COHERENCE for DEVELOPMENT

Better Policies for Better Lives

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The water-energy-food-nexus: The imperative of policy coherence for sustainable development

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Abstract

Humans need water, food and energy for their survival and demand for all three is expected to accelerate further over the coming decades. Today, 850 million people in the developing world still suffer from hunger and undernourishment; and more than 1.3 billion people lack access to electricity. The *OECD Environmental Outlook to* 2050 projects that the number of people living in water-stressed river basins will rise from 1.6 billion in 2000 to 3.9 billion (40% of the world's population) by 2050 (OECD, 2012a). These situations are compounded by climate change, which will affect water demand and availability, energy use, and agricultural production in all countries. They affect growth and well-being and they can also be a source of social unrest, conflict and instability between countries.

These situations cannot be addressed through single sector actions taken in isolation. Policy decisions in any one sector – particularly in energy, agriculture or land use – can have detrimental consequences on others and tensions may arise from real or perceived trade-offs between various objectives. A coherent and integrated nexus approach can help identify synergies and trade-offs, leading to better outcomes for current and future generations.

The 17 Sustainable Development Goals (SDGs), adopted by UN member states in September 2015, affect practically all aspects of public policy, including those related to water, energy and food. This *CODE Report* shows that policy coherence for sustainable development (PCSD) can help to better understand the inter-linkages between economic, social and environmental policies in trying to ensure access, availability and sustainability of our planet's natural resources beyond 2015. ■

What is policy coherence for sustainable development?

Policy coherence for sustainable development (PCSD) is an approach and policy tool for integrating the economic, social, environmental and governance dimensions of sustainable development at all stages of domestic and international policy making. Its main objectives are to:

- Foster synergies across economic, social and environmental policy areas.
- Identify trade-offs and reconcile domestic policy objectives with internationally agreed objectives.
- Address the spillovers of domestic policies.

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What is at stake? Overview of policy coherence challenges and development impacts

Governments around the world, in developed and developing countries alike, face significant challenges in managing their natural resources effectively and in securing water, food and energy for sustainable and inclusive growth. Water, energy, and food determine the basic patterns of settlement and economic activity and changes in their availability can have a profound effect on communities in all countries. This CODE report focuses on how to meet the demands for water, energy and food sustainably – and in the face of climate change and population growth. In particular, it highlights the key linkages between *a)* water and energy; *b)* water and food; and *c)* energy and food. *Figure 1* provides a schematic overview of the interconnectedness between these resources:

- Agriculture is the largest user of water at the global level, and also a growing source of energy (i.e. biofuel crops).
- Energy is needed to produce and distribute both water and food.
- The food production and supply chain accounts for almost one third of total global energy consumption.

Demand for water, energy and food is expected to increase further

Competition for water is increasing among the different uses and users, of which agriculture and electricity generation are the largest – as well as between different countries. Globally, it is estimated that water demand rose twice as fast as population growth in the last century, exacerbating water stress in river basins across the world. It is expected to increase by another 55% over the next 40 years (OECD, 2012b). Agriculture is by far the largest user of water, accounting for about 70% of total global freshwater demand.

Similarly, global energy demand is expected to grow by more than one-third over the period to 2035, with China, India and the Middle Eastern countries accounting for about 60% of the increase. Electricity demand is expected to grow by approximately 70% by 2035. Today, more than 1.3 billion people still lack access to electricity. Notably, sub-Saharan Africa accounts for 13 percent of the global population, but only 4 percent of global energy demand (IEA, 2014). This will put more pressure on water resources and other water uses. Global water withdrawals for energy production in 2010 were estimated at 583 billion cubic metres (bcm), or some 15% of the world's total water withdrawals. Of that, water consumption – the volume withdrawn but not returned to its source – was 66 bcm (IEA, 2012).

Projections show that feeding a world population of 9.1 billion people in 2050 would require raising overall food production by some 70 percent between 2005/07 and 2050. Production in the developing countries would need to

Key observations

- The linkages between water, food and energy are numerous, complex and dynamic. Policy decisions made in these sectors can have significant impacts on each other, requiring a careful consideration of multiple and sometimes conflicting objectives.
- Demand for water, energy and food are expected to increase further, adding pressure on already strained resources. Population growth, urbanisation and climate change give rise to additional challenges with people in poor countries being the hardest hit.
- Addressing the nexus sustainably requires policy makers to consider *(i)* the social dimension, i.e. accelerating access and integrating the bottom billion; or addressing equity issues related to the allocation of risks and opportunities; *(ii)* the economic dimension, i.e. creating more with less, and allocating scarce resources where they add value to the community; and *(iii)* the environmental dimension, i.e. investing to sustain ecosystem services.
- The achievement of greater coherence between water, energy and agriculture policies will depend on removing policy inconsistencies and perverse incentives, as well as building relationships between different actors and across sectors and levels of governance.
- The Sustainable Development Goals include dedicated goals and targets on food security (SDG2), water (SDG6) and energy (SDG7); these goals will also contribute to other SDGs (on poverty eradication, health, cities, or climate change). Meeting them will require integrated approaches and policy coherence for sustainable development can provide a tool for identifying the synergies and trade-offs between different policy options.

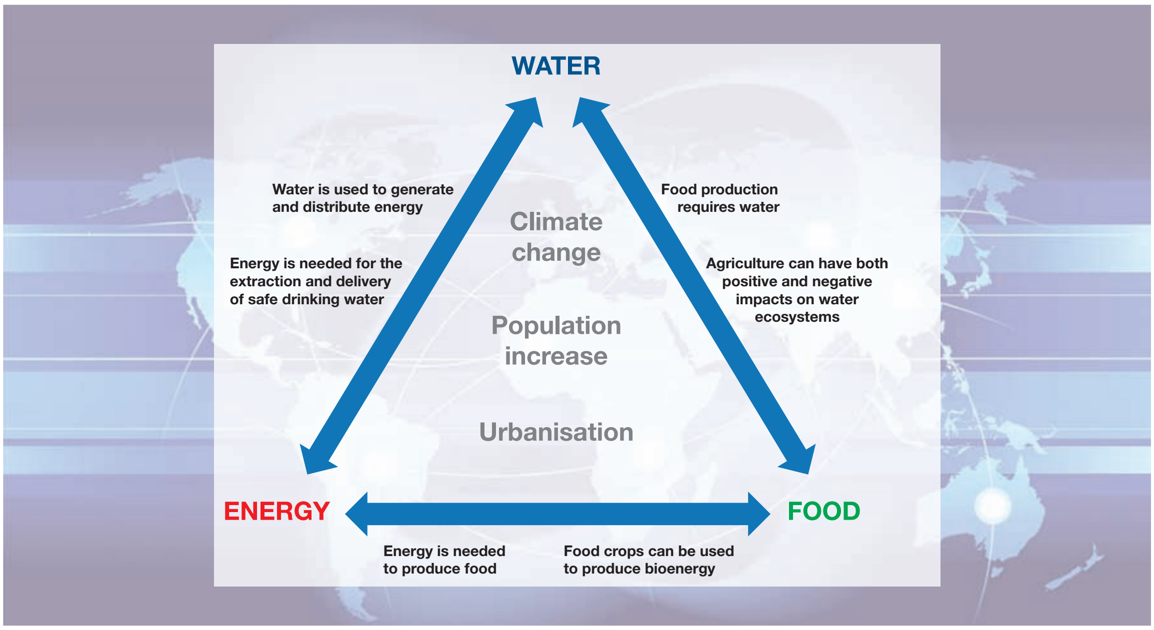
almost double. Feeding the world population adequately would also mean producing the kinds of foods that are lacking to ensure nutrition security (FAO, 2009).

Population growth, urbanisation and climate change give rise to additional challenges

These challenges are exacerbated by population growth, urbanisation, and changing lifestyles as a result of economic growth. Between 2011 and 2050, it is estimated that the world's population will increase by 2.3 billion, while the urban population will increase by 2.6 billion (UNDESA, 2012). This means that urban areas will absorb all the population growth over the next four decades while the rural population will start to decrease in about a decade. Many of the rapidly growing cities in developing countries are likely to become major hotspots for water and energy crises in the future (WWAP, 2014).

Climate change will lead to increasing spatial and temporal water variability, as well as more torrential rains, floods and droughts in many areas. Changing precipitation patterns are shifting rainy seasons and affecting the timing and quantity of melt water from snow pack and glaciers. Impacts on water quality can be expected and freshwater ecosystems are especially vulnerable. Climate change projections also show that these trends will require adaptive responses whereby the resilience of agricultural systems is enhanced to produce more food, fibre, fuel and ecosystem services. In some countries, however, that are presently climatically constrained in terms of expanding agriculture, climate change may lead to benefits and positive opportunities for the sector. Climate change will inevitably generate more uncertainties about future water demand and availability, urging for new development in science and resilience, partly through investments in water infrastructure *(Table 1)*.

Figure 1. **Key water-energy-food linkages**



Source: Own adaptation.

Changes in climate and climate variability that affect the profitability of agriculture will in turn lead to changes in the location of crop and livestock production, as well as in the technologies and management practices used to produce them. These economic responses to climate change could lead to indirect consequences in changing pollutant run-off rates and the use of water resources, but the relationships are likely to be complex. Flooding, for example, could mobilise sediment loads and associated contaminants and exacerbate impacts on water systems. On the other hand, more severe droughts could reduce pollutant dilution, thereby increasing toxicity problems. Whatever the net impacts on water systems will be, climate change is believed to make the task of achieving sustainable management of water in agriculture more difficult in the coming years.

People in poor countries are most vulnerable to risks related to water, food and energy

Ensuring water, energy and food security for the poorest of the poor emphasises the human rights dimension of the nexus. As pathways to provide access to essential resources and services for the bottom billion are explored,

Table 1. **Direct climate change impact and indirect effects on water quality**

Increased severity and frequency of flooding	Increased severity and frequency of droughts	Sea level rise	Increased water temperature
Increased release of combined sewer overflow	Reduced dilution of pollutants from point sources	Extension of estuaries and salt water intrusion of groundwater aquifers, especially in areas where rainfall (and recharge) is expected to decline. Increased treatment costs for drinking water use, industrial production and agriculture	Increased algal blooms and associated toxins, subsequent risks to drinking water quality
Increased runoff and nutrient loading leading to increased eutrophication	Soil shrinking and damage/cracking of water infrastructure, subsequent risks to drinking water quality and environment, and increased maintenance costs	Intrusion of saline water to sewers, subsequent increase of corrosion and maintenance of water infrastructure	Increase of the growth and survival of pathogens, subsequent risks to drinking water quality
Increased runoff and greater loads of heavy metals, salts and other pollutants	Increased severity and frequency of forest wildfires, increase in erosion and reduced filtration/regulation ecosystem services affecting water quality	Impacts on freshwater ecosystems: extinction and shifts in distribution of species, loss/reduced functioning of ecosystem services	Impacts on freshwater ecosystems: extinction and shifts in distribution of species, loss/reduced functioning of ecosystem services
Increased soil erosion, sediment, organic matter content and pathogens loadings, subsequent impairment of conventional drinking water treatment	Impacts on freshwater ecosystems: extinction and shifts in distribution of species, loss/reduced functioning of ecosystem services		
Disruption of treatment facilities during floods, subsequent risks to drinking water quality			
Impacts on freshwater ecosystems: extinction and shifts in distribution of species, loss/reduced functioning of ecosystem services			

Source: OECD (forthcoming), The Economics of Water Quality, OECD Publishing, Paris.

synergies can be built and positive feedbacks generated while improving living conditions and livelihood opportunities for vulnerable populations. Secure access to resources also leads to more sustainable use of natural capital. Hence, investment and innovation that accelerate equitable access and benefits for the poor can have high rates of return in terms of development and environmental sustainability (Bonn2011 Conference, 2012).

Scarcity is not the only water-related risk: too much and too polluted water affects communities and their development as well. Again, the poor are most affected and less resilient than more well-off groups. The OECD promotes a risk-based approach to water management, which includes an equitable sharing of water-related risks (OECD, 2013).

a) Key water-energy linkages

The linkages between energy and freshwater are crucial to human wellbeing and sustainable development. Water is essential for the production, distribution and use of energy, and energy is necessary for the extraction and delivery of safe drinking water. However, humans are depleting fossil energy resources and consuming or degrading water supplies faster than alternatives are becoming available, and renewable energy and water resources that do not deplete over time have limited flows that restrict their use temporally or geographically. There are also important spillover effects that need to be taken into account when designing policies, such as high energy costs of desalination *(Box 1)* or the impact of energy generation on water through dams, pollution etc.

Options to increase water security[1] often have energy security[2] costs and new sources of freshwater typically require vastly more primary energy. Singapore provides a good illustration: to minimise water imports from Malaysia, Singapore has invested in energy-intensive water sources (reclaimed water and desalination), thereby increasing its need to procure energy on global markets. The main challenges related to the water-energy dimension of the nexus are outlined below.

Box 1. **Using renewable energy to desalinate water**

The Gulf Co-operation Council countries (Saudi Arabia, Qatar, United Arab Emirates, Oman, Bahrain and Kuwait) are situated in one of the most water scarce regions of the world and face critical challenges in addressing the growing interdependence between water and energy. While integrated water resources management (IWRM) has been promoted in the region for more than a decade, limited understanding of the interdependencies affecting the management of water and resources has stymied co-ordination between the water and energy policy makers, even when these sectors are managed within the same ministry.

Given the region's limited endowment of renewable water resources, desalination, mainly through cogeneration power desalting plants (CPDPs), has become a common method of satisfying the increasing demand for water. However, desalination is the most energy intensive water treatment technology available and its use requires policy makers to carefully balance the sustainability aspects of both water and energy security. For example, in Saudi Arabia, which has more than 18% of the world's desalination capacity, 25 percent of domestic oil and gas production is used to produce water through CPDPs. If the current trend continues, this share will reach as high as 50 percent by 2030. Similarly, projections for Kuwait show that in a business-as-usual scenario the energy demand of desalination plants will be equal to the country's 2011-2012 oil production (2.5 million barrels of oil per day) by the year 2035. This is not sustainable.

Solar energy can help alleviate desalination projects' dependence on hydrocarbon energy sources. Biogas recovered from wastewater provides another viable solution to reducing the carbon footprint for producing more energy to keep pace with rising demands for water provision and services. Recognising that good water management is just as important as technical solutions, Saudi Arabia launched the King Abdullah Initiative for Solar Water Desalination in 2010. The initiative aims to use solar energy to desalinate seawater at a low cost and contributes to the dual objectives of water security on the one hand and reduced dependence on fossil fuels on the other, thereby also reducing GHG emissions.

While such developments illustrate some consistency between water and energy policy, it is noteworthy that a significant share of water demand increase derives from food security policy, whereby countries such as Saudi Arabia grow irrigated crops on arid land, to supply domestic markets. This situation illustrates the potential benefits of trade and stable global food markets – to manage the water food and energy nexus.

Source: WWAP, 2014.

1 The OECD defines water security as maintaining acceptable levels of risks for four water risks: risk of shortage (including droughts), risk of inadequate quality, risk of excess (including floods) and risk of undermining the resilience of freshwater ecosystems (see OECD, 2013). More recent work has identified risk of inadequate access to water and sanitation as a stand-alone risk (see Sadoff et al., 2015).

2 The International Energy Agency defines energy security as the uninterrupted availability of energy sources at an affordable price. Energy security has many aspects: long-term energy security mainly deals with timely investments to supply energy in line with economic developments and environmental needs. On the other hand, short-term energy security focuses on the ability of the energy system to react promptly to sudden changes in the supply-demand balance.

Firstly, growing populations and depleting water supplies are pushing many countries to the boundaries of technologies for providing new freshwater supplies, only to find that their constrained water situation exacerbates their energy constraints. In addition, water efficiency improvements are in some cases made at the expense of energy efficiency. Policy coherence for sustainable development can be used to identify such negative trade-offs and to reconcile policy objectives and exploit potential positive synergies in their place.

Secondly, energy subsidies to pump irrigation water from aquifers have led to unsustainable water uses in parts of India or Mexico. They illustrate inconsistent water, food and energy policies, usually motivated by food security issues and the willingness to support farmers. This support, however, comes at a high economic and environmental costs, and can only last until aquifers are depleted.

Thirdly, water is a critical aspect in meeting climate goals. Biofuel and bioenergy production relies to a large extent on water-dependent agricultural feedstocks. The water demand for irrigated biofuels is very high compared to conventional transportation fuel sources, although highly dependent on regional differences and the irrigation-intensity of various crops. In some cases, subsidised or free access to water may actually lead to inefficient crop selection, e.g. irrigated cotton cultivation in Uzbekistan has had detrimental effects on the Amu Darya and Aral Sea.

Given that the global energy market has twenty times the size of the food market (when measured in calories), even low percentages of biofuels in the total energy mix will have a major impact on water availability and, as a result, on food security. Non-irrigated biofuel feedstocks also cause water quantity concerns. Thus, biomass agriculture and biofuels production need to be well-integrated into a broader water resource management perspective. Increased production of biofuels can also increase water pollution, marked by increases in nitrogen and phosphorus agricultural chemical concentrations and hypoxia (low oxygen levels) in surface water draining from farmland.

Carbon capture and storage (CCS) is another element of climate change mitigation mixes. It requires water intensive cooling systems. Conversely, warm weather and heat waves can affect power plants as higher temperatures limit the cooling effectiveness of the water source, and can push power plants up against environmental limits. Hydropower, in turn, does not require water for cooling but is instead subject to significant evaporation of water from the surface of dam reservoirs: in some cases, this increased evaporation is several times larger than the evaporation associated with thermal power plant cooling.

Additional impacts of water on energy demand come from water collection, treatment, distribution and heating of water for public water supplies. This energy consumption for water varies with distance to the water source, existing water quality, water treatment standards, distribution system terrain, and end-use of water. New technologies allow to capture the heat (and energy) embedded in wastewater.

b) Key water-food linkages

In most OECD countries, agriculture is the major consumer of water and a significant source of diffuse water pollution, with irrigated agriculture making a substantial contribution to the growth in agricultural production. Yet, agriculture can have significant impacts (both positive and negative) on water ecosystems, and both agriculture and water are becoming increasingly vulnerable to climate change. The following paragraphs highlight the key challenges related to the water-food dimension of the nexus.

Firstly, a key challenge for the agriculture sector will be to produce almost 50% more food globally by 2030 and to double production by 2050. In many countries, water availability for agriculture is already limited and uncertain, and is set to worsen. Agricultural water withdrawal accounts for 44% of total water withdrawal in OECD countries; for an average of 74% in the BRIC countries; and for more than 90% in least developed countries (FAO-AQUASTAT).

Secondly, another challenge relates to agriculture as a significant source of water pollution from fertilisers, pesticides and soil sediment. Treatments to remove these pollutants from drinking water, as well as broader policy responses to address agricultural water pollution, have cost OECD taxpayers billions of dollars annually. Yet, efforts have still fallen short and in the last decade, agricultural pollution has worsened water quality in OECD countries – although there have been a few exceptions.

Thirdly, bioenergy production from agricultural feed stocks, especially cereals and oilseeds, can also have significant impacts on water quality and availability, but the overall impact is still unclear. In general, however, feedstocks from annual crops such as maize and oilseeds (first generation feedstocks) can have a more damaging impact on water systems than feedstocks produced from grass and woody materials (second generation feedstocks).

Moreover, agriculture's influence on habitats and wildlife systems (i.e. ecosystems) is significant. Overall changes in farming management practices and systems and the intensity of input use are key driving forces on the quality and conservation of ecosystems, including the management of water resources on-farm and disposal of farm waste into bodies of water.

c) Key energy-food linkages

Energy has always been essential for the production of food. However, as a result of industrialisation and consolidation of agriculture, food production has become increasingly dependent on energy derived from fossil fuels. Today, industrial agriculture consumes fossil fuels for several purposes (GCF, 2015):

- *Fertiliser production:* Industrial farms use large quantities of synthetic fertilisers, which require significant energy inputs (primarily natural gas) to be produced. Other fertilising agents, such as potassium and phosphorus are mined, consuming even more energy.
- *Water consumption:* The overuse of water in agriculture has implications for the energy sector as well, as pumping, treating and moving such large volumes of water require a great deal of energy (see also the section above on key water-food linkages).
- *Farm equipment:* Modern agriculture relies upon machinery that runs on gasoline and diesel fuel (e.g. tractors and combines), and equipment that uses electricity (e.g. lights, pumps, fans).
- *Processing, packaging and transportation:* Much of the food produced today is highly processed and heavily packaged, which further increases its energy footprint. As a result of consolidation and centralisation of production, foods are often transported long distances, requiring additional energy inputs.

In addition to being an energy user, agriculture also has the role of energy supplier in the form of bioenergy. This energy function of agriculture offers important rural development opportunities as well as one means of climate change mitigation by substituting bioenergy for fossil fuels (FAO, 2000). With regard to food security concerns, there is a general consensus that the production of biofuels provokes a rise in food commodity prices; while some analysts claim that rise may be minimal, it can have disproportionate effects on poor populations in selected countries. The knowledge and assessment of the positive and negative, short-term and long-terms impacts of biofuels on food prices and food security remain preliminary (HLPE, 2013).

What has been done and what needs to be done? Key policy areas for action

Policies across water, energy and agriculture are often formulated without sufficient consideration of their inter-relationship or their unintended consequences. The sectoral nature of many governments' approaches to policy design in the different areas and at different scales is the key contributor to this incoherence. Institutional arrangements need to be re-engineered, policies and policy instruments need to be redesigned to create a greater intersection of these areas, at different spatial and temporal scales. This section outlines options available to governments for improving policy coherence between water, energy and agriculture.

Strengthening institutional mechanisms and co-operation to enhance coherence

There is no one-size-fits-all governance approach to the coherence challenge between water, energy and agriculture, as each solution needs to reflect local governance and norms. Greater attention needs to be paid to institutional mechanisms to provide early warning of incoherent policies and promote and implement coherent policy approaches. This will require strengthening the capacities of the institutions in the three sectors for better integration and joint planning, giving more careful consideration to the cumulative and interrelated impacts of policies and regulatory regimes, and moving towards a more coherent set of policy instruments. Incentives for institutional co-operation are key. This is true also within each sector. In Chile, for example, as many as 15 central government actors are involved in water policy making (OECD, 2011).

Promoting engagement and knowledge sharing to connect the science and policy spheres

Countries should encourage enhanced engagement across the science-policy interface as the research being produced on the nexus does not necessarily connect with policy outcomes. In India, for example, most planned power plants, which will require significant amounts of water, are located in areas with known water stress. Better data and knowledge sharing can help policy makers make the case for reform by helping the general public to connect with the facts and understand the full costs and benefits of different actions. For example, research shows that Saudi Arabia could reduce water consumption by 20 percent through the elimination of wheat cultivation (KAPSARC, 2015).

Continued use of support for energy in agriculture, both directly through support for diesel and electricity use, and indirectly for feedstocks to produce bioenergy, can increase pressure on water resources. This is most evident where support for energy, by reducing pumping costs, in some countries is leading to excessive extraction of groundwater. Removal of this form of support may contribute to more sustainable water use in agriculture (OECD, 2010). A telling example of this is India's Jyotigram Scheme, which enabled the local government to halve the power subsidy to agriculture *(Box 2)*.

***Box 2.* Separating agricultural energy from other uses to reduce groundwater overdraft**

In the state of Gujarat in India, free groundwater and subsidised electricity to pump it contributed to severe groundwater overdraft, as well as poor power supply to farmers and other rural residents. But any rationalisation efforts to price groundwater and electricity to reflect their value met great resistance by farmers.

An alternative approach, the Jyotigram Scheme, was introduced in 2003. Rather than viewing subsidies as a default component of free electricity supply, the Jyotigram scheme focused on providing rationally managed subsidies where needed, and pricing where possible. Villages are given 24-hour, three-phase power supply at metered rates for domestic use and in schools, hospitals and domestic industries. Farmers operating tube wells continue to receive free electricity, but for 8 hours rather than 24 and on a pre-announced schedule designed to meet their peak demands.

This separation of agricultural energy from other uses and the promise of quality supply proved sufficient to gain political and social backing for implementation. The Jyotigram has now radically improved the quality of village life, spurred non-farm economic enterprises, and halved the power subsidy to agriculture. And while groundwater itself is still free, the programme has indirectly raised the price of groundwater supply, thus providing a signal of scarcity and reducing groundwater overdraft.

Source: WWAP (2014), from Shah et al (2004, 2008) and Shah and Verma (2008).

Investing in innovation and technologies to reconcile policy objectives

Innovation policy provides an important tool for promoting investment in new technologies that support resource efficiency and help improve resilience. The future choices and adoption of agricultural technologies, for example, will fundamentally influence not only agricultural production and consumption but they will also have implications for water, land, and energy resources, as well as for climate change adaptation and mitigation (IFPRI, 2014).

The invention of drip irrigation by Israel in the 1960s has contributed to reducing evaporative losses from agriculture. Oftentimes, drip irrigation is also associated with a switch to high-value crops and it can help to reduce fertiliser use, while at the same time improving productivity. However, if sustainability concerns are lacking in policy making, modern irrigation technologies could also result in expansion of irrigation onto fragile lands. A policy coherence lens could help to detect such trade-offs already at the policy planning stage.

Similarly, in terms of simultaneous impacts on water and energy policy objectives, technologies can represent "win-win" solutions, "trade-off" solutions, or "mixed" solutions (i.e. solutions that imply choices and trade-offs that make the effect upon the policy objective site-specific or unclear). Win-win scenarios for achieving energy security and water availability include, for example, solar hot water heating, wind power, and converting municipal waste to energy. Technologies that involve trade-offs, on the other hand, include biofuels development, groundwater pumping, and carbon capture and storage. *Table 1* illustrates the relation between the various objectives of these water and energy technologies.

Recognising different country contexts to establish policy priorities

Each country faces specific challenges in its pursuit of sustainable development. Understanding the country context is essential in order to understand how the different sectoral silos can work together and how to adapt national systems to the most pressing needs (OECD, 2014). National contexts can be characterised by resource endowment (water, energy and land, essentially) and development trajectories (national strategies that drive social, economic and environmental policies; determine reliance on natural resources, and investment needs).

In the area of energy, for example, the development priority for many low-income countries is to ensure universal access to energy services and secure a potential for economic growth, whereas middle-income and emerging economies, where growth is already occurring fast, might focus on to develop their energy systems in ways that decouple growth from energy consumption and greenhouse gas emissions. High-income countries, in turn, may wish to decarbonise their energy sectors and reach new levels of efficiency performance. For advanced

Table 1. **Impacts of different technologies on water and energy policy objectives**

Technologies	**Multiple policy objectives**			
	Ensuring water availability	*Protecting water quality*	*Increasing energy security*	*Mitigating climate change*
Synergies:				
Solar hot water heating	↑	↑	↑	↑
Wind power	↑	---	↑	↑
Municipal waste to energy	↑	---	↑	↑
Trade-offs:				
US corn ethanol (Midwest)	⟷	↓	⟷	⟷
Groundwater pumping	⟷	---	↓	↓
Carbon capture and storage	↓	⟷	⟷	↑

Source: OECD (2012b), adapted from King et al (2010).
Note: (↑) the technology helps to achieve the policy objective
(↓) the technology hinders achievement of the policy objective
(⟷) technology has choices and trade-offs that make its effect upon the policy objective site-specific or unclear
(--) the technology has no appreciable impact on the policy objective.

societies, with relatively clean energy systems, both efficiency and reduced levels of energy are required (Nilsson *et al*, 2013). *Figure 2* shows how policy objectives could be expected to change as countries' income level rises. However, this is not to say that the policy objectives are always the same between countries at the same stage of development. Political, social and environmental priorities also have a role to play.

Promoting a risk-approach to water management

A risk-approach to water management is palatable language to policy makers and the private sector alike. The public sector relates to issues of food-, energy- and water security, while the private sector is well versed in managing and hedging risks. The usefulness of a risk approach is to make policy decisions about the appropriate level of risks and risk management explicit through both informed policy discussions with relevant stakeholders, as well as policy responses tailored to the agreed levels of risks.

One additional issue with the nexus is that risk and trade-offs will differ depending on the scale at which the nexus is approached. Priority water uses in selected basins in Brazil may be agriculture (e.g. in São Marcos basin), as this is where labour is, but the national priority is feeding the national electricity grid. Reconciling both scales is not straightforward. Economic instruments can help, for instance by adjusting the tax hydropower generators pay on the energy they produce so that it reflects pressures on water resources in the basin.

Investment is an important part of the answer: how infrastructures are designed, operated and maintained, and financed can potentially contribute to nexus management at the least cost. It is critical to avoid building future liabilities, e.g. infrastructures which will create additional tensions between, or which will negatively affect, water, food and energy security. The international community is gaining experience with the design, management and financing of multipurpose infrastructures (e.g. reservoirs, or urban drainage systems that contribute to several policy objectives).

Summing up. Where do we go from here?

Humans need water, food and energy for their survival and development, and the demand for all three is expected to increase further over the coming decades. Access to these resources and their sustainable management must therefore be a cornerstone of any efforts to promote sustainable development (DIE, 2013). The integration of the water-energy-food nexus into the post-2015 agenda will require coherent policy making that takes into account synergies and trade-offs between the sectors, as well as complementarities of actions at multiple levels (local, national, global) and involve a wide range of stakeholders working together.

Water, energy and food in the post-2015 development agenda

The United Nations' Outcome Document *"Transforming our World: The 2030 Agenda for sustainable development"* contains three inter-related Sustainable Development Goals (SDGs) on food security, water and energy (UN, 2015). Each of them also contributes to other SDGs, with specific references to water under the goals related to e.g. health, cities, climate change, and poverty eradication. In addition, SDG 17 on the means of implementation of the post-2015 agenda includes a target on policy and institutional coherence. While the goals are universal and apply to all countries,

Figure 2. **: Illustration of national focus areas for energy depending on level of development**

Source: Nilsson, M., P. Lucas and T. Yoshida (2013).

implementing them will require each country to balance the needs for ensuring access to resources, efficiency, and sustainability to fit the local context and capabilities. The goals are also indivisible and policy makers need to ensure that progress on one goal or target does not undermine progress on any other goals or targets. The following sections highlight the linkages between the water, energy and food goals and outline some of the actions needed to achieve them.

Sustainable Development Goal 2 – food and agriculture

SDG 2 *'End hunger, achieve food security and improved nutrition and promote sustainable agriculture'* calls for an end to hunger and all forms of malnutrition by 2030. It aims to double agricultural productivity and the incomes of small-scale food producers, and to implement resilient agricultural practices that help maintain ecosystems and strengthen our capacity for climate change adaptation.

Meeting this goal will require increased investment in rural infrastructure, agricultural research and extension services, technology development, and plant and livestock gene banks to enhance agricultural productive capacity in developing countries. It will also require the correction and prevention of trade restrictions, distortions and support policies in world agricultural markets, as well as the adoption of measures to ensure the proper functioning of food commodity markets to help limit extreme food price volatility. Additionally, proposed goal 12 *'Ensuring sustainable consumption and production patterns'* and its goal to reduce food waste will generate synergies and support the achievement of the goal for food security.

Sustainable Development Goal 6 – water

SDG 6 *'Ensure availability and sustainable management of water and sanitation for all'* calls for universal and equitable access to safe and affordable drinking water by 2030. It sets out to improve water quality by reducing pollution; to substantially increase water-use efficiency across all sectors; and to implement integrated water resources management at all levels.

This will require expanding international co-operation and capacity-building support to developing countries in water and sanitation related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reusing technologies; obviously the energy required to manage these technologies, and competition between water users (farmers, energy suppliers, cities, the environment, industry) will need to be factored in.

The participation of local communities for improved water and sanitation management will be equally important. Several other goals and targets also have implications for water security and sanitation, e.g. the reduction of water-borne diseases (3.3); the reduction of the release of chemicals to air, water and soil (12.4); and the conservation, restoration and sustainable use of terrestrial and inland freshwater eco-systems (15.1).

Sustainable Development Goal 7 – energy

SDG 7 *'Ensure access to affordable, reliable, sustainable, and modern energy for all'* calls for universal access to affordable, reliable and modern energy services by 2030. It aims to increase substantially the share of renewable energy in the global energy mix and to double the rate of improvement in energy efficiency.

Enhanced international co-operation will help to facilitate access to clean energy research and technologies. Investment in energy infrastructure and clean energy technologies will also help to achieve this goal. A related target is target 12.c, which calls on countries to rationalise inefficient fossil-fuel subsidies that encourage wasteful consumption by removing market distortions.

Sustainable Development Goal 17 – policy coherence for sustainable development

Finally, SDG 17 '*Strengthen the means of implementation and revitalise the global partnership for sustainable development*' cuts across – and far beyond – all three domains of the water-energy-food-nexus. It includes targets to enhance global macroeconomic stability through policy coordination and policy coherence; to enhance policy coherence for sustainable development; and to respect each country's policy space and leadership to establish and implement policies for poverty eradication and sustainable development.

Concluding remarks

The guiding principles of an integrated "nexus approach" are to ensure access to resources for the most vulnerable, especially the poor; to promote efficiency in resource use; and to ensure sustainability (Weitz *et al*, 2014). The challenge for policy coherence for sustainable development is to ensure that policies affecting one resource reinforce synergies and do not entail negative externalities for another resource.

To a large extent, success in achieving greater coherence between water, energy and agriculture policies will depend on greater awareness of policy impacts and on removing any policy inconsistencies, especially where energy and agricultural support policies conflict with sustainable water management goals. This inherently is a political process, that involves power and bargaining. The more transparent and the better informed the process, the more sustainable the outcome, from economic, social, environmental and political perspectives.

The Coherence for Development series is available on the OECD's Internet site:
www.oecd.org/development/pcd/

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