



TEXAS A&M  
UNIVERSITY.



# THE WATER-FOOD-ENERGY NEXUS IN DRYLANDS:

## Bridging Science and Policy

Rabat, 11-13 June, 2014



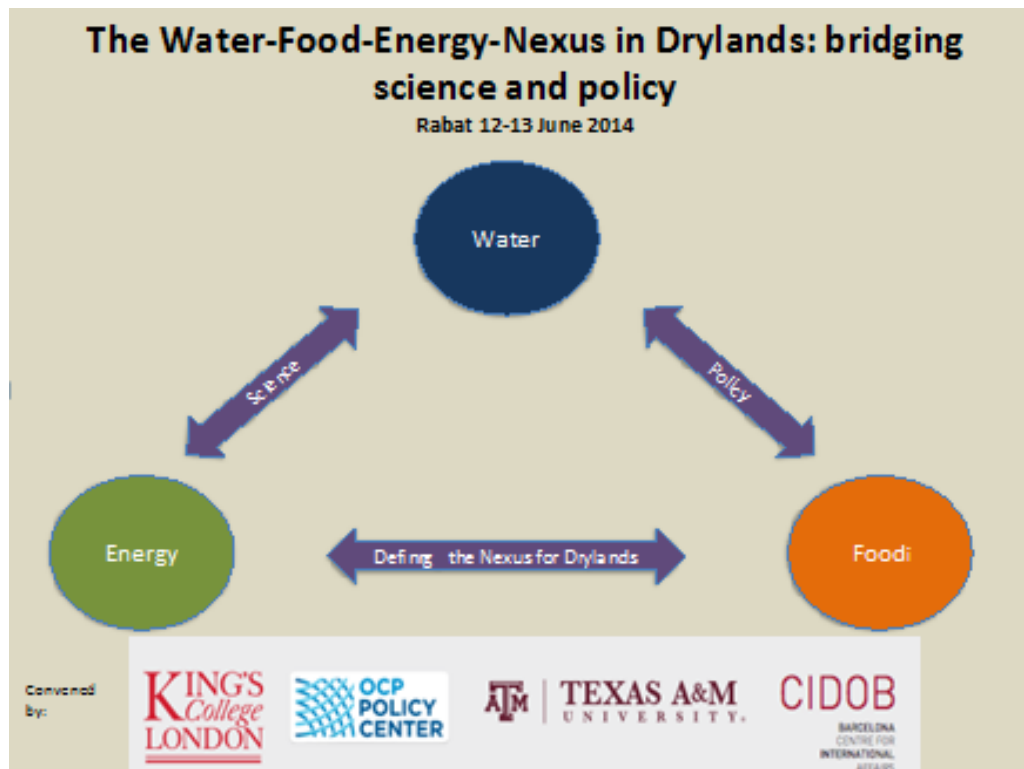
MEETING SUMMARY

## Preface

**Approximately two billion people live in arid countries. One third of the global population will be most affected by water scarcity and climate change.** Efficient management of water resources for food and energy production is a developmental challenge that requires holistic approaches. The water-energy-food (WEF) nexus highlights that food, water and energy security are inextricably linked and that any decision in one of the three sectors has consequences for the other.

Energy will be required to pump, treat and desalinate water for domestic and agricultural purposes. Water will be required to produce energy. About 1-2 percent of global energy consumption can be attributed to the production of nitrogen fertilizer alone. Such development challenges call for a nexus approach to broaden the analysis from a mere 'blue water' focus to the more efficient use of soil moisture ('green water') and sustainable policy options.

**Nowhere else this nexus is as evident as in drylands and in the MENA region in particular whose** water, energy and food resources face considerable stress. Except for Lebanon, Iraq, and Morocco, all the Arab World is water deficient where withdrawal of water far exceeds renewable water resources. The Arab world is the largest food importer of the world with 44 percent of global net-imports of cereals. Apart from the oil exporting countries in the Gulf and North Africa all Arab states are net importers of energy, too. In Jordan and Lebanon 98 percent of energy is imported. Even Saudi Arabia might cease to be an oil exporter after 2040 if it does not manage to curb its skyrocketing domestic demand and develop alternative energy sources like solar energy.



The Middle East and North Africa (MENA) have long lived with the challenges of an arid and extremely variable climate, but **pressure on regional water systems is increasing rapidly, driven by population growth, socio-economic development, urbanization and environmental degradation**. Existing supplies simply cannot meet the growing demand for irrigation and municipal water; as a result, the region must import its food to such a large extent.

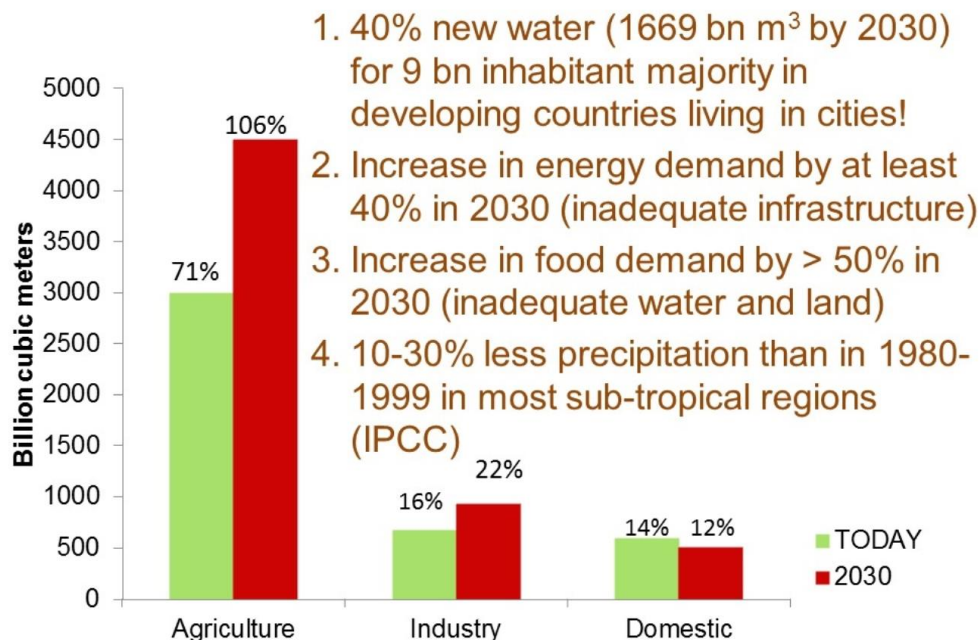
**Climate change** is expected to bring even hotter, drier and more variable conditions in many cases; at the same time, the region's green-house gas emissions are rising rapidly, driven by the same socio-economic trends that are squeezing water supplies. It is clear that both adaptation and mitigation are urgently needed – and that to be effective, they **cannot be undertaken in isolation, but rather must be mainstreamed into these countries' development strategies**.

Climate change will severely affect the region, bringing significant warming and uncertainty about rainfall variability. This makes the **MENA region very vulnerable to all kinds of shocks, in addition to its reliance on volatile global food markets**.

In most places, the water situation is already dire. **The Nile, the Jordan and many other regional rivers are “closed basins”, with no unallocated water remaining**, and many aquifers are severely over-exploited – far beyond natural replenishment rates. Yet climate change is typically seen as a distant threat, not an urgent priority, so **it may not be taken into account in major long-term investments such as water harvesting, improved irrigation and new energy systems.**

Responses to climate pressures are often limited to short-term, reactive emergency and coping measures. Climate information services and climate impact projection in the region are improving, but they are still not regionally coordinated. Socio-economic vulnerability is also significant. The rural poor, unskilled workers and internally displaced people – all large populations in the region – are particularly exposed and vulnerable.

### Business as Usual: HEAD-ON CRASH!!



Source: Water Security: The Water-Energy-Food-Climate Nexus. WEF, 2010



**These vulnerabilities are aggravated in most MENA countries by underinvestment in social safety nets and insufficient public services, such as water supply. Hence adaptation needs to be mainstreamed in conjunction with poverty alleviation, development and environmental planning. It is not an easy task, especially in countries dealing with political instability. However, the increased attention to climate change in the region creates an opportunity to implement more effective, integrated approaches to these challenges.**

**In the MENA region, as in most of the world, water and energy have historically been managed separately, with little consideration of cross-sectoral interactions.** In many cases, climate change has been assigned to yet another realm (in particular environment ministries). In the MENA context, adaptation is essentially about water (including water for food), while mitigation is about energy. **To the extent that mitigation and adaptation have begun to be “mainstreamed” into national policies it has been within sectoral boundaries.**

Yet in reality, water and energy are closely interconnected, and so are related adaptation and mitigation choices. **Desalination technologies, for example, can be very energy-intensive and increase CO2 emissions; some low-carbon energy solutions require large quantities of water.** A robust scientific framework complemented by tools and consolidated databases can help decision-makers understand how man-made systems interact with one another and with nature, and how they can be co-managed.

**By addressing water and energy together, planners can identify crucial interactions, conflicting demands and potential synergies.** The resulting solutions may serve both adaptation and mitigation, such as combining wastewater treatment and reuse with energy production from sludge. Or they may simply avoid negative impacts, as with carbon-neutral solar desalination. **This is what we mean by a “nexus” approach: cutting across sectoral boundaries and looking at the “big picture” to ensure a more climate-resilient future.**

**The Rabat conference has been a crucial part on the way to seize the opportunities of the Nexus.** The vision for the conference is to help establish a roadmap on how to implement Nexus policies in the region to increase the efficiency of natural resources management.

**At the same time, this roadmap needs inspiration from other dryland regions.** How can we learn from each other? How can we collaborate to address the challenges ahead? The Nexus also provides immense opportunities for bridging science with policy and business? How can governments be inspired by business? How can business be inspired by science? In a nutshell, how can we work together towards a better future?

In the two days, we discussed the complex nature of the WEF Nexus. We heard many presentations from the different countries. We listened to different conceptual approaches and policy suggestions. However, the most important is that we connected to each other intellectually both inside the conference room and outside of it in order to guide the MENA region into a better future.

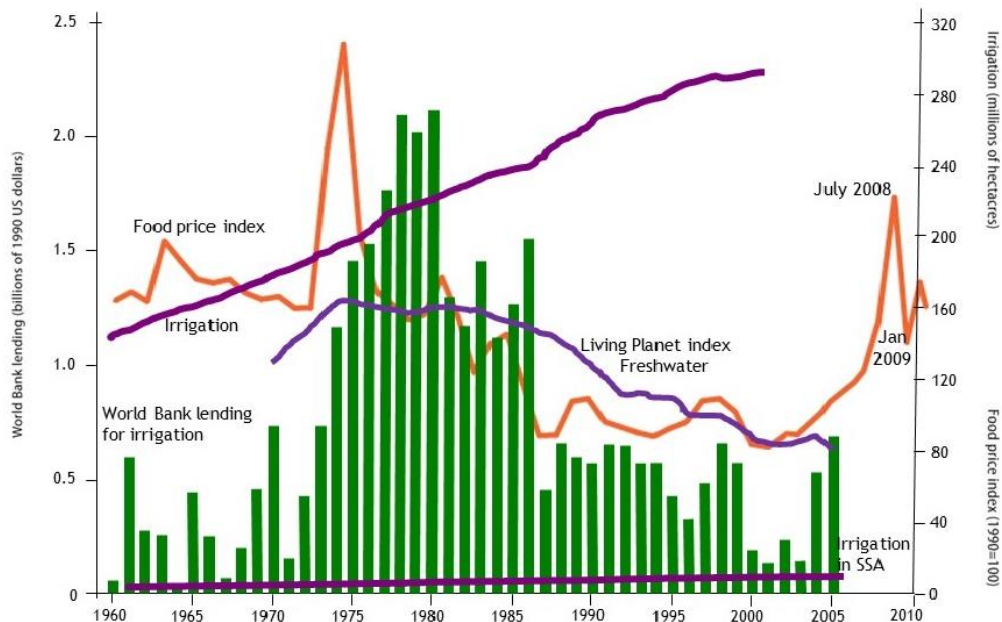
## Major highlights of the discussions

### Defining the Nexus

In the **opening session facets of the nexus approach were defined.** **Rabi Mohtar of Texas A&M University** outlined the interconnections and technical trade-offs between water use, energy and food production and how these challenges will relate to the impact of climate change. **Tony Allan of King's College (KCL)** pointed out that the nexus between water, energy, and food was first conceptualized at World Economic Forum 2011, which was then followed by a high profile conference organized by the German Ministry of Economic Cooperation (BMZ).

Since the 1980s there have been growing sustainability concerns about the various hydraulic missions that have been undertaken since the 1850s. **The constant rise in irrigation since the 1960s coincided with declining food prices – until 2008. Further irrigation growth is unsustainable.** There has been a peak of World Bank dam financing in 1980.

## Trends in investment, food prices & environmental impacts



Source: Based on World Bank and Food and Agriculture Organization data.



As a result the focus has shifted **from blue water to green water since the 1990s** and the latter's major role in food and virtual water trade. **About 70 percent of global crops are rainfed and rely on green water.**

**Existing reporting and accounting rules do not account sufficiently for natural resources like water as inputs.** Rainfall frequency is often reflected in land prices, at least in developed markets, there are also varying pricing schemes for irrigation water in some countries, yet **often water remains external to the economy.** **In case of environmental damage there are only limited sanctions in place to internalize costs, while water provision as a public good is compromised by limited state capacities** that have been weakened after decades of neo-liberal reform.

**Harry Verhoeven of Oxford University** pointed out that a **purely technocratic approach is misleading, yet widespread in nexus focused policy research.** He argued that **the nexus is quintessentially political and should be perceived as such.** It is not enough to identify technological trade-offs; there are political trade-offs as well.

Control of water has meant control over people as he outlined in a political economy of the Nile valley. One needs to identify struggles, winners and losers of nexus related ideas and narratives that have been around since the beginning of modernization, not just since the WEF Nexus conference in 2011.

As for climate change **Mark Mulligan of KCL** departed from the current consensus and argued that African dry lands will possibly receive more rather than less rainfall in the future, which could compensate for the negative effects of higher temperatures on agricultural productivity. African countries would need to prepare accordingly and increase their adaptability to highly variable impacts of climate change. In contrast, **Holger Hoff of the Stockholm Environment Institute (SEI)** was more pessimistic and pointed to the large body of models and scenarios that expect decreasing rainfalls in MENA dry lands north of 25 degrees latitude.

## Farming

Sustainable intensification, protection of farm livelihoods, supply chain management, waste and consumption issues are crucial in Allan's view. This was echoed by **Brian Chatterton, a farmer and a former Minister of Agriculture of South Australia** and **Lynn Chatterton, an independent consultant**. They complained that farmers have not been at the center of attention of the international agro research establishment, which has focused on higher yields instead of lower costs and ecological factors, which are crucial for farmers.

**They also deplored a relative neglect of pastoralists in extension services, symbolized in the FAO's closure of its pasture department.**

The Chattertons described the green revolution as an abject failure in dry lands because its application of nitrogen fertilizer relies on reliable rainfalls, yet they were optimistic that yields can be improved without more water and irrigation and pointed out that **productivity in Australian drylands is 2-4 times higher than in the MENA region without more water and in similar climatic conditions**. In the same vein **Kris Dodge of ICARDA demonstrated how adapted seeds and plowing techniques, rain harvesting and supplemental irrigation can improve yields in the MENA.**



**Guy Jobbins of the Overseas Development Institute** pointed out that Moroccan subsidies for drip irrigation rather benefit wealthier and literate farmers as ‘urfi land of the poor cannot be mortgaged. He also showed the limits of technical fixes: **Drip irrigation improves efficiency, but it has not reduced water consumption in Morocco as it prompted farmers to increase the irrigated area and switch to more commercial but water intensive crops.** Rural electrification in Morocco went up from 18 percent to 97 percent between 1995 and 2011 and caused a massive growth in installed pumps and irrigation.

**Saqib Mukhtar of Texas A&M University** described problems of the **Texan Ogallala aquifer that are similar to challenges in the MENA:** Agriculture in Texas uses 80 percent of groundwater and 35 percent of surface water. 66 percent of all groundwater comes from the Ogallala aquifer that stretches all the way up to South Dakota. Its current recharge rate only covers about 15 percent of withdrawals. Given the accumulated over-extraction it would require 300-1000 years of recharge to go back to the level of the 1940s when large-scale irrigation took off. Simple steps like metering and localization of water allocation via community councils could improve water management.

**Omar Aloui, the Managing Director of Rabat based Agroconcept,** proposed changes in the global discussion and debate toward domestic policy. He stressed issues of food accessibility as central challenge of food security and pointed out that farmers are often the most food insecure people in society.

## **Case Studies: Senegal, Morocco, Tunisia**

**Several workshop sessions were dedicated to country-focused case studies** that highlighted different challenges associated with nexus applications in varied contexts. The importance of sound data as input into integrated cross-sectorial planning emerged as a strong unifying theme of this session, with all three presentations addressing innovative efforts to generate knowledge for improved decision-making, within the water sector specifically in Senegal, where serious problems of hydrological monitoring persist, and across the WEF nexus spectrum in Morocco and Tunisia.

In the **Senegal River Basin**, a key obstacle to sound water resource development and management is the **absence of information on the hydrological functioning of the upper basin**. To address this shortcoming through an extensive streamflow simulation exercise, **Ansoumana Bodian of the Université Gaston Berger (UGB)** and colleagues applied the GR2M rainfall-runoff model using the key parameters of precipitation, evapotranspiration and soil moisture retention capacity. Based on success to date in enhancing the hydrological information base, verified through comparisons of the simulated and observed flow patterns at select functional gauging stations, plans are in place to expand the application of the model to other areas of the basin so as to allow for proper planning of water infrastructure and use.

The **Moroccan case study** highlighted one of the central opportunities presented by the nexus approach, namely the **identification of negative unintended consequences brought about by uncoordinated sectoral policies**. Focusing on the substantial energy costs associated with a strong policy push undertaken in Morocco to shift irrigation technology from gravity to localized irrigation in the name of water savings, **Rachid Doukkali of Institut Agronomique et Vétérinaire Hassan II** made a compelling evidence-based case for adopting a more integrated view that allows for clarity in managing trade-offs and for identifying alternative solutions, within the overall context of a global economic development strategy. Applying a SAM approach analyzing key parameters such as energy mix in production and consumption, cropping patterns, national investment costs and subsidies, the case study reached the **key conclusion that investment in rain-fed agriculture could increase profitability and sustainability of the Moroccan economy**.

Beside improved irrigation systems, “Green Water” also emerged as a potential key solution area in the **Tunisian case study**. It explored the relationship between agricultural and water policies, and urged, in the context of fully exploited “Blue Water” resources in the country, a concerted effort to a more comprehensive analytical and decision-making frame that accounts for the important role of green as well as virtual water in achieving food security goals. A systematic assessment of water resources in the production of crops such as cereals and olive tree framing illustrates the great potential, all the more important **as rain-fed agriculture in Tunisia accounts for two thirds of national food production and occupies nine tenths of cultivated areas**. Yet its contribution is not taken into account in the balance of water resources and receives little attention from policymakers.

**Jamel Chahed of ENIT Tunis hence urged the implementation of a strategy to support rain-fed agriculture, including the development of technical assessment tools and regulatory and legislative measures to optimize all water use.**

### **Case Studies: Qatar, Egypt, Darfur**

The case studies on the second conference day zeroed in on different aspects of the overall puzzle of how to measure, operationalize and institutionalize nexus concepts in different national contexts, facing unique challenges and requiring unique responses, from which broader lessons can be derived.

**Bassel Daher of Qatar Foundation** presented a **sophisticated nexus tool (wefnexustool.org)**, developed in the context of the Qatar National Food Security Program (QNFSP) that incorporates a host of WEF as well as climate and environment parameters. Populated with specific local data from Qatar, this tool helps decision-makers explore the multiple consequences of development policy choices, and highlights their costs and trade-offs, as part of an effort to optimize resource use in light of specific endowments, production structures and national goals. **Findings can be dramatic, such as the requirement of 764% more land that Qatar would require to increase its self-sufficiency to 50%** in a number of fruit and vegetable products, identifying limiting factors and pointing to alternative and more sustainable pathways.

In recognition that broad-based institution-building will be required for the nexus approach to take hold, a project titled **Knowledge-Triangle Platform (TriNex, [www.trinex.eu](http://www.trinex.eu))**, funded by the EU and presented by **Gabriele Cassetti of Milan Politecnic**, aims to build University capacity and strengthen the synergy between Research, Education and Innovation for sustainable resource management in the context of Egypt.

In its early stages, the initiative seeks to overcome some of the classic problems in the nexus – such as the lack of knowledge sharing across sectors and the treatment of water, food and energy as separate issues in national strategies – through a partnership **between Egyptian and European universities dedicated to inter-disciplinary research and training.**

A **case study on Darfur** highlighted nexus related aspects in a crisis context. **Brendan Bromwich** who worked for many years for **UNEP** in Darfur emphasized the central role of livelihoods in determining local nexus outcomes. He illustrated how the conflict and associated population displacement caused the disruption of long-standing resource use patterns and understandings among groups, with serious consequences for long-term environmental sustainability and peacebuilding. Noting some **unintended negative effects of the humanitarian response itself**, for example in terms of severe groundwater depletion associated with the emergence of a brick-making industry to service the influx of aid workers, the presenter urged nexus practitioners to engage with humanitarian and peacebuilding actors to ensure resilience is more effectively incorporated into immediate life-saving support.

### Case Studies: Lebanon, Syria, Jordan

**Talal Darwish** of the **National Center for Remote Sensing (CNRS)** in **Beirut** dealt with the impacts of climate change **Impact on water, agriculture and energy in Lebanon**. The effects of climate change in Lebanon have been mainly in the form of irregular rainfall patterns. Decline of overall rainfalls was relatively benign in comparison. There has not been that much change in snow cover of Lebanon's mountain's yet, but significant changes in maximum temperatures. This has contributed to a growing water shortage and perturbations of the hydrological regime. Drought tolerance of farming has been reduced and hydropower potential has declined.

**With the help of remote sensing analysis Hadi Jaafar** of the **American University of Beirut** monitored the effects of the **Syrian civil war on irrigated agriculture**. Conflict areas in Syria overlap with very productive crop areas in the north, north-east and south (Syria's previous bread-baskets). Remote sensing can show the impact of conflict on net primary production and agricultural productivity, e.g. in the Orontes basin.

**Samer Talози** of the **Jordan Technology University in Irbid** showed the spatial and temporal variations in blue and green agricultural water in Jordan. Jordan is extremely water scarce, now even more under pressure from refugees. Water resources are largely transboundary, with Jordan in many cases being the downstream riparian.



There has been an increase in climatic extremes, including floods. **Energy costs in desert farming amount to 1/3rd of total production costs and 14 percent of Jordan's electricity production is used for water treatment and pumping.** Hence a green water focus could help lower energy costs, compared to the current focus on blue/ irrigation water only.

## Implementing the Nexus

The panel discussion presented and discussed ways on how to implement the Nexus into policy in dryland economies. The presenters focused on practical policy recommendations targeted at the crucial role of institutions and farmers. The session echoed a current initiative by Texas A&M and Stockholm Environment Institute (SEI) to establish a Nexus roadmap for MENA dryland economies.

**Holger Hoff of the Stockholm Environment Institute (SEI) presented the current initiative by SEI, Texas A&M, UNESCWA, GIZ and Chatham House.** The roadmap seeks to bring together stakeholders over the coming years to develop Nexus tools for decision-making to quantify water, energy and food resources in the MENA region. The initiative was launched in Bonn in May 2014 at the 'Sustainability in the Nexus' conference. It will be presented to a wider audience during the 2014 Stockholm World Water Week in August/September 2014. Apart from devising tools, the initiative also seeks to identify policy recommendations such as economic incentives such as harmonized food and energy policies for MENA economies.

**Lynne Chatterton, an independent consultant,** presented a holistic view on the current implementation gaps. She highlighted the crucial role of human capital in the MENA region and argued that farmers' interests and their knowledge have been neglected in research and extension services. She illustrated the need of the MENA region to become more independent from big agricultural production systems and regions through a strong focus on smallholder farmers.

**Caroline King of Ecosystems and Human Development Association (EHDA)** echoed the call for a greater emphasis on farmers by highlighting a leitmotif of the meeting: the **potential of green water in the MENA region**. Her presentation focused on recent research conducted by EHDA on how to devise sustainable intensification methods through green water management, particularly in Yemen. Her recommendation concluded that green water is the foremost policy choice MENA decision-makers should pursue. It is even more important than more efficient use of blue water resources that are mostly in focus of debates.

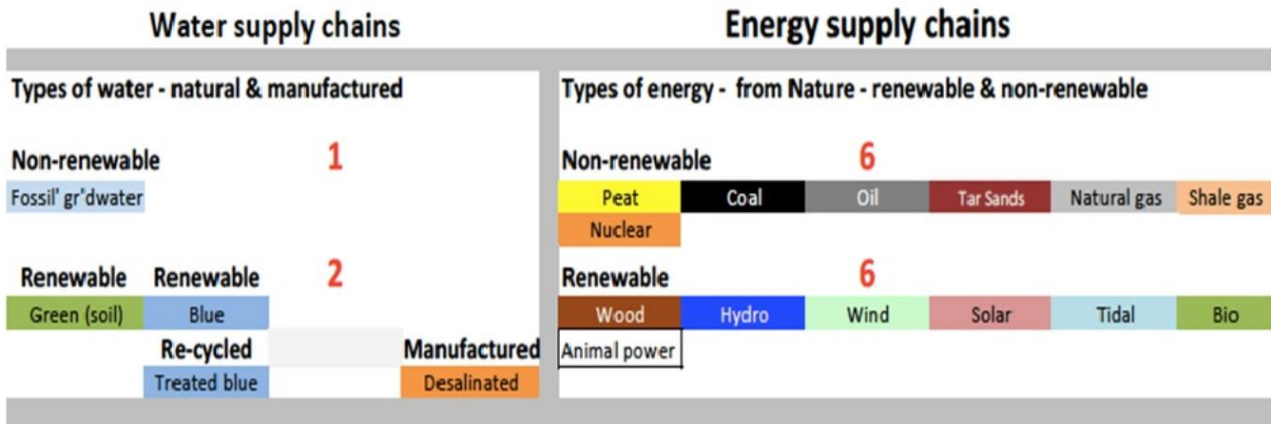
**Hammou Lamrani of GIZ shed light on his organization's work with the League of Arab States to establish a regional Nexus initiative.** He pointed out the currently inadequate institutional arrangements that treat resources separately. His presentation showed the road ahead to harmonize food, water and energy policy, which is currently revised by the League of Arab States supported by GIZ.

In a keynote address **Rabi Mohtar of Texas A&M** pointed out that there is a lack of capacity for Research and Development in the MENA, lack of integrated resource management and not enough interaction between policy makers and scientists. He also pointed to the opportunities. The region has considerable human capital and it has already started to harvest its rich solar energy resources and encourage corresponding research. Examples include QEERI of Qatar Foundation, the Masdar initiative in the UAE, King Abdullah University of Science and Technology in Saudi Arabia (KAUST) and MAZEN in Morocco.

## The Energy Water Nexus

Connections between water and energy consumption were addressed in a specific session. Referring to Tony Allan's work **Eckart Woertz of CIDOB** described the substitution factor; while various forms of energy can be substituted with each other there is little substitution between different kinds of water like blue and green water. Woertz was optimistic about the expansion possibilities of renewable energies in the MENA and more critical of the economic viability of nuclear energy in the long run, especially if costs for decommissioning and waste storage were accounted for appropriately.

## What types of water and energy are available?



Source: Allan, J. A, 2014, current research.

With further anticipated cost reductions, especially in the field of PV cells, **grid parity of renewables is not so much an issue anymore, but intermittency.** A renewable energy share of more than 20 percent is difficult if not impossible to achieve without storage solutions like molten slats, batteries, electric cars, pressurized air, pumped hydroelectric storage etc.

With technological breakthroughs in storage solutions a real take off of renewables can be expected. More integrated (smart) grids could also be part of the puzzle. **Studies have argued that Morocco, Spain and Portugal could provide base load electricity if their grids were sufficiently integrated** as somewhere on their land mass the wind is always blowing or the sun is shining.

While renewables are less harmful to the environmental than hydrocarbons they affect it as well ranging from the mining of Rare Earth Minerals that are required for the production of wind turbines and solar cells, to the water needs of Concentrated Solar Power plants. Similarly, unconventional shale oil and gas resources require water to be lifted. **Rabi Mohtar of Texas A&M pointed out that about 70 percent of the water that is used for unconventional oil and gas production via fracking remains underground and is withdrawn permanently from the hydrological cycle.** This could diminish water availability in the long run.

**Guy Jobbins of the Overseas Development Institute** showed interlinkages between electrification and water consumption. Rural electrification in Morocco went up from 18 percent to 97 percent between 1995 and 2011 and caused a massive growth in installed pumps and irrigation. Similarly, Samer Talazi for Jordan reported high rates of energy consumption by water pumping and agriculture.

**Francis Ghilès of CIDOB** described current resource issues in the MENA reminiscent of debates 30 years ago, even though scarcity is more intense now. He spoke of the resource allocation of rentier states that maintain energy subsidies that cause high growth rates of domestic consumption. Like **Harry Verhoeven** he described the importance of the political process where logical decisions may not be adopted for political reasons. Understanding the political process is critical to implementing the nexus. Like the **Chattertons** he pointed out that farmers have not been heard in the MENA policy process, even though they are crucial stakeholders that have to add to the debate.

## Financing the Nexus

**Tony Allan of KCL** pointed out that there are many possible nexi, and the linkages between them – in terms of supply chains etc. – are not always as convergent as one might think. They can be quite separate and need to be managed separately. Hence, the nexus is ill-defined and means many things to many people, an attractive banner-word looking for a meaning. **Allan suggested that Natural Ecosystems expect Understanding Stewardship could be an attractive and inclusive umbrella description.**

**Martin Keulertz of Purdue University and Eckart Woertz of CIDOB** argued that private sector organizations and investors are not just concerned by scarcity issues, but also by risks, e.g. water can raise reputation risk. **They stressed that it is difficult to price water appropriately because of its externalities.** Hence, it is important that there are sanctions in place to internalize costs of pollution and to ensure water provision as a public good. The latter requires state capacities that have been weakened after decades of neo-liberal reform.



Because of such unresolved externalities financing nexus related projects will **require a degree of soft financing that could come from international organizations and Gulf development funds beside national institutions.** There are also cultural issues around water pricing. It is important to develop legal frameworks that reflect cultural norms, yet are useful policy tools that incentivize desirable use and recover operating costs.

**Musa McKee of SOAS, London** showed interlinkages between culture and water, food and energy allocation. Politics is crucial to understand the role of state institutions and organizational structures and their cultural aspects (rules, norms & institutions) in shaping, confining and otherwise conditioning nexus related decision making.

**Daniel Yeo of the Global Green Growth Institute in Addis Ababa** argued that the nexus debate needs to be more aware of the development agenda of policy makers in order to be relevant. Food, energy and water are not abstract resources – they are situated within political and institutional frameworks, and should serve developmental agendas. Making decisions is about shifting resources around and it implies winners and losers.

Yeo argued that nexus conversations so far have sometimes been conducted with a tone of informed scientists informing ignorant policy makers. This doesn't work and isn't accurate. **We don't need perfect decision making, we need good enough decision making,** based on a range of views, that gets us to implementation and delivery of services.

Researchers need to understand the priorities and knowledge needs of policymakers and develop the skills and language to communicate with them.

The latter was also highlighted in the concluding key-note address by **H.E. Miguel Moratinos, the former Spanish Minister of Foreign Affairs** who passionately argued to move food and water issues up the priority list of politics by outlining some of the challenges he has faced in food and water related diplomacy.

In sum water, food and energy are inextricably linked via various nexi and should not be regarded separately. However, a purely technocratic approach should be avoided given the importance of political economy issues in allocation procedures.

## Way Forward

### BULLET LIST OF TAKE-AWAY MESSAGES

- **Approximately two billion people live in arid countries. One third of the global population will be most affected by water scarcity and climate change**
- **These vulnerabilities are aggravated in most MENA countries by underinvestment in social safety nets and insufficient public services**
- **By addressing water and energy together, planners can identify crucial interactions, conflicting demands and potential synergies**
- **To the extent that mitigation and adaptation have begun to be “mainstreamed” into national policies it has been within sectorial boundaries**
- **The constant rise in irrigation since the 1960s coincided with declining food prices – until 2008. Further irrigation growth is unsustainable and more efficient irrigation systems are needed**
- **Green water management and rainfed farming will be of the essence as blue water resources are (over) allocated**
- **There is potential to increase productivity of dryland farming without more water. The higher productivity rates of Australian dryland farming could provide valuable lessons**
- **Adapted seeds and plowing techniques, rain harvesting and supplemental irrigation can improve yields in the MENA**
- **Existing reporting and accounting rules do not account sufficiently for natural resources like water as inputs**
- **Water remains external to the economy. In case of damage there are only limited sanctions in place to internalize costs, while its provision as a public good is compromised by limited state capacities**
- **A purely technocratic approach to nexus issues is misleading, yet widespread in policy research. The nexus is quintessentially political and should be perceived as such**
- **African dryland countries need to increase their adaptability to climate change, especially to highly variable rainfall patterns**

- **Farmers need to be put at the center of attention of the international agro research establishment, which has focused on higher yields instead of lower costs and ecological factors, which are crucial for farmers**
- **A relative neglect of pastoralists in extension services (e.g. FAO's closure of its pasture department) should be reconsidered**
- **Drip irrigation improves efficiency, but it has not reduced water consumption in Morocco and elsewhere as it prompted farmers to increase the irrigated area and switch to more commercial but water intensive crops**
- **Information on the hydrological functioning of the river basins needs to be improved (e.g. Senegal river)**
- **Remote sensing is a valuable tool in this regard, also for the assessment of conflict related harm to agriculture**
- **Tools and platforms like [www.wefnexus.org](http://www.wefnexus.org) and [www.trinex.eu](http://www.trinex.eu) can provide guidance for policy makers and facilitate exchange between researchers and decision makers**
- **Renewable energies are not without environmental impact, but more environmentally friendly than hydrocarbons. Their costs have decreased substantially. Storage solutions that address intermittency could enhance the integration of renewables into grids and would expand their application tremendously**
- **Nexus related projects will require a degree of soft financing that could come from international organizations and Gulf development funds beside national institutions**
- **The dialogue between scientists and policy makers should be improved. It shouldn't be about "informed scientists meet ignorant policy makers". We don't need perfect decision-making; we need good enough decision-making.**



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