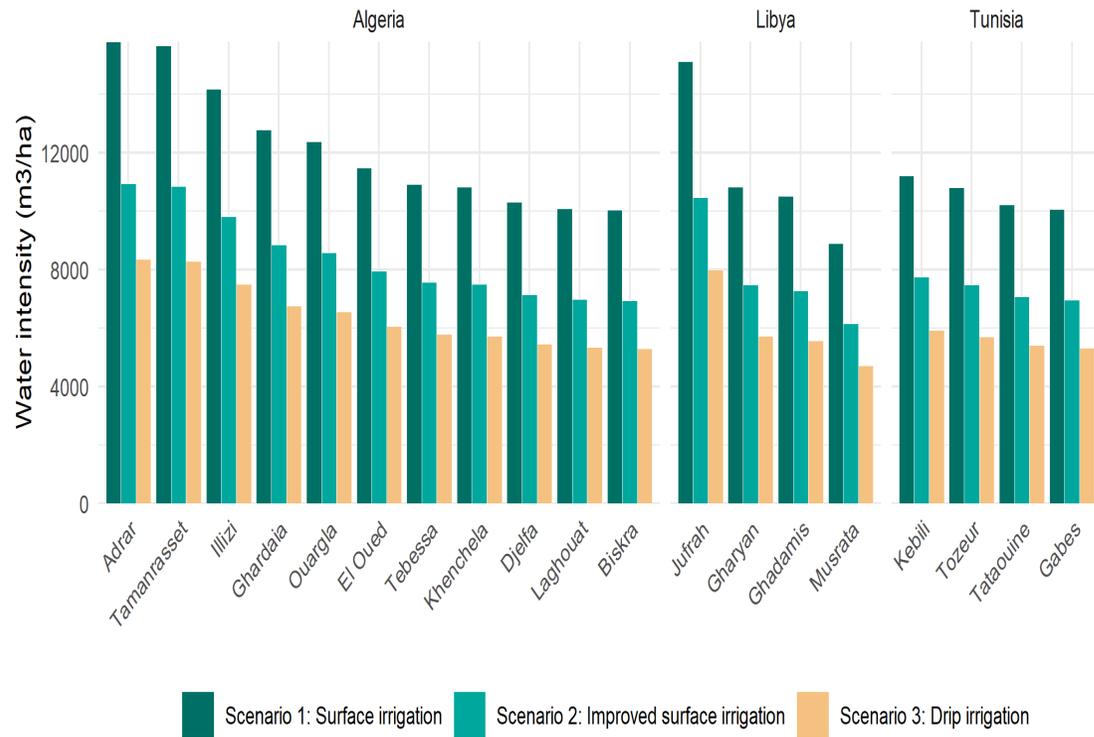




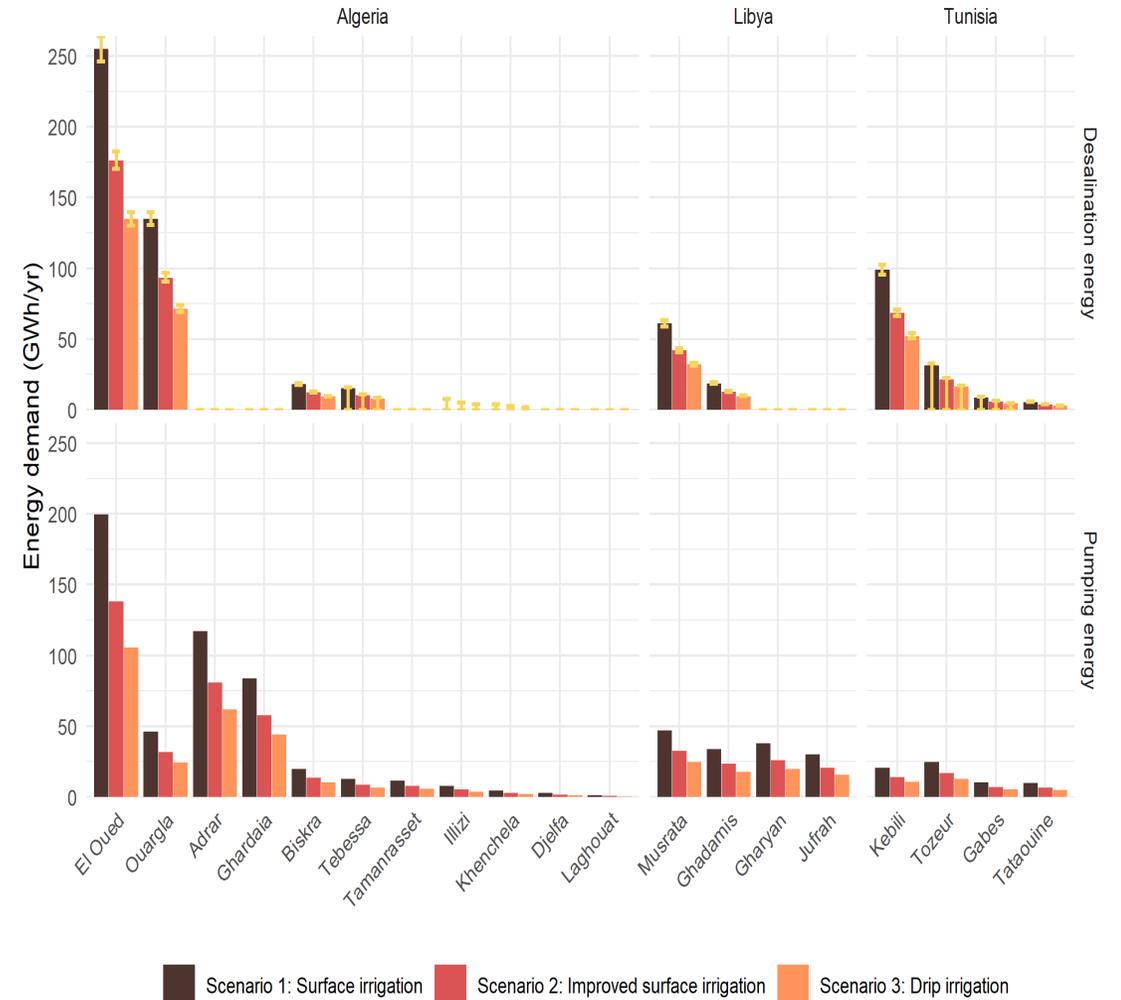


Selected results

Irrigation water demand

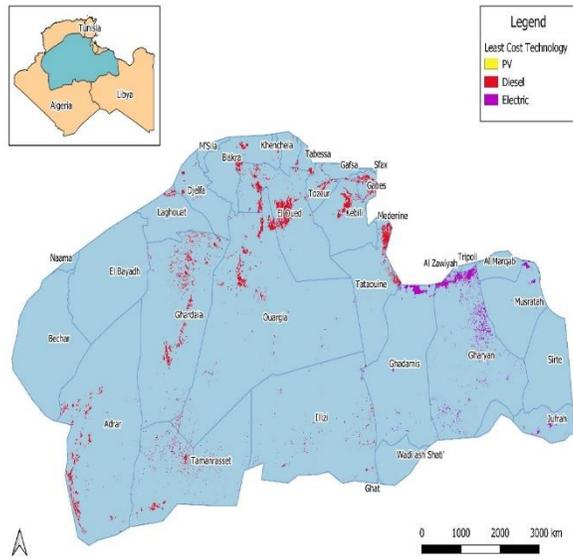


Energy demand

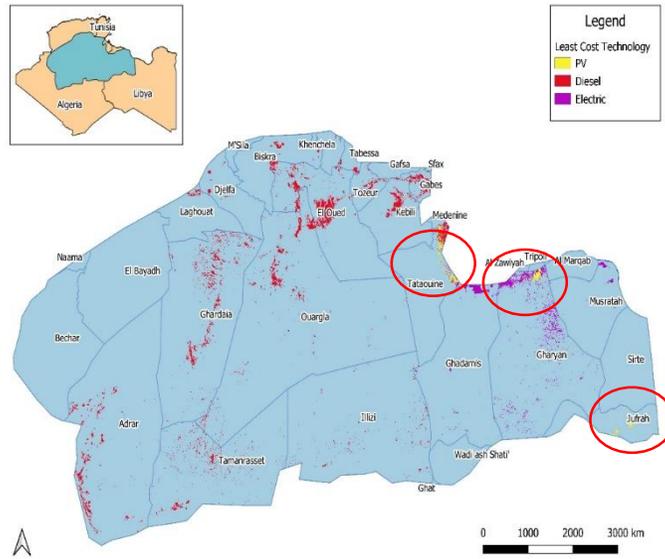




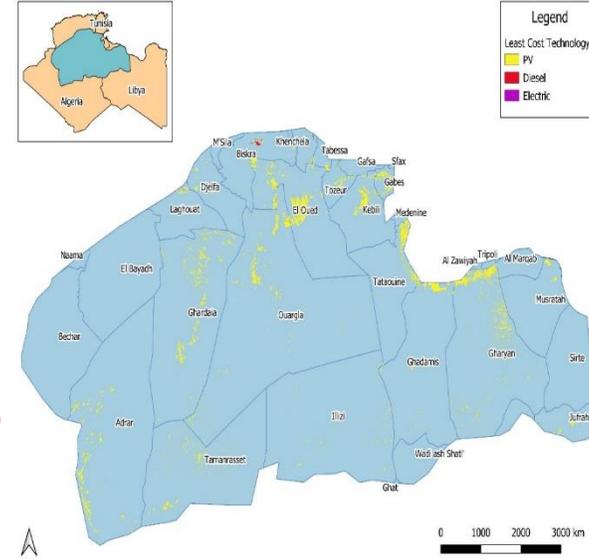
Selected results- The least cost electricity supply option



CAPEX level 1 (1140 USD/KW)



CAPEX level 2 (970 USD/KW)



CAPEX level 3 (680 USD/KW)



Selected results- The least cost electricity supply option

Sensitivity analysis:

Capital cost of PV (CAPEX):

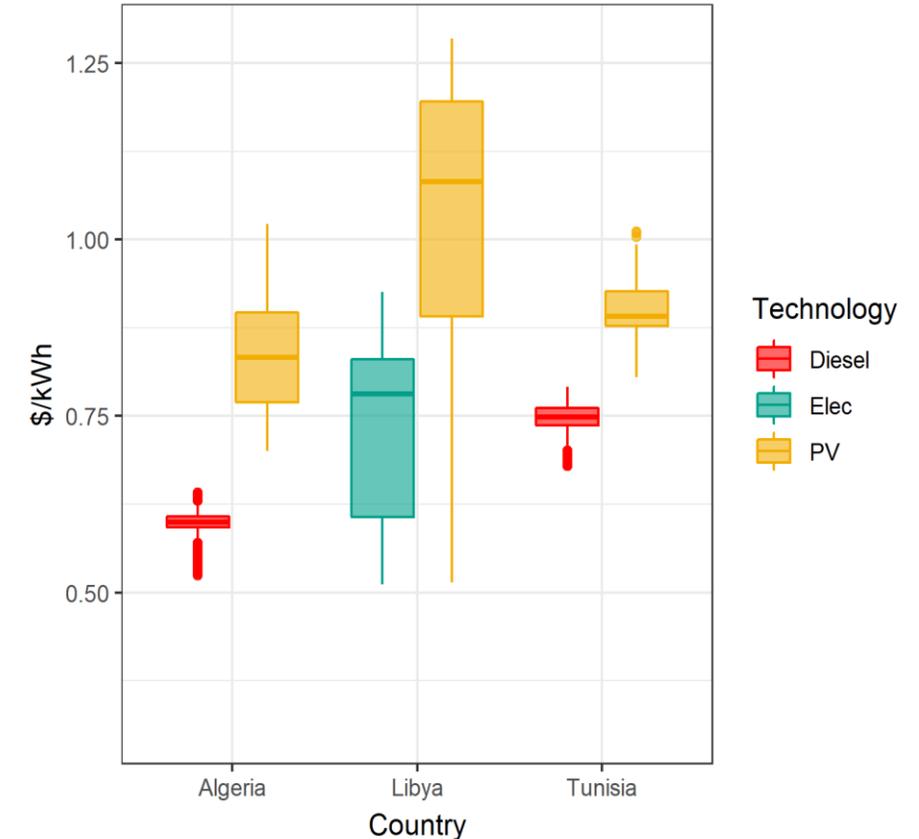
- Level 1: 1140 USD/KW (ref)
- Level 2: 970 USD/KW (15% decrease)
- Level 3: 680 USD/KW (30% decrease)

Fuel subsidy (Fuel):

- Level 1: Current cost of diesel and electricity in each country
- Level 2: 30% increase
- Level 3: 50% increase

LCOE value per country

PV CAPEX level 1, Fuel level 1





Take away messages:

- The Water-Energy-Agriculture Nexus framework is important to ensure sustainable management of the water sources.
- The complexity of the challenges requires active stakeholders engagement.
- The nexus framework can be applied at different scales: sub-national, national and regional.
- Nexus modelling: although it is challenging and data intensive, it brings valuable insights to inform the decision making process.



Break out groups



Discussion points (15 min)

1. Each participant identify one very important WEF nexus challenge in your country? (2-3 min)
2. Each participant presents that challenge to the rest of the group
3. Discuss: What common nexus challenges are emerging among the members of your group?



Menti



Food and Agriculture Organization
of the United Nations

This activity is implemented under the project “Implementing the 2030 Agenda for water efficiency/productivity and water sustainability in the NENA countries”, which is funded by the Swedish International Development Cooperation Agency. This project is implemented under FAO’s Water Scarcity Initiative.



Sweden
Sverige





Food and Agriculture Organization
of the United Nations

Thank you!

<http://neareast.fao.org>



WATER

Productivity
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