Water-food-energy nexus

A quick scan

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Summary

S.1 Nexus is promising concept, with room for developing further insights

Water, energy and food are inextricably linked. This is the so-called ‘nexus’. There is growing recognition that a movement is needed away from a sector-by-sector approach to policy, science and practice, towards an approach that considers the interactions between water, food and energy, while taking into account the synergies and trade-offs that arise from the management of these three resources.

The nexus is a promising concept to concretise food policy efficiently. However, it is not a mature concept and there is room for developing further insights.

The nexus’ strength lies in implementing a multi-sectoral, multi-stakeholder process. Given that the nexus is still largely water-sector driven, the inclusion of other sectors (e.g. food and energy) is crucial for the further development of the nexus approach.

S.2 Analysis

An analysis of the nexus could include:

a. Definition of goals
   Relation with UN’s Sustainability Development Goals (SDGs) (2. Zero hunger, 6. Clean water and sanitation, 7. Affordable and clean energy, 13. Climate action)
b. Definition of scales
   Social, economic and environmental goals should be specified at different scales
c. Definition of integration issues
   The potential synergies between water, food and energy.

The nexus methodology should include:

a. Identification of issues that have to be handled with the nexus approach
b. Coherent plan with nexus (or sectoral) approaches to achieve goals; a nexus approach will by definition be a multi-sectoral and multi-stakeholder process.

S.3 Method

The water-food-energy nexus is an approach to consider the interactions between water, food and energy, while taking into account the synergies and trade-offs that arise from the management of these three resources, and potential areas of conflict.

The objective of this study is to answer the following two questions. Is the nexus concept sufficiently developed to be used for evidence-based analyses to support the water-related policy of the Dutch Ministry of Economic Affairs, where the main focus is on food policy? What are the essential elements of water, food security and energy to optimise the nexus system?

In this quick scan the nexus approach is operationalised as ‘the water-food-energy nexus approach’ implying that the system interactions (water/energy/food) are understood to enable that results/outcome in one domain (for example food/nutrition) can be reached through targeted interventions in other domains (in this example water and/or energy).

1 Introduction

1.1 Context

At the World Economic Forum in Davos in 2011, the water-food-energy-climate nexus was discussed, first. The book *Water security: water-food-energy-climate Nexus* (Waughray, 2011) is based upon this conference. In November 2011, the German government held a global conference on the Food, Water and Energy Nexus. It resulted in a growing recognition that a movement is needed away from a sector-by-sector approach to policy, science and practice, towards a more interlinked approach (Hoff, 2011; Dodds and Bartram, 2016). Water, energy and food are inextricably linked (WWDR, 2014).

The Asian Development Bank (ADB, 2013) states that the global debate is not about water security or water scarcity in isolation. Instead, it is about the water-food-energy nexus. It is the growing demand for food, with its high water requirement, superimposed on population growth, which crucially turns an abstract crisis into a critical and immediate one (see Figure 1.1).

1.2 Objective

The objective of this study is to answer the following two questions. Is the nexus concept sufficiently developed to be used for evidence based analyses to support the water related policy of the Dutch Ministry of Economic Affairs, where the main focus is on food policy? What are the essential elements of water, food security and energy to optimise the nexus system?

1.3 Definition

No commonly agreed definition or conceptual framework for the nexus has emerged and therefore different organisations and authors—intentionally or not—interpret its essence quite differently (Keskinen et al., 2016; Wichelns, 2017). Also, climate change is frequently added to the nexus, as climate change has interactions with all components of the water-food-energy nexus (WEF, 2011).

The water, food and energy nexus is an approach to consider the interactions between water, food and energy, while taking into account the synergies and trade-offs that arise from the management of these three resources, and potential areas of conflict (adapted from De Laurentiis et al., 2014).

In this quick scan, the nexus approach is operationalised as 'the water-food-energy nexus approach' implying that the system interactions (water/energy/food) are understood to enable that results/outcome in one domain (for example food/nutrition) can be reached through targeted interventions in other domains (in this example water and/or energy).

The water-food-energy nexus is closely related to:
- Water, food and energy security: availability & access to water, food and energy (for the poor);
- UN's Sustainability Development Goals (2. Zero hunger, 6. Water and sanitation, 7. Affordable and clean energy, 13. Climate action); (social, economic and environmental goals should be specified at different scales);
- Governance;
- Knowledge of the integrated system and capacity building.

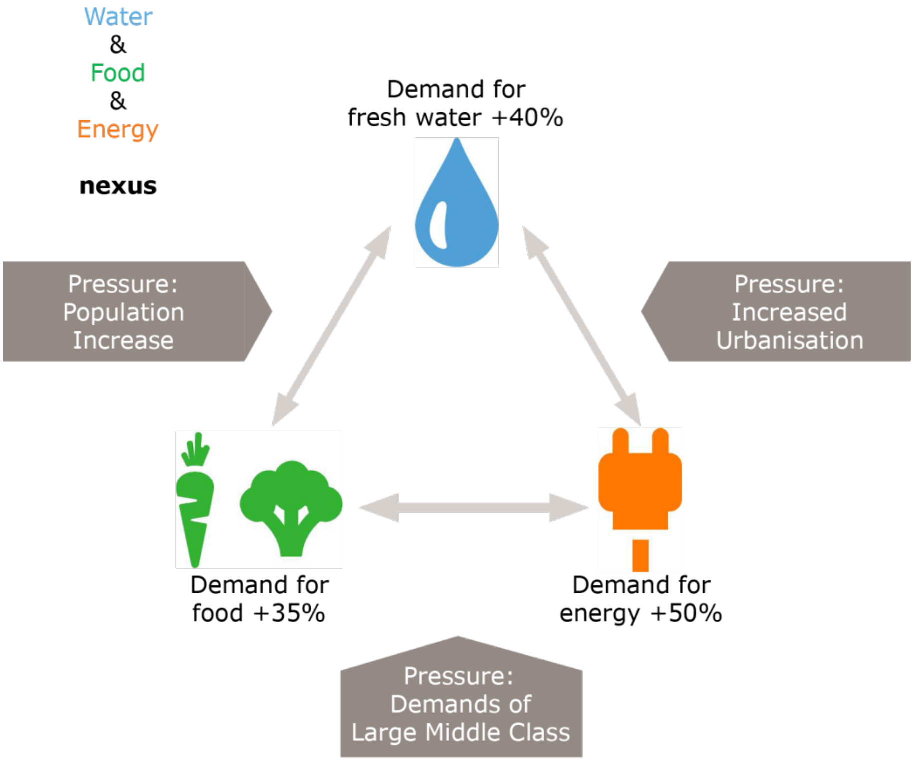

Figure 1.1 *Relevance of the water-food-energy nexus*

2 Nexus approaches

The added value of a nexus approach (FAO, 2014) is that it provides a cross-sectoral and dynamic perspective and that it helps us to better understand the complex and dynamic interrelationships between water, energy and food, so that we can use and manage our limited resources sustainably. As well, it forces us to think of the synergies and impacts of sectoral decisions beyond that sector. Anticipating these potential trade-offs and synergies, we can then design, appraise and prioritise interventions.

ACCWaM (2017) concludes, based on numerous recent nexus publications, that a nexus or systematic approach, which is implemented by way of integrated resource management and governance, can improve human securities and development, while reducing pressures on resources and on the environment. Accordingly, a nexus approach which supports the integration across institutions and sectors, scales and borders, is an important contribution to sustainable development and eventually to political stability.

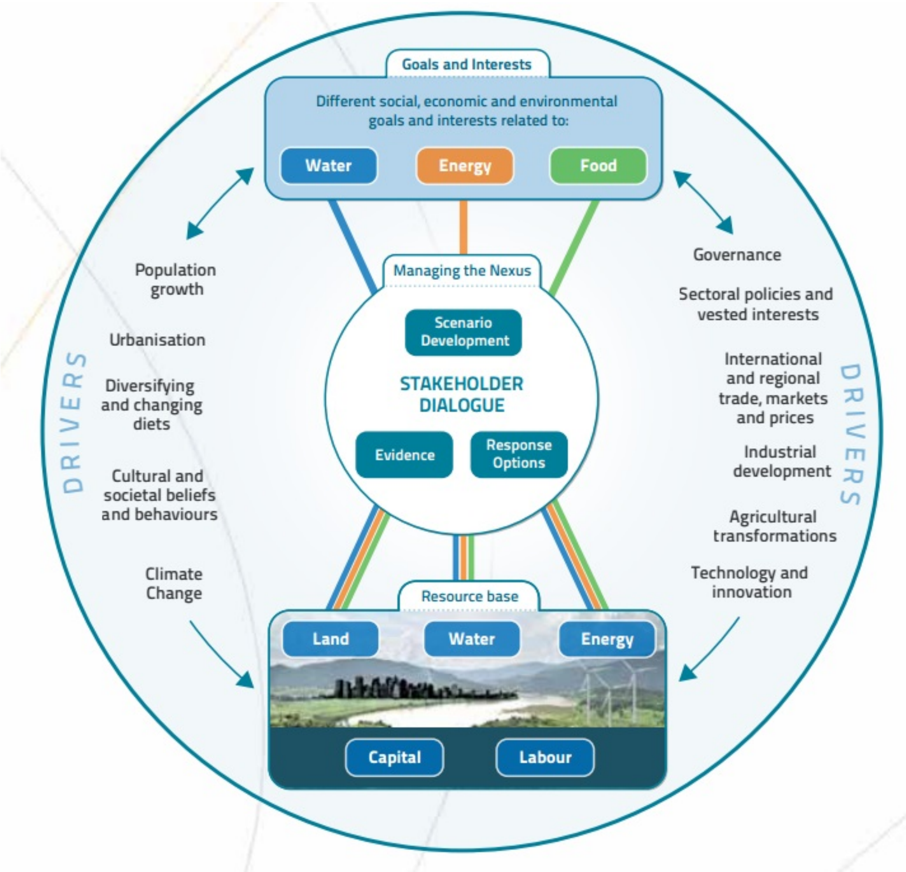

Figure 2.1 *The FAO approach on the water-energy-food nexus*
Source: FAO (2014).

The assumption is that the decision-making unit at the lowest level (for instance the farmer) will take all available information on inputs and risks into account, and applies the resources (water, energy) according to the prices the farmer faces. In the ideal world, the farmer would select the efficient combination of resources, based on their prices that reflect scarcity, and applies the synergies between these resources using the available substitution possibilities. If resources' prices reflect scarcity and local markets for resources are connected to markets at higher levels, synergies between farm level and higher levels are taken into account.

If resource (input) prices are distorted (e.g. related to interventions of the national government), markets are not functioning well, infrastructure is not aligned to his needs or to the SDGs, the farmer will make suboptimal choices (in view of optimal resource use or according to the SDGs). For example: if in an arid region the national government subsidises diesel, the energy price farmers face will be reduced, and farmers will use more diesel compared to the situation without subsidy, and pump more groundwater. Hence it becomes more likely that the aquifer will be used unsustainably and the groundwater table will drop, jeopardising food security in the long run.

The EU H2020 SIM4NEXUS project (Laspidou et al., 2017) identifies (based on the Roadmap to a resource-efficient Europe) three sources for problems that can benefit from a nexus approach:

- Policy incoherence: policy made for a good reason in one field can have unintended consequences that hold back efficient resource use in another field;
- Knowledge gaps on how environmental systems interact will constrain policy-makers from taking adequate actions to secure future food supply; knowledge gaps can also trigger the precautionary principle (better safe than sorry), which can also lead to inaction;
- Technology lock-ins exist, leading to an advantage for established ideas or practices over innovations.

A general method to describe and analyse the nexus is (e.g. GIZ/ICLEI, 2014):

a. Define goals (SDGs or regional goals based upon elaboration of SDGs towards regional level)
b. Define the system (the scope)
    I. Food system/value chain
    II. National, water basin, regional
c. Define short and long-term integration issues, relevant to achieve goals
    I. Integration over scales
    II. Integration over silos
    III. Integration over systems and resources

A general methodology to apply the nexus approach:

d. Identify which issues have to be handled with the nexus approach
e. Coherent plan with nexus (or sectoral) approaches to achieve goals, a nexus approach will by definition be a multi-sectoral and multi-stakeholder process.

The ideal nexus approach consists of a systematic process for both analysis and policy-making that focuses on the linkages between water, energy, food and other linked sectors to promote sustainability, synergies and resource-use efficiency (Keskinen et al., 2016). The water-food-energy nexus approach means a change from business as usual and current mind-sets, linking and adding value to existing sectoral approaches and expertise, and in that way reducing trade-off and promoting synergies (ACCWaM, 2017). The nexus approach supports the recycling and reuse of waste products and by-products across sectors, and with that a circular economy. This translates into producing more with less – ensuring more human securities and economic development while using less natural resources and reducing environmental pressure (ACCWaM, 2017).

3 Nexus issues

The linkages between water, food, and energy are numerous, complex and dynamic (Lindberg and Leflaive, 2015). Central in the nexus approach is the identification of integration and synergy issues. In Figure 3.1, these issues and their relation with SDGs are depicted.

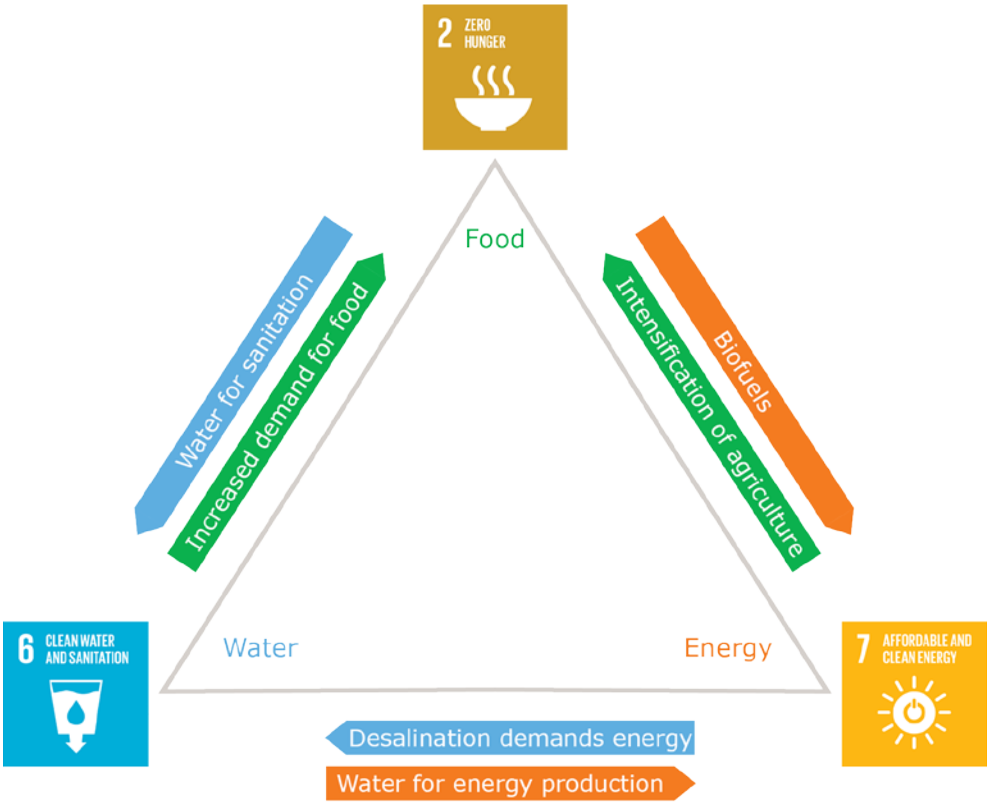

Figure 3.1 *The interactions and potential synergies between water, food and energy*

To facilitate nexus approach in Table 3.1 a gross list of potential nexus interactions is given. Table 3.1 can act as a starting point for an analysis of potential nexus relation for a specific case study.

Table 3.1 *Gross list of nexus relations*

Nexus relations	Water	Energy	Food
Water		Desalinisation requires energy	Water for sanitation competes with water for food
		Withdrawal of groundwater requires energy	
		Energy is needed for waste water treatment	
Energy	Water reservoirs for energy production		Bio energy crops compete for land with food crops
	Fracking (and other types of energy) requires water		
	Bio energy crops need water		
Food	Crops need water	Fertiliser and pesticides use energy	
	Food production may lead to water pollution	Farm mechanisation uses energy	
	Water is used in processing	Energy is used in food chain and transport	

The OECD, (2017) analysed what would be the global and regional biophysical and economic consequences by 2060 of policy inaction to account for the limited availability of land, water and energy, given all the complex relations between these resources. Bottlenecks in water supply, land supply (urban sprawl and protection of natural areas) and energy supply (through increased bioenergy production) were analysed, using models that distinguish sectors and regions. The following bottlenecks were studied:

- Depletion of selected deep groundwater reservoirs
- Reduced access to potentially very suitable land for agriculture, (i) by increased urban sprawl and (ii) excluding more natural areas from conversion to agricultural land to reduce biodiversity loss and (iii) safeguard provision of ecosystem services reducing the reliance on increasingly scarce fossil fuels through a partial shift in energy supply towards biofuels.

They assumed that the supply risks of energy are low, due to alternative sources and a large traded volume of energy sources. The study concludes that nexus interactions are relevant if the impact of the combined bottlenecks in water, land and energy sources significantly differs from the summed effect of the individual effects. These related bottlenecks are really an issue in specific regional hotspots (and local disruptions), e.g. North Africa, Middle East, and India. Zooming to finer scales would reveal more striking examples.

4 Case studies

4.1 Introduction

The nexus approach consists of key elements:
- Defining goals, the relevant system and integration issues
- Identifying which of these issues are handled with the nexus approach
- Developing a coherent plan with nexus approach

As the goals, system and issues differ, the nexus approach and nexus solutions are not generic. To exemplify the nexus approach and its results, in this chapter three case studies are presented. The first is the Mekong Delta in Vietnam, where drought and salinity threaten agricultural production. Here, the nexus is analysed at farm level. The second case study deals with dropping groundwater and unreliable electricity supply in Gujarat (West India). Here, the nexus approach is applied at regional scale. The third case study is Egypt, where the fast-growing population needs to be fed, while the only source of fresh water is the Nile with a lot of competing claims. The nexus approach should be applied a national or transboundary level. These case studies are described in line with the nexus approach: define goals, identify integration issues, and develop nexus solutions. After this has been done, the impact of the nexus approach is given and conclusions are drawn per case study.

4.2 Mekong Delta (farm level approach)

4.2.1 Problem definition

Rising sea levels and land subsidence are slowly increasing the risks of salinisation of the coastal lowlands. In addition, drought, as experienced during the 2015-2016 El Niño Southern Oscillation (ENSO) phenomenon, will not only enhance saline intrusion but also has direct implications for crop production systems in the Mekong Delta.

The main agricultural products of the delta are rice, fruits, fish and shrimp. It contributes 30% of the agricultural production value, 57% of total rice production and 41% of aquaculture production of the whole country (GSO, 2010). More than 2 million ha of agricultural land are dedicated to rice production. There are only 150,000 ha of cash crops (vegetables, soybean, maize, sugar cane, etc.) and 320,000 ha of perennial crops (durian, coconut, mango, longan, etc.). With a total area of agricultural land in the delta of 2.6 million ha, the region produces about 50% of the total amount of food in Vietnam and ensures food security and livelihoods for approximately 70% of the region's population. Agricultural products of the delta are also exported to the international market. Thus the development of the agriculture sector directly correlates with poverty reduction.

4.2.2 Define goals

The goal is to stabilise and increase productivity via the application of crop and cropping-system level strategies that address salt and drought stress.

4.2.3 Integration issues

At the farm level, several issues come together. When we look at salt and drought tolerant production, the most important issues are crop selection and water management. Farmers need access to quality seeds, water and technologies, often requiring energy e.g. tractors and pumps. The farmer or farm household is the decision maker and decisions are based on the resources at the farm taking into account the trade-offs and synergies. While their livelihood depends on the use of these resources, poor management does not go unpunished: poor water management will aggravate effects of drought and salt, using sensitive crop varieties will increase the risk of failure. At regional level farmers often opt to cooperate in order to manage shared resources such as machines, water, land and labour and reduce risk of failure.

4.2.4 Conclusions

Needs and options at farm level are co-determined by higher level processes (markets, technological change, policies) outside the direct influence range of the individual farmer. Water and food issues are not new, energy for e.g. pumping is also not new as are many other issues. Claims for increasingly scarce resources need coherent policies and actions in which cross-sectoral impacts are considered. Farmers are not a sector and it is difficult to see how the nexus approach at farm level, which may result in coherent policy making, can lead to positive results for this group.

At a higher level of nexus analysis, other problems in the Mekong River Basin would have been identified. For instance, the impact of proposed dams in the Mekong river on fish catches and protein intake (e.g. Orr et al., 2012).

4.3 Gujarat (West India – regional level approach)

4.3.1 Problem definition

In Gujarat (West India), farmers first used surface water irrigation, which was centralised and controllable. Farmers substituted surface water for groundwater using electric pumps, because diesel pumps were unable to follow declining groundwater levels. Groundwater wells are very small and not controlled (Shah, 2010). In 1988 the Gujarat Energy Board changed from metered to flat tariffs, making the marginal costs of electricity for tube-well owners zero, leading to uncontrolled farmer power subsidies. Groundwater could be abstracted against less costs. Farmers overused energy and water, leading to falling groundwater tables and over-usage of the power grid, leading to trippings (Shah and Verma, 2008; Shah et al., 2008).

The electricity system links farmers to municipality. The quality and timing of power supply (for farmers and villages) deteriorated, it came with low voltage, more often during the night and with frequent trippings. Farmers started to use capacitators to convert two-phase power into three-phase power, affecting the power supply to the village community negatively (Mukherji et al., 2010). Problems in Gujarat are the dropping groundwater table, which jeopardises the food supply in the long run and the unreliable supply of electricity (for farmers and domestic users).

4.3.2 Define goals

The goal was to reduce unsustainable groundwater withdrawal (with consent of the farmers) and to improve electricity distribution (infrastructure) for municipality.

4.3.3 Integration issues

- Energy required to withdraw groundwater necessary for food production
- The government cannot control groundwater withdrawal, but can control electricity use (not diesel use) of farmers
- Reliable water supply depends on reliable electricity supply, farmers pump too much water to be assured of water (and deplete the aquifer even faster);
- Farmers all use electricity at the same time and hamper the community electricity supply.

4.3.4 Nexus solution

Economic solution (first best): set the right price for energy and water to create the incentive for optimal use of water and energy. IMWI proposed a second-best solution (the first-best solution, metering and appropriate pricing, was strongly rejected by the farmers):

- Flat tariff on farm power use should gradually approach the average cost of power consumed by a tube well
- Low-cost night power should keep the average costs of farm power supply low
- Enhancing the predictability and reliability of power supply.

The Jyotigram Scheme (JGS) was initially launched in eight districts of Gujarat on pilot basis, and was soon extended to the entire state. By 2006, over 90% of Gujarat's 18,000 villages were covered under the JGS. Every village got agricultural power during the day and night in alternate weeks that were pre-announced.

4.3.5 Impact of the nexus approach

a. Improved power supply in the villages (Grönwall, 2014) led to better drinking water supply, use of fans, street lighting; improving quality of rural life.
b. It reduced the costs of non-farm business, by consuming less power, because they get full voltage. Except for the pump repair business non-farm economy benefited from JGS.
c. Farmers encountered the following positive effects:
    a. Full voltage power supply
    b. Reliable and predictable power supply, eight hours of power during a fixed time schedule.
    c. It put a cap on collective groundwater withdrawal, step towards sustainable groundwater management. Capacitators (illegally installed by farmer) were prohibited under JGS.

d. And negative effects:
    a. Tube-well owners used to sell water to farmers without a well, this water market is reduced due to power rationing. Water-buying marginal famers, tenants and landless farm labourers cannot buy irrigation water anymore at an affordable price.
    b. Farmers indicate that they do not receive eight hours a day three-phase power (but 6 hours).
    c. Every alternate week they receive night power, night irrigation is inconvenient.
    d. Farmers felt that villages benefited more from JGS than farmers (Grönwall, 2014).

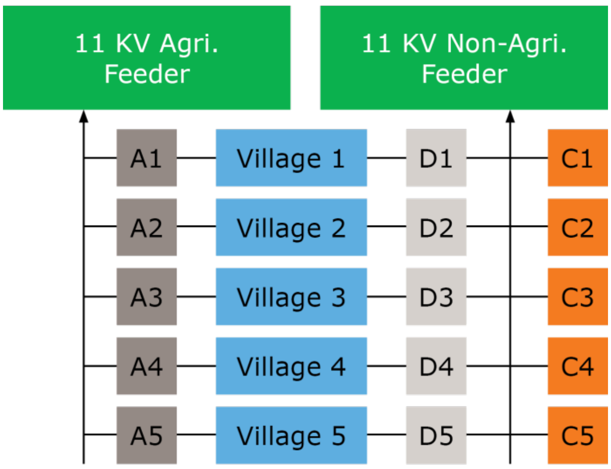

Figure 4.1 *The Electricity network after implementation of JGS, when farmers were provided with an independent electricity infrastructure*

4.3.6 Conclusion

The government could use the electricity supply to control groundwater withdrawal and make food production sustainable in the long run. The Jyotigram Scheme (JGS) is an example of the nexus approach, because an intervention in the electricity infrastructure and supply improved both the electricity supply and sustainable ground water use. JGS can be called a success because:

- The improved electricity supply improved quality of rural life.
- The groundwater withdrawal is reduced.
- The pumps are not metered, as farmers preferred.

The Gujarat case also shows the dynamic aspect of the nexus approach. Since implementation of the Jyotigram Scheme, solar power has become more attractive, allowing farmers to withdrawal groundwater while off-grid. A solution for this recurrent incentive to deplete groundwater aquifers is to allow farmers to sell excess electricity to the power company.

4.4 Egypt (National and water basin level approach)

4.4.1 Problem definition

Problems in Egypt are manifold:

- Water
  Egypt's water resources are under enormous pressure due to many factors, including population growth, developments upstream in the River Nile Basin (including for instance the Grand Ethiopian Renaissance Dam) and climate change.
  Actually, climate change acts as a 'threat multiplier' on top of the other pressures, by increasing uncertainty about water availability and by posing additional water-related risks such as more frequent and more intense floods and droughts. Although climate (impact) models do not agree on the climate change effect in terms of total water availability in the Nile river, there is unanimous agreement that agricultural water demand will further increase with higher temperatures; there will be negative effects on water quality through sea level rise and subsequent salt water intrusion into coastal aquifers; as well as negative water quality effects of higher water temperatures and lower water volumes for diluting pollutants.
- Food
  Egypt is not self-sufficient in food and remains, for instance, the world's largest wheat importer. The overall cereal import requirements in the 2016/17 marketing year (July/June) are forecast at around 20.6 million tonnes, about the same as the previous year and 11% higher than the five- year average.
  To mitigate the impact of the rising inflation due to the devaluation of the Egyptian Pound, the Government increased its food subsidy allocation by 20% per beneficiary in May 2016. Currently, 67 million citizens (out of a total population of 92 million) are carrying the smart cards to benefit from the food subsidy system. The Ministry of Supply and Internal Trade is committed to reviewing eligibility criteria.
- Energy
  Egypt suffers from an energy gap that frequently leads to electricity cuts and also hampers industrial production. The government is working on closing this gap by, for instance, passing a law that paves the way for privatisation of the energy sector. The sector suffers from:
  – Generation capacity falling short
  – Growing energy demand and high energy intensity
  – Unsustainable financial burden due to subsidies
  – Inefficient governance structure.

Egyptian agriculture has two faces: highly productive but fragmented smallholder agricultural systems producing mainly 'traditional' crops in the Nile Valley and Delta (the Old Lands) and a new modern agricultural sector developed in desert areas (the New lands) using mainly groundwater. In comparison with the agriculture in the Old Lands, New Land agricultural entrepreneurs are highly competitive, produce high quality food and have a good access to the national and international markets. However, as agriculture has the lowest priority in water allocation in Egypt - having to bear the shortages in water supply - and given that many New Land aquifers are non-renewable, putting New Land developments at risk, the agricultural sector needs to be challenged to develop innovative new agricultural production systems that require less water.

Water is increasingly to be treated as an economic good at this stage. Generally, agriculture is the water user that gets a lower priority in water allocation and agriculture no longer can supply the national food requirements. The national economy needs to be diversified and other economic sectors must be developed. Food imports (virtual water) have to fill the gap in the food production shortages.

Cairo and the delta
Metropoles in deltas or urban deltas all over the world face major risks associated with water security and Cairo is no exception to this. Issues concern e.g. water shortages, supply of drinking water, waste water treatment, solid waste in waterways and polluted streams (drains) flowing through the outskirts of the city. Climate change exacerbates the already high stress on water resources. Climate change all point to a rise in temperature in Egypt and this is not only affecting agriculture, but will also lead to more urban heat stress.
The city of Cairo is expanding and the delta is also urbanising at a high rate. Egypt's population is increasing at a high rate, as shown in Table 4.1.

Table 4.1 *Differentiated projections for population growth*

Population Projections	Unit	2015	2020	2030	2037
Optimistic	millions	90	101	124	141
Probable	millions	90	102	129	145
Pessimistic	millions	90	103	132	150

Source: National Water Resources Plan, Egypt.

Notwithstanding the water-food-energy nexus, there are more issues at stake in Egypt: one of the planet's most important bird migration routes is through the Nile Delta. Millions of birds traveling between Africa and Europe pass through the delta region. Their habitat is in grave danger due to the high pressure on land and the increasing urbanisation.

4.4.2 Define goals

The ultimate goal, as recently set by the Egyptian government in the context of the UN Sustainable Development Goals (SDGs), is that Egypt will be a 'Top 30 country', which implies that Egypt should be in the top 30 of global statistics in terms of the size of its economy, its market competitiveness, human development, quality of life and anti-corruption.

SDS2030 provides a very ambitious vision to be realised on a very ambitious time-scale and its vision and ambition form the backdrop for all Government-issued strategies and plans. The strategy is elaborated along three dimensions: economic, social and environmental. For each dimension, pillars have been defined, which in turn are further specified in key performance indicators (for results, outcomes and inputs) and programmes. For water, these KPIs are presented in the Table:

Key Performance Indicators for 2030 (from Vision SDS 2030)	Programmes identified by Vision 2030
• 100% of population has access to safe drinking water • 100% of population has access to sanitation services • Only 80% of the total water resources is used • 950 m³ renewable freshwater available per capita per year • 40% of the water usage supplied by non-traditional water resources • Sanitation comprises 80% of the sewage flow (i.e. as an effect of less wastage of good water.) • Illegal industrial sewage to the Nile is reduced to zero • 100% of the sewage into the Nile is treated according to the standards • Less than 5% system loss in water transfer networks • Less than 10% system loss in wastewater treatment plants	• Rationalisation of water usage • Rehabilitation of mega water pumping stations • Addressing climate change, including protection of the coast and buildings thereon • Water resources development • Water quality improvement • Expanding sustainable development program for Nubian sandstone aquifer • Developing groundwater and facing its infringement • Developing covered sewage networks • Strengthening the institutional and legislative structure of water resources management system • Expanding infrastructure for supporting a sustainable water system • Adopting of fiscal policy reforms to encourage sustainable consumption patterns of water and natural resources • Raising the awareness to preserve the environment and natural resources, providing incentives for more advanced alternatives and technologies for water conservation and natural resources protection.

N.B. Not all KPIs for 2030 have been looked at through a nexus lens (for instance, the KPI 950 m³ renewable freshwater available per capita per year is a clear (and ‘dangerous’) sign of ‘sectoral’ thinking)

4.4.3 Integration issues

Strengthening resilience of the water sector also means to better coordinate and integrate with other sectors’ activities and plans, including the agriculture, energy, urban and trade sectors, each of which depends on and/or affects water resources. Hence all water measures need to be aligned with other sectoral plans, strategies, policies and measures.

4.4.4 Nexus solution

Egypt’s INDC (Intended Nationally Determined Contributions as per the UNFCC (United Nations Framework Convention on Climate Change)) lists adaptation and mitigation activities strictly separated, but nexus analyses for Egypt show that more energy-smart water planning and more water-smart energy planning as well as more water- and energy-smart agricultural planning are urgently required to meet the growing challenges of climate change and other pressures.

Agriculture takes the major share of water allocation in Egypt, at about 85%. But, agriculture also has a lower priority of water allocation than domestic water use and water for industry. Therefore, the main ‘nexus solution’ for Egypt lies in producing more food with less water, i.e. an increase in water productivity through innovation. This also has energy implications; more intensive agriculture will require more energy. For the New Land development, the government already prescribes the use of solar energy only. A move from using fossil fuel to solar energy is urgently required and there are some initiatives in this regard (Kom Ombo Solar farm and Suez Canal Wind farm).

The next figure shows how a ‘nexus process’ could be beneficial in producing more food with less water in Egypt. There are several actions possible, that all are linked when applying a ‘nexus lens’. These include:

- the use of fossil fuel can be reduced when solar energy is prescribed by the government. This will assist the government in reducing the (heavy) subsidies on fossil fuel. Currently the productivity of the solar pumping systems is not so high that an ‘excessive use’ of water will happen. There are currently discussions between the government and business investors about the requirement of sole application of solar energy (Wolters, 2016). The investors, looking to expand their operations in the desert, prefer to have more control over the water supply than the current solar pumping systems can deliver. In future, this situation may change due to technology steps.

- Agricultural operations can be modernised through application of (already existing) improved practices, leading to water saving. This will have a beneficial effect on the already scarce water resources of the country. This action will require the establishment of some form of ‘centres of excellence’ on how to modernise agricultural water management, using national and international knowledge. The private sector in Egypt is also known for its sometimes innovative approaches to agriculture.

Another important issue is food loss and food waste. FAO (2011) estimated that globally about one-third of food produced for human consumption is lost or wasted throughout the supply chain, from initial agricultural production all the way to the household. Egypt is no exception to this and food losses represent a waste of resources used in production such as land, water, energy as well as other inputs.

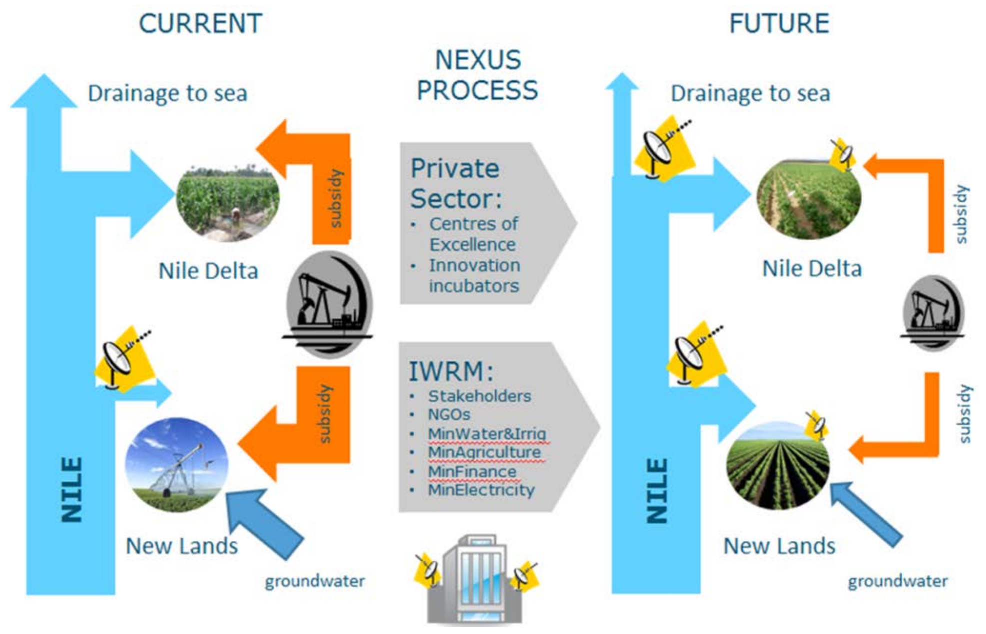

Figure 4.2 *Overview of an Egyptian nexus process*

4.4.5 Impact of nexus approach

Integration of water-related climate adaptation and mitigation with the Sustainable Development Goals (SDGs) can promote synergies, trigger co-benefits and reduce (potentially water-intensive) trade-offs and negative externalities. The nexus approach applied to Egypt’s water, energy and agriculture sectors demonstrates significant opportunities for increasing overall resource-use efficiencies and achieving more with less water.

In Egypt, there is a huge impact on the nexus through the subsidies in the country on water, food *and* energy. All nexus work in Egypt should take into account the socio-economic impacts of changes in the subsidy system.

4.4.6 Conclusion

There is an urgent need for application of the nexus approach. Too often the sectoral policies (and even national goals) are created separately from other sectors. The main issues in the nexus in Egypt are not so much ‘technical’; they are largely institutional. For the water sector, the need for ‘integration of policies’ has been advocated for about ten years now and there is governmental recognition that it should be done and some steps towards improvement have been taken. However, reality sometimes seems unruly.

5 Nexus conclusions and recommendations

5.1 Conclusions

The objective of this quick scan is the answer to the following question: Is the nexus concept sufficiently developed to be used to support water-related policies of the ministry of economic affairs, where the main focus is on food policy?

The nexus is a promising concept to concretise food policy efficiently. However, it is not a mature concept and there is room for developing further insights in the sense that we do not advocate to turn the nexus concept in a structured and fixed framework, and that it is more an 'inclusive look', with flexibility depending on the case under investigation. This is in line with Bird (2014), who argues that 'We shouldn't turn nexus concept into a structured framework – its value lies in its principles and flexibility'. He also puts forward that the nexus approach does not displace other forms of planning (regulatory frameworks, SEA, IWRM, etc.), but provides a focus or 'lens' for integration.

The nexus' strength lies in implementing a multi-sectoral, multi-stakeholder process (see section 2). Given that the nexus is still largely water sector driven, the inclusion of other sectors (e.g. food and energy) is crucial for the further development of the nexus approach. The nexus is useful to develop policies, strategies and investments to exploit synergies and mitigate trade-offs among development goals, with interactive participation by and among governmental agencies, the private sector, academia and civil society (adapted from Dodds and Bartram, 2016).

An analysis of the nexus could include:

a. Definition of goals: Relation with UN's Sustainable Development Goals (SDGs) (2. Zero hunger, 6. Clean water and sanitation, 7. Affordable and clean energy, 13. Climate action);
b. Definition of scales: Social, economic and environmental goals should be specified at different scales;
c. Definition of integration issues: the potential synergies between water, food and energy.

The Nexus methodology should include:

d. Identification of issues that have to be handled with the nexus approach;
e. Coherent plan with nexus (or sectoral) approaches to achieve goals, a nexus approach will per definition be multi-sectoral and multi-stakeholder process.

An 'inclusive' look at the interrelationships between water, food and energy, at all relevant levels, holds promise of choosing the best suited policies, investments and solutions for water, food and energy issues. The nexus could align the goals of the Dutch Ministries. However, there is no single way of applying steps that will automatically lead to the 'best' solution. A test for the nexus is: will the policy actually change if the nexus approach is used in policy making.

The nexus approach will be a solution for problems involving resources (water, food, energy) due to policy inconsistency, knowledge gaps and technology lock-ins in the synergies between water, food and energy (at various levels) and technology lock ins. Hence, the nexus methodology should address these sources in a multi-sectoral and multi-stakeholder process. The recommendations are presented as governance and knowledge oriented. Most examples of the nexus approach in literature did not start as a nexus process. The knowledge base of working with the nexus approach from start needs to be extended, and learn from mistakes.

5.2 Advantages and disadvantages of the nexus

A formal test whether the benefits of applying the nexus approach costs outweigh the costs was not found in literature. This is partly due to the fact that many examples of the nexus approach in literature did not start as an explicit nexus approach (to be compared with an alternative approach).

The nexus approach leads to an expansion of the set of possible solutions, increasing the possibility to find the best solution. This comes with the cost of more time devoted to analysis and processes.

Advantages
- Negative feedbacks are foreseen and anticipated on;
- Water food and energy are considered together, scarcity in one (or all) of these may be solved.

Disadvantages
- Holistically complicated, approach costs more time, capacity;
- It is not possible to define an optimum.

5.3 Recommendations - governance oriented

- Increase policy coherence by ensuring that synergies and trade-offs among water, food and energy are identified in both the design and implementation of policies, plans and investments.
- Abandon silo thinking and vested interests (Ringler et al., 2013).
- To understand the nexus it is necessary also to take into account political and market forces in the form of subsidies, profit seeking and state agendas (Allen and Matthews, 2016; p87).
- A nexus approach, implemented by way of integrated resource management and governance, can improve human securities and development, while reducing pressures on resources and on the environment. Such a nexus approach, that supports the integration across scales and borders, is an important contribution to sustainable development and eventually to political stability (ACCWaM, 2017).
- An important institutional pre-condition to make nexus solutions work is the political will in the respective country to coordinate and cooperate across sectors, ministries and authorities (ACCWaM, 2017).
- The nexus requires strengthening the capacities of the institutions in the three sectors for better integration and joint planning, giving more careful consideration of the cumulative and interrelated impacts of policies and regulatory regimes (Lindberg and Leflaive, 2015), as for example in the case of the promotion of solar pumps which can lead to over-abstraction of groundwater (ACCWaM, 2017).

5.4 Recommendations - knowledge oriented

- Comprehensive food security and climate change research analysing access, volatility, extreme events and nutrition should be high on the science agenda, as well as information and behavioural change support in complex nexus environments (Von Braun and Mirzabaev, in Dodds and Bartram 2016; p67);
- Given that nexus approaches are more complex than conventional sectoral management, there is a need to address, reduce and communicate this complexity (and to develop capacity accordingly) (ACCWaM, 2017);
- Consolidation of data and methodologies of the nexus approach, to stimulate the dissemination of the nexus approach;
- The nexus approach has hardly been used from the start of the process, knowledge sharing of nexus approach experiences will enhance learning from best practices.

5.5 Overall Recommendations

- Implementation of the nexus approach in a country, region, watershed, landscape taking into account:
  - Recognition that implementation of the nexus approach is a ‘country, region, watershed, landscape’-driven and owned process (this calls for a ‘long-term’ relationship)
  - Recently acquired nexus insights, starting but not limited to water, food and energy.
  - Established development goals for the chosen area
  - Political will of the prospective partner
  - Existing ‘silos’ and related ongoing plans and programmes are to be respected
  - Building on Dutch strengths, expertise and interest
- Implementation of such a ‘nexus approach’ will reveal the benefits of it and increase insight in the interrelationships between water, food and energy. The approach of the Dutch Delta Programme (MIE, 2016) could facilitate application of the nexus approach in other regions. This programme can serve as an example of how a government is dealing with serious water issues related to climate change and increasing population density: its approach includes water governance, adaptation, also includes ‘soft’ solutions (building with nature) and multiple lines of defence, and it offers space for innovations while keeping a keen eye on legislation and financial issues.
- The farmer (entrepreneur) makes integrated decisions if he receives the correct (price)signals (see chapter 2). The private business model supported by the nexus approach should be identified, as well as the barriers which prevent implementing these business cases (see for example van Meijl et al., 2017). Dutch government could co-invest in these nexus type business models to enhance implementation. Link the nexus approach to impact investment.
- Link a knowledge programme to the investment programme (see previous) to incorporate learning by doing

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MEMORANDUM
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To explore
the potential
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