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NEXUS REGIONAL DIALOGUE PROGRAMME

Water, Energy & Food Security Nexus Indicator Framework

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Introduction

“You can’t manage what you don’t measure.” (Peter Drucker)

The WEF Nexus approach helps to understand complex and dynamic interlinkages between water, energy and food security, seeking to minimize unintended resource management risks and conflicts that arise with solely sectoral approaches. The approach however is often criticized for its lack of quantification in cross-sectoral resource utilization and analytical tools to support policy and decision-making process for integrating the WEF Nexus approach in resource governance as well as in facilitating monitoring processes. Therefore, the following set of indicators has been compiled to provide a means to monitor and evaluate respective projects as well as for assessing sustainability performance. The main challenge is to capture meaningful information on projects that feature a great diversity in characteristics both internally – since they include at least three different sectors – and externally in comparison to other projects.

The attached Excel sheet comprises a compilation of suitable indicators that can be used in a flexible methodology. The comprehensive indicator table is presented along this introduction manual that features one practical example on possible application, based on project proposals from the WEF Nexus Action Plans. It shall further improve transparent and inclusive dialogues across actor networks and between the Nexus Regional Dialogues Programme for further action planning. As an early-stage draft, the document is still subject to changes; constructive feedback from users and practitioners is very much welcome.

Fostering Development with the WEF Nexus

WEF Nexus and the Sustainable Development Goals



The adoption of the SDG targets by all UN member states in 2015 offers an appropriate framework to monitor WEF security-related measures. Three goals are specifically important to the WEF Nexus approach, namely SDG 2 (End hunger, achieve food security and improved nutrition and promote sustainable agriculture); SDG 6 (Ensure availability and sustainable management of water and sanitation for all) and SDG 7 (Ensure access to affordable, reliable, sustainable and modern energy for all). However, many aspects of the WEF Security Nexus approach are linked to other SDGs, among others, SDG 15 (Life on Land) and SDG 11 (Sustainable Cities and Communities). This in turn means that efficient and sustainable WEF Nexus approach applications ultimately have positive effects on the achievement of other goals.

Figure 1: Applicable SDGs

The proposed quantitative and qualitative WEF Nexus indicators can support the assessment of efforts to foster a successful WEF Nexus implementation, which subsequently can lead towards achieving SDGs and thus leads towards greater resources security for all.

Nexus Principles

The WEF Nexus principles were derived from experiences of the WEF Nexus Regional Dialogues Programme in the MENA region, Latin America, the Niger Basin, Southern Africa and Central Asia as well as the Bonn 2011 WEF Nexus conference. The principles function as guidelines for a successful mainstreaming and operationalization of the WEF Nexus approach on different levels and in different regions. They apply to the WEF policy cycle and should be implemented in a systemic and inclusive manner. The WEF Nexus principles formed the basis for the development of the indicator framework. Nevertheless, these principles are also subject to further refinements through lessons to be learned in the regions and by the implementing partners.

The need for WEF Security Nexus Indicators

When analysing the situation of the water, energy or food sectors, consideration is usually given to the resource use and demand of one sector individually. Therefore, the indicators for water, energy, or food security are mostly used in silos and hence do not consider the impact on other resources and sectors. This silo approach thus has limited capacity to capture the interlinkages with adjacent sectors.

The goal of this framework is to introduce a cross-sectoral assessment procedure, that facilitates the evaluation and the increase of resource efficiency of WEF Nexus conform projects.

Many analysis frameworks and methodologies have been introduced to facilitate a better understanding of the WEF Nexus (Aboelnga et al., 2018). All of these require varying amounts of data, provide different benefits and limitations and operate at different geographical scales. The availability of data and information is paramount, since without sound information WEF security Nexus interactions cannot be properly identified. Moreover, the assessment of WEF interventions and responses to the adoption of the WEF Nexus approach and policies require qualitative as well as quantitative data. In contrast to strictly sectoral approaches, clear rules, trust and transparency are of utmost importance in the WEF Nexus approach. This will ensure multi-sectoral collaboration and information exchange between sectors and users, thereby improving monitoring and evaluation data and practices. Sharing data and trust become crucial when managing WEF Nexus in a transboundary setting and between sovereign states (Ringler et al., 2013). Hence, the setting of quantitative targets and monitoring progress towards them is essential for WEF interventions.

Any proposed WEF security Nexus Indicators should be applicable across governance levels (local, basin, national, etc.) and WEF functions (water resources management, agricultural land management, and energy management).

The WEF Nexus Assessment Framework

Indicator-based approaches

As the WEF Nexus approach has various components and is based on a highly interconnected web of influencing factors reflected through indicators, an indicator-based framework was chosen for the WEF Nexus assessments. An indicator can be described as a function of measurable variables, while indicator-based approaches can be applied to any socio-ecological and socio-economic system (temporal and spatial) from global to district level (Adger & Kelly, 2000). In multivariate indicator-based approaches, several sets of observable proxy variables (sub-components) are combined.

In general, indicator-based approaches are used when the real-life complexity of a system is difficult to capture completely. The results are easily conveyable to the public and can also serve as a tool for monitoring. With indicator-based approaches, the dynamics in the researched system can be understood more easily, as multidimensional and multifaceted realities can be summarized and easily used for understanding WEF Nexus interrelations (OECD et al., 2008).

Indicators for practical application

The development of the WEF Nexus indicators has been conducted with a strong focus on practical application within projects of the Nexus Regional Dialogues Programme more than just for academic purposes. This means it does not provide a comprehensive scientific background at this point. The structure of the indicator table is based on an integrated nexus-livelihoods framework (Briggs et al. 2015). It combines WEF Nexus and sustainable livelihoods approaches and provides a tool for assessing environmental livelihood security. The complex system of interconnections between the resource sectors and respective livelihoods is visually presented in a component matrix which has been used as a template for the creation of (sub)categories for the Nexus indicators. In addition to the categories *Water, Energy, Food and Livelihoods*, the indicator table features *Governance* as a specific category, since governance plays a crucial role in institutionalising the WEF Nexus approach and due to the diverse orientation of WEF Nexus projects, which often aim for processes beyond the technical scope. Ecosystems were not added as a specific pillar, as they are integrated in each resource pillar. Arguably this could be adapted.

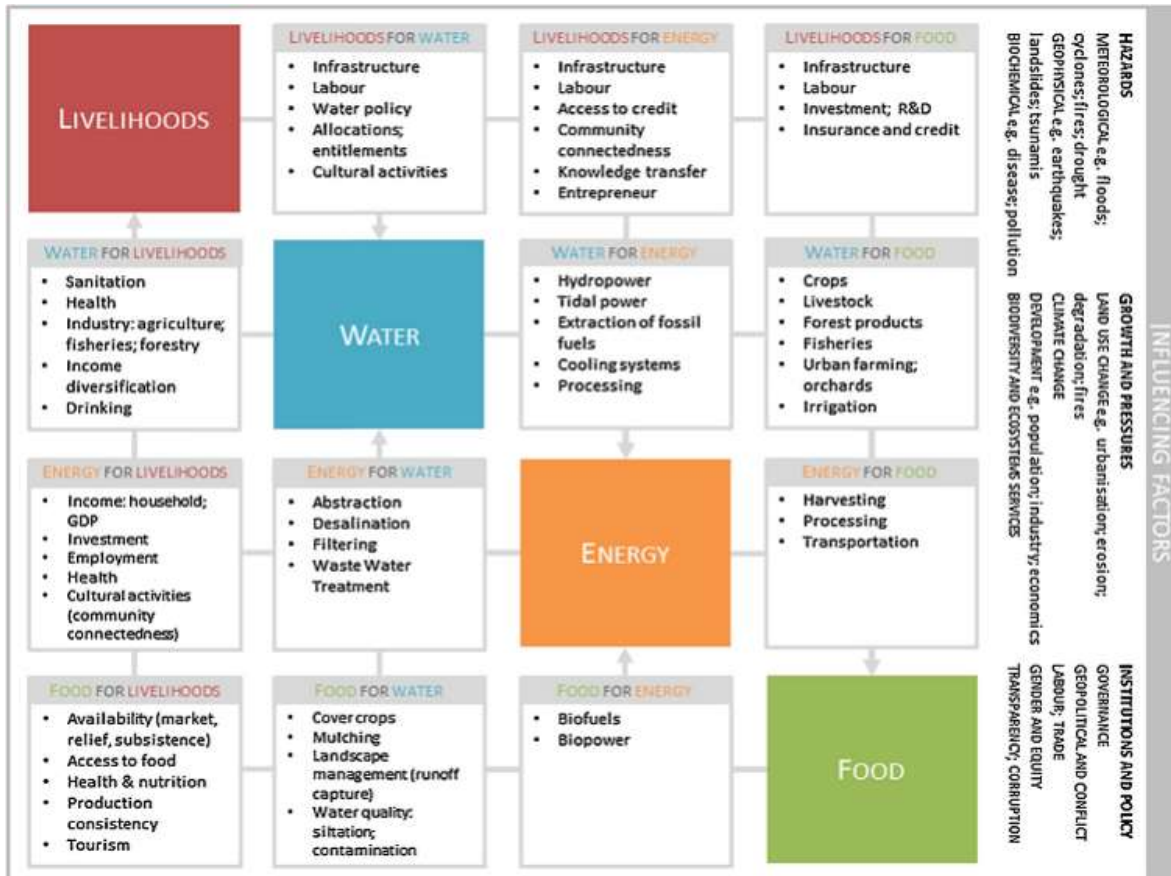


Figure 2: Frameworks of WEF Nexus assessment framework by Biggs et al. 2015

The four categories provide the basis for the indicator table and are furtherly divided into subcategories in a structure that reflects the interdependence between each category.

How to use the indicator table

The attached indicator table provides a comprehensive variety of indicators. For the evaluation of a project however, it is not necessary to assess all of them. The authors suggest, depending on the nature of the project, an appropriate selection of indicators to be evaluated – meaning the table is not a mandatory list to check off, but rather a catalogue with useful suggestions. Projects including technical measures should utilise indicators from each of the categories *Livelihood*, *Water*, *Energy* and *Food*, projects conducting mostly non-technical measures should utilise indicators from the category *Governance*. Extensive projects should, if applicable, utilise two indicators from each of the categories. After all, it is certainly possible to evaluate more/less indicators than the minimum number, in that case however, the number of indicators from each category should be properly balanced. Users should furthermore carefully select between indicators that are the most relevant for the project and indicators that are easily measurable. After choosing suitable indicators, a baseline should be established to allow significant measurements and demonstrate progress.

Creation of a framework: Aspects to be considered

There is no fixed WEF Nexus assessment approach because of its various dimensions. Before applying WEF Nexus indicators on a specific intervention, it is therefore important to consider different aspects:

1. What kind of intervention is assessed?

- Infrastructure project
- Small-scale demonstration project
- Policy and governance guidelines

2. What is the aim/objective/overall purpose of the intervention?

- Determines the attributes and what indicators are needed

3. What is the level of intervention?

- Transboundary context
- Regional level
- National level
- Basin level
- Local level

4. What is the regional/national context?¹

- What are the main energy, water and food resources relevant to the intervention?
- What are the main energy users, water users and agricultural producers relevant to the intervention?
- Is there relevant information about the effects of climate change -current situation and predictions- in the intervention area?
- What are the most relevant public institutions involved?
- Are there policy instruments that support WEF Nexus action?
- How is the social and cultural context? Who are the stakeholders affected (natural resource-based livelihoods) by the intervention?
- Role of the private sector in natural resource use/accessibility/distribution

5. What is the temporal reference?

- Determination of the time period for the assessment

¹ This is a preliminary list of questions to be considered, it can be enhanced depending on the type of intervention.

Structure of the WEF Nexus Indicators: Governance, Livelihoods, Water, Energy and Food



First pillar: Governance

The WEF Nexus is typically studied from an energetic, hydrological or agronomic angle, with a limited focus on cross-cutting governance issues in resources management of the involved sectors. Often, environmental decision-making processes involve trade-offs between different sectors (horizontally) over time, space and policy level (vertically). Governing the WEF Nexus approach specifically includes competing resource usage as well as the possibility of creating synergies between agricultural resource usage, water management, and energy generation and distribution. The pillar here includes indicators on the integration of all three sectors in decision-making processes and identifies relevant policy tools that have the potential to foster multi-sectoral collaboration.

In the scope of this framework, the OECD Water Governance Indicator Framework (OECD, 2018) were adapted to suit the WEF Nexus assessment approach. The indicators are used to assess the status of WEF governance, policy frameworks and regulatory instruments. Often, policy-making processes happen in sector silos, leading to a lack of coordination among stakeholders and sectors. This can then result in inefficient resource management, resource depletion, degradation, and conflicts. The objective of the proposed indicators is thus to assess the level of good or effective governance as well as the process of transparent and inclusive dialogues across sectors and actors' networks.



Second pillar: Livelihoods

The WEF Nexus is important for securing sustainable livelihoods in terms of resource security and development. Often, the livelihood level has not been taken into account in WEF Nexus research (Biggs et al., 2015), however, the European Commission's WEF Nexus Report (EC, 2015) states that WEF Nexus work should focus more a "local level, applying local solutions and decentralised approaches" by including social aspects. The definition of livelihood includes the "capabilities, assets (stores, resources, claims and access) and activities required for a means of living" (Chambers & Conway, 1992, p. 6).

In research, livelihood is described as the access to resources and income, activities and assets in any form which fulfil needs and establish a living. This specifically includes assets which shape the wellbeing of an individual or a group, hence tangible assets such as resources are included in this indicator framework, as well as access and availability of resources namely water, energy and food, are also critical to ensure sustainable living. Unsustainable resource management as well as competing interests which result in conflicts over resources can thus increase the level of vulnerability of an individual or a group and hinder sustainable development of livelihoods. Improved and integrated management of the three resources can increase the well-being of humans and increase the standard of living especially for vulnerable groups.

Improved project planning as well as good governance and management of resources can enhance livelihoods significantly, either in rural or urban contexts. The indicators depict this by including important aspects of livelihoods.



Third pillar: Water

Water security encompasses complex and interconnected challenges. Water security is at the centre of achieving a basic sense of security, sustainability, development and general human well-being. As such, water security tries to capture the dynamic dimensions of water and offers an integrated avenue to address water-related challenges. According to UN-Water (2013), water security is defined as the capacity of the population to have access to an adequate quantity and quality of water to sustain livelihoods, human well-being and economic development. Moreover, ecosystems in a climate of peace and stability should be preserved by means of sustainable water resource management. This common definition of water security facilitates its incorporation in the international development dialogue, in particular to achieve the SDGs. Water is needed to support livelihoods with drinking water, sanitation as well as to generate energy and agricultural products. At the same time, energy is needed for the provision of drinking water and sanitation and for water pumping in agriculture.

In addition, water resources are crucial for ecosystem services, of which communities' benefit, such as biodiversity, clean air, nutrient cycling and cultural values. Untreated wastewater and over-exploitation of water resources can degrade these and thus threaten the wellbeing of livelihoods and the ecosystems.



Fourth pillar: Energy

Energy security reflects access to affordable, clean and reliable energy. Full access to energy services as such drives the economic development path of a society (Azzuni et al., 2018). Sustainable livelihoods can thus be enhanced by access to energy, as communications, cooking, lighting, heating and water pumping become possible. Renewable energy takes the lead in building a more diverse and more secure energy system, especially in remote and rural areas in developing countries. In addition, in many cases renewable energies have smaller negative impacts on the cost of the traditional energy system (renewables are cheaper), environment (renewables are cleaner), health, employment, and other areas, resulting in improved access to energy (Azzuni et al., 2018). Moreover, efficiency plays a significant role towards achieving energy security. A shift to highly efficient solar and hydropower systems will eradicate losses of low-efficiency nuclear and coal power plants and thus result in an increase in the efficiency of the secure new energy system (Azzuni et al., 2018).

Often, water is a key input for energy production processes: water for cooling, hydropower, water for extraction (e.g. fossil fuels) and transportation. At the same time, energy can function as an input for water treatment and extraction (e.g. pumping). This is directly related to food

security, as energy plays an important role in the mechanization and irrigation of agricultural production processes as well as for the processing, distribution, and preparation of food.

The pillar Energy can be divided in two processes:

1. Renewable energy production (hydropower, solar, wind, etc.)
2. Energy efficiency (for livelihoods, agriculture and drinking water provision and wastewater treatment)



Fifth pillar: Food

According to the World Food Summit 1996 (as cited in FAO, 2006), “Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life”.

As such, food security (FAO 2006) consists of four dimensions:

1. Food availability: sufficient quantities of adequate quality foods.
2. Food access: affordability of food as well as physical accessibility of food and socio-cultural access to food (e.g. common resources, gender etc.).
3. Food utilization: safe and nutritious food including drinking water to meet dietary and physiological needs including safe storage and preparation of food/ conflict in utilization e.g. with biofuels.
4. Food stability: guarantee of access, availability and utilization to food at all times.

To ensure food security and thus foster sustainable livelihoods, the input of water resources is vital: more than 70 percent of freshwater used globally is used in the agricultural sector. This includes irrigation needs for production of various crops for direct consumption, as well as water as an input for livestock fodder and breeding. To ensure food security and sustainable agricultural and agroforestry practices, efficient water management practices and the reuse of wastewater are therefore essential to ensure water-use efficiency. At the same time, energy production with biofuels must be managed in line with ensuring food security for the population. From an energy use perspective, it is worth noting that modern technologies have concentrated and have been successful at progressively reducing or optimizing the use of water together with increasing agricultural productivity, but this has often simultaneously meant increasing energy use and costs, reaching even up to 60% of the overall direct food production costs (Ferreyra, Gill and Sellés, 2010).

In addition, ecosystem protection plays an important role concerning agricultural production, as the conversion of forests into farmland, the over-usage of water and pesticides as well as monocultures can lead to ecosystem degradation and water pollution.

Possible further steps

While the indicator table allows for some flexibility, it could still improve on creating comparability. A first step could be setting target values, milestones or other appropriate means of comparing the progress between the indicators. Furthermore, setting a comparable scale would allow for the visualisation of indicators in radar charts. This might be very useful in order to see how (un)evenly progress has been achieved among the different categories/sectors, which ultimately provides some insight on the success of the WEF Nexus application. Setting up suitable metrics for the individual indicators could eventually mean the first step towards the construction of a “nexus index”, which would represent a project’s nexus progress in a single score.

Exemplary application of WEF Nexus Indicators

Project in Santa Eulalia river basin (Peru)

The use of payments for ecosystem services for the rehabilitation of ancestral lagoons in San Pedro de Casta to improve WEF security Nexus in a rural community

The Santa Eulalia river basin:

The basin supplies the capital city of Lima with 50% of its drinking water, while 1/3 of the electricity used in Lima is generated in Santa Eulalia, and 98% of the basin is under cultivation. Since 2015 the water utility of Lima SEDAPAL collects funds to compensate for ecosystem services through their water tariffs.

Project description:

Rehabilitation of four ancestral lagoons in the San Pedro de Casta community through the construction of levees will significantly increase infiltration and lead to higher and more continuous spring flow, including during the dry period.

The additional runoff will be used to irrigate an orchard of 10 ha and power a micro generator to be installed together with solar panels to provide electricity to the community.



Expected outcome:

Improved food security through the irrigation of a fruit orchard and improved energy access in the rural community of San Pedro de Casta (2,800 inhabitants)

Exemplary application of WEF Nexus indicators

The following list of WEF Nexus indicators has been chosen from the set of proposed indicators with the goal of demonstrating their applicability and relevance, in order to monitor and demonstrate progress towards achieving the project's expected outcome: **Improved food security through the irrigation of a fruit orchard and improved energy access in the rural community of San Pedro de Casta (2,800 inhabitants)**. Three aspects are key to be measured to ensure a sustainable intervention: institutional aspects, livelihoods, water, food and energy security.

- *Selected Indicator comes first*
- ✓ Source of measurement comes after

Governance

Good Governance

- *Number of platforms (multi-stakeholder meetings and roundtables, etc) that enable intersectoral exchange (All stakeholders - Civil society, government, private sector, etc.*

take part in a roundtable discussion/ dialogue platform during project planning; stakeholder mapping has taken place before hand)

- ✓ Intersectoral working groups at basin level

Policies

- *Number of policies and economic instruments that are in place to manage scarcity, depletion and pollution of natural resources at catchment scale*
- ✓ Water Management Plan for the basin

Regulatory instruments

- *Number of regulatory instruments that support WEF Nexus action*
- ✓ Payment for ecosystem services has been approved at the level of the Ministry of the Environment

Livelihoods

Development for Livelihoods

- *X% of people who completed capacity building measures provided by the Action*
- *X% of the target population whose awareness of the WEF Nexus approach has been increased*
- *% of (rural) population living on >\$1.90/day (or above national poverty line)*
- ✓ To be determined after baseline is conducted to measure impact

Water for Livelihoods

- *X% of people have access to water purification and storage technologies thanks to the Action.*
- ✓ To be determined after baseline is conducted to measure impact of the project
- *X% of people in the project area with less than (500, 1000, 1700 m³/person/year of water, depending on the context) water availability.*
- ✓ To be estimated with help of data from the Ministry of Environment
- *% of water expenditures as total of household expenditures in the project area per person/ household.*
- ✓ To be estimated with the data of the National Household Survey

Energy for Livelihoods

- *X% of population in project area that have access to energy*
- ✓ To be estimated with the date of the National Household Survey

- *% of households that have access to renewable energy at household level (in off-grid areas)*
 - ✓ To be determined after baseline is conducted to measure impact of the project

Food for Livelihoods

- *% of farmed food for self-consumption of households in the project area.*
 - ✓ To be determined after baseline is conducted to measure impact of the project
- *% of people that do not have access to sufficient food supply (X calories per capita per day according to the WHO)*
 - ✓ To be estimated with the data of the National Household Survey

Water

Livelihoods for water

- *% of people informed about the existence and distribution of water entitlements in the project area.*
 - ✓ Information to be collected from the National Water Authority
- *Extent to which the protection of aquifers is fully acknowledged in project planning and implementation of the Action.*
 - ✓ Information to be collected from the National Water Authority
- *Extent to which ecosystem protection and services are fully acknowledged in project planning and implementation of the Action.*
 - ✓ Information to be collected from the Ministry of Environment

Energy for water

- *% of energy from renewables used for water pumping (agriculture and drinking water, MWH/m3)*
 - ✓ Information to be collected by project implementers directly with users

Food for water

- *X% of monitoring sites in agricultural areas which exceed limits for nitrates, phosphorous and pesticides (according to WHO or national standards) in surface water and ground water.*
 - ✓ Information to be collected from the Ministry of Agriculture

Energy

Livelihoods for Energy

- *Number of businesses created (in the project area which are related to the WEF Nexus project advancements) due to the availability and access to energy*
- ✓ Information to be collected by project implementers

Water for Energy

- *% of hydropower energy generation to total energy supply*
- *% of renewable water resources stored in dam reservoirs (Resilience by water storage for energy production)*
- *Extent to which a multipurpose logic is integrated in dam construction logic (multipurpose dam)*
- ✓ Information to be collected from the Ministry of Energy

- *% of the project area that is under flood risk by the hydropower project*
- ✓ Information to be collected from the National Water Authority

Food

Livelihoods for Food

- *Number of jobs created in the agricultural sector (in the project area due to activities of the Action)*
- *Average producer's net income per ha for production activity/activities of interest*
- *Extent to which yields (e.g. forest goods/ vegetables etc.) are available and sold on the local market*
- *Extent to which investments in Nexus conform agricultural production means are favoured over conventional agricultural production means (e.g. hydroponics, etc.)*
- ✓ Information to be collected by project implementers

Water for Food

- *Annual surface water withdrawal as % of total actual water withdrawal for the cultivation of crops and agricultural produce in project area (dependency on surface water for agricultural usage)*
- *Annual groundwater withdrawal as % of total actual water withdrawal for the cultivation of crops and agricultural produce in project area (dependency on groundwater for agricultural usage)*
- ✓ Information to be collected from the National Water Authority
- *% of people/ households that use efficient irrigation techniques (such as drip irrigation) for agricultural purposes*
- ✓ Information to be collected from the Ministry of Agriculture

Energy for Food

- *% of total energy consumption used for harvesting*
- *% of energy used for processing*
- ✓ Information to be collected by project implementers

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