

The Water-Energy-Food Nexus and Agricultural Investment: A sustainable development guidebook

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List of Acronyms

DPSIR	The Driving forces-Pressure-State-Impact-Response analytical framework
EGS	Ecosystem Goods and Services
FAO	Food and Agriculture Organization of the United Nations
IAASTD	The International Assessment of Agricultural Knowledge, Science and Technology for Development
IDRC	International Development Research Centre
IFC	International Financial Corporation
IISD	International Institute for Sustainable Development
OECD	Organisation for Economic Co-operation and Development
SEI	Stockholm Environment Institute
UNCTAD	The United Nations Conference on Trade and Development
UNEP	United Nations Environment Programme
UNITAR	United Nations Institute for Training and Research
USAID	The United States Agency for International Development
WB	World Bank
WEF	Water-Energy-Food

1.0 Introduction

The nexus between water, energy and food (WEF) security is a critical component of human well-being, and billions of dollars are spent annually on investments intended to ensure that it is adequately addressed. A central concept throughout this guidebook is that the rural poor (i.e., those who benefit most from investments in agricultural productivity) will fare best if the underlying environmental determinants of water, energy, and food security—the WEF nexus—are protected and enhanced. The issue is complex, but the global, sustainable development benefit of well-designed and implemented agricultural investment deserves careful review to ensure implementation of best practice principles and processes. This guidebook is intended to familiarize policy-makers and practitioners with state-of-the-art methods for ensuring long-term sustainability of agricultural investments.

Approaches that take the WEF nexus into account are gaining attention from practitioners, policy-makers and researchers, who are experiencing the failures of well-intended, but uncoordinated strategies and actions that have had cascading consequences in all three areas. Global forums such as the World Economic Forum, Rio+20, Bonn 2011 Nexus Conference (2011), and World Water Week 2012 have strongly advocated for integrative frameworks that address the interlinked causes of WEF security. For example, the World Economic Forum (2011, p. 7) stated that “any strategy that focuses on one part of the water-food-energy nexus without considering its interconnections risks serious unintended consequences.”

While the need for taking a holistic approach has been recognized and supported around the globe, there is limited understanding of how exactly to handle the complex relationships encompassed in WEF when conducting assessments and implementing investments in agriculture. For instance, in the case of investments in agricultural land, there are guidelines available indicating that such investments should

... not harm, safeguard against dispossession of legitimate tenure right holders and environmental damage, and should respect human rights. . . . They should strive to further contribute to policy objectives, such as poverty eradication; food security and sustainable use of land, fisheries and forests; support local communities; contribute to rural development; promote and secure local food production systems; enhance social and economic sustainable development . . .” (FAO, 2012a)

This guidebook addresses that gap and provides policy-makers and practitioners with convenient access to key WEF and ecosystem service concepts. These include leading-edge principles of ecosystem and water management, social inclusion, participatory scenario development and adaptive management for designing and implementing high-quality agricultural investments. We recently synthesized and adapted many existing WEF frameworks into a conceptual framework based on the principles of natural capital and ecosystem services (Bizikova, Roy, Swanson, Venema, & McCandless, 2013). In this guidebook, we further build on existing frameworks and our conceptual representation to guide policy design and investment implementation by addressing the challenges of operationalizing all of the complex relationships among water, energy and food security.

1.1 Purpose

The purpose of this guidebook is to provide a practical, spatially explicit, ecosystem-based framework for the design and management of land investments that deliver increased water, energy and food security. It also provides an implementation-oriented means of operationalizing an otherwise theoretical concept highlighted as a significant global risk and opportunity for integration. To achieve this, our approach has the following key steps:

- Provide a structured process covering key steps in developing an investment strategy for a systems approach to the WEF nexus.
- Enable identification of synergies and trade-offs between different WEF-relevant sectors in the context of natural and built systems, governance and institutions at the landscape/watershed level to identify investments that maximize WEF security.
- Help with integration of both qualitative and quantitative data when assessing WEF relationships, clarifying consequences of past and present actions and policies, and identifying desired future investments, policies and actions.

This approach relies on engagement of stakeholders, experts and policy-makers (as well as supporting analytical research) to develop a diagnosis of systemic threats and opportunities related to WEF security, and to develop practice and policy-level response options.

1.2 Target Audience

The intended users of this guidebook are agencies and stakeholders involved in strategic planning and allocation of domestic and foreign investments. There are three major target audiences for this guidance document:

- Agencies and departments working at the national and international levels (top-down approach) that are involved in identifying investments, designing policies and developing strategies.
- Agencies and organizations active at sub-national and local scales that are concerned about WEF in their areas and/or are target locations for major investments, and thus would like to ensure that investments provide long-term benefits (bottom-up approach).
- Investors and development practitioners interested in ensuring that their agricultural or development investment is resilient to risks due to social, ecological and economic factors and in ensuring sustained return on investment.

These three audiences are not mutually exclusive. During implementation of the process articulated in this guidebook, local stakeholders will be brought into the top-down approach and national and international agencies will be connected to the bottom-up approach.

Other potential audiences of this guidebook include members of international agencies that engage in supporting, guiding and/or evaluating investments in other countries. Their work often involves assessing impacts of development on well-being, especially that of poor and vulnerable people. This guidebook provides a framework for conducting such assessments.

1.3 Structure of the Guidebook

This guidebook presents a practical, participatory planning process that empowers comprehensive integration of WEF security issues in a place-based context. The goal is to help develop needed inputs for an investment strategy and policy design while adaptively managing opportunities and risks.

Specifically, the guidebook presents the rationale for the WEF approach and provides suggested tools and methods. The following section outlines four specific steps and sub-steps discussed in the next sections:

1. **Assessing the WEF Security System:** This stage provides tools to assess the WEF nexus in a specific, place-based context. It addresses past, present and potential future changes including tenure rights, as well as impacts and relationships among investment choices, policies and incentives.
2. **Envisioning Future Landscape Scenarios:** This stage focuses on envisioning a preferred future landscape and conditions of the sectors in that landscape relevant to the WEF. It also describes key adaptations needed to reach these conditions. This will help identify development obligations for investors, specific investments and policies to support them.
3. **Investing in a WEF-Secure Future:** This step assists in developing an investment strategy bringing together inputs from earlier steps.
4. **Transforming the System:** This element provides tools and approaches for implementation and adaptive management for ensuring effectiveness over time by specifying monitoring systems, ways of reaching stakeholders, and feedback to the operational phases.

Each section of this guidebook begins with a brief introduction to the step, followed by specific goals, approaches and tools that users could employ to achieve identified goals. These tools and approaches are illustrated through case study examples. Each section also includes a set of questions and/or issues to consider during implementation.

The guidebook Annex tabulates some of the tools and approaches from the chapters to demonstrate the flow of activities throughout the process.

2.0 Rationale

2.1 What Is the WEF Nexus?

In recent decades, policy-makers, researchers, practitioners and the public have become aware of the close and complex relationships among water, food and energy securities. Global trends such as increasing population, rising incomes, income disparity, urbanization and resource extraction are applying tremendous pressure on our ability to secure clean and adequate water supplies, nutritious and available food supplies, as well as sustainable and secure energy supplies. A number of key linkages among these needs have been articulated by the Stockholm Environment Institute (SEI, 2011):

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

An integrated approach is becoming increasingly important and urgent as pressures increase on each of these sectors. Working on water, energy and food together ensures that resulting policies or investments minimize negative consequences for the other closely interlinked sectors, and that interventions ensure that two, or all three areas are addressed. Rather than focusing on the challenges of ensuring security separately as individual elements, a number of authors emphasize the interconnected nature of WEF security, which results in challenges crossing two or all three of the domains.

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

Our WEF nexus-based approach is intended for policies, programs and institutions that will enable sustainable management of landscapes, and increase quality of life for communities while protecting and building natural and social capital as a means to address long-term sustainability. In order to be sustainable, the society of a region or country must maintain and (preferably) build stocks of natural,¹ social² and financial capital assets, rather than contribute to the depletion and degradation of those stocks. This fact highlights the need for an integrated approach linking not only all three securities, but also underlying capitals and their sources (Box 1).

¹ **Natural capital** refers to the elements of nature that produce value (directly and indirectly) to people, such as the stock of forests, rivers, land, minerals and oceans. It includes the living aspects of nature (such as fish stocks) as well as the non-living aspects (such as minerals and energy resources) (Natural Capital Committee, Department for Environment, Food and Rural Affairs, 2013).

² **Social capital** is generally defined as the relationships, networks and norms that facilitate collective action (Helliwell, 2001).

BOX 1. REVIEW OF WEF SECURITY NEXUS

Food security	The elements of food security are food availability; including production, distribution and exchange of food; access to food; including affordability, allocation and preference; food utilization; including nutritional value, social value, food safety, and food stability over time (Ericksen, 2008; Schumidhuber & Tubiello, 2007).
Water security	The elements of water security are water access; water safety; and water affordability so that every person can lead a clean, healthy and productive life, while ensuring that the natural environment is protected and enhanced (Global Water Partnership, 2000).
Energy security	The elements of energy security are continuity of energy supplies relative to demand; physical availability of supplies; and supply sufficient to satisfy demand at a sustainable price (Department of Energy & Climate Change [DECC], 2009; International Energy Agency [IEA], 2001).

2.2 What Are the Key Components of the WEF nexus?

WEF frameworks developed by a range of international organizations focus on promoting security and consider different domains. Their general structure, after Bizikova et al. (2013), includes:

- Society, by changing human behaviour and improving well-being of the poor and vulnerable.
- Economy, by using a range of approaches to economic growth or livelihoods.
- Environment, by promoting sustainability of ecosystem services and natural resources.

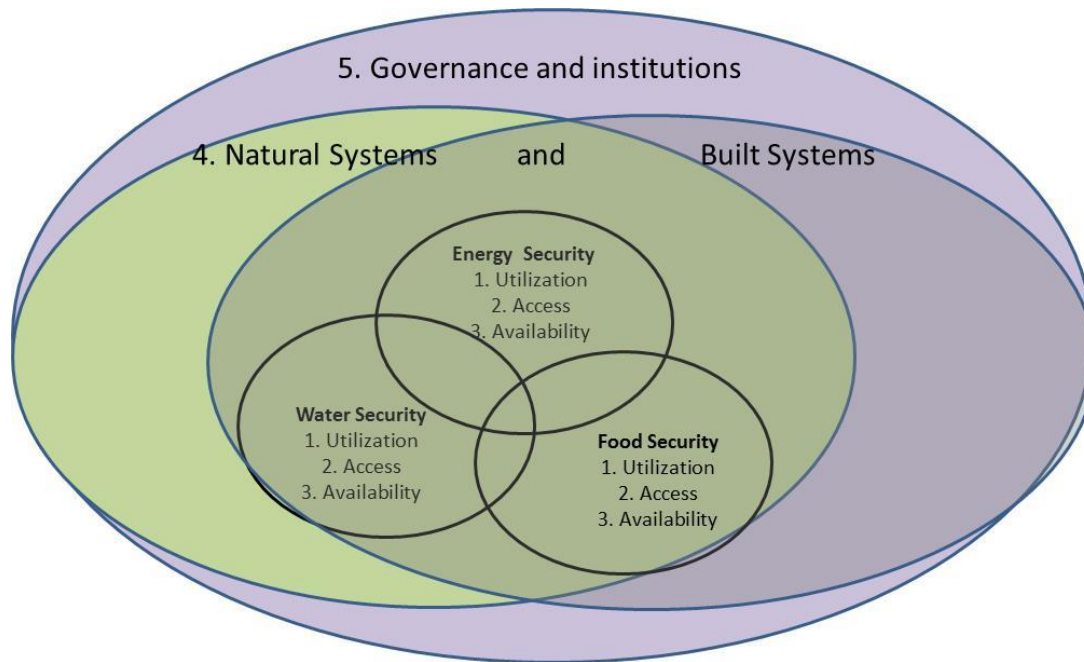


FIGURE 1. OVERVIEW OF THE FRAMEWORK LINKING WATER, FOOD AND ENERGY SECURITY

We offer a framework (Figure 1) that serves to unpack the complex relationships embodied in the WEF nexus (see Bizikova et al., 2013 for a detailed description). In implementing such a framework, we suggest first understanding key aspects of individual securities, then connecting these through complementary natural, built and institutional systems. For example, natural and built systems include irrigated systems for food production or natural water availability influencing food production, and built infrastructure used for transportation of food, as well as energy production. Governance systems include institutions and mechanisms influencing how resources are allocated for elements of WEF and their relationships (Figure 1). Governance and institutions include organizations, policies, and other mechanisms for production, supply or management of water, energy and/or food. These latter also include markets and allocation mechanisms.

The rationale and key elements of our WEF framework are as follows:

- A focus on ecosystem services and natural systems, recognizing their importance in complementary solutions to water, energy and food security. Investments in ecosystems hedge land investments against a wide variety of socio-ecological risks and so are instrumental in the long-term performance of the primary objectives of policies and investments.
- Built systems such as roads, pipelines, and processing systems have crucial importance in delivering and supplying benefits from ecosystem services. The quality and types of these systems determine how the services can be used sustainably.
- Institutions and governance systems are crucial for ensuring property rights, sustainable use, equitable and timely distribution and management of WEF elements, as well as the ecosystem services underpinning these securities.

Our framework, including consideration of natural, built and governance systems, naturally lends itself to a place-based approach where a context-specific system (and potential responses) is analyzed. The ultimate utility of this guidebook is in providing a practical and implementation-oriented means of operationalizing this framework and articulating steps needed to develop a regional investment strategy that optimizes WEF synergies.

2.3 How to Tackle the WEF Nexus in Practice?

Our approach for optimizing WEF linkages combines stakeholder-based processes with a systems approach using scenarios to cover a broad time horizon from the past to the future. This enables identification and integration of practical actions and policies to improve WEF security.

Implementation of the framework requires a **participatory process**, the goal of which is to create a means of regular and effective interaction among stakeholders, including sector-specific experts, decision-makers, and other local and regional actors. The process of participation is integral to the approach to ensure that there is broad buy-in to the process and its outcomes. Particularly in places that are experiencing significant water, energy and/or food insecurity, there is often great interest in participating in addressing these issues. In such cases, an effective participatory process can help build strong, sustainable initiatives as well as social capital. If there is no broad support available, stakeholders need to be identified and involved early in the process. Stakeholders contribute to the approach by sharing their experiences with past drivers, by providing their views on preferred future landscapes and measures to reach them, and by expressing acceptable trade-offs and synergies. Engaged stakeholders also will have access to data, reports and

expert information developed and synthesized through the process that could be used to guide assessment of the WEF nexus and development of the investment strategy.

Another core component of our proposed WEF approach is the **systems perspective** taken to map elements of the WEF nexus and their linkages. Many of our implementation-focused case studies were limited to specific sub-elements of WEF security, such as looking at available water for agricultural production, trade-offs between water and land allocation for food production versus biomass production, or exploring food security challenges in areas impacted by land degradation and conflict. Such studies provide practical insights into WEF-relevant linkages and implementation opportunities, but often fall short in articulating trade-offs and barriers for the remaining components of WEF security.

On the other hand, taking a truly integrated WEF nexus approach with all its elements could be complex and unmanageable, due to constraints such as time, personnel, money, and data. Therefore, we suggest beginning with a rapid assessment to look at WEF-related linkages and then help prioritize those that are relevant for current and past trends. That should include envisioning a preferred future landscape in terms of natural and built systems, institutions, and governance. That initial step serves to build awareness among decision-makers about the broader implications of their decisions and to prioritize actions based on this understanding. In this way, application of our WEF approach could be seen as choosing from a “menu” of potential linkages relevant for the specific area.

It is important to look at the past, present and future status of the system to identify desired actions and policies that could improve WEF security. **Scenario development** provides opportunities to think about the future in a structured manner and identify possible and plausible future scenarios, needed actions and/or potential investments to achieve preferred scenarios that optimise WEF security and reconcile necessary trade-offs. Quantitative, integrated models could be used to improve scenario relevance. This approach provides opportunities to bring together consequences of different scenarios and actions targeting different elements of the WEF nexus, comparing benefits that contribute to human security and well-being.

A modeling approach also allows a common platform for comparing alternatives. For example, an analysis might examine food or energy security of investments or policies that influence water availability or water quality. An important outcome of the Bonn Conference on the WEF nexus was recognition that water management is a practical entry point for analysis, a particularly salient observation in the context of agricultural investment where water rights are frequently the fundamental underlying asset and the one most vulnerable to climate change. We therefore propose an integrated watershed modeling approach for analysing the WEF nexus. This approach allows examination of alternative policy scenarios, systems of land use, and energy or food production through the lens of water and watersheds.

The scenario-based approach also will assist in the identification of investments and policies appropriate to the ecological and institutional context. For this, we propose a participatory process that combines qualitative and quantitative scenario approaches to analyze the WEF nexus, strengthening identification of investments and policies.

3.0 Operationalizing the WEF Nexus

Our proposed framework for implementing a phased, inclusive process for optimizing WEF security in a region or watershed requires planning and convening an effective and transparent stakeholder process. This process is aimed at exploring policy and program synergies for WEF and empowering decision makers to allocate resources and negotiate investments to optimize these synergies.

The process of implementing the framework begins with identifying appropriate stakeholders and conducting a preliminary analysis of key issues and drivers affecting the region. The framework is operationalized through collaborations with policy-makers, experts, and civil society groups active in the region or watershed to be considered. The overall project is orchestrated by a core working group comprising expertise in key elements of WEF, built systems, governance and overall project implementation, facilitation and delivery. This work is structured such that experts provide key inputs for investment strategy development and monitoring. These steps are context-specific and require that decisions around region, scale of application and appropriate stakeholders are made prior to embarking on the process.

The basic participatory planning process (Figure 2) includes four main stages:

1. **Assessing the WEF Security System:** This stage focuses on assessing current status of water, energy and food security in the context of natural, built and social capital. This requires understanding linkages among WEF elements to uncover relationships and identify the most influential drivers and risks impacting those elements in the past and present, as well as under future scenarios. This helps identify and link current and potential future elements such as land ownership, impacts and relationships among different investment choices, policies and incentives.
2. **Envisioning Future Landscape Scenarios:** The objective of this stage is to craft plausible scenarios of the future. The starting point for doing so is building a set of shared principles leading to a refined articulation of the future and the societal benefits of such a future. Plausible scenarios or stories of the future provide the context participants use to discuss actions for ensuring WEF security. These scenarios help to create a list of actions that are robust (i.e., make sense in most scenarios and involve minimum regrets) and trigger-able (i.e., make sense only under specific scenarios and/or might require more information before being implemented). These scenarios will help identify development obligations for investors, as well as specific investments, policies and incentives to support these obligations.
3. **Investing in a WEF-Secure Future:** In this stage, participants develop a specific investment strategy for ensuring WEF security of the region or basin. An effective strategy will be owned by participants of the process, and ideally will be representative of the aspirations of people of the basin and region as a whole. This stage brings together outcomes developed in previous steps and involves multiple interactions with stakeholders to develop a coherent investment strategy.
4. **Transforming the System:** This stage focuses on implementing the selected strategy by ensuring that key stakeholders are on board, ready and able to take action. This is the stage in which to address gaps that would prevent implementation such as capacity (in the broad sense), technical knowledge, tools, or personnel. One of the most important mechanisms leading to successful implementation is clear identification of an organization

or formal consortium of organizations that will be accountable for implementing the investment strategy. Also, it is important to ensure a regular, formal monitoring and reporting process through which stakeholders learn from successes and failures, and the project team actively adapts and improves performance. Monitoring and adaptation are required to ensure effective implementation in the context of future uncertainty and risk management.

These four principle steps are part of an iterative process and require follow-up as other stages advance, and as more information and input from stakeholders is gathered. Iteration is important because information on key system components usually will be limited, and primary data collection will often be necessary.

In the next sections of this guidebook, we provide detailed guidance on conducting each of the steps with specific indications of inputs, outputs, processes and examples from literature or experience.

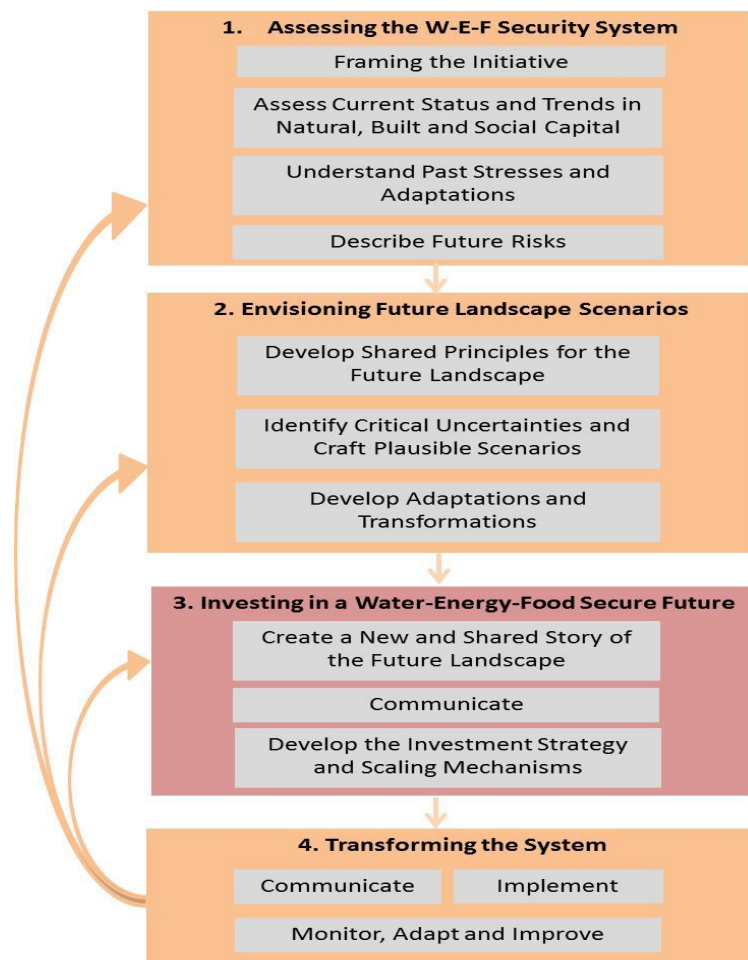
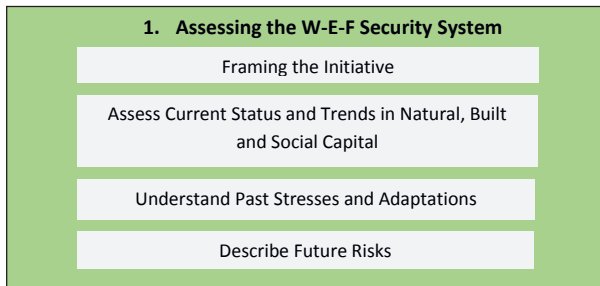


FIGURE 2. PARTICIPATORY SCENARIO PLANNING PROCESS FOR WATER-ENERGY-FOOD SECURITY

3.1 Assessing the W-E-F Security System



3.1.1 Framing the Initiative

Development of a WEF strategy begins with the creation of a project team to manage and implement the framework. This includes assembling a group of stakeholders to provide input during the initiative. A key starting point is identifying the scale and scope of the project, including relevant policy and investment processes that the project would inform and impact.

Approach

The project will rely upon a **diverse group of relevant stakeholders** that are able and willing to participate in the initiative. The group should be structured such that their participation covers all necessary aspects of the potential investment. Stakeholder involvement is an essential component of the framework in general. It helps strengthen the resulting strategies, investments, policy relevance and legitimacy. Stakeholder mapping is a very helpful tool in ensuring that a range of stakeholders is represented. Mapping identifies and examines key stakeholders, fulfilling criteria such as representation across sectors, gender and available capacities. However, the analysis alone does not guarantee that identified stakeholders will be active in the process. Engagement may require incentives, strong leadership and articulation of a suite of issues relevant to those stakeholders whose participation is desired. It is also critical to ensure that stakeholders from diverse levels participate. For example regional and national-level stakeholders can lead negotiations with the investors, and community-level stakeholders can ensure their involvement in current and future WEF security. Finally, it is also important to structure the participatory process so it meets the needs of stakeholders' conditions by promoting leadership at the community-level and effective linkages between the community, regional and national levels.

Stakeholder analysis includes three elements (Bizikova, Bellali, Habtezion, Diakhite, & Pintér, 2009):

1. **Identify key issues or problems that will be discussed throughout the project:** Approach the WEF nexus as a system that offers key ecosystem services linked to WEF security. Seek stakeholders with awareness about potential actions that might improve components and linkages within the WEF system, and stakeholders who have experience with investment strategy development and investment negotiations.
2. **Identify key mandates and responsibilities linked to strategies, investments and policies that will be targeted during the initiative:** Seek stakeholders who have responsibility and power to influence decisions about relevant WEF sectors, strategy and policy development. Others might include key authorities in the watershed who are connected to the decision-making process and who might reach out to investors for implementation and/or monitoring. Such actors could become part of negotiations with investors in later stages of the initiative.

3. **Develop a stakeholder list.** Prepare a detailed list of potential stakeholders, structured by general categories (e.g., sectors, levels of management, scale) as well as sub-categories. Box 2 provides an example of such a detailed list.

BOX 2. KEY TYPES OF POTENTIAL STAKEHOLDER GROUPS TO ENGAGE IN THE WEF INITIATIVE

STAKEHOLDER GROUPS	ROLE IN THE WEF INITIATIVE
National agencies and negotiators	<p><i>To ensure that WEF security is a key consideration of investment decisions and operationalization.</i></p> <p><i>To ensure that WEF-relevant data and information relating to both management practices and development obligations are assembled for the negotiations.</i></p> <p><i>To ensure that regionally appropriate WEF strategies are incorporated into national policies, programs and decision-making, as well as investment allocation.</i></p> <p><i>To clarify the role of domestic regulations, law and strategies in relation to the planning investments.</i></p> <p><i>To create a negotiating team to bring together strong negotiating capacity and relevant expertise on the range of issues that will arise in the negotiation.</i></p>
Regional and local government authorities	<p><i>To provide guidance and inputs on specific sub-national future policies and measures relevant for WEF.</i></p> <p><i>To translate national-level policy and programs into locally appropriate WEF-outcomes such as poverty reduction, community development, etc.</i></p> <p><i>To provide regional and local data and information collected at this level for the negotiators and to guide the investment monitoring.</i></p> <p><i>To help identify and convene other stakeholders relevant to WEF for the region.</i></p> <p><i>To understand necessary institutional, policy and market changes necessary for WEF security and implement these changes as appropriate with other stakeholders.</i></p>
Research institutions and academia	<p><i>To help inform integrated/systems approaches in the region correlating water-energy-food information.</i></p> <p><i>To help quantify and interpret data on WEF security.</i></p> <p><i>To develop a quantitative model of relevant areas of WEF security to assess trade-offs and synergies between investment choices and WEF.</i></p> <p><i>To develop monitoring procedures and help interpret data.</i></p>
Private stakeholders	<p><i>To inform key components of WEF security- access, availability and utilization of water, energy and food in the region.</i></p> <p><i>To understand and incorporate the notion of multiple benefits and trade-offs in day-to-day decisions and processes.</i></p>
Sector-specific and market stakeholders	<p><i>To represent key sectors such as industry, agriculture, livelihoods and other key components of WEF at the local level.</i></p> <p><i>To inform and test discussions on trade-offs and synergies.</i></p> <p><i>To understand necessary institutional, policy and market changes necessary for WEF security and lobby for these changes.</i></p>
Community groups and non-governmental organizations	<p><i>To identify key WEF contributions, including property and resource rights.</i></p> <p><i>To express needs and preferred future areas of WEF security and related poverty reduction, employment and other environmental and social goals.</i></p> <p><i>To participate in monitoring and review of the impacts of investments on WEF.</i></p> <p><i>To communicate and gather insights on key issues from community members.</i></p> <p><i>To understand necessary institutional, policy and market changes necessary for WEF security and lobby for these changes.</i></p>
Development and international agencies and banks	<p><i>To share best practices from other places and help replicate successes from regional initiatives to other regions.</i></p> <p><i>To provide guidance on investments obligations, monitoring and feasibility and impacts of investments based on their experiences with other jurisdictions.</i></p> <p><i>To share lessons with the international community and development peers.</i></p> <p><i>To act as moderators, facilitators, or simply as “observers.”</i></p>

Selecting the study area is key for the project because this will be the context for an investment strategy to maximize WEF security. Overall, we suggest focusing on a watershed that allows investigating hydrologic processes as the bases of food-, energy- and water-related cycles (Box 3). Focusing on a watershed or catchment also allows comparing consequences over larger areas, involving a larger number of activities and their spatial allocations and interactions to optimize the WEF sectors through time. However, sometimes stakeholders focus their interests on smaller areas where they might undertake investment. In such cases, a small watershed scale may be appropriate or local governance units could be linked to a broader watershed context so the relevance of investments can be assessed more holistically, looking at both upstream and downstream changes in the watershed. The following questions can be useful in identifying the spatial scale of a potential project:

- What spatial/watershed boundaries and scale would be most practical for addressing the WEF sectors and their linkages? For example, areas with limited or no data could be excluded, but areas with high WEF relevance should be included.
- How do jurisdictional boundaries overlap with the potential spatial/watershed boundaries? For example, a watershed may be governed by multiple regional and municipal governments. This influences stakeholder choices, data needs, and expected outcomes.
- Are agro-ecoregions defined in the area of interest? If so, how might they complement understanding of WEF security and how might they influence investment?

BOX 3. KEY BENEFITS OF WORKING AT THE WATERSHED/CATCHMENT SCALE

- A watershed or catchment-based approach provides an effective scale at which to assess complex ecological issues because at this level, fundamental connections among all components of the landscape are represented by the network of streams and other water bodies that define the watershed.
- Watersheds or prominent water bodies are readily recognized by local communities and resonate with members of the public as a logical way to address resource management issues.
- Watersheds are integral parts of broader ecosystems and can be viewed and evaluated at a variety of spatial scales.
- Because watersheds are spatially located landscape features covering multiple scales, they are ideal for tracking accomplishments both in terms of outputs (e.g., land-use changes and agriculture) and outcomes (e.g., improvement in watershed conditions).

Modified from: United States Department of Agriculture (2011)

3.1.2 Assess Current Status and Trends in Natural, Built and Social Capital

Goal

The goal of this step is to understand water, energy and food security in the context of the chosen region/watershed. This step helps us understand WEF relationships in the context of past, present and future trends to gain insights about how investments, policies and actions are likely to impact security. This step incorporates attention to natural environments, built environments and governance systems, including land ownership and tenure rights. This information helps ensure that management strategies optimize multiple securities and minimize risks of unintended or unforeseen consequences.

Approach

The approach uses a combination of participatory and analytical methods. It is based on data collection and analysis, literature reviews and expert opinions, as well as a consultative process to understand qualitative and quantitative implications of WEF. Analysis of the linkages among WEF sectors can include building a conceptual or quantitative model to describe current trends. The next step is to simulate future conditions and the potential impacts of actions.



FIGURE 3. OVERVIEW OF THE MILLENNIUM ECOSYSTEM ASSESSMENT FRAMEWORK

Source: MEA (2005).

To understand **current water, energy and food security**, we suggest starting by unpacking water, energy and food components, and seeking to understand synergies. Our concept of integrated management is based on the ways individual securities for each of the three components interact to form WEF security. Each component stems from a combination of access, utilization and availability (as seen in Figure 1). In order to identify interventions for optimising and balancing the three, we must examine them individually and then assess their relationships to each other. This should include a focus not only on WEF security directly, but also on understanding contributions of natural and built systems, as well as intermediate institutions, processes and mechanisms that help or hinder access and supply of WEF in the watershed. This is the part of the process where issues specific to the most vulnerable or insecure parts of the population should be identified.³

³ To explore in-depth linkages between the WEF elements, the DPSIR framework can be used. See Appendix for details.

- Layers 1 to 3—Defining individual WEF securities: At a watershed level, the analysis focuses on addressing WEF utilization or consumption, demands or needs, and supply. This requires identifying quality, quantity and distribution of each component of WEF. This could be accomplished by calculating a per capita usage within the watershed and exploring issues around how water, energy and food are being supplied to watershed, regional and community residents. Availability issues can include production, processing, supply infrastructure, retail or markets, and storage.
- Layer 4—Natural systems and built systems: Natural and built systems can be interchangeable from the perspective of goods and services, and securities needed by society. A key point is that ecological goods and services provided by resilient, well-managed natural systems can sometimes fulfill the role of engineered alternatives. This equivalence underlies the ecological goods and services/human well-being framework introduced by the Millennium Ecosystem Assessment (2003; Figure 3). In the context of agricultural investments, this process attempts to increase WEF security through co-investment in ecosystem goods and services. Our position is that watersheds are the most appropriate geographic unit for analyzing and optimizing the basket of ecosystem goods and services that contribute to WEF security.
- Layer 5—Institutions and governance: This layer analyzes some of the less tangible institutional determinants that affect both supply and demand issues of water, energy and food. This layer helps identify issues that enable or hinder elements of WEF security, including policies, prices, priorities, information and research that impact utilization, access or availability. This layer integrates the three components and provides a means to prioritize institutional roles and governance methods relevant to an integrated WEF approach.

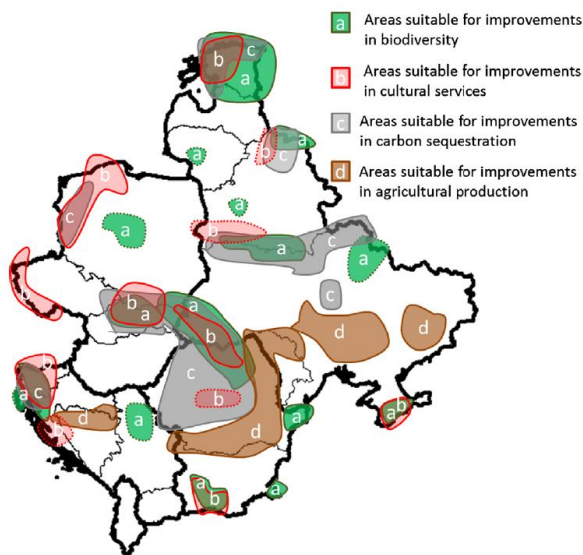


FIGURE 4. MAP OF AREAS SUITABLE FOR EXPANSION OF BIODIVERSITY, CULTURAL SERVICES, CARBON SEQUESTRATION AND AGRICULTURAL PRODUCTION IN EUROPE

Source: Ruijs et. al. (2013)

Historical analyses can be built on both quantitative data, like price of production, and qualitative information, like historical land ownership and tenure rights, or households' past coping mechanisms.

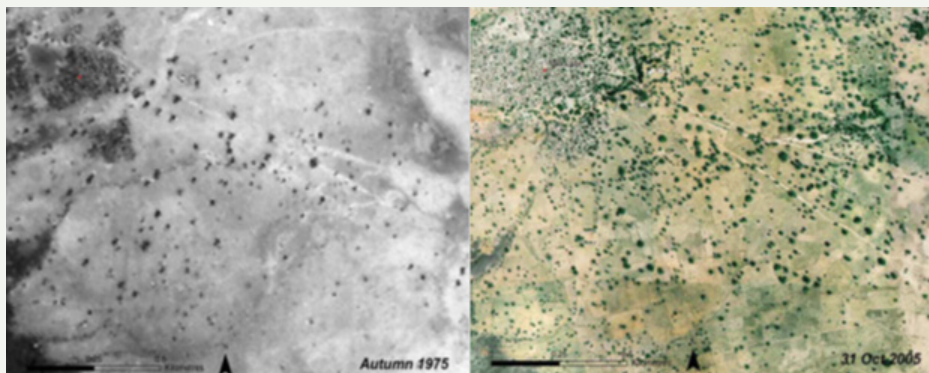
For example, such analyses could help understand important cause-and-effect relationships in the watershed as affected by previous investments. Retrospective analyses can also identify turning points in decisions such as creating settlements, or consequences of rural development policy and planning. A visual representation of retrospective analysis such as mapping how land use changed over time (Box 4) can help inform future decision-making by building strong stakeholder understanding. (See Appendix for an example of a visual representation of a retrospective analysis).

BOX 4. AFRICA: ATLAS OF OUR CHANGING ENVIRONMENT

UNEP's Atlas of our Changing Environment (2008) provides a series of comparative images of landscapes and watersheds across the African continent. It uses satellite photos and imagery to depict environmental change in each African country during the last thirty years. Through a rich array of satellite images, graphs, maps, and photographs, the Atlas presents a powerful testament to the adverse changes taking place on the African landscape as a result of intensified natural and human impacts.

While many of the images show environmental degradation due to pressures such as resource overuse, some remarkable exceptions show environmental revitalization. One such positive story is that of large-scale environmental improvement through farmer-managed regeneration of field trees in vast, sandy, agricultural plains of south-central Niger. Farmers noticed that crop production is better with trees and that trees provide other benefits such as fruits, medicines and firewood. As a result, farmers have planted trees, improved resilience to failed crops, and are actively buying degraded plateau land for regeneration.

Images from the Atlas reproduced below offer a comparison of land revitalization in Tahoua Province, Niger



Source: UNEP (2008).

This **analysis to identify potential future risks** can be complemented by evidence from the literature that identifies potential future trends in availability of and demand for resources, projected changes in consumer preferences, the growing middle class in fast-growing economies, or assumptions about power balances and priorities. The goal is also to identify potential future challenges in the region such as policy decisions, infrastructure development, possible investments, climate change impacts, and immigration/emigration in response to national and regional policies and strategies, trade and other agreements, and market prices. An important approach to future drivers seeks ways to

understand how a changing climate could affect WEF components, their relationships and overall human well-being. As with other drivers, if climate change is chosen as a key driver for the region, the project team will need to specify impacts and consequences relevant for the initiative, such as occurrence of heat waves, re-occurrence of droughts, and changes in temperature and precipitation during the growing season. Box 6 provides suggested steps for identifying future drivers in a region.

In order to bring together past, current and future trends in WEF securities, quantitative modeling could be used to analyze aspects of WEF and their relationship in a way that is relevant for decision making. An example of a modeling contribution is presented in Box 5.

BOX 5. MODELING APPROACHES RELEVANT FOR IDENTIFYING WEF TRADE-OFFS

Hydrologic models

Hydrologic models simulate the spatial and temporal distribution of water, given natural and anthropogenic activities in a basin. The purpose of hydrologic models in the WEF context is to provide policy-makers, managers and stakeholders with a common understanding of major hydrologic processes as a basis for comparing WEF sectors and their linkages in the area of concern. All hydrologic models approximate the hydrologic cycle, but models differ in the schematization of the physical conditions and the algorithms used to simulate hydrologic processes such as evapotranspiration, overland flow, surface water flow in rivers and lakes as well as anthropogenic water use and management. The general data requirements for hydrologic models include physical conditions (e.g., topography, stream network, reservoir and water user locations), meteorological and hydrologic time series (e.g., precipitation, river gauges, groundwater levels), and anthropogenic operations (e.g., water use demands, reservoir operation rules, crop water requirements). Output from hydrologic model simulations includes spatial and temporal descriptions of water distribution within a basin that can be used for understanding ways water in the basin responds to pressures and drivers, and as input to additional analysis such as computation of environmental goods and services (EGS). Outputs of the models also help in determining consequences of land-use change and in evaluating trade-offs between land-use options, for example, among food production, water security, and energy used to produce and deliver water.

Decision-support models

The Integrated Valuation and Ecosystem Services and Trade-offs (InVEST) model was developed by the natural capital project, a collaboration between the University of Minnesota, The Nature Conservancy, Stanford University, WWF and others to integrate the values of nature into major decisions affecting the environment and human well-being. This tool incorporates a range of software models to map and value ecosystem services, or the tangible benefits from well-functioning ecosystems to inform policies, programs and other processes. The InVEST model “enables decision-makers to assess quantified trade-offs associated with alternative management choices and to identify areas where investment in natural capital can enhance human development and conservation. The InVEST toolset currently includes sixteen distinct InVEST models suited to terrestrials, freshwater, and marine ecosystems.”* The InVEST models have been used in a variety of contexts and provide a range of decision-support services.

* See www.naturalcapitalproject.org/InVEST.html for more details.

BOX 6. GUIDING QUESTIONS AND STEPS TO UNDERSTAND CURRENT STATUS OF WEF IN THE CHOSEN AREA

See also the template in the Appendix

Layers 1 to 3—Defining WEF securities

- **What are the total and per capita WEF needs in the region?**
- **What is the WEF contribution to sustaining quality of life in the watershed/region?** For water, break down drinking water vs. non-potable water. For food, identify nutritional components (e.g., proteins, vegetables, grain). For energy, specify types of regionally relevant energy.
- **What are the sources of water, energy and food for the watershed or region and how much of it is produced within the watershed?** For example, include hydropower from regional generating stations, and imported grains.
- **What underlying social and economic issues (including livelihoods and gender issues) affect equitable distribution of WEF in the watershed?**
- **What portion much of the WEF components in the region are needed to provide or maintain WEF interlinkages?** For example, of total water needs, what portion is attributable to food production and supply, how much for energy production and supply?

Layer 4—Natural systems and built systems

- **What key regional ecosystem services are relevant for WEF supply and access for the watershed/ region?** For example, a local lake might provide drinking water supply and fulfill irrigation needs, or a regional forest might provide food as well as wood fuel for energy and food preparation.
- **What key natural and built systems provide access and supply of WEF to the watershed/ region?** For example, a regional drinking water filtration plant might provide clean water, while energy might come from regional biomass supplying a thermal power plant.

Layer 5—Institutions and governance

- **What key institutions are relevant for WEF supply, management, pricing, and controls?** For example, this might include regional government departments for agriculture, energy and environment, the regional energy and water supply company, and cadaster offices that allocate land rights.
- **What key mechanisms govern supply, distribution, and access to WEF in the region?**

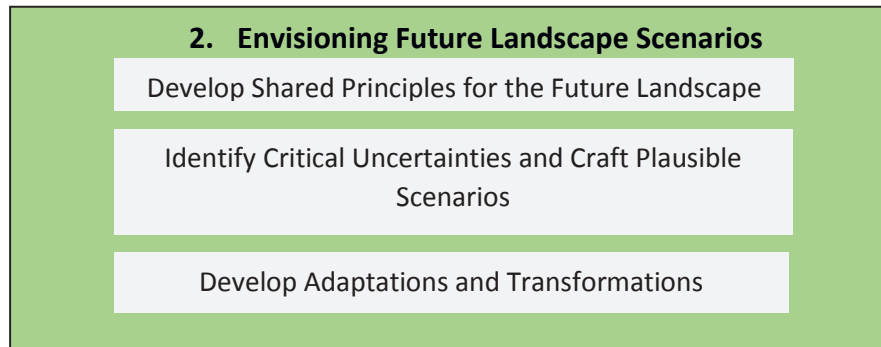
Past stresses and adaptations in the chosen area

- **What is the state of the ecosystems providing the most important EGS relevant to WEF (identified in steps under Layer 4), in the past and how have they changed over time?**
- **What built systems contributed most to provision of these EGS for WEF over time?** For example, if wetlands or forests are identified as key ecosystems providing a variety of EGS for WEF, assess how the state of those wetlands or forests has changed through time.
- **What key socioeconomic factors changed utilization, provision/access and supply of these EGSs most relevant to WEF?** For example, perhaps urbanization meant that average income increased and changed access to market and technological advancements for WEF provision.
- **What institutional mechanisms were most relevant to provision of WEF and how have they changed over time?** For example, a local farmer's cooperative might have emerged because of a lack of regional markets for produce or because of the high costs associated with transport.
- **Develop a visual timeline to show key natural, built and institutional factors contributing to the current state of WEF in the region.** See Appendix 1 for an example of a visual representation of a historic timeline.

Future risks

- **Based on current and past trends, what major challenges relevant for WEF in the area are expected to exert pressure in the future?** For example, migration, urbanization, technological change, and/or climate change may pose risks for the area.
- **What key trends in natural and built systems in governance will need to be addressed in the future?** For example, consider expansion of infrastructure, increased demand for resources, changes in tenure rights and resource governance, and their impact on ecosystems and their services.
- **Which key drivers identified in the literature are relevant for WEF in the study area?** Consider variables such as population growth, climate change impacts and global/regional agreements.
- **Create a list of relevant risks with explanation of how each could impact WEF sectors, their relationships and overall human well-being.** For example, use qualitative information and indicate direct or inverse relations for these.

3.2 Envisioning Future Landscape Scenarios



This stage works with trends in regional variables, as well as experiences with investments, policies and actions to identify plausible scenarios outlining the status of WEF sectors and their relationships. These scenarios could be used to guide investors' development obligations. At this step, it is important to explore a range of actions at different spatial and temporal scales because many actions (e.g., management practices) will be more relevant at the local level while others (e.g., policies, standards, codes) will be targeted at the national level. This analysis will provide a basis for investments included in the strategy.

Approach

The approach suggested here builds on both analytical and participatory approaches to move from understanding current trends and potential future risks to envisioning the preferred future WEF components and their interaction in the watershed. These steps use collaborative stakeholder engagement processes to develop necessary principles for such a future. These principles help all parties work together to define and prioritize key elements of future scenarios and visions. The process of building these futures is about asking questions as well as suggesting actions based on knowledge of historic state trends, current conditions and drivers of change. These principles can act as boundary conditions that, if combined with a scenario, would result in a predicted future condition for the landscape/watershed. Further, developing scenarios from basic principles can enable creativity in development of a strategy and of actions because they act as general rules to guide us in the right direction instead binding us to a restricted vision of the future (Holmberg & Robèrt, 2000).

Because we focus mostly on land-based investments, **shared principles for a future landscape/watershed** could be guided by commonly accepted principles of responsible land investments (Box 7). Naturally, these principles would need to be adapted to the specific context watershed of the target watershed using information gathered through a collaborative process.

BOX 7. KEY GUIDANCE AND PRINCIPLES OF RESPONSIBLE LAND INVESTMENTS

Responsible investments should do no harm, safeguard against dispossession of legitimate tenure right holders, avoid environmental damage, and respect human rights.

1. Existing rights to land and associated natural resources are recognized and respected.
2. Investments strengthen rather than jeopardize food security.
3. Processes relating to investment in agriculture are transparent, monitored, and ensure accountability by all stakeholders, within a proper business, legal, and regulatory environment.
4. All those materially affected are consulted, and agreements from consultations are recorded and enforced.
5. Investors ensure that projects respect the rule of law, reflect industry best practice, are viable economically, and result in durable shared value.
6. Investments generate desirable social and distributional impacts and do not increase vulnerability.
7. Environmental impacts of a project are quantified and measures taken to encourage sustainable resource use, while minimizing the risk/magnitude of negative impacts, mitigating such impacts when possible.

Source: Principles for Responsible Agricultural Investment (RAI) that Respects Rights, Livelihoods and Resources (FAO, IFAD, UNCTAD, World Bank) in FAO (2012a).

When specifying these principles to **create plausible future scenario(s)**, the goal is to explore possibilities and create plausible descriptions of how the future might look. The principles also help explore outcomes that might result if basic assumptions are changed (UNEP, 2002). Scenarios can be used for multiple purposes (Jaeger, Kasemir, Stoll-Kleemann, Schibli, & Dahinden, 2000) including aiding recognition of weak signals of change. This helps avoid being caught off guard, as well as helping to live the future in advance, challenge assumptions and raise awareness. The ultimate aim, in most cases, is to provide better policy or decision support. In our case, that includes providing guidance for investments and details about development obligations for investors.

In the context of the WEF scenarios, we need to focus on outlining goals, actions, policies, and investments to understand how WEF security will be ensured in the future. This assurance should be based on thresholds of natural and built systems and how those systems deliver EGS and WEF securities. Further, we need to ascertain how institutions now and in the future enable interactions among people and the natural and built systems. From the perspective of future investments, it is important to envision how property rights and user rights will be shared both formally and informally so that key natural and built resources will be accessible even after investments are completed. The roles of property and tenure rights are discussed in Box 8.

BOX 8. EXAMPLES OF THE ROLES OF PROPERTY AND TENURE RIGHTS AND POLICY OPTIONS IN PLANNING INVESTMENTS

1. Secure property rights are crucial to investments. However, property rights are also important to current land users because they derive all or part of their livelihoods from the land, even if the land resource is low quality or marginal. Rights are especially critical for requiring access to lands that outsiders may consider to be “empty” or “marginal.” This designation is often misleading because informal property rights may exist for these areas even though formal rules may be missing. Failure to recognize informal rights will have negative impacts on local people because performance is strongly dependent on land. It is important to recognize rights that are informal, and/or those that combine both community and individual rights.
2. Recognition of rights to land and associated natural resources, together with the power to negotiate their uses, can greatly empower local communities. Such recognition should be viewed as a precondition for direct negotiation with investors. Customary and informal tenure systems, whether based on individual or collective rights, or a combination of these, should not be assumed to be a constraint impeding agricultural intensification. Many nations offer examples of investment and rising agricultural productivity on farmland under informal regulation. For example, in Northern Nigeria and the Kenya highlands, rights promote vegetable gardens around towns. In West Java, Indonesia, rights to land adjacent to homes provide kitchen gardens that positively affect gender roles and child health.*
3. Maintaining small-scale land ownership rights can increase benefits to rural populations
 - The International Fund for Agricultural Development (IFAD) states that appropriately designed land reform measures can significantly boost food production and rural incomes. Small farms employ more people per hectare than larger units, often to the benefit of the landless and unemployed. Owning land often means that family farmers can secure bank credit that was previously denied them. The IFAD offers the examples of El Salvador, where a 10 per cent rise in land ownership has boosted income by 4 per cent per person, and India where the states in which poverty has fallen fastest are those that have implemented land reforms. Most notably, land reforms in China between 1977 and 1985 shifted production from large to small units, which brought about a substantial increase in farm output and lifted millions of poor rural families out of poverty (IFAD, 2000 in FAO, 2002).
 - Brokered long-term contractual arrangements (e.g. market alliances, commodity chains, public and private outgrower schemes) have proved effective in improving livelihoods of small-scale farmers. These approaches can promote value-chain activities and generate employment provided there is transparency and equitable power relations among actors. They can allow small-scale producers to respond to opportunities through institutional arrangements that provide market access and credit for inputs and planting materials. However, in a number of cases, these schemes have fostered misuse and corruption, compromising their effectiveness. The contribution of these arrangements needs further testing to determine if they generate sufficient opportunity in resource-poor agricultural systems (McIntyre, Herren, Wakhungu, & Watson, 2009)

Sources: EU Task Force on Land Tenure (2004); Knowledge Exchange Platform for Responsible Agro-Investment (n.d); CFS and FAO (2012a and 2012b); FAO, 2002; McIntyre et al., 2009.

* See <http://www.fao.org/docrep/x0051t/x0051t02.htm>.

A key part of the scenario development process is identifying trade-offs among WEF elements and **developing adaptations and transformation** to address them. For example, a scenario envisioning investing in hydroelectric power to improve energy security and provide additional revenues may identify the potential to flood land used for food production and/or reduce water availability for other purposes. Thus, there is a need to assess implications of choices outlined in scenarios, modifying them as appropriate to improve synergies among WEF elements and seeking acceptable trade-offs. For example, typical farmlands produce a multitude of ecosystem services, but investments

in agriculture prioritize food production. This may reduce other ecosystem services used by local residents (Figure 5). Prioritizing complementary ecosystem services in investment frameworks for farmland can improve long-term sustainability of these investments. By maintaining land and water resources, environmental sustainability of farmland is improved. Further, maintenance and enhancement of ecosystem service can have benefits for neighbouring communities, improving social and economic sustainability.

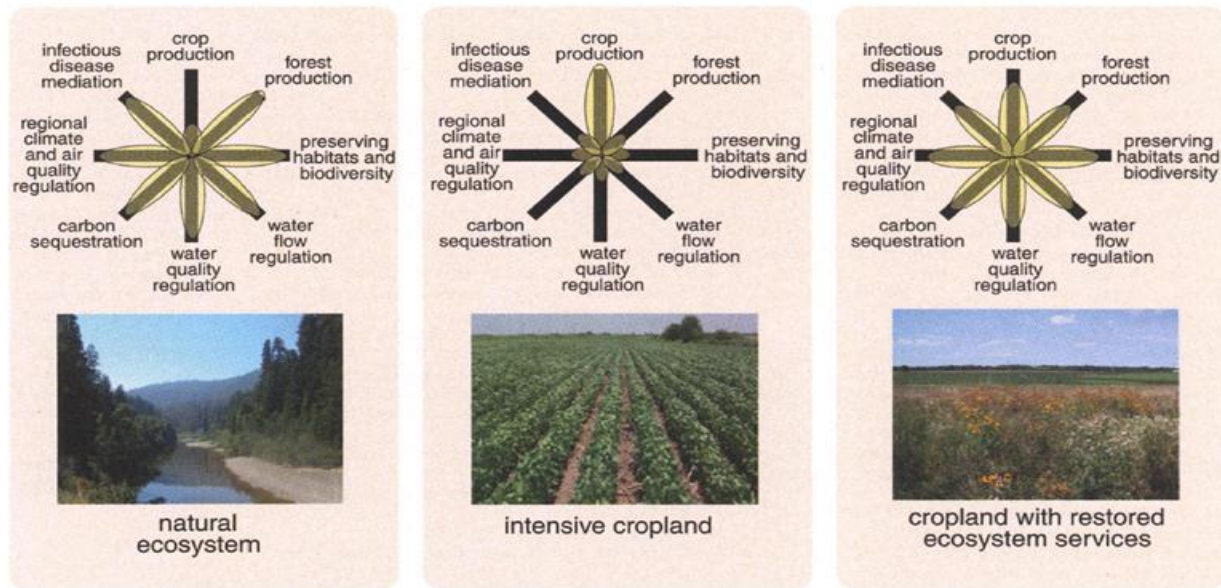


FIGURE 5. ECOSYSTEM SERVICES AVAILABLE FROM NATURAL ECOSYSTEMS, INTENSIVE CROPLAND, AND CROPLAND WITH RESTORED ECOSYSTEM SERVICES

A range of policy instruments can be considered at different scales (local, national, supranational) that could improve the status of WEF and human well-being in the landscape/watershed to improve scenario utility. An overview of an array of such policy options is presented in Box 9. When identifying these measures and investments, the project team should consider ways of implementing policy measures, specific issues related to resource ownership, and concerns such as property rights and tenure systems in areas where the investments are planned. Box 10 presents a case study in which ecosystem services management was mainstreamed into land-use policies in China.

BOX 9. TYPES OF POLICY INSTRUMENTS AND EXAMPLES

TYPE	SUPPORTING INSTRUMENTS	EXAMPLES RELEVANT FOR WEF
Command and control regulations	Standards, bans, permits & quotas, zoning, liability, legal redress & flexible regulation	Standards can be used to ensure compliance with key types of practices such as water used during production, allocation of activities on different land types, and types of actions applied downstream and upstream. These standards can be established by government (e.g., International Federation of Organic Agriculture Movements [IFOAM]); by NGOs (e.g., the Forest Stewardship Council [FSC], and the Rainforest Alliance); and/or by industry, including exporter/ retailer groups (e.g., European Good Agricultural Practice [EUROPEGAP]).
Direct provision by governments	Environmental Infrastructure, eco-industrial zones or parks, protected areas and recreation facilities, ecosystem rehabilitation	<p>When developing new approaches in agricultural and forestry management, consider traditional and community-based approaches to address increasing pressures on natural resources, such as reduced availability and quality of water, degraded soils and landscapes, loss of biodiversity and agroecosystem function, degradation and loss of forest cover, and degraded marine and inshore fisheries. Agricultural strategies also will need to include limiting emission of greenhouse gases and adapting to human-induced climate change including increased variability in weather conditions (McIntyre et al., 2009).</p> <p>Furthermore, increased investments in agricultural science and technology can generate high economic rates of return and reduce poverty, particularly if complemented by supporting investments in rural development (e.g., infrastructure, telecommunications, processing facilities) (FAO, 2002).</p>
Engaging public and private sectors	Public participation, decentralisation, information disclosure, eco-labelling, voluntary agreements, public private partnerships	<p>Special efforts need to be made to introduce improved management practices to farmers and other stakeholders, including broader “education related to resource conservation.” Local governments and business groups engaged in campaigns to encourage conserving resources and appropriate technologies are helpful for that purpose (UNEP, 2010).</p> <p>Agricultural science and technology can contribute to substantial increases in agricultural production over time, contributing to food security. However, publicly funded research and education institutes in some countries have weakened considerably over the last 25 years. Innovative forms of collaboration are emerging such as regional networks, public-private consortia, more effective division of labor and capacity between research institutes and universities, and recognition of the research roles that NGOs and farmers themselves play (McIntyre et al., 2009).</p>
Using Markets	Removing perverse subsidies, environmental taxes, user charges, deposit-refund systems, targeted subsidies & self-monitoring	<p>Developing countries could benefit from reduced barriers, elimination of escalating tariffs for processed commodities, deeper preferential access to developed country markets for commodities important for rural livelihoods, increased public investment in local value addition, improved access for small-scale farmers to credit, and strengthened regional markets (IAASTD, 2009).</p> <p>In developing country urban markets with poor rural connectivity, there could be increasing reliance on imports, which provide cheaper food but undermine rural employment and livelihoods, and deter investment in mitigating land degradation. These trade imbalances also favor high-input, energy-intensive agriculture, which currently rarely internalize environmental or social costs of production, an increasingly unsustainable approach (IAASTD, 2009).</p>
Creating markets	Property rights, tradeable permits, offset programmes, green procurement, environmental investment funds, seed funds, PES incentives,	<p>Property rights are a key concern for investments in places with weak/informal rights and low enforcement of rights. Such conditions limit the benefits local land users receive from investments, and local people could be disproportionately impacted by lack of access to their land for food security, water and livelihoods (Keenleyside, Veen, & Baldock, 2004).</p> <p>In some cases, landowners give up the right to use part or all of their farmland in exchange for payments. In Costa Rica, the national forestry fund pays close to US\$50/hectare/year to landowners who promise to preserve forests or allow natural regeneration. Currently, there are nearly 200,000 hectares under this program) (Echeverria & Ibrahim, 2009).</p>

BOX 10. INCORPORATING PRIORITY ECOSYSTEM SERVICES INTO LAND USE PLANS IN BAOXING COUNTY, CHINA

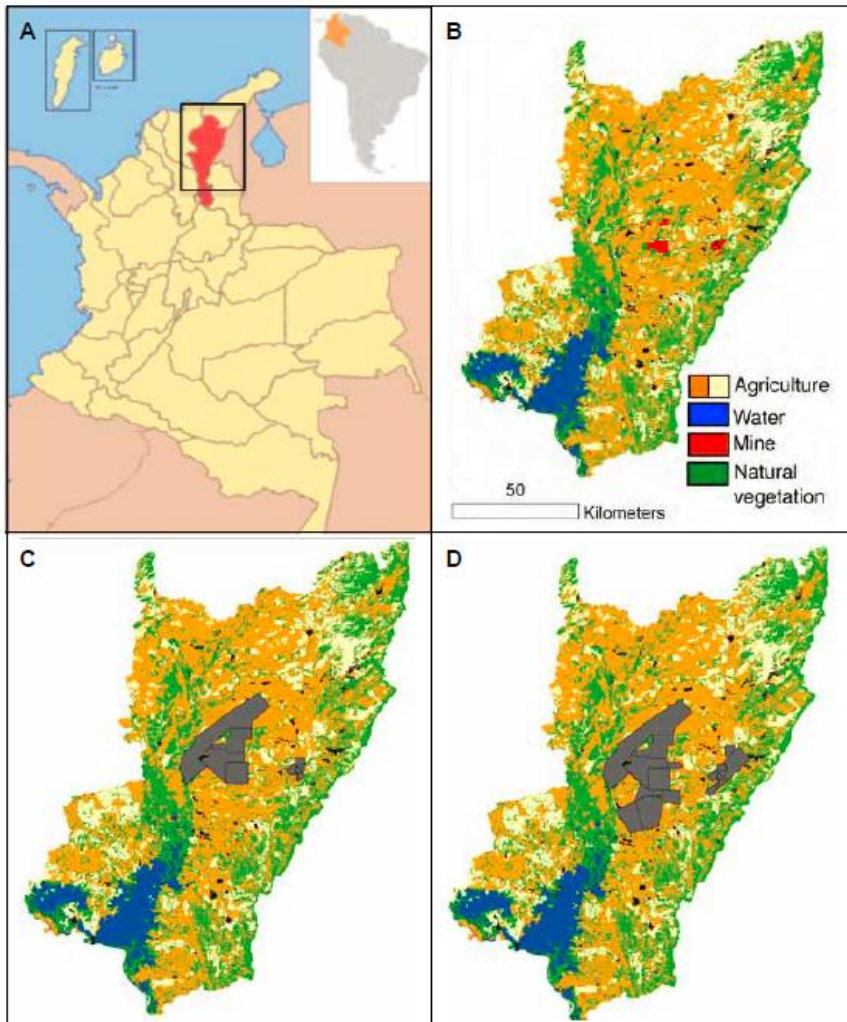
China is facing significant negative environmental impacts from economic growth and industrialization. National and regional decision makers are beginning to understand the close relationship among industry, local livelihoods and ecosystem services.

Current drivers and pressures: In the past two decades, China has experienced double-digit increases in GDP, large-scale alleviation of poverty, and overall improvement to livelihoods and physical infrastructure. Based on an increased understanding of the foundational role of ecosystem services in human well-being and economic development, the Chinese government is now placing environmental protection higher on the national agenda.

Past trends: Increasing floods and other natural disasters are highlighting the economic and social costs of environmental degradation.

Future stresses and scenarios: New strategies must consider critical ecosystem service areas when designating zones where development is permitted. Zone designations reflect biodiversity and ecosystem services, and prescribe four levels of development: optimised, intensive, restricted and prohibited. InVEST was used in Baoxing County to assist the local government in integrating ecosystem services into the Land Use Master Plan. InVEST's sediment retention, water retention and carbon models were used to estimate and map annual average delivery of these services. The resulting maps were bundled and overlaid with a biodiversity map to delineate areas where development would have minimal negative impact on important of ecosystem services. The mapping exercise showed that protected areas cover the boundaries of key ecosystem services, particularly in the north. However, it also highlighted that development activities currently are planned in areas important for several priority ecosystem services. Based on this analysis, local government officials reconsidered development patterns in the 2010 Land Use Master Plan.

Source: Yukuan, et. al. (2010).



Maps showing (A) the study location in Cesar Department in Colombia, (B) Land cover in the base landscape, (C) Scenario 1 with full build out of existing/granted permits, and (D) Scenario 2 with full build out of all proposed permits. *Figure from H. Tallis.*

FIGURE 6. SCENARIOS OF MINING DEVELOPMENT IN CESAR, COLOMBIA

Source: McKenzie, et al. (2012).

BOX 11. GUIDING QUESTIONS FOR ENVISIONING FUTURE LANDSCAPE SCENARIOS

See also the template in the Appendix

- **What are the key social, economic and environmental priorities for the region?** This might include problems (e.g., soil erosion due to droughts, water conservation in water stressed areas), successes (e.g., high levels of literacy, public health, improved agricultural yield), or overarching priorities for the region (e.g., decreasing unemployment or poverty, increasing local production of goods and services).
- **What common key principles shared among these best practices have contributed to their success?** For example, integration (of land and water, sectors of management, or government departments or jurisdictions); collaborative management (including gender, socioeconomic sectors, aboriginal or other traditional perspectives); innovation (including new technologies, or new ways of applying traditional techniques); or principles around equitable access to resources (e.g., social inequity, poverty, justice).
- **Go through the list of best practices with regional stakeholders and develop shared principles for the future landscape (with an emphasis on WEF security).** Such a collaborative process will improve broader applicability of future scenarios and help ensure that these principles act as building blocks for any participatory scenario for future WEF security.

Identifying critical uncertainties and crafting plausible scenarios

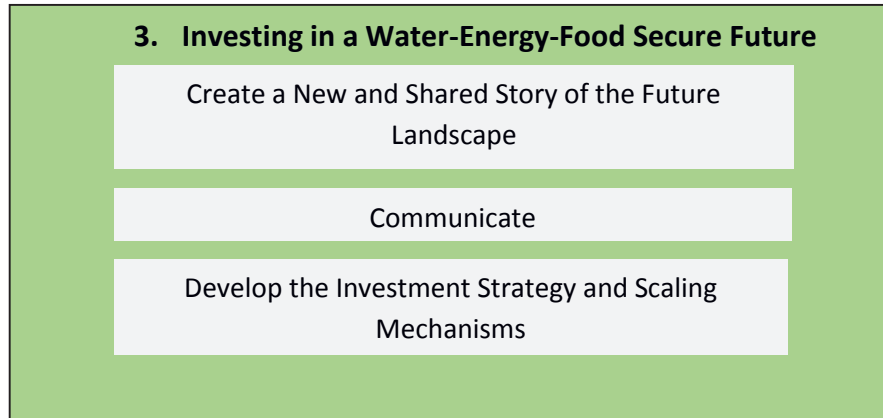
Based on identified risks and principles, develop plausible scenarios collaboratively with stakeholders.

- **What risks and drivers are most important at the landscape/watershed level?** Narrow down the list of risks and drivers according to their importance for the future landscape.
- **Use the shared landscape principles to describe risks and drivers under each scenario.** For example, if a risk is lack of support for involvement in resource governance among local institutions, possible future assumptions could include increasing the competencies of those institutions.

Develop possible adaptations and transformations

- **How well do scenarios optimize WEF benefits and synergies among them in the context of shared principles of the region?** For example, some scenarios could do very well in achieving high-level agricultural production but may have high water demand for irrigation and be energy-intensive, which might not be sustainable over time in places with rising population and low water availability, or might not be compatible with a shared principle of equitable land access.
- **What adaptations/ modifications to investments might improve scenario performance?** For example, consider how land-use management practices, types of energy production, spatial allocation of activities, or standards and thresholds for water extraction could change scenario performance.
- **How do potential investments and other actions, as well as their combination improve performance of the scenarios?** For example, use outcomes from quantitative modeling to compare options and/or use qualitative, experts' judgments for comparison.
- **Identify a list of key investments and actions that would improve the system, achieving high WEF security.** For example, changing both crops and irrigation practices might improve yields more significantly than only one of these measures. Building institutional capacity for ecosystem management and agricultural productivity could improve WEF security significantly.

3.3 Investing in a Water-Energy-Food Secure Future



In this stage, the team develops a specific investment strategy that can deliver WEF security and explore synergies for the basin or region. The strategy developed at this step will bring together assessments, materials, data and recommendations developed in previous steps. The investment plan can be seen as a shared document representing a strategy owned by participants in the process, ideally, a document representative of the aspirations of the people of the basin and region as a whole.

Approach

At this stage of the initiative, we are moving towards implementation. It is important to involve stakeholders who are already-engaged with others who should be engaged in investment strategy development, negotiation and implementation of selected actions. It is important that these latter stakeholders have the opportunity to review and comment on preferred scenarios and prioritized investments, policies and actions, instead of only receiving the final product. Collaborative inputs at this stage should help adjust the language used in the scenarios and the way priority actions are presented.

Also at this stage, many steps necessary for **development of the actual strategy** will already have been identified. For example, earlier steps have specified ways investment will do the following: contribute to long-term sustainability of the region; protect and enhance priority natural and social capital elements, such as ecosystem services and watershed management institutions; help stakeholders understand feasibility of investment-related actions; and gain insights into property rights structure and rights over resource use, as well as link investments with the country's and region's environmental, social and economic safeguards.

Work with the material developed earlier to justify relevance of selected investments, their direct contributions to improving WEF securities, especially for the most vulnerable. Illustrate these contributions by listing quantitative and qualitative trends and indicators. It is also important to be clear in specifying tenure rights to ensure benefits for the investor and user rights for the local residents and users. Review of WEF past and current trends provides a good grasp of how the tenure structure has developed over time and how tenure would function in the preferred scenario. This information provides a basis for the tenure system that should be part of the investment negotiations and contracts.

Steps taken during development of the WEF initiative assess the viability of investments. For example, the outcomes of quantitative modeling will indicate the most beneficial measures for the area, and will identify outcomes from stakeholders' consultations that suggest optimal ways of addressing trade-offs. Beyond new data, the modeling outputs, assessments and consultations during previous steps provide ways of understanding the possible impacts of investments. However, additional feasibility studies may be required to determine specific areas (such as economic viability of investor business plans) and to identify areas for targeted impact assessments such as Environmental Impact Assessments (EIAs), Strategic Environmental Assessments (SEAs) or Social Impact Assessments (SIAs) (see Box 12).

In order to attract and frame conditions for investors, it is important to specify investors' development obligations to demonstrate contributions they will make to improve WEF security across multiple elements. Measures necessary to achieve a certain scenario can easily be used to illustrate investor obligations for WEF in the area. In this context, it also is important to look at potential future environmental challenges that investments may create. Such challenges may not be limited by current legislation and may not be consistent with WEF security goals. These might include, for example, introduction of invasive species, use of genetically modified organisms, or intensive water use. Such consequences could easily be a part of scenarios and principles, but they need to be specifically included in the strategies and contracts. Selecting actual investments and defining development obligations and constraints is only a part of the process; it is also important to look at the enabling policy environment to identify needed incentives, regulations and other instruments necessary to progress with incentives and safeguard their implementation. This information can be part of the investment strategy to illustrate incentives and rules for investors and strategy implementation.

Investment strategies also rely upon indicators for monitoring and reporting. In the next phases of the WEF initiative, we focus on identifying indicators and creating a system for reporting and communicating information to stakeholders.

BOX 12. ASSESSING IMPACTS OF PLANNED INVESTMENTS

Environmental Impact Assessment (EIA): The process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made.

Strategic Environmental Assessment (SEA): A process to ensure that significant environmental effects arising from policies, plans and programs are identified, assessed, mitigated, communicated to decision-makers and monitored. It also ensures that opportunities for public involvement are provided. SEAs have become important instruments in helping achieve sustainable development in public planning and policy-making.

Social Impact Assessment (SIA): A process that provides a framework for prioritizing, gathering, analyzing, and incorporating social information and participation into design and delivery of developmental interventions. It ensures that development interventions (i) are informed and take into account key relevant social issues; and (ii) incorporate a participation strategy for involving a wide range of stakeholders

Sources: *International Association For Impact Assessment (1999); SEA-Info.net (n.d.) ; Misra (n.d).*

BOX 13. GUIDING QUESTIONS AND STEPS TO DEVELOP A SHARED STORY OF THE FUTURE LANDSCAPE

(See also the template in the Appendix)

Communicating the new shared story of the future landscape

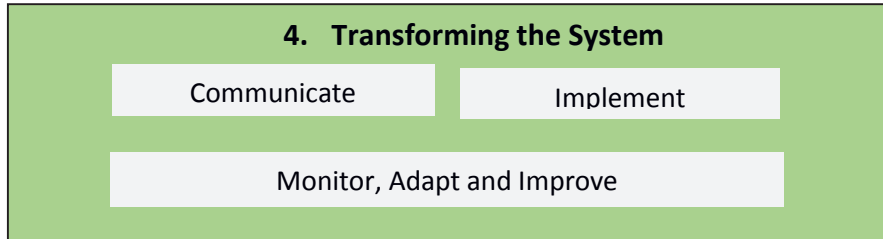
This stage involves working with the scenarios and proposed actions to create a coherent vision for the watershed/region. This step combines stakeholder involvement with expert participation.

- **Create a coherent story of the future landscape, bringing together the scenarios, their predicted future performance and the previously identified measures.**
- **Review the story with stakeholders, including those who will be involved during development of the investment strategy, investment negotiations, and implementation.** Consider including stakeholder groups in the participatory process so they are familiar and comfortable with the story and can become advocates for its implementation.
- **Identify specific investments, actions and policies needed to achieve the future landscape.** For example, examine investments in land-use practices, policies and standards, or renegotiated land tenure and other user rights.

Developing an investment strategy

- **Prioritize the suite of key investments.**
- **Conduct feasibility studies** to ensure that investments are viable from economic, technical and other perspectives.
- **Determine how access and tenure rights over natural resources involved in the investments will be allocated.** This information provides a basis for the tenure system that should be part of investment negotiations and contracts; consider a range of natural resources such as land, pasture, and water, and types of rights such as formal, informal, individual, community, and their combinations.
- **Conduct Impact Assessments.** If there is uncertainty about potential consequences of planned investments, consider conducting impact assessments such as an Environmental Impact Assessment (EIA) or Strategic Environmental Assessment (SEA). Build on information from previous steps when completing assessments.
- **Identify financial and other incentives for investors.** This information can be part of the investment strategy to illustrate incentives and rules for investors. Cost-benefit or return-on-investment (RoI) assessments can be useful here. It also is useful to demonstrate reduced long-term risk, improved long-term cost-efficiency and/or improved return on investment from mitigated social or environmental degradation.
- **Avoid Stabilization Provisions.** A common demand of investors, particularly in Africa, is inclusion of stabilization provisions. These are clauses in investment contracts that impose obligations on the government to either preclude application of (or compensate investors for) new or changed laws and regulations that affect investments (Smaller, 2013).
- **Specify investors' development obligations.** These obligations demonstrate contributions of the investors to improvements in WEF security. They might include, for example, improving land use, improving efficiency of water use, or improving capacities of the local population. Outputs from previous steps that focused on preferred future scenarios can be helpful in illustrating investors' obligations for WEF in the area.
- **Identify environmental parameters** to ensure that actions undertaken by investors that are undesired or harmful for the environment are avoided by linking performance to monitoring, WEF securities and specific domestic law and international instruments included in the contract.
- **Choose an Appropriate Dispute Settlement Mechanism.** It is advisable to refer to domestic courts as the forum of choice for disputes arising under the contract (Smaller, 2013).

3.4 Transforming the System



This stage focuses on implementing the strategy by ensuring that key stakeholders are on board. This can be achieved by addressing barriers that might prevent or compromise implementation actions such as lack of capacity or resources. One of the most important mechanisms for implementation is clear identification of an organization or formal consortium of organizations that work with investors and can be accountable for implementation. Further, it is important to ensure a regular and formal process of monitoring progress, learning from successes and failures, and actively adapting and improving performance to ensure effective implementation in the context of future uncertainties and unknowns.

Approach

Developing a **targeted approach to communication** is crucial because different stakeholder groups have different information needs and interests. A critical part of a communication strategy is bringing together stakeholders who have already been involved in the initiative with new stakeholders so the former can act as advocates for the approach to the newcomers. It is important to aim for regular communication to build trust among stakeholders as they get to know each other, thereby helping overcome future challenges (see case study examples in Box 14). It is useful to work with media and journalists to spread information about planned activities so the project reaches audiences beyond those organizations and stakeholder groups already involved. At this stage, it is important to be proactive. Very often, communication is initiated only when stakeholders are dissatisfied with outcomes and responses are reactive, a practice that does not contribute to building trust and sound relationships, and does not help address pressing issues.

BOX 14. CHALLENGES IN INVESTMENT-RELATED COMMUNICATIONS

Case Study: Mining communications in Hunter Valley, Australia

For almost three decades, open cut coal mines have been expanding deeper into the densely settled, agricultural landscape of the Hunter Valley in New South Wales (NSW) in Australia. When it was announced in 1999 that a NSW government-owned company (Powercoal) had been granted an Exploration Lease for coal at Anvil Hill, concerned Wybong residents formed the Anvil Hill Project Watch Association (AHPWA), which became incorporated the following year. Initial opposition of the AHPWA to the mine was based on local concerns such as impact on nearby residents from noise, dust, traffic, water shortages, and damage to the local ecology, as well as the feeling that the land use was inappropriate for the agricultural and emergent leisure enterprises in the area.

In dealings with the company and state government, members of the AHPWA and other residents had difficulty obtaining critical information about the mine development. Government departments delayed release of information without explanation. For example, a critical environmental report completed in April 2005, was not publicly released by the Department of Natural Resources more than eight months later. In March 2006, as presaged by Greenpeace media releases, AHPWA and other locally based opponents of the development joined forces with about 30 local, national and transnational environmental and conservation groups to form the Anvil Hill Alliance (AJHA).

Source: Connor Freeman, & Higginbotham (2009).

The dissatisfaction of local residents could have been eased to some degree by better communication and more effective engagement of AHPWA members as the environmental report was developed. There is no assurance that local residents would have (or should have) become supporters of the mine had communication been better. But each side would have better understood the other's perspective, and it would have been more likely that a broad understanding could have been reached, at considerable savings to all parties involved.

Communication with investors

Receiving regular feedback from investors and providing quick and accurate responses to their queries enables governments to develop a sound, business-friendly investment climate. Investment promotion agencies can play an important role in facilitating effective communication between investors and the government. Such agencies often are often the main source of feedback between investors and policy-makers and can be an effective communication channel for investors about government activities that impact the business climate. Such interactions can take many forms. For instance, investment-promotion agencies can act as facilitators by matching foreign investors with local entrepreneurs, hosting a database of business opportunities, or advocating policies. These functions require in-house technical and managerial capacity, such as a qualified staff with relevant business experience in the field (e.g., agriculture) (OECD, 2012).

Case Study: Overcoming communication challenges in the Democratic Republic of Congo

When consultants working for Adastra Minerals in the Democratic Republic of Congo initiated public engagement relating to the proposed Kolwezi Tailings Project in Katanga Province, they faced a number of challenges. Aside from local officials, few of the potentially affected community members spoke the national language (French). Communication was based in oral tradition in many areas because paper had become expensive and difficult to obtain, and literacy rates were very low. The town of Kolwezi had no newspaper published in town, there were no billboards, no functioning telephone system and no postal system. In order to overcome some of these obstacles, the community engagement process made extensive use of six local radio stations that use both French and Swahili. That strategy proved very effective once a network of key informants had been established. Graphically rich posters depicting likely impacts were developed to overcome the lack of literacy at environmental impact assessment meetings and local community presentations were delivered in both Swahili and French to overcome language barriers (International Finance Corporation [IFC], 2007).

Implementing a WEF-based investment strategy involves mainstreaming good communication practices into policies and decision making. A range of policy instruments can help with management and delivery of priority ecosystem services, institutional systems and other aspects of natural and social capital for WEF. Payments for ecosystem services, education, training and capacity building, regulatory protection of critical EGS, and taxes and incentives all are part of the policy-makers' toolkit for implementation.

BOX 15. EXAMPLES OF IMPLEMENTATION OF POLICIES TO ENHANCE KEY NATURAL AND SOCIAL CAPITAL

Community access and benefit sharing are crucial to improve local livelihoods (Kumar et al., 2011)

Despite successful restoration of the Chilika lagoon in India and a subsequent increase in fish stocks, traditional fishermen remained in debt, and conflicts about access and benefits persisted. A change in policies towards more traditional, community-based management systems taking ecological conditions into account and giving more power to local fishermen, allowed local communities to benefit from improved fisheries. This was an example of effective policies increasing access and benefit sharing, steps crucial for ensuring that benefits of ecosystem services reach local communities (ten Brink et al., 2013)

Ecosystem restoration creates jobs and improves local livelihoods (Department of Water Affairs, Republic of South Africa, n.d.; Bushbuck Ridge Project, n.d.; Pollard, Biggs, du Toit, & Cousins, 2008).

In South Africa, invasive species have had negative impacts on ecosystems and the services they provide, in particular water supply, causing damage to the national economy. "Working for Water" was introduced in 1995 to lead efforts clearing invasive species from lands. Each year, the program provides jobs and training to about 20,000 people from marginalized groups of society, thereby also contributing to poverty reduction.

"Working for Wetlands" is a parallel effort which targets restoration of wetlands. The restored Manalana wetland, for example, now contributes provisioning services such as food, grazing and construction materials, valued at around R3,466 (US\$353) per year to about 70 per cent of local households, in an area where half of the households have an income of less than R5,700 (US\$580) per year. Improvement in livelihood benefits was estimated to be twice as high as the cost of restoration

Water Funds can be a tool to improve water management, while creating employment and ecosystem benefits (Arias et al., 2010.)

About 80 per cent of the water for the 1.8 million inhabitants of the city of Quito, Ecuador, comes from three protected areas. Water users pay into the Quito Water Conservation Fund (FONAG) and FONAG invests about US\$800,000 per year into projects for watershed protection. Principle beneficiaries are the local communities that live close to the water sources. During 10 years, FONAG has:

- Helped conserve all watersheds over 500,000 hectares.
- Involved 30,500 children in Environmental Education Programs.
- Reforested 2,033 hectares with over 2,000,000 trees.
- Generated employment and engaged over 200 families in community development projects in rural basins.

The focus of a **monitoring system** is on ensuring that project outcomes are fulfilled and that necessary steps are being taken for achievement of the principles of the future landscape. As a result, monitoring should include both outcome- and process-based indicators:

- Outcome-based indicators measure changes in the physical and socioeconomic environment, such as changes in water quality, levels of specific species, availability and quality of habitat, changes in forest cover, employment levels, disease occurrence, migration, types of technology used, management practices, and types of energy sources used.
- Process-based indicators aim to ensure that procedures used to implement actions meet standards and rules of conduct. For example, indicators might include amount of stakeholder/specific group involvement in decision making, timeliness and frequency of availability of information about investments, public impacts and outcomes from audits.

An effective monitoring program combines these two types of indicators to include outcome-based monitoring systems which focus on direct and indirect outcomes to assess performance of a program or a project on the basis of impacts and benefits that the program is expected to produce. Here we include the full continuum of outputs delivered by a project, ranging from improved capacities of key stakeholders to improved robustness of specific systems that address future WEF securities and challenges (Pringle, 2011).

When dealing with complex systems and relationships among their elements, we must review intermediate outcomes, challenges and risks and how they address **learning and adaptation**, for example, by regular review. Such reviews should be discussed with stakeholders. Some lessons learned can be identified and applied to other areas. Adaptive management can be resource and time consuming, but it improves effectiveness, and can prevent policy or process failure, and save time and resources over the longer-term. Indicators are a key component of keeping track of what is working and what is not—they should be supplemented with regular review processes that focus on redesigning parts that are not working and enhancing parts that are working well. The indicator system also can be used to facilitate learning and improvements. Improvements assist in achieving WEF outcomes and governance efficiency by measuring key aspects of implementation success (or failure) through outcome-based and process-based indicators. This is achieved through monitoring programs, using indicators as learning tools in developing and reviewing strategic plans and policies, bringing together multiple stakeholders, interpreting information and trends, and providing new perspectives in strategic planning processes (Gyawali, et al., 2006; Giordano, Urricchio & Vurro, 2009). Suggestions for indicators based on the literature are presented in the Appendix.

BOX 16. GUIDING QUESTIONS AND STEPS IN COMMUNICATING THE OUTCOMES OF THE INITIATIVE

Communicating

Work with stakeholders who are already involved and outcomes of stakeholder-mapping to reach out to new stakeholders to become involved in the implementation. Use the following steps for guidance.

- **What key stakeholders are involved in implementation of the initiative?** Reach out to existing stakeholders to help identify connections to the new stakeholders.
- **Seek stakeholder feedback to ensure that information is locally relevant, meaningful, and understandable. Adjust further outputs based on this feedback.** For example, jargon used by policy-makers, experts, and modelers may not be understood by other audiences. Help stakeholders work together to develop a shared understanding of terms and issues.
- **Establish and strengthen connections with the media so they can tell the public about the initiative and planned actions.** For example, develop press releases and short communications that can easily be used by diverse media.
- **Maintain regular communication with stakeholders.** For example, provide regular updates on the initiative's progress; this step will be especially useful for new stakeholders or those that cannot participate often.

Implementing and monitoring

Work with stakeholders to identify key actions and indicators for the investment strategy, and monitor performance.

- **What actions could be integrated into currently planned/ongoing initiatives?** Explore already planned activities for opportunities to integrate key actions identified in the strategy.
- **Seek new investment opportunities to finance remaining key actions.** For example, work with national government departments negotiating investment agreements. Work to sensitize the investment community to the riskmitigation benefits of directing some investment funds towards longer-term sustainability through building natural and social capital.
- **Create a set of core indicators to monitor outcomes and impacts of investments.** For example, review key steps of the initiative to elicit indicators dealing with key WEF securities. Consider process-based indicators, as well as indicators specifically suited for work with investments.
- **Test the selected indicators with stakeholders, including those involved with project actions.** For example, conduct a review with stakeholders to ensure that they understand how indicators are defined, what data sources are needed, and how reporting will occur.

Adapting and improving

- **What key trends emerge among elements of the WEF securities based on information from indicators?** Explore whether trends in the data indicate improvement. In cases where there are data gaps on key indicators, try to estimate progress by involving stakeholders and expert scrutiny.
- **What major lessons learned and conclusions can be drawn from initial progress made and what are the implications for current and potential future actions?** For example, through involvement with stakeholders, summarize specific challenges and investigate how they can be addressed.
- **Summarize key lessons learned and distribute them to key stakeholders.** Target audiences can include agencies involved in policy-making, planning and implementation, international agencies and forums. Use collaborative inputs to design ways to improve implementation and impact.

4.0 Summary and Conclusions

Water, energy and food (WEF) securities are closely interlinked and interdependent. They have attracted attention as a sustainable development issue for several decades. The world's poor are often the most severely impacted by water, energy and food insecurity, but risks associated with those insecurities also are felt at the highest geopolitical levels. A key response of the WEF insecurity problem has manifested in large scale international investments in agriculture, where national governments and agencies invest in land and infrastructure for agricultural and bioenergy production, as well as for access to key resources such as water. Unfortunately, these investors often overlook primary drivers, resulting in WEF insecurity in regions where they invest. A report by a collaboration between the FAO, IFAD, UNCTAD and the World Bank has promoted principles of responsible agricultural investments (PRAI), stating that “we recognise both the need for investment and the legitimate concerns arising from such investment. We therefore need to find solutions that maximize benefits and that allay concerns about land grabbing, protect smallholders and do not hurt the environment” (FAO, 2013b). The policy attention to issues of inclusion and environmental sustainability (in addition to water issues) has arisen in part to due to recent work such as the PRAI initiative.

Current research helps us make the case for inclusion of social (e.g., livelihoods) and environmental benefits (e.g., preservation and enhancement of priority regional ecosystem services) in such investment. It is our assertion that a sustainable approach to land investment requires an integrative framework. Design of such investments should explicitly take natural and social systems into account. From an investor perspective, a key motivation for investing through an integrative framework is that land investments made with broader social, environmental and economic objectives will perform better due to improved socio-ecological risk management. The preponderance of available evidence supports this contention.

This guidebook outlines practical steps towards advancing an integrative investment framework. We provide a practical, spatially-explicit, ecosystem-based framework and process to design and inform land investment agreements and programs that deliver increased water, energy and food security, illustrated by case studies and examples of component steps. The framework also provides implementation-oriented guidance for an otherwise theoretical concept being explored as a significant global risk and opportunity for integration. The framework targets an international investment audience, but we believe that the process outlined also will yield success in regional and national decision-making processes for budget allocations and in understanding benefits and trade-offs from agricultural development.

A subsequent phase of this work will focus on lessons learned by implementing the stages articulated in this guidebook in a relevant developing country region. As those lessons emerge, we will continue to adapt and enhance this guidebook to improve usability and impact.

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6.0 Appendix

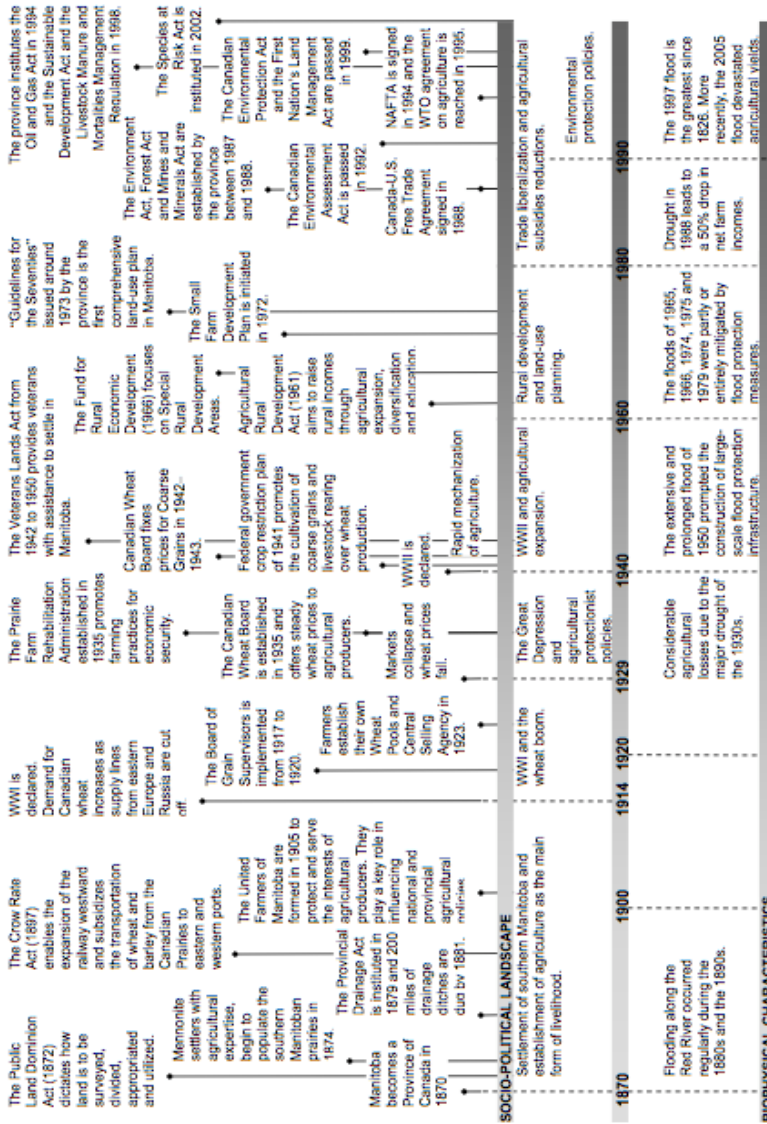


FIGURE A1. VISUAL REPRESENTATION OF HISTORICAL TRENDS—OVERVIEW OF CHANGES IN SOUTHERN MANITOBA 1870–2000.

Source: Voora and Venema (2008).

Prioritizing WEF elements using DPSIR

A useful approach to assist in taking a systems approach is represented in the Drivers, Pressures, State, Impacts and Responses (DPSIR) analytical framework developed by OECD in 1994 (UNEP, 2007). DPSIR has been used largely to understand relationships between the natural environment and human well-being. Pressures are the human activities that exert needs on regional and global natural systems. Pressures can include specific investments and policies implemented in the region such as resource extraction, land-use change, crop plantations or introduction of invasive species. Figure A2 provides a graphic overview of the DPSIR process.

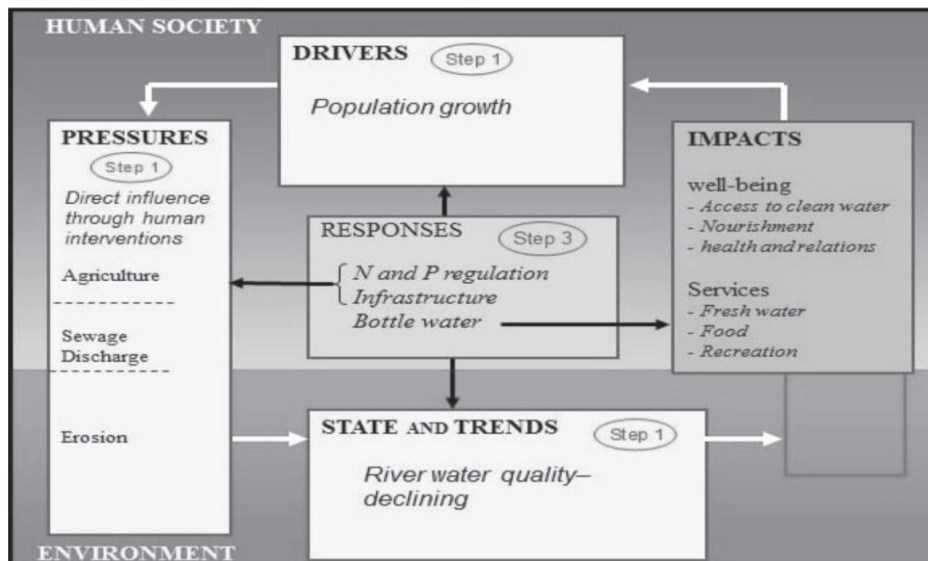


FIGURE A2. THE DPSIR FRAMEWORK DEVELOPED FOR GEO-4. ARROWS INDICATE THE GENERAL CAUSE-AND-EFFECT RELATIONS AMONG THE FRAMEWORK'S COMPONENTS

Source: UNEP (2007).

There are three core questions that are addressed by the DPSIR framework. These are described below.

Q1: What is happening to the environment, and why?

Analyzing the states and trends of the environment is central to identifying how obligations and priorities relevant for WEF sectors are actually unfolding in a country. This involves identifying key environmental state issues, and analyzing changes retroactively. To effectively answer the question (Step 1, Figure 1), an analysis of state variables must be accompanied by an understanding and appreciation of the drivers (driving forces or indirect drivers) and pressures (direct drivers) that affect state variables individually and collectively. Drivers (including demographic changes, economic and societal processes) lead to more specific pressures on the environment (e.g., investments into natural resources, land-use change, resource extraction, polluting emissions, and the modification and movement of organisms). These pressures lead to changes in the state of the environment (e.g., climate change, stratospheric ozone depletion, changes in biodiversity, and pollution or degradation of air water and soils), which are in addition to those that result from natural processes.

Q2: What are the consequences for the environment and humanity?

These changes affect the ecological services that the environment provides to humankind, such as the provision of clean air, water, food, and protection from ultraviolet radiation as well as impacts on other aspects of the environment itself, such as land degradation, habitat quality and quantity, and biodiversity. As a result of changes in ecological services, mediated by demographic, social and material factors, there are impacts on the environment and human well-being (health, economic performance, material assets, good social relations and security).

Q3: What is being done and how effective is it?

Societal responses can influence the environmental state and their associated drivers and pressures (either intentionally or unintentionally). Societal responses essentially fall under two categories: (1) Responses directed at reducing exposure to negative environmental impacts (e.g., through environmental restoration and enhancement), and (2) Responses which help society adapt directly to the impacts that occur and/or build the capacity to adapt to changes in the environment (e.g., laws, formulating and implementing public policy, establishing/strengthening institutions) as well as through advances in science and technology. The exposure to changes in various environmental states, combined with the ability of society to adapt to these changes, determines the degree to which people are vulnerable or resilient to environmental change.

TABLE A1. AN EXAMPLE OF AN INITIAL SCOPING OF KEY WEF SECTORS USING THE DPSIR FRAMEWORK

	Water	Energy	Food
States of the Environment			
Decimation of fisheries resources and increased algae cover	X		X
Sedimentation (moderate sedimentation) (increased land activity)	X		
Loss of forest cover; deforestation	X	X	X
Loss of coastal vegetation esp. 25 kilometers of endangered coasts	X		X
Deteriorating coastal water quality (in areas up to 10 square kilometers)	X	X	X
Pressures and Drivers			
Severe storms and natural hazards and disasters (droughts)	X	X	X
Overfishing (small catch size during recent years)	X		X
Increasing presence of invasive species	X		
Coastal development (tourism, agriculture) with limited planning		X	X
Increased deforestation and habitat destruction	X		X
Water pollution: runoff from agriculture and other land-based pollution	X	X	X
Limited use of best management practices in development at the coasts	X	X	
Unplanned and planned development	X	X	X
Improper sewage management (30 per cent of untreated water)	X		
Using forest species for fuel, charcoal to smoke fish for sale			
Loss of arable lands due to erosion and salt water intrusion		X	X
Impacts			
Reduced fish stock/decrease in food security	X	X	X
Reduced coastal biodiversity	X		X
Decrease in water quality	X		X
Loss of livelihood (fisherman)	X		
Destruction of livelihood, socioeconomic impacts.		X	X
Loss of the ecosystem services (water filtration, shoreline protection)	X	X	X
Responses			
Land-use plans for major municipalities	X	X	X
Water quality standards adopted and enforced especially in populated areas	X	X	X
Beach protection act adopted	X	X	X
Reforestation plans and forest code is being developed	X	X	X
Guidance for investments is being developed	X		X

TABLE A2. SUGGESTED MONITORING AND EVALUATION INDICATORS OF INVESTMENTS

Type of indicator	Description
Cross-cutting	An overarching policy defining the environmental and social objectives and principles that guide the project (IFC, 2012)
	A process for identifying the environmental and social risks and impacts of the project (IFC, 2012)
	Management programs that describe mitigation and performance improvement measures and actions that address the identified environmental and social risks and impacts of the project (IFC, 2012)
	An organizational structure that defines roles, responsibilities, and authority to implement the Environmental and Social Management System (ESMS) (IFC, 2012)
	An emergency preparedness and response system to respond to accidental and emergency situations associated with the project (IFC, 2012)
	Procedures to monitor and measure the effectiveness of the management program, as well as compliance with any related legal and/or contractual obligations and regulatory requirements (IFC, 2012)
	Stakeholder engagement: stakeholder analysis and planning, disclosure and dissemination of information, consultation and participation, grievance mechanism, and ongoing reporting to Affected Communities (IFC, 2012)
	Arrangements for land-use planning and taxation that avoid negative externalities and support effective decentralization (Deininger, Selod, & Burns, 2012)
Economic	Number of businesses in the value chain supported by the investment; this is a proxy for entrepreneurial development and expansion of the formal (tax-paying) economy (UNCTAD, 2012)
	Total number of jobs generated by the investment, both direct and induced (value chain view), dependent and self-employed (UNCTAD, 2012)
	Total household income generated, direct and induced (UNCTAD, 2012)
	Number of jobs generated, as a proxy for job quality and technology-levels, including technology transfer (UNCTAD, 2012)
	Real income per unit of energy-related CO ₂ emitted (OECD, 2011)
	Energy productivity, GDP per unit of TPES (OECD, 2011)
	Energy intensity by sector, manufacturing, transport, households, services (OECD, 2011)
	Domestic material productivity <ul style="list-style-type: none"> Biotic materials (food, other biomass) Abiotic materials (metallic minerals, industrial minerals) (OECD, 2011)
	Nutrient balances in agriculture per agricultural land area and change in agricultural output (OECD, 2011)
	Unit of water consumed, by sector (for agriculture: irrigation water per hectare irrigated) (OECD, 2011)
	Gross value added in the EGS sector (in % of GDP) (OECD, 2011)
	Employment in the EGS sector (in % of total employment) (OECD, 2011)
	Foreign Direct Investment, % of GNI (OECD, 2011)
	Structure of environmentally related taxes, by type of tax base (OECD, 2011)
	Energy pricing, share of taxes in end-use prices (OECD, 2011)
	Production-based CO ₂ productivity (OECD, 2011)
	Share of renewable energy in TPES, in electricity production (OECD, 2011)
	Waste generation intensities and recovery ratios by sector, per unit of GDP or VA, per capita (OECD, 2011)
	Most land that has had a change in land use assignment in the past 3 years has changed to the destined use (Deininger, Selod, & Burns, 2012)
	Agricultural FDI to GDP ratio (FAO, 2013)
	Share of land on which soil conservation practices (e.g., no-tillage, strip contouring, terracing) are adopted (Suvedi, den Biggelaar, & Morford, 2003)
	Changes in total agricultural land area in relation to the total land area (Suvedi et al., 2003)
Enterprise development in eco-sectors (UNCTAD, 2012)	
Environmental	Technically and financially feasible and cost effective measures for improving efficiency in its consumption of energy, water, as well as other resources and material inputs, including reducing GHG emissions and avoiding or reducing water usage (IFC, 2012)
	Measures to avoid, minimize and/or control the release of pollutants (IFC, 2012)
	Measures to avoid or reduce the generation of hazardous and non-hazardous waste materials (IFC, 2012)
	An integrated pest management and/or integrated vector management approach targeting economically significant pest infestations and disease vectors of public health significance (IFC, 2012)
	A biodiversity offset to achieve measurable conservation outcomes that can reasonably be expected to result in no net loss and preferably a net gain of biodiversity (IFC, 2013)
	A systematic review to identify priority ecosystem services: i) those services on which project operations are most likely to have an impact; and/or ii) those services on which the project is directly dependent for its operations (IFC, 2012)
	Credible globally, regionally, or nationally recognized standards for sustainable management of living natural resources (IFC, 2012)
	Measures to identify risks and potential project's impacts on priority ecosystem services that may be exacerbated by climate change (IFC, 2012)
Social	Preventive and control measures against risks and impacts to the health and safety of the Affected Communities consistent with good international industry practice, such as in the World Bank Group Environmental, Health and Safety Guidelines or other internationally recognized sources (IFC, 2012)
	Measures to avoid or minimize the potential for community exposure to water-borne, water-based, water-related, and vector-borne diseases, and communicable diseases that could result from project activities (IFC, 2012)
	Measures to assess risks posed by the project's security arrangements to those within and outside the project site (IFC, 2012)
	Population exposure to air pollution (OECD, 2011)
	Population connected to sewage treatment (at least secondary, in relation to optimal connection rate) (OECD, 2011)
	Population with sustainable access to safe drinking water (OECD, 2011)
	Feasible alternative project designs to avoid or minimize physical and/or economic displacement, paying particular attention to impacts on the poor and vulnerable (IFC, 2012)
	Measures to compensate displaced communities and persons transparently and consistently for loss of assets at full replacement cost and other assistance to help them improve or restore their standards of living or livelihoods (IFC, 2012)
	A Resettlement Action Plan and/or Livelihood Restoration Plan, when physical and/or economic displacement is inevitable (IFC, 2012)
	Measures to ensure that internationally recognized practices for the protection, field-based study, and documentation of cultural heritage are implemented (IFC, 2012)
	A legal, institutional, and policy framework that recognizes existing rights, enforces them at low cost, and allows users to exercise them in line with their aspirations and in a way that benefits society as a whole (Deininger, Selod, & Burns, 2012)
	Clear identification of state land and its management in a way that cost-effectively provides public goods; use of expropriation only as a last resort and only for direct public purposes with quick payment of fair compensation and effective mechanisms for appeal; and mechanisms for divestiture of state lands that are transparent and maximize public revenue (Deininger, Selod, & Burns, 2012)

TABLE A3. OVERVIEWS OF KEY ELEMENTS OF THE WEF INITIATIVE

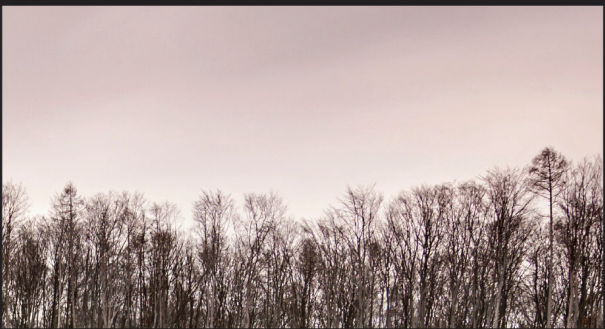
Steps	Stakeholders' participations	Analytical approaches	Decision-making processes
1. Assessing the W-E-F Security System Framing the Initiative Assess Current Status and Trends in Natural, Built and Social Capital Understand Past Stresses and Adaptations Describe Future Risks	<ul style="list-style-type: none"> Assemble key stakeholders to lead the initiative Identify stakeholders including those involved in investments strategy development and negotiations Hold a workshop for stakeholders' group to prioritize key WEF securities and assess the performance of WEF sectors in the present and in the past (Workshop 1) Discuss with stakeholders potential future risks (Workshop 2) 	<ul style="list-style-type: none"> Quantify past and present WEF trends based on available date and risks listed in the literature (locally and globally) Identify a quantitative model that is relevant for the region Developing a watershed/landscape model to simulate changes in the region Assemble data and validate the model 	<ul style="list-style-type: none"> Connect with agencies and their members involved in policy-making, investments strategy development and negotiations and invite them to participate in the WEF initiative Collect and review key policies and strategies influencing past and present WEF securities Review previous strategies, policies and investments
2. Envisioning Future Landscape Scenarios Develop Shared Principles for the Future Landscape Identify Critical Uncertainties and Craft Plausible Scenarios Develop Adaptations and Transformations	<ul style="list-style-type: none"> Discuss key principles of the future landscape/region with involvement of the stakeholders (Workshop 2) Identify critical uncertainties and drivers and sketch out a set of scenarios (Workshop 2) Complete and then validate the scenarios and identify relevant adaptations with stakeholders' inputs (Workshop 3) 	<ul style="list-style-type: none"> Using the model, test future scenarios including the impacts of potential future drivers (local and global) Test and compare future adaptations and using the model to prioritize them 	<ul style="list-style-type: none"> Review documents outlining future plans, policies and actions Involve policy-makers in future scenario development and its consequences for future investments Review with policy-makers considered adaptations to already identified investments during their planning processes
3. Investing in a Water-Energy-Food Secure Future Create a New and Shared Story of the Future Landscape Communicate Develop the Investment Strategy and Scaling Mechanisms	<ul style="list-style-type: none"> With stakeholders create a shared story of the future landscape (Workshop 3) Provide a create story for wider consultations; consider holding small events to review and discuss the story Validate the investment strategy with key groups of stakeholders Create press releases about the strategy 	<ul style="list-style-type: none"> Assess the coherence of the future scenarios to ensure that the suggested measures increase WEF securities Use model outcomes to illustrate and justify investment strategy 	<ul style="list-style-type: none"> Review and validate the story of the future with policy-makers and identify key investments Identify key entry-points for decision-making and planning and their role in reaching to investor to implement the investment strategy
4. Transforming the System Communicate Implement Monitor, Adapt and Improve	<ul style="list-style-type: none"> Review and complement the created set of indicators Inform stakeholders about the progress in the monitoring and gathered trends Collect feedback about needed future changes and adaptations (re-occurring events) 	<ul style="list-style-type: none"> Develop a set of monitoring indicators Design the data collection process and ensure data collection Using the model to communicate the need for the investments and policies 	<ul style="list-style-type: none"> Discuss the regular monitoring process Keep policy-makers informed about the outcomes of monitoring and needed changes during the implementation

TABLE A4. TEMPLATES TO COMPILE THE IMPLEMENTATION OF THE FRAMEWORK ASSESSING THE WEF SECURITY SYSTEM

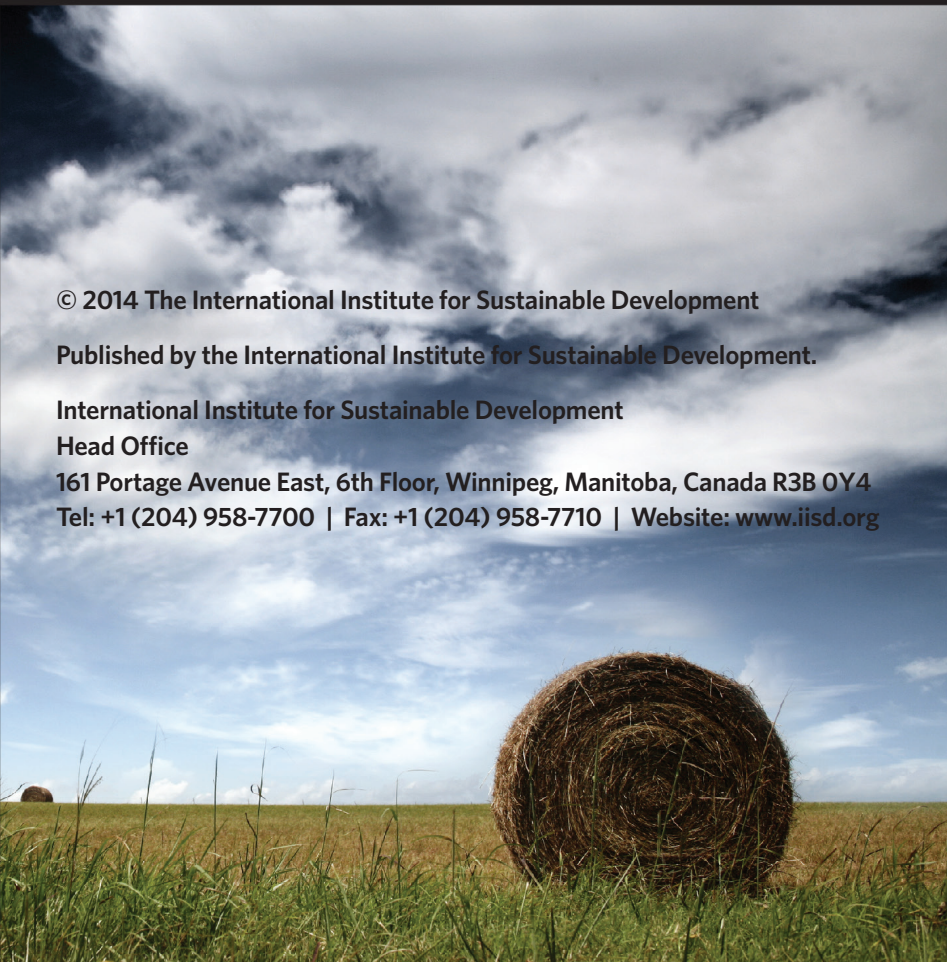
	Water	Energy	Food	Overlaps including synergies and trade-offs
Natural System				
Total and per capita resource needs				
Resource needs and contributions				
Underlying social and economic issues				
Specific cross-cutting resource needs (quantitative and qualitative)				
Natural and Built System				
Key natural systems and their condition				
Key built systems and their condition				
Services provided by natural/built systems				
Specific cross cutting services				
Institutions, governance				
Key institutions, governance systems				
Mechanisms used to govern supply, distribution and access of WEF resources				
Past stresses, adaptations				
Changes in natural systems in relation to WEF				
Changes in built systems in relation to WEF				
Changes in institutions and governance in relation to WEF				
Future risks				
Risks in the natural systems				
Risks in the built systems				
Risks in governance and institutions				

TABLE A5. ENVISIONING FUTURE LANDSCAPE SCENARIOS

	Scenario 1	Scenario 2	
Social priorities for the region			
Environmental priorities for the region			
Economic priorities for the region			
Common principles for future success			
Future scenario title:			
Key risks and drivers that the scenario address			
Description of the scenario			
Detailed overview of the scenario vision according to the desired principles			
Principle 1:			
Principle 2:			
Principle 3:			
Principle 4:			
Principle 5:			
Scenario and exploring synergies between WEF			
Performance of the scenario in the context of maximizing WEF			
Key synergies between WEF elements			
Key trade-offs between WEF elements			
Adaptations and investments			
Needed adaptations for WEF security			
List of relevant investments for needed adaptations			



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