



Brussels Policy Briefing n. 56

The Land-Water-Energy nexus and the Sustainability of the Food System

Organisers: CTA, ACP Secretariat, European Commission/DG DEVCO, Concord

Wednesday 3rd July 2019, 9h00-13h00

ACP Secretariat, 451 Avenue Georges-Henri, 1200 Brussels, Room C

<http://brusselsbriefings.net>

BACKGROUND NOTE

1. Context

Global trends such as increasing population, rising incomes, income disparity, urbanization and resource extraction are applying tremendous pressure on our ability to secure clean and adequate water supplies, nutritious and available food supplies, as well as sustainable and secure energy supplies.

In the coming decades, growing populations with higher incomes will drive a strong increase in global demand for goods and services. Global gross domestic product (GDP) is projected to quadruple between 2011 and 2060, according to the central baseline scenario projected with the OECD ENV-Linkages model. By 2060, global average per capita income is projected to reach the current OECD level (around USD 40 000). Production and consumption are shifting towards emerging and developing economies, which have higher materials intensity.¹

In most of the analysed scenarios the temperature shows significant increase in all Sub-Saharan Africa regions, while the yearly distribution of the precipitation does not follow the same increasing pattern, with the majority of climate models projecting decreases in annual precipitation that reach 20% by 2080. At the same time, it is expected that the agricultural production will require larger water quantities for irrigation, to maintain and increase the output. Thus, scaling up the efficient and sustainable utilization of both surface and groundwater resources is absolutely necessary to adapt to a dynamically changing environment and the increasing needs for food production.

In a growing natural resource scarcity context, making progress in one area, such as food security, will likely adversely affect progress in other areas, such as water security or environmental sustainability. As a result, business-as-usual approaches are no longer an option. Instead, advances in food security need to be addressed within a nexus perspective incorporating key interlinkages with related sectors, including water and energy.²

In parallel to the pivotal challenge facing human kind of reducing hunger and extreme poverty, the need to create and expand efficient systems of energy supply and use in emerging economies highlights the need for research on alternative forms of energy use, in particular the role of biomass.³

Delivering water, energy and food for all in a sustainable and equitable way is a major challenge faced by society. The interactions between water, energy and food in a nexus approach are crucial for the implementation of the Sustainable Development Goals (SDGs) and key to fight poverty, protect the planet and promote peace and prosperity. Out of the total seventeen SDGs, three of them have a particular focus on water, energy and food. Accordingly, SDG#2 aims at

¹ OECD, Global Material Resources Outlook to 2060. [Economic drivers and environmental consequences](#), OECD Publishing, Paris.

² Ringler, Claudia; Mondal, Md. Hossain Alam; Paulos, Helen Berga; Mirzabaev, Alisher; Breisinger, Clemens; Wiebelt, Manfred; Siddig, Khalid; Villamor, Grace; Zhu, Tingju; and Bryan, Elizabeth. 2018. [Research guide for water-energy-food nexus analysis](#). Washington, DC: International Food Policy Research Institute (IFPRI).

³ ZEF. [Land, Water, Food and Energy](#).

fighting hunger and malnutrition. SDG#6 aims at providing access to safe water and sanitation as well as ensuring a sound management of freshwater ecosystems. SDG#7 promotes energy access for all and supports actions to meet targets for increased share of renewable energy sources' (RES) use and high levels of energy efficiency (EE).

2. Land, Water, Energy nexus approach

Water, energy and food systems are inextricably interconnected. Water and energy are needed to produce food; water is needed for almost all forms of power generation; energy is required to treat and transport water. The relationships and trade-offs within this triangle of resources are known collectively as the water-energy-food nexus.

The analysis of beneficial synergies between the water, energy, food and the ecosystem through a nexus approach, has attracted the interest of scientists, policy-makers and the private sector.

'Nexus thinking' was first conceived by the World Economic Forum (2011) to promote the inseparable links between the use of resources to provide basic and universal rights to food, water and energy security.

The Water-Energy-Food (WEF) nexus is an approach to assessment, policy development and implementation that focuses on water, energy and food security simultaneously.

Nexus framings consider key issues in food, water and energy security through a sustainability lens in order to predict and protect against potential risks of future insecurity, driven by the availability of and access to resources, the capacity to utilise resources as well as dynamics of social power relations and the strength of institutions.

A number of key linkages have been articulated (SEI):

- Water needed for food production: rain-fed or irrigated agriculture.
- Water needed for energy production: hydropower, biofuels and other growing trends in renewable energy production.
- Energy needed for food production: harvest, transport, processing, packaging and marketing. • Energy needed for water: desalination, water and wastewater treatment, water distribution and irrigation.

Energy and water systems depend on each other in many ways. The power sector is a clear example, since almost all electricity generation technologies, as well as carbon capture and storage, use significant amounts of water. Water is necessary in the coal sector too, to extract oil and gas and to refine oil products into fuels and petrochemicals; it is also used to grow biomass for the bioenergy sector. Conversely, energy is required to extract, convey, deliver and treat water.⁴

Increased biofuel production also affects our nexus. Biofuels are an economic opportunity and have the potential to grow fast in countries like Brazil and Russia, with their abundant land and rain-fed agriculture. But in many cases biofuels reduce land availability for food crops. This "indirect land use change" can have several effects. It can push up global and regional food prices as supply is squeezed, with particular impacts in regions where food security is already vulnerable, such as India and northern Africa. More biofuels can also lead to higher energy prices, and cause new vulnerabilities among producers.

A new modelling approach⁵, focusing on the "land-water-energy nexus", has been developed which assesses the biophysical consequences and economic costs of the nexus in 2060. It clearly shows how shocks to one part of the system affect the other parts.

⁴ EC. [The relevance of the water-energy nexus for EU policies](#). Setis Magazine No. 18.- October 2018.

⁵ OECD (2017), *The Land-Water-Energy Nexus: Biophysical and Economic Consequences*, OECD Publishing, Paris, <https://doi.org/10.1787/9789264279360-en>

The analysis is based on coupling a gridded biophysical systems model with a multi-regional, multi-sectoral dynamic general equilibrium modelling assessment. Numerical insights are provided by investigating a carefully selected set of scenarios that are designed to illustrate the key bottlenecks: one scenario for each resource bottleneck, plus two scenarios that combine all bottlenecks, with and without an overlay of climate change.

2.1. Systems, Institutions and Governance

The use and regulation of one resource creates bottlenecks for others. Water management, for instance, leads to trade-offs between needs for energy production and irrigation for agriculture, particularly (but not only) in water-stressed regions. Urban sprawl eats away at the land available for growing food, but so do green policies promoting biofuels. We need to take into account the effects on the land-water-energy nexus for more holistic and effective policies that work for everyone concerned. Trade-offs exist between water and land allocation for food production versus biomass production or exploring food security challenges in areas impacted by land degradation and conflict.⁶ Producing more crops meet present and future food demands means developing new water governance approaches.

To understand and manage the interdependencies between the various sectors and their global impact will require comprehensive planning and policy implementation, institutional resilience, partnerships across economic sectors, and innovation in development in order to sustainably manage resources in the wake of population growth and climate change.

Implementation of the framework requires a participatory process among stakeholders, including sector-specific experts, decision-makers, and other local and regional actors.

2.3. The need for cross-sectoral collaboration

The combined effects of growing population, rising incomes and expanding cities, demand for water will continue to grow, while in many regions water availability is becoming more uncertain (i.e. Africa and the Middle East). This increasing water stress will intensify competition between water users. A lack or an excess of water may undermine the functioning of the energy and food production sectors, with societal and economic effects.

Solutions need to focus on efficient and equitable allocation of water across all sectors, recognising at the same time that they should be tailored to the socio-economic and ecological specificities of a region. More integrated approaches are needed to take into account the interactions between water, energy and agriculture as well as household demand.⁷

Examining the policies for coherence highlights overlaps and complementarities which lend themselves to a coordinated approach. Institutional constraints (particularly structures and resources) restrict opportunities for inter-sectoral action and thus collaboration is confined to ad hoc projects with mixed success to date. The results highlight the need for institutional frameworks that recognize and address these constraints to enable development goals to be pursued in a more sustainable and climate-resilient manner.⁸

Water resource management and governance often involves transboundary collaboration and is fundamental for peace and stability, as disputes over access to water often lead to severe conflicts (i.e. Nile basin water resources sharing between Egypt, Sudan and Ethiopia which impacts food and energy security).

2.3. Expanding good practices

- Extending biomass production and processing beyond food, feed and fibre to include a range of value-added products with potential applications in many sectors, such as pharmaceuticals, green chemicals, industrial materials and energy⁹

⁶ Livia Bizikova, Dimple Roy, Henry David Venema, and Matthew McCandless with contributions from Darren Swanson, Avet Khachtryan, Carter Borden and Karla Zubrycki. IISD. Water-Energy-Food Nexus and Agricultural Investment: A Sustainable Development Guidebook. 2014.

⁷ EC. [The relevance of the water-energy nexus for EU policies](#). Setis Magazine No. 18.- October 2018.

⁸ Joanna Pardoe, Declan Conway, Emilinah Namaganda, Katharine Vincent, Andrew J. Dougill & Japhet J. Kashaigili. [Climate change and the water-energy-food nexus : insights form policy and practice in Tanzania](#). In: Climate Policy. Pages 1-15.

⁹ Dr. Jan Janosch Förster. [Bioeconomy between Europe and Africa](#). Policy Brief. N. 29. Center for Development Research (ZEF) University of Bonn.

- Adaptation of crops to climate which provide higher income with less water
- Modernising infrastructure (i.e. irrigation systems) can lead to considerable water efficiency gains and improving controls on water use
- Using saved water to ensure environmental flows and ecosystems.
- Adjusting the amount of water applied to the actual needs of the crop can also deliver good water savings.
- Small-scale water harnessing and irrigation is particularly suitable for rural communities at relatively low cost
- Adoption of new technologies and modernizing infrastructure including the utilization of solar photovoltaic water pumping systems (PVWPS)¹⁰
- The potential of the solar photovoltaic technology. Solarbased water pumping systems can to provide electricity to communities, through the development of rural mini-grids.¹¹
- Need for research on alternative forms of energy use, in particular the role of biomass.
- Eco-innovations are key as they focus on use efficiencies redefine the way we produce and consume water, energy or food.
- Upscaling intelligent solutions (ICT driven)

3. ICTs in support of WEF nexus solutions

Technology innovations that strive to address the nexus stress in an integrated manner are also emerging. Such technologies typically aim to increase water conservation by power utilities and agricultural businesses through means such as dry-cooling thermoelectric power plants, using renewable energy sources (for example, wind and solar), and leveraging information and communications technologies (ICT) to foster more efficient and effective use of water and energy for agricultural, residential, and commercial needs.

ICT applications at the nexus can now be used to collect data remotely, from orbit or in the field through the use of drones. They can also empower individuals with mobile applications to, for instance, help organizations crowdsource information about water flow and condition to monitor pollution and improve water management. Digital connectivity, which includes remote sensing, machine-to-machine communication, and digital applications, is also emerging as a driver for smarter, precision agriculture, whether it takes the form of traditional agriculture companies buying data and information companies or agriculture machinery companies embedding smart sensors into their products.

The Internet of Things (IoT) technologies like data analytics, cloud computing, augmented intelligence and blockchain give us new capabilities to analyse, automate, correct in real time, predict and minimise risks in water, food and energy sectors.

Beyond numerous examples of technology innovation—“precision agriculture,” renewable energy, and water efficiency, reuse, and recycling technologies among them—several organizations have also innovated in the ways they work together to address this nexus issue.

The INCOVER project¹², a H2020 collaboration on “Innovative eco-technologies for Resource Recovery from Waste-water,” explores how the Internet of Things¹³ concept could be used to rationalise irrigation while, at the same time, facilitating the implementation of the water, energy

¹⁰ Kougiass I., Szabó S., Scarlat N., Monforti F., Banja M., Bódis K., Moner-Girona M., [Water-Energy-Food Nexus Interactions Assessment: Renewable energy sources to support water access and quality in West Africa](#), Luxembourg, European Commission, 2018.

¹¹ *ibid*

¹² INCOVER is a collaborative project funded by the European Commission under the Horizon 2020 Research and Innovation programme. Its aim is to develop innovative and sustainable added-value technologies for a resource recovery-based treatment of wastewater, using smart operation monitoring and control methodologies. At demonstration scale, three added-value plants treating wastewater will be implemented and optimized to recover energy and added-value products. <https://incover-project.eu/>.

¹³ The Internet of Things is the process of giving an online identity and virtual personality to all the physical objects that surround us which would independently and autonomously make decisions based on certain conditions, without human intervention.

and food nexus.¹⁴ Examples show drip irrigation systems optimised with data generated from both users and machines, including crop, microclimate and weather data have shown success in managing water more efficiently.

The Internet of Things can offer innovative and valuable insights like predictive analytics for irrigation, water and food waste patterns and even sharing their data with cross-sectorial domains to deliver novel services to multiple stakeholders.¹⁵

4. The way forward

By understanding the linkages between resources and economic choices, we can adapt agricultural practices more strategically, allowing them to adjust to shocks in a more integrated manner and to manage impacts and costs. This would help improve policymaking aimed at managing competing land uses, at local, regional and global levels.

Water, energy and food (WEF) securities are closely interlinked and interdependent. The world's poor are often the most severely impacted by water, energy and food insecurity, but risks associated with those insecurities also are felt at the highest geopolitical levels.

Recognition of spatial and sectoral interdependencies should inform policies, institutions and investments for enhancing water, energy and food security.¹⁶

As climate change advances, the multiplication of extreme weather events and their growing unpredictability will directly impact agriculture, transform irrigation requirements and add pressure to groundwater resources. Climate change exaggerates the nexus bottlenecks especially in regions where it is the most acute, such as India, North and Sub-Saharan Africa. In these regions, the depletion of groundwater resources will increase people's vulnerability where precipitation is low and boost global dependency on regions with rain-fed agriculture. Our global economic welfare depends on getting this balance right.¹⁷

Objectives of the Briefing

To improve information sharing and promote networking, CTA, the European Commission (DG Devco), the ACP Secretariat and Concord organise since 2007 bimonthly briefings on key issues and challenges for agriculture and rural development in the context of EU/ACP cooperation. This Briefing will bring different views and experiences on the Land-Water-Energy nexus and its contribution to the Sustainability of the Food System.

Target group

More than 160 ACP-EU policy-makers and representatives of EU Member States, embassies of ACP countries, civil society groups, research networks and development practitioners, and international organisations based in Brussels.

Available material

Input and comments before, during and after the meetings will be included in the Briefings blog: <http://brusselsbriefings.net/>. A short report and a Reader in printed and electronic format will be available after the meeting.

¹⁴ Harris Moysiadis. [The Internet of Things as a Key Enabler for Quantifying the Water, Energy and Food Nexus](#). Future Earth. 2018.

¹⁵ European Commission, 2018. Digital Policy Development and Coordination (Unit F.1). Shaping the Digital Single Market.

¹⁶ Declan Conway et al. [Climate and southern Africa's water–energy–food nexus](#). Nature Climate Change. 2015.

¹⁷ OECD (2017), *Land-water-energy nexus: Biophysical and Economic Consequences*, OECD Publishing, Paris, <http://dx.doi.org/10.1787/9789264279360-en>



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PROGRAMME

8h15-9h00 Registration

9h00-9h15 Opening of the Briefing: Isolina Boto, Manager, CTA Brussels Office

Introductory remarks: *Patrick Gomes, Secretary-General, ACP Secretariat; Leonard Mizzi, Head of Unit, Rural Development, Food Security, Nutrition, Europeaid, European Commission; Michael Hailu, Director, CTA*

9h15-11h00 Panel 1: The Land-Water-Energy nexus: what do we know?

This panel will provide an overview of linkages between land-water-energy from a research and practice perspective and its implications for the sustainability of the agrifood system with a focus in developing countries and ACP countries in particular.

Panellists:

- Food-Energy-Water nexus: implications for developing countries
Paolo D'Odorico, Professor, Dept Environmental Science, Berkeley University, USA
- Sustainable agriculture and the water–energy–food nexus
Sir Gordon Conway, Member of Malabo Montpellier Panel and Professor of International Development, Imperial College London
- Sustainability of resources and conflict prevention through the nexus approach
Craig Hanson, Vice President for Food, Forests, Water & the Ocean, WRI
- Policy dialogue on the water-energy-agriculture nexus: the EU-German Programme
Veronica Girardi, Policy Officer, Water Sector, European Commission, DEVCO

11h00-11h15 Coffee Break

11h15-13h00 Panel 2: Best practices in integrated approaches on LWE

This panel will look at specific examples of successful practices in linking Land-Water-Energy nexus, with a focus in developing/ACP countries.

Panellists:

- Space for Food Security: use of more efficient inputs through use of satellite data
Ruud Grim, Senior Advisor for Applications, Netherlands Space Office
- Overview of best practices in promoting a sustainable use of resources in Africa
Olufunke Cofie, West Africa Regional Representative, IWMI, Ghana
- Mitigating tradeoffs & promoting synergies in the Water-Energy-Food Security nexus
Dawit Guta, Center for Environment & Dev Studies, Addis Ababa University, Ethiopia
- Assessing the state of the water-energy-food (WEF) nexus in South Africa
Tafadzwa Mabhaudhi, Researcher, School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, South Africa

Concluding remarks

13h00 Networking Lunch