Sustainability Living Lab for Food – Water – Energy in Urban Environments

Documentation of Stakeholder and Expert Workshops in Amman, Jordan

FUSE in a nutshell

FUSE (Food-water-energy for Urban Sustainable Environments) is a transdisciplinary 3-year research project (2018-2021) on the future of Food-Water-Energy (FWE) resources in Jordan, with a focus on its capital, Amman. The project will develop a long-term systems model that can be used to identify viable paths to sustainability. It brings together scientists, engineers, economists, and stakeholder engagement experts from Stanford University in California, USA, IIASA (International Institute for Applied Systems Analysis) in Laxenburg, Austria, UFZ (Helmholtz Centre for Environmental Research) in Leipzig, Germany, and ÖFSE (Austrian Foundation for Development Research) in Vienna, Austria. The project is a not-for-profit research effort and is part of the Sustainable Urbanisation Global Initiative of JPI Urban Europe and the Belmont Forum. Each of the national teams is supported individually by its own national science-funding agency.

More information: https://fuse.stanford.edu/

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Context:

The provision of food, water and energy (FWE) resources is crucial for human well-being. Population growth, rising consumption, and growing urban environments increase the demand for these resources. To secure their provision, a long-term integrated approach is needed that considers human decisions under different biophysical and economic constraints. This integrated approach can anticipate trade-offs and identify synergies between sustainability paths. The design and implementation of long-term strategies to achieve FWE-sustainability is a challenging task for all actors – including policy makers, civil society, the private sector and academia – and can only be achieved by working together.

Amman and its greater metropolitan region have been growing rapidly over the past two decades. More than 5 million people currently live in this region and it is forecast to grow significantly in the future. Such rapid growth presents challenges and opportunities. For example, in the context of increasing water and energy uses for urban areas there is both dwindling freshwater availability and significant potential for solar energy. Understanding the food-water-energy nexus for Jordan with a focus on Amman is key to evaluating different paths and promoting those that target sustainability while avoiding those that are headed toward crisis.

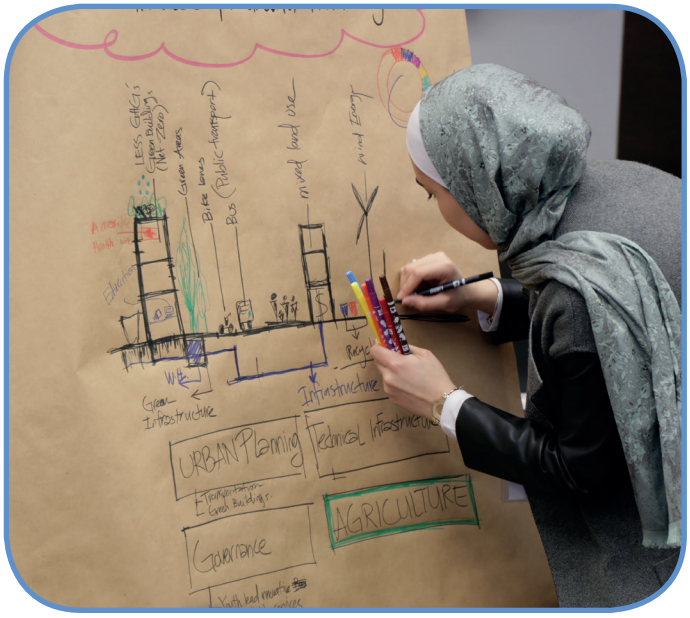
FUSE is a transdisciplinary research project that aims to contribute to identifying solutions for long-term FWE sustainability in Jordan, with a focus on the Greater Amman region. Building on the knowledge of local stakeholders and experts, FUSE will construct a FWE systems model that captures connections and feedbacks among users, producers, distribution mechanisms, and resources. Our approach integrates narratives of future changes in climate, demographics, land use, and economic development, and considers the behaviour of a wide range of actors. The model will be used to evaluate policy interventions and innovative governance forms to identify implementable sustainability options.

Sustainability Living Lab Approach

To incorporate the knowledge, expertise and views of local actors, FUSE adopts a Sustainability Living Lab (SLL) approach. The SLL approach includes a stakeholder analysis and two series of workshops, at the beginning and the end of the project period, respectively. In the first set of workshops (conducted in the spring of 2019), stakeholders and policy experts shared visions, challenges, coping strategies, and potential infrastructural and policy solutions involving limited FWE resources. The information gathered is being processed and integrated into the system model to explore the potential benefits of these solutions. In a second set of workshops (to be held in early 2021), the results of the modelling exercise will be presented to the participants of the first workshops, and feedback will be elicited. Between the two series of workshops, further exchange with the stakeholders takes place.

FUSE Living Lab Approach

1. Get stakeholder ideas about future challenges. Experts add ideas and propose solutions.
2. FUSE team develops a policy-evaluation model incorporating all ideas.
3. Get stakeholder and expert response to the results.



Key messages

- Stakeholders are fully aware of Jordan's limited water resources and related challenges comprising:
  - Groundwater depletion
  - Climate change
  - Water pollution
  - Transboundary water and energy issues
  - Increasing future water scarcity
- Workshop participants were forward-looking and excited about imagining and designing a sustainable future for Jordan, with a focus on Amman.

Key points raised during the workshops:

- The provision of food-water-energy resources in Jordan is highly dependent on surrounding countries, that have experienced crises of their own.
- It is within Jordan's culture to welcome people, live together in solidarity, and pay attention to social cohesion.
- Concerns were expressed that food-water-energy resource availability, economic growth, and employment opportunities might not be able to keep pace with population growth.
- In Amman most wastewater is already treated and used. For participants, wastewater re-use is an important issue, and should be implemented throughout the country.
- Decentralized supply solutions were discussed as options to increase resilience, e.g.:

  (1) An extended electricity grid could allow Jordan's citizens to harness the substantial potential for renewable solar energy.

  (2) Decentralized wastewater treatment could improve water resource efficiency in rural areas.
- Silo-thinking between the food, water, and energy sectors was identified as an important challenge in achieving resource sustainability.
- The maintenance of local food production in the Jordan Valley but also in the Highlands was important to the participants.

Workshops in Amman – March 2019

In Amman, the first set of workshops took place from 24-27 March 2019, organised in cooperation with our local partner organisation, MIRRA (Methods for Irrigation and Agriculture). Two one-day and one half-day workshops were held: the first workshop had stakeholders from different FWE fields, the second workshop had experts from the public and private sectors and academia, and the third workshop was focused exclusively on input from modelling experts. This report documents the first two workshops.

1. Stakeholder Workshop (March 24, 2019)

What: Share and discuss FWE challenges that stakeholders face, their coping strategies, ideas, and solutions for the future.

Who: There were 35 participants from diverse Non-Governmental Organisations (NGOs) in the areas of water, food, energy, urban matters, environmental protection, social issues, as well as farmers, youth group representatives and small companies.

How: After an introduction to the project, participants formed small groups and discussed current FWE challenges and coping strategies. In the second part of the workshop, four future perspectives were presented. Participants discussed possible solutions and future coping strategies within these perspectives in a World Café format.

Step 1: Collect current challenges and coping strategies

"We need more cooperation instead of silo-thinking"

Challenges:

Growing pains: Participants expressed that Jordan, and Amman in particular, face several challenges, such as rapid population growth, unplanned urbanization, general lack of natural resources, low degree of industrialization, a very high unemployment rate – in particular among young people, and strong dependencies on other countries concerning food and energy (e.g., long-term contracts for gas and oil, leading to a very small share of renewables). These concerns are superimposed on the geopolitical situation of countries in the region engaged in recent war or other crises, and are exacerbated by climate change.

Freshwater provision: The above concerns have led and will further lead to enormous FWE challenges. On the environmental level the biggest concern in Amman is the inability to meet freshwater needs, which is heightened by issues of pollution (including salinization of groundwater). There is already a highly intermittent water supply (e.g., one or two times per week with limited hours during the day, averaging 37 hours per week of supply in Amman in 2018). As people seek to circumvent the unstable water supply, there has been growing water theft, well-installation on farms and illegal pumping of water in the areas surrounding Amman. This has environmental and financial consequences with falling water tables (by at least 1 m/y) and high levels of non-revenue water. Water stolen, billed and unpaid, not billed for, or lost through leaking pipes is on the order of 50%.

Environmental degradation: Agriculture in Jordan is intertwined with environmental concerns such as soil and groundwater degradation, excessive use of fertilizers and pesticides, and loss of crop diversity. Participants stated that farmers lack long-term plans regarding improved water efficiency, and still plant water-intensive crops such as strawberries or melons.

Lifestyle changes: In addition to physical constraints on FWE resource supplies, lifestyle changes were raised as key concerns. At the individual level, participants stressed that changes in lifestyle have led to increased energy demand and consumption in general. In this context, a lack of responsible "sustainability behaviour" (e.g., low share of recycling, high use of plastic, lack of awareness in disposing waste, hardly any household collection of rainwater) was stressed.

Governance: With respect to governance, concerns were raised about the low level and transparency of planning processes, with hardly any existing public participation (e.g., in urban planning, or dam construction plans), about the management of waste and about the ineffectiveness of existing infrastructure (leaking pipes, dams unable to handle floods). Dissatisfaction was expressed regarding weak law enforcement. Participants advocated for better cooperation and communication between Ministries to help overcome silo-thinking.

“Jordanians have learned to accept the situation, to wait and see”

Coping strategies:

When asked about coping strategies, stakeholders mentioned that people have learned to adapt to limited water availability. Among the things they try to do, are the following:

minimising their water use, installing water saving technologies, repairing pipes, reusing dishwashing water for irrigation or installing additional rooftop storage tanks. Farmers leave their land and move to new land, and some have changed crops and/or shifted to new irrigation technologies. To increase access to water, farmers and citizens deepen their wells and increasingly resort to water supplied by tanker trucks.

To deal with low formal employment opportunities and low salaries, people try to find informal work, and have multiple jobs. It was also stated that Jordanians have learned to accept the situation and to wait and see.

“Better planning, management and maintenance offer opportunities and solutions”

Opportunities and solutions:

Stakeholders expressed the need and the opportunity to overcome silo-thinking within ministries or municipal departments by taking a holistic view of the FWE nexus and considering linkages between natural, engineered, and socio-economic systems. Initiatives financed and promoted by the government, such as Smart City development, green building initiatives, sustainable agriculture, education to raise awareness for sustainable lifestyles and for the value of the rural areas to the urban population were regarded as opportunities for facing challenges and supporting both cooperation and communication. For farmers, particularly highland farmers, who face even greater water scarcity, a pro-active and market-oriented approach, the use of alternative crops, and new irrigation and farming technology were seen as increasing their chance for survival.

The following were among the solutions proposed by participants:

- better planning (land-use, urban, agricultural, dams)
- better management (water, wastewater, dams, waste)
- increased law enforcement and monitoring
- maintenance of existing infrastructure and building new infrastructure, such as a water distribution network and a water metering system
- tax and subsidy systems supporting sustainable agricultural and urban development plus investments (e.g., true prices for agricultural water to plant less-water intensive cash crops, investments in the food industry)
- decentralisation and support of small-scale projects (e.g., use of grey water, rooftop rainwater harvesting)
- reduction of food waste and transforming it into energy
- a much quicker switch to renewable energy, especially solar, as well as residential energy efficiency programmes

Step 2: How to react to future challenges?

"We need more $ per drop rather than more crops per drop"

In the second part of the workshop, four future perspectives (see p. 9) were presented by the FUSE team. They are related to the potential increases in water scarcity, urbanisation, challenges for agriculture in the Highlands, and changes to the energy system.

Participants divided into four groups, and discussed which strategies and solutions can support sustainable development within one of the four perspectives. Each group finally proposed up to five measures.

- The group that worked on the **water perspective** regarded the Red Sea-Dead Sea desalination project as a "must-have". Smart water and flood management, and functioning infrastructure were seen as a basis for a sustainable water system. All this should be supported by transparency of tariffs, where the full economic costs of water are reflected. In addition, improved water sharing agreements with neighbouring countries were regarded as key.

The group suggested technological innovation in treatment of wastewater including use of grey water for the whole of Jordan; rainwater harvesting at household and institutional levels, partly used for urban infiltration of groundwater, for flushing toilets, and irrigation of urban gardens; repair of piped-supply network leaks. The group also proposed reducing pressure created by Amman's population growth by creating incentives for people to move to other cities plus Smart City development that accounts for environmental impacts.

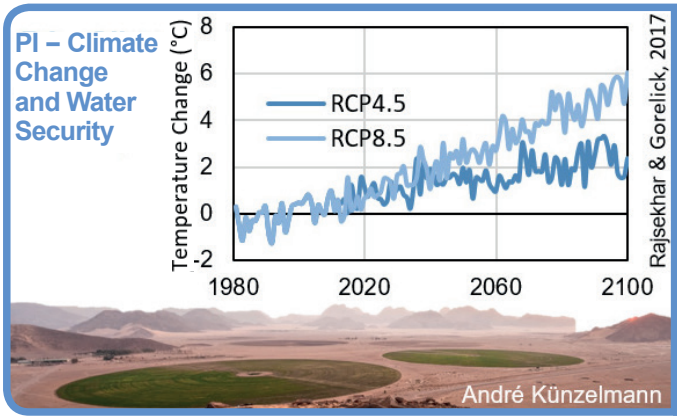
- In the group on the **urban and industrial development perspective**, participants proposed solutions such as: re-design and retrofit old buildings and neighbourhoods to make them "greener", prioritize improvement of water, wastewater and energy infrastructure, water-efficient greening of the city, law enforcement and measures against corruption. A stronger focus on transit-oriented and polycentric development was suggested, potentially including further satellite towns. Furthermore, a strong improvement of public transport was seen as a premise for a change in the individual mobility patterns since under the current mobility situation public transport is not seen as an alternative to private vehicles.

- The group on **rural development perspective** concluded: It is important to invest in the rural areas, to enable decent living conditions for the rural population. The need to restructure agricultural institutions and enforce existing and new regulations and to enhance cooperation among ministries, farmers and intermediaries. In general, cropping and irrigation plans combined with IT and high-tech solutions were seen as important for farmers. Decentralisation of freshwater, wastewater treatment and energy systems were also regarded as critical in rural regions. To implement this successfully, awareness for sustainable development of the rural areas among the rural population and farmers needs to be raised. Participants proposed that a minimum standard for water saving and efficiency should be required of each rural household, under the precondition that enough water is provided to all such households. Processing vegetables, fruits and animal products further should target value-addition and increased income of farmers.

- The group on **energy** noted: It is necessary to put the focus on switching to renewable energy. This would help Jordan to curtail greenhouse gas emissions and to reduce energy dependence; however, a potential obstacle is that due to long-term energy purchase contracts, Jordan currently has excess electricity production. Solar energy was viewed as the most important energy source followed by wind and hydro. Large solar farms in unoccupied sunny parts of the country may be the greatest opportunity. Examples mentioned solar farming in the Jordan Valley and in barren land in southern Jordan. Planning, incentives and pricing need to support the implementation of solar farms and energy, in order for farms to become economically self-sustaining (with establishment of a viable electric transmission grid). To achieve this, improvement and dismantling of the existing electric grid, large investments as well as new forms of energy storage are needed. On the individual level, the need to move energy behaviour towards greater efficiency and saving, and towards more sustainable mobility behaviour (reducing the individual use of cars) was expressed.

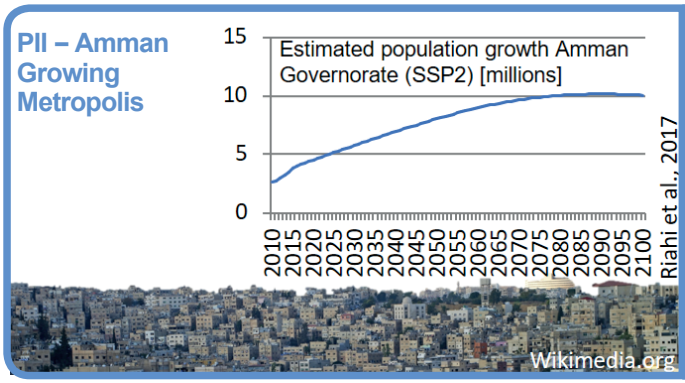
Perspectives of potential future developments presented by the FUSE team during the workshops

PI – Climate Change and Water Security



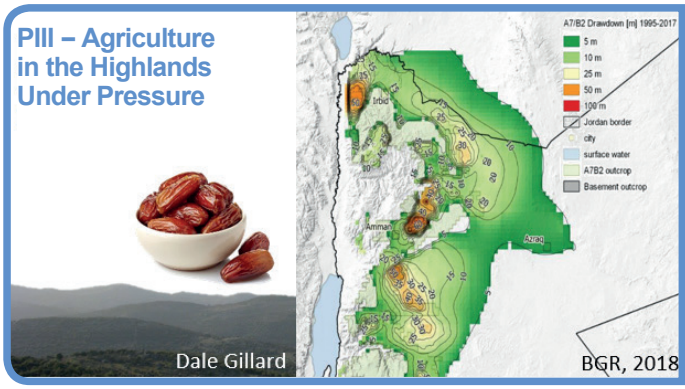
The Jordan Water Project found climate change to have severe impacts on the average temperatures in Jordan: By 2100, temperatures may increase between 2°C and 6°C compared to the baseline (1980-2010). Climate change will also reduce water availability in the region. Already being among the most water-scarce countries in the world, the situation is expected to worsen over the next decades.

PII – Amman Growing Metropolis



Between 2004 and 2014, Amman's population almost doubled. The city's rapid and erratic growth has been driven mainly by migration, both domestic and cross-border. The expected continuous growth of Amman will entail strong increases in resource and land use and pose stress on infrastructure.

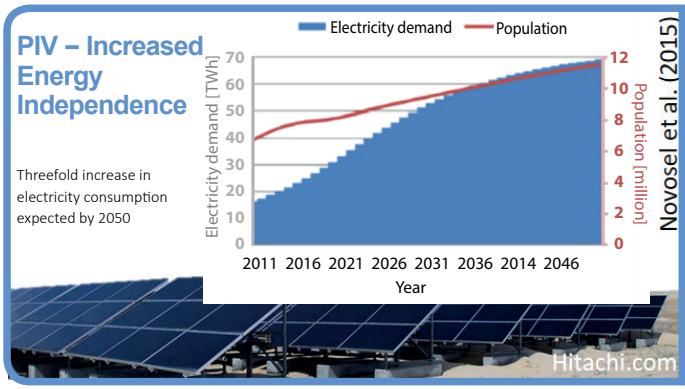
PIII – Agriculture in the Highlands Under Pressure



Jordan's highland farmers are confronted with increasingly difficult irrigation conditions through lowering of groundwater tables and increasing water pollution. These issues are expected to become more severe. Between 1995 and 2017, water levels in the A7/B2 aquifer were lowered by up to 60m. Many highland farmers will need to change their agricultural practices to stay profitable.

PIV – Increased Energy Independence

Threefold increase in electricity consumption expected by 2050



Jordan's energy demand has been rising in the recent decades and it is expected that this trend is going to continue. The electricity demand is projected to increase threefold by 2050. Currently, almost all energy resources that are consumed in Jordan are imported. Increasing energy independence is a goal to which renewable energy, especially wind and solar, could contribute, if a well-coordinated scale-up starts soon.

2. Expert Workshop (March 26, 2019)

What: Create a common vision of the Greater Amman Region in 2050, and develop ideas and proposals for measures and policies aimed at developing a sustainable FWE system.

Who: There were 42 participants from academia, public institutions, NGOs, former government officials, and from the private sector.r

How: After an introduction to the project, and after a presentation of the results of the stakeholder workshop, the participating experts elaborated on their vision of a sustainable Amman region in 2050. Subsequently, they developed and rated measures to reach this vision based on the challenges collected in the stakeholder workshop and on the four future perspectives.

Step 1: Vision exercise

Participants in different groups produced pictures or mind maps representing a future vision of a sustainable Amman region. They were asked: What would the region ideally look like in 2050 with a focus on FWE resources and on social dimensions? Then each group came up with a common understanding of this ideal future. Though the pictures looked different, there were many similarities in their respective visions.

"The common vision in 2050"

There was a consensus that Jordan has a unique cultural heritage and that it is imperative to maintain it. However, in addition to maintaining traditions, social and technological innovation is seen as important to achieve a sustainable FWE future.

In the common vision for 2050, a sustainable Amman region has solved its water and energy problems by better management and planning, use of the latest technology and changes in (individual) behaviour, and open, transparent governance and implementation of new as well as existing regulations. It offers affordable and accessible resources for all, job opportunities due to a transition from traditional and agricultural industries to a service-oriented industry, including tourism and IT, and by serving as a major trade hub in the Middle East. Urbanisation is smart and green, and Amman is a liveable green city.

Relevant elements of the common vision

- Water: Continuous and affordable water supply everywhere and every day for all, including wastewater and sewage treatment, rainwater harvesting, managed aquifer recharge, grey water use. Water quality is improved and there has been a technology revolution that reduces non-revenue water from 50% to no more than 10%.
- Energy: Renewable sources (mainly solar, but also wind, hydro, biomass) provide 80-100% of energy use.
- Agriculture: There is a master plan for agricultural development so that healthy and organic agriculture and food options exist, water efficient crops are used, the water distribution system for the agricultural sector is efficient and the price for crops reflects the real costs for water.
- Urban: Urban development is well planned, there is improved zoning in the cities (concentration of living areas, schools, supermarkets, hospitals) including more green space; the buildings are green and energy efficient. Rooftop gardening and vertical farming have been installed so that the city can produce a part of its own food. Solid waste is recycled and partly transformed to energy. Industry has moved out of the city. Within the city there are primarily service-oriented businesses and industries.
- Governance: Trust in government has been restored, corruption does not exist, laws and regulations are enforced and monitored, productive cooperation between the different sectors exists; laws are implemented; silo-thinking has been overcome and public participation has become the norm. Decisions are transparent and can be relied upon.
- The visioning exercise offered further ideas outside the food-water-energy nexus, including accessible and affordable health, education, and housing; a walkable city; public transport, and electric public and individual transport.

Step 2: How can this vision be reached?

The next 30 years will be affected by big and fast changes, such as climate change, increased urbanisation, further population growth, technological advances, changes in lifestyles with likely higher resource consumption. The demand for land, food, water, energy will further increase. As a second step, the participants elaborated in small groups on how their vision can be reached within the four different perspectives that the FUSE team presented. The following graphic summarizes the proposals that participants came up with.

Measures proposed by participants - Highlights

PI: Climate Change and Water Security

- implementation of big infrastructure projects, such as the Red Sea-Dead Sea conveyance project
- realization of small-scale projects, such as reducing non-revenue water losses
- regulated management of wells with enhance enforcement
- capture and store rare-event urban flood waters
- water saving technologies and practices
- further expanding wastewater treatment to further support agriculture that does not divert water resources from other sectors
- tertiary treatment of wastewater, combined with groundwater injection and blending as a potential last-resort solution to make treated wastewater acceptable as a drinking water source
- desalination of deep aquifers close to the Dead Sea, where brine disposal would be feasible
- optimizing water use: drip irrigation, rain water harvesting, behaviour change campaigns aimed at greater use efficiency
- better agreements for transboundary water use
- reducing virtual water exports
- local and national cooperation
- in addition to public investment, private sector involvement and investment is needed

PII: Amman's Growing Metropolis

- implementation/enforcement of a master plan and long-term strategies for infrastructure development, e.g., through acquisition of private land by the Greater Amman Municipality (GAM) at strategically important locations
- overcoming the critical budget constraints of GAM and/or development of innovative financial instruments (private public partnerships etc.)
- better maintenance of existing drainage system in order to avoid flooding in after stormwater events
- additional flood protection through green infrastructure in valleys, where open and vegetated land can improve stormwater retention
- densification and intensification of urban areas to limit urban sprawl toward the west
- implement design principles of transit-oriented development, include affordable bus rapid transit system adapted to Amman's terrain challenges
- instructions/guidelines for environment-friendly and resource +efficient construction, e.g., promotion of rainwater-harvesting techniques
- awareness building among citizens about importance of green development of Amman

PIII: Agriculture – Highlands under pressure

- agriculture in the highlands: change of crop patterns, support of high-tech and lower resource solutions, and shifting away from traditional water-intensive crops (a development plan is needed)
- market access for producers from the highlands
- potential reallocation or sale of water from agriculture to urban uses
- rainwater harvesting and energy production in rural areas
- agro-tourism projects for foreigners and locals

PIV: Increased energy independence

The energy group in the expert workshop discussed, whether a scenario of unsatisfied power demand is realistic in Jordan and concluded that the opposite is true, i.e., that the country is currently producing more electricity than it consumes. This trend, according to the group members, is likely to continue because long-term natural gas delivery contracts have been signed recently.

In order to move towards a more renewable-based system, the group discussed the following solutions:

- electricity sector reform and development of an integrated strategy taking into account different forms of renewable energy resources, all relevant actors, expected demand and supply, legal situation, dependencies from other countries, etc.
- improve and expand the electricity grid and perform load management so that renewable energy can be used more extensively
- install energy storage systems (primarily decentralised systems)
- support (decentralize) renewable energy production and eventually export it to neighbouring countries
- develop Jordan's fossil fuel resources
- use excess electricity for pumping water or for seawater desalination; requires intensified cooperation between the Ministry of Water and Irrigation and the Ministry of Energy and Mineral Resources

Outlook / Next Steps

The FUSE team collected, documented and processed the information gathered during the workshops and will include it in different parts of the model and other elements of our research.

At the beginning of 2021, results of the research will be presented to and discussed with the stakeholders and experts.

Participants in Stakeholder Workshop

Participants in Expert Workshop

The FUSE team thanks all participants for their valuable contributions and MIRRA (in particular, Dr. Samer Talozi and Alham Walid Al-Shurafat) for their support.

Participating Institutions

Agri Jordan
Agricultural Credit Corporation
Arab Countries Water Utility Association (ACWUA)
Association for Climate Change and Environmental Protection of Jordan (JOCCEPS)
BGR – Federal Institute for Geosciences and Natural Resources Germany; Jordanian Office
BORDA WesCA
Catalyst Investment Management
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)
EDAMA
Energy & Minerals Regulatory Commission (EMRC)
Farmer Union
Friedrich Ebert Stiftung (FES)
Greater Amman Municipality (GAM)
Hashemite University
Horizons for Green Development
Housing and Urban Development Corporation (HUDC)
International Center for Agricultural Research in the Dry Areas (ICARDA)
International Union for Conservation of Nature (IUCN)
International Youth Ambassadors Foundation (IYAF)
Jordan Aqua Conservation Association (JACA)
Jordan Enterprises Development Corporation (JEDCO)
Jordan Environmental Protection Association (JEPA)
Jordan Food and Drug Administration (JFDA)
Jordan Green Building Council (JGBC)
Jordan Renewable Energy & Efficiency Fund (JREEEF)
Jordan Renewable Energy Society (JRES)
Jordan Standards and Metrology Organization (JSMO)
Jordan University of Science and Technology (JUST)
Jordan Valley Authority (JVA)
Jordan Water Company LLC Miyahuna
Jordanian Environmental Union (JEU)
Jordanian Hashemite Fund for Human Development (JOHUD)
KfW Entwicklungsbank (Germany)
Mennonite Economic Development Association (MEDA)
Methods for Irrigation and Agriculture (MIRRA)
Ministry of Agriculture (MoA)
Ministry of Energy and Mineral Resources (MEMR)
Ministry of Environment (MoEnv)
Ministry of Transport
Ministry of Water & Irrigation (MWI)
National Center for Agricultural Research (NARC)
National Electric Power Company (NEPCO)
National Energy Research Center (NERC)
Rasheed
Royal Scientific Society (RSS)
Royal Society for Nature Conservation (RSCN)
University of Jordan
University of Surrey (United Kingdom)
USAID
Water Authority of Jordan (WAJ)
Water Wise Women Initiative (WWWI)

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Imprint: ÖFSE, Sensengasse 3, 1090 Vienna, Austria. Authors: Ines Omann, Karin Küblböck and Hannes Grohs, ÖFSE, Steven Gorelick and Anjuli J. Figueroa, University of Stanford, Raphael Karutz, Christian Klassert, Bernd Klauer, Heinrich Zozmann, UFZ and Mikhail Smilovic, IIASA. © Photos: Safi Al-Sakran, Steven Gorelick, Raphael Karutz. Design: Alexandra Erös, ÖFSE

This work was conducted as part of the Belmont Forum Sustainable Urbanisation Global Initiative (SUGI) Food-Water-Energy Nexus theme for which coordination was supported by the US National Science Foundation under grant ICER/EAR-1829999 to Stanford University. The Austrian partners ÖFSE and IIASA are funded by the Austrian Research Promotion Agency (FFG). UFZ receives funding from the Federal Ministry of Education and Research (BMBF). Any opinions, findings, and conclusions or recommendations expressed in this material do not necessarily reflect the views of the funding organizations.