DEFINE THE WSI SPACE AND ASSESS WATER SECURITY RISKS

Toolkit #2

This series of toolkits presents an effective and efficient process to address risks to water security, both long-term water stresses that constrain socioeconomic development and threaten political stability, as well as sudden shocks that can endanger the health and livelihoods of vulnerable populations. These toolkits aim at disseminating the practice of water management. Local decision-makers as well as development specialists should use these toolkits as guidelines to engage water users in a collaborative process that results in improved water resources management.

Water security is the adaptive capacity to safeguard the sustainable availability of, access to, and safe use of an adequate, reliable, and resilient quantity and quality of water for health, livelihoods, ecosystems, and productive economies.

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This publication is made possible by the generous support of the American people through the United States Agency for International Development (USAID), under the terms of the Sustainable Water Partnership (SWP) Leader with Associates Cooperative Agreement No. AID-OAA-L-16-00006 to Winrock International. The Sustainable Water Partnership is a partnership of Winrock International, TetraTech, CEO Water Mandate, mWater, International Union for the Conservation of Nature, World Resources Institute, and Stockholm Environment Institute. The contents are the responsibility of the SWP consortium partners and do not necessarily reflect the view of USAID or the United States Government.

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The river flow diminishes to a trickle during the dry season in the Rangun Khola watershed, Nepal.

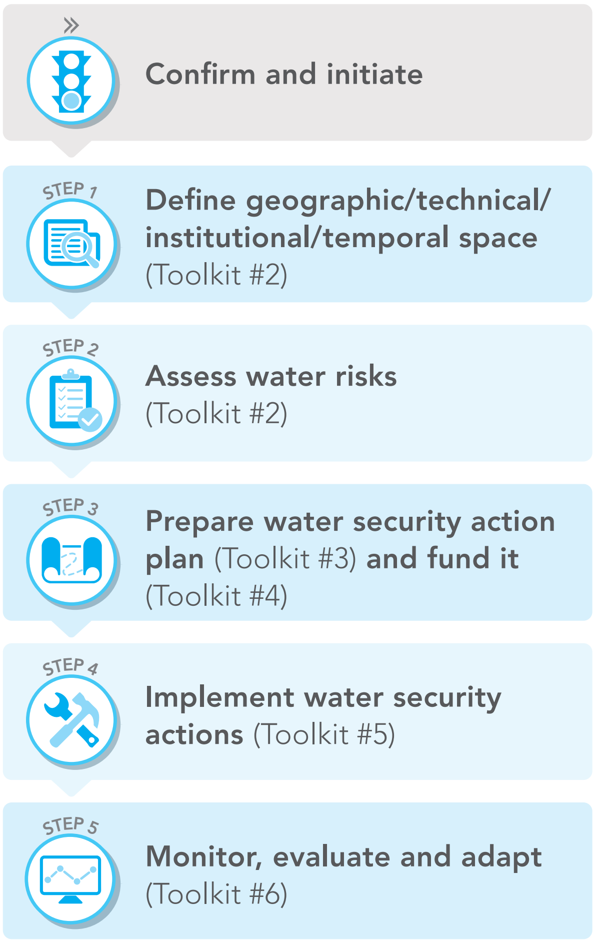
INTRODUCTION

Unsustainable water and land use practices and increasing demand for water are contributing to over-abstraction and degradation of surface and groundwater in many watersheds around the world. Climate change is impacting every part of the water cycle, causing extreme weather, sea level rise, and increased temperatures. As a result, the future availability of water resources is increasingly uncertain, and communities and ecosystems are vulnerable to water stress and natural disasters.

Improving water security in a targeted geography requires a focused and collaborative effort to identify and prioritize water risks, and to plan and implement activities to mitigate the risks. This series of toolkits presents the Water Security Improvement (WSI) process, an iterative approach to addressing risks that cause water to be "too little, too much, too dirty, or too erratic" for use by people, animals, and ecosystems. The WSI process involves five steps to assess, plan, and implement water security interventions (Figure 1). This toolkit covers Step 1: Define the WSI Space and Step 2: Assess Water Risks. The approach outlined in this toolkit will help you create a transparent, participatory process, engage stakeholders, define an appropriate technical scope, and design and conduct a water security assessment to understand and address the water security risks in your target geography.

This toolkit series is aimed at national and local governments, international and local non-governmental organizations, and donors interested in water resource management.

FIGURE 1: THE WATER SECURITY IMPROVEMENT (WSI) PROCESS



Representatives from provincial line departments and civil society organizations collaborate to create a comprehensive stakeholder inventory for the Stung Chinit watershed.

STEP 1: DEFINE THE WSI SPACE

The WSI process is designed to be facilitated by a lead entity and driven and owned by local stakeholders. This section explains how to define the WSI space, including the target geography, facilitator, participants, key water problems to be addressed, and timeline for planning and implementing water actions.

Define the Target Geography

Water resource management programs are typically organized around a basin or sub-basin, but some water security issues are best addressed within political or administrative boundaries, or within WASH districts or systems. An important first step is to define the target geography, including political, administrative, and hydrological boundaries. The geography should be refined if needed as the scope of water security challenges and actions are clarified.

Identify a Convening Entity

The WSI process is most effective when a lead entity or group is responsible for facilitating the process. Responsibilities of the lead entity include organizing stakeholder meetings; compiling and disseminating meeting minutes, validation documents, and study results; supervising consultants and technical advisors; and liaising with government authorities and donors. The lead entity may be a non-governmental organization (NGO), an inter-agency river basin management committee, or a government agency.

Conduct a Stakeholder Inventory

Engaging stakeholders in the WSI process can help ensure sound decisions, smoother implementation, and more effective capacity building. You should conduct a stakeholder inventory to identify the individuals and organizations that influence and/or are affected by water use and decision-making in your target geography (Table 1), with a particular focus on water users who may be under-represented in local governance and decision-making systems.

The goal of the stakeholder inventory is to create a preliminary baseline of stakeholders who should be involved in the WSI process. The stakeholder inventory will serve as a starting point for the stakeholder analysis that you will need to conduct during the water security assessment (Step 2 below). Suggested questions for the stakeholder inventory include:

- Who currently uses water in the target geography?
- Whose activities have an impact on water availability and quality?
- Who designs, builds, and operates water infrastructure?
- Who decides on water allocations?
- Who monitors water resources?
- Who regulates water uses and services?

Local entrepreneurs collect water from the Mara River in Kenya to use for their car washing business.

TABLE 1: WATER SECURITY STAKEHOLDERS

COMMUNITY-BASED WATER USERS	PRIVATE SECTOR WATER USERS	WATER SECTOR INSTITUTIONS	VULNERABLE AND MARGINALIZED GROUPS
Water user associations	Private water operators	National ministries of water/irrigation, energy, agriculture, environment, planning, finance	Subsistence farmers
Community forestry groups	Commercial farms/ plantations and processing facilities	Transboundary water management authorities	Ethnic minorities
Community fishery groups	Smallholder farms	Water utilities	Youth
Agricultural Cooperatives	Factories, mines, quarries	River basin authorities	People with disabilities
Civil Society Organizations	Hotels and tourism businesses	Irrigation agencies	Peri-urban dwellers
Domestic water users	Power plants	Regional and local governments	Women

Farmer in Kampong Thom province, Cambodia, sprays rice paddy with pesticides without personal protection equipment.

Clarify Stakeholder Engagement, Decision-Making, and Communication Procedures

Sustained participation from local stakeholder representatives helps legitimize the WSI process. Each stakeholder group should appoint a representative who will be involved in the WSI process. Representatives may be leaders such as the mayor or a traditional village chief, or they may be selected through an ad-hoc or election process. Participating in the WSI process will strengthen their leadership capacities as they exercise their communication, negotiation, collaborative decision-making, facilitation, and conflict resolution skills. Other groups, such as donors, investors, and universities, will support and guide the WSI process, but should defer decision-making to local stakeholders.

Setting a schedule and structures for stakeholder involvement will make it easier for stakeholders to commit to participating over a period of time. Stakeholders may want to create working groups around priority themes and hold community forums to raise awareness and gather broader feedback. The WSI facilitator should work with participating stakeholders to define equitable decision-making procedures and protocols for internal and external communications.

Define and Validate Key Water Security Problem Areas

You should create a shortlist of the water security problems that will be assessed under Step 2 (Assess water risks). In some cases, water security problem areas have already been defined by a donor or by government partners. If this is not the case, a desk review and key informant interviews with decision makers can inform the shortlist. Examples of water security problem areas are water contamination, significant water shortages in the dry season, or open defecation. Key questions about water security problems include:

- What water problems exist in the target geography?
- Are the water problems inter-related? If so, how?
- What uncertainties complicate or exacerbate the water problems?
- Does one social group experience the water problem(s) more than others?
- What is being done to address each water problem?

To generate stakeholder buy-in and ensure that the WSI process is transparent and equitable, the shortlist of water security problem areas should be validated with participating stakeholders. You may want to use workshops, surveys, or focus group interviews to get stakeholder input on water security problem areas.

Set a Timeline for the WSI Process

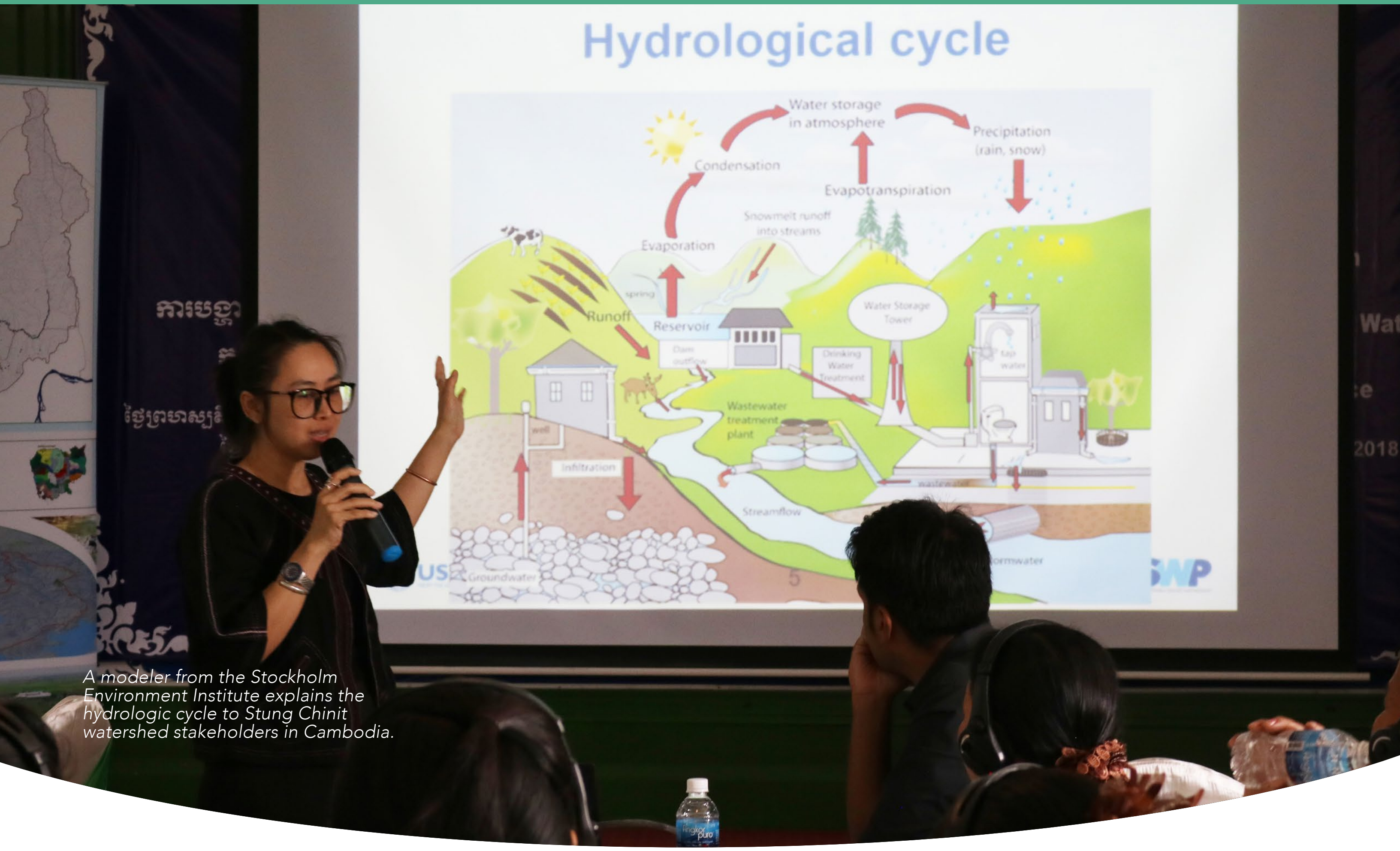
In consultation with participating stakeholders, you should define a timeline for the remaining steps in the WSI process. You may want to use more than one time horizon for implementation of water security actions under Step 4:

- Quick wins (1-3 years) to gain buy-in and implement pilot water security actions;
- Short-term (3-5 years) to address imminent water security risks;
- Medium-term (5-10 years) to address more complex water security challenges; and
- Long-term (10-30 years) to assess trends and define strategic long-term objectives.

Step 1 Output

The output of Step 1 is a summary of the key water problem areas, target geography, participating stakeholders, convening entity, and stakeholder engagement, communication, and decision-making procedures, as well as the expected timeline for assessing water risks (Step 2), planning interventions (Step 3), and implementing water security actions (Step 4).

Industrialized (left) and traditional (right) agriculture in the Mara River Basin, Kenya.



A modeler from the Stockholm Environment Institute explains the hydrologic cycle to Stung Chinit watershed stakeholders in Cambodia.

STEP 2: ASSESS WATER RISKS

The second step of the WSI process is to describe and quantify the current and potential water security risks related to the water problem areas defined in Step 1. As shown by the examples in Figure 2 from the USAID-funded Sustainable Water Partnership (SWP), a water security assessment is a compilation of information and studies that provide an understanding of water security issues in a target geography. The water security assessment will be used in Step 3 to prepare a water security action plan, such as a river basin management plan or water allocation plan for the target geography.

Water security assessments typically include three technical areas: a profile of the targeted geography, a water resource assessment, and a water sector governance assessment, explained in detail below. Stakeholders should be engaged during each step of the water security assessment as they can help collect and interpret existing information and support field assessments.

WATER SECURITY ASSESSMENT

Definition: An assessment of current and potential risks affecting the availability of, access to, and safe use of water within a targeted geography.

Goals

- Establish an agreed-upon information base among stakeholders
- Inform efforts to plan, finance, implement, and monitor water security activities
- Provide evidence to justify government and donor funding for water security activities and policies

FIGURE 3: CONTENT OF TWO WATER SECURITY ASSESSMENTS CONDUCTED BY SWP

STUNG CHINIT BASIN WATER SECURITY ASSESSMENT (CAMBODIA)

Existing Information Collected

- Topographic data delineating basins and sub-basins
- Land use (including Economic Land Concessions and mining licenses) and river networks GIS data
- Precipitation data from meteorological stations
- Stream flow data from hydrometric stations
- Stakeholder inventory
- Population by commune

Studies Conducted

- Household Knowledge, Attitudes and Practices survey
- Two water quality studies, wet and dry season
- Institutional assessment
- Water balance
- Biodiversity evaluation
- Hydrological modeling (WEAP model)
- Infrastructure inventory
- Stakeholder analysis

LOWER MARA RIVER BASIN WATER SECURITY ASSESSMENT (TANZANIA)

Existing Information Collected

- Topographic data delineating basins and sub-basins
- Land use and river networks
- Precipitation and river flow from meteorological and hydrometric stations
- Hydrogeology and soil properties
- Population by district/basin
- Livestock population by type
- Water quality assessments
- Geomorphology
- Riparian vegetation

Studies Conducted

- Water resources availability
- Water abstraction surveys
- Water demand analysis
- Environmental flow assessment
- Hydrological modeling (WEAP model)

Collect and Review Existing Information on Water Security Risks

You should begin by collecting existing information on the three technical areas and determining whether you need to conduct studies to fill any information gaps. In some cases, there may be too much information; it may help to set criteria for what information should be considered. Consider the following questions:

- Where can I find the information I need?
- What will be required for me to collect this information (e.g. approvals, payments)?
- Where will I store this information?
- What information is missing and may require a study?

Table 3 lists typical sources of information for water security assessments. You may also find useful information in news or academic articles, published dissertations, feasibility documents for construction projects, evaluation documents from donor-funded projects, and global datasets such as FAO Aquastat, WRI Aqueduct, and the Sustainable Development Goals. Stakeholders can help secure access to information, identify information gaps, and give insights into social, cultural, and power dynamics that explain how water is accessed, used, and managed. Collaborating on finding information and identifying gaps allows government agencies and water user groups to strengthen their relationship.

TABLE 3: ILLUSTRATIVE SOURCES OF INFORMATION FOR A WATER SECURITY ASSESSMENT

TECHNICAL AREA	ILLUSTRATIVE SOURCES OF INFORMATION
Profile of the Target Geography	• Statistical abstracts • Census reports • Demographic and health surveys • National, regional, and local development plans • Land use maps, geospatial analyses • Satellite imagery
Water Resources	• Groundwater and surface water resources and quality assessments • Environmental flows assessments • Environmental impact studies • Water allocation plans • Flood plain maps • Databases from weather, hydrometric, and water quality stations • Climate change assessments
Water Governance	• Water laws and policies and regulatory reports • Strategic plans, development plans, integrated water resource management plans • Water balances/budgets • Utility or service provider performance reports • Budgetary allocations and spending • Progress towards Sustainable Development Goals • Service coverage maps

Conduct Studies to Fill Information Gaps

It is important to review the existing information with participating stakeholders to confirm information gaps and prioritize additional studies based on the budget available. Additional studies may be needed to characterize current and future water security risks, and/or to provide baseline data that can be used to monitor the impacts of water security activities. Consider the following questions:

- What type of studies do I need to conduct to fill key information gaps?
- What is my budget and timeframe for studies?
- Will the study require data collection, or can I use existing data?
- How can I access the required data to complete these studies effectively and on time?
- Are other actors interested in the same information? If so, would they collaborate on designing or funding a study?
- Can local communities help complete these studies (see Box 1)? Can I leverage information from a local organization or donor-funded project doing similar work?
- Can the data analysis be done in-house or will it require technical experts? Are technical experts available to consult during the given timeframe?

Table 4 shows illustrative studies for each technical area.

TABLE 4: ILLUSTRATIVE STUDIES FOR THE WATER SECURITY ASSESSMENT

TECHNICAL AREA	ILLUSTRATIVE STUDIES
Target Geography Profile	• Physical and socioeconomic trends • Stakeholder analysis • Gender Equality and Social Inclusion (GESI) analysis • Land use and land cover change analysis • Environmental threats • Natural disasters • Climate vulnerability assessment • Water infrastructure inventory
Water Resource Assessment	**Water availability** • Hydrologic analysis • Future water availability **Water balance** • Water demand by sector • Evaluation of environmental flows **Water quality** • Testing drinking water quality • Testing ambient water quality • Surface water quality modeling
Water Governance Assessment	• Political economy analysis • Policy review • Mapping institutions and processes • Organizational assessment • Capacity building needs assessment

BOX 1: ENGAGING CITIZEN SCIENTISTS IN WATER SECURITY ASSESSMENTS

Citizen science can be an effective way to collect data and to engage stakeholders in gathering data on water availability and water quality. Data can be crowdsourced using low-cost water resource monitoring technologies, such as home-made rain gauges and optical sensors. Internet-connected smartphones/tablets can enable citizen science in data-scarce geographies.

Citizen Science References

- Nigussie, L., Haile, A. T., Gowing, J., Walker, D., Parkin, G. 2020. Citizen science in community-based watershed management: an institutional analysis in Ethiopia
- United Nations Educational, Scientific and Cultural Organisation (UNESCO). 2019. Tools for Water Security: Mobile Applications
- Walker, D., Haile, A.T., Gowing, J., Forsythe, N., Parkin, G. 2019. Guideline: Selecting, training and managing para-hydrologists
- Walker, D., Haile, A. T., Gowing, J., Legesse, Y., Gebrehawariat, G., Hundie, H., Berhanu, D., and Parkin, G. 2019. Guideline: Community-based hydroclimate monitoring

Describe and Validate Water Security Risks Related to Problem Areas

You should use the water security assessment findings to describe the key risks within each problem area assessed. For each risk, identify the causes, stakeholders, impacts, and desired water security outcomes. An excerpt of this analysis from SWP's work in Cambodia is shown in Table 5. Determine whether each risk relates to the availability of, access to, and/or safe use of water. Consider the root causes of each risk and potential interconnections between two or more risks. For example, upstream environmental degradation and midstream agrochemical pollution are risks in their own right, but together they can cause downstream risks to freshwater biodiversity. As you look at the interconnections between water risks, cross-cutting themes may emerge, such as a need for more GESI-related interventions or a need for strengthened water governance.

Stakeholders should be engaged to validate and refine the risks. Working with stakeholders to document the full range of risks associated with each problem area helps stakeholders to take ownership of the WSI process. You may want to create a structured exercise to help stakeholders prioritize the risks they want to carry forward into Step 3 (Planning). The scope of the priority risks should be narrow enough to ensure that actions can be taken to produce tangible benefits. Key considerations when prioritizing risks include the current and future social, economic, or ecological severity of impact; the degree to which basin planning can address the risk; and the degree of uncertainty surrounding the risk. More information about prioritizing water security risks can be found in Toolkit #3.

TABLE 5: EXAMPLES OF RISKS ASSOCIATED WITH WATER SECURITY PROBLEM AREAS IN CAMBODIA

Problem Area	Specific Risk(s)	Causes	Stakeholders	Current and future impacts	Desired water security outcome
Dry season water shortages	Shortage of water for drinking, domestic use, and irrigation	• Ineffective water supply management, including water • Source protection • Climate variability • Insufficient water storage capacity • Lack of incentives for water conservation	• Provincial Department of Water Resources and Meteorology • Local authorities (district, commune, and village) • Water User Associations • Farmer Water User Committees • Farmers • Communities	• Conservative scenarios project that water demand will exceed supply within 90 years due to growth in population and irrigated area	• Increase community water storage and assess feasibility of household rainwater harvesting systems • Install water saving technologies for irrigation during the dry season • Reduce non-revenue water los in community water supply systems
Inadequate fecal sludge management	Groundwater contamination and proliferation of waterborne diseases	• Poorly constructed pit latrines and septic tanks leaking fecal sludge into groundwater • Waste discharged directly into open water bodies • Lack of monitoring and enforcement of polluter laws • Insufficient capacity at local sewage treatment facility	• Residents • Urban and peri-urban landlords • Municipal/county governments • Sewage truck businesses • International, national, and local WASH organizations and forums • Sewage treatment operator	• A household survey found that 21% of respondents practice open defecation and 70% of latrines are simple pit latrines without septic tanks • Dry season water quality testing found E. coli in 98% of samples, indicating fecal pollution of surface water	• Develop municipal guidelines to ensure latrines are located a safe distance from homes and water sources • Market low-cost, improved sanitation solutions to low-income residents • Implement a "polluter pays" policy to stem illegal discharge into surface water

Stakeholders play an applied game on water modeling in the Stung Chinit watershed, Cambodia.

HELPING STAKEHOLDERS UNDERSTAND AND VALIDATE RISKS THROUGH A HANDS-ON GAME: AN EXAMPLE FROM CAMBODIA

In Cambodia, SWP used an innovative exercise to help stakeholders understand and prioritize risks in the Stung Chinit watershed. Stakeholders were divided into groups of ten people and given a map of the watershed (Figure 1). The objective of the exercise was to score the most points by planting and irrigating rice and keeping flows in the river for fish. The exercise consisted of drawing one card per time step (month), representing the units of water available for that month. They would then decide, by moving game pieces around the poster, how they would allocate water to the various demands, and how much water they would keep in their reservoirs and the downstream section of the river. Participants recorded their allocations in a table for each season (wet and dry) and each year, resulting in a time series of data.

The exercise helped participants think about the balance they wanted to achieve in the watershed between the competing demands of fisheries and rice cultivation, and prioritize water security actions to protect that balance.

Step 2 Output

The goal of Step 2 is to produce a stakeholder-validated report on the current and future status of water resources and water governance, as well as priority water security risks related to the main water problems in the target geography. The report should be shared in different forms through a variety of media (e.g. print, television, radio, and blogs) so it reaches the widest possible audience of water users.


In Cambodia's Stung Chinit watershed, 91% of residents engage in rice farming.

TECHNICAL CONTENT OF THE WATER SECURITY ASSESSMENT

Profile of the Target Geography

The water security assessment should include a profile of the target geography which describes the short- and long-term trends under each parameter below and their impact on water resources and water sector governance. Creating a profile of the target geography may require field research in addition to a desk study. This section describes the technical areas you may want to include in the target geography profile.

PHYSICAL AND SOCIOECONOMIC TRENDS

Demographics. Understanding the population in the target geography will help to ensure that the water security assessment, and the WSI process overall, is responsive to local needs. Key demographic variables include age, sex, ethnicity, income level, race, employment, location, homeownership, and level of education. Demographic questions include:

- What are the current and projected demographics of the target geography?
- Where and how big are the urban areas?
- Who within the population is most vulnerable to water security risks?
- What are the main livelihoods?
- What are the migration trends?
- What are the key health issues?

Land use and land cover change. Changes in land use or land cover over time can positively or negatively impact the water cycle. Anthropogenic land use change has been found to influence the global hydrological cycle on the same order of magnitude as human water use (Bosmans, et al., 2017). Key questions about land use and land cover include:

- What are the different land covers and land uses in the target geography?
- What do the land uses indicate about national interests and priorities, and the level of economic development in the target geography?
- How, and at what rate, has the land use and land cover changed over time?
- What are the projected future trends in land use change?
- What effects has land use change had on water resources and water users?

Economy. Global water demand is projected to increase by nearly 55 percent, due to growing demand from manufacturing (+400%), thermal electricity generation (+140%) and domestic use (+130%) (OECD, 2012). Economic trends include major policies and investment decisions affecting water resources and water services, such as investments in large-scale irrigation infrastructure or hydropower development, or privatization of domestic water services. Key questions about economic trends include:

- How are economic trends impacting, or likely to impact, water resources?
- Are there water-related conflicts?
- Is the political economy stable?
- What sectors are the largest consumers of water?

STAKEHOLDER ANALYSIS

Stakeholder analysis is an important tool to clarify the relationships between water-related stakeholders, determine how and when to engage stakeholders in the WSI process, and facilitate transparency and equity in water management decision making. As the Global Water Partnership explains,

> *Because stakeholder attributes and dynamics change over time and as a result of the project, stakeholder analysis should be an iterative process that starts at the beginning of a water management initiative and is revisited throughout, helping to guide the planning and implementation.... Identifying stakeholders and assigning attributes must be done with sufficient information or participation (surveys, interviews, etc.) from stakeholders, otherwise certain stakeholders will likely have undue influence while others may be left out entirely.*

An in-depth stakeholder analysis will assess stakeholder water use practices, relative influence in water-related decision making, and involvement in day-to-day water operations. When possible, it can be helpful to group stakeholders by which water use they prioritize, like water for agriculture or water for the environment. Representing stakeholders on a visual map to show their relationships, influence, and motivations may be helpful. Key questions for a stakeholder analysis include:

- What are the water use practices and management structures of the main water user groups?
- How do different stakeholders work together on water problems? What is their history of collaboration and/or conflict?
- Which stakeholders have the most influence in the community? With the local government? Within their circle of stakeholders?

Stakeholders irrigate their household permagardens (a climate-smart agriculture technique) using their community's newly retrofitted Multiple Use Water System in Hamtad village, Province 7, Nepal.

> How do stakeholders contribute to water management and water infrastructure planning and implementation?

> How do stakeholders contribute to or experience the impacts of problems with water quality, availability, and access?

Guidance on Conducting Stakeholder Analysis

- USAID. 2018. Measuring Impact. Best Practices for Stakeholder Engagement in Biodiversity Programming
- USAID. 2010. Using Rapid Appraisal Methods
- Lienert, Juri. 2020. Stakeholder Analysis from the Sustainable Sanitation and Water Management Toolbox
- World Health Organization. 2018. Core Questions on Drinking Water and Sanitation for Household Survey

GENDER EQUALITY AND SOCIAL INCLUSION (GESI) ANALYSIS

Understanding the context for water use practices by different groups and power dynamics within a community is critical to ensuring that the WSI process helps to make water management more equitable and inclusive of all members of the community including women, youth, ethnic and religious minorities, people with disabilities, and low-income households. These marginalized groups are often not equally represented at all levels of water resource management institutions or decision-making bodies, which can result in inequitable distribution of water resources and impact livelihoods and health of marginalized households. Findings of the gender and social inclusion (GESI) should incorporated into each step of the WSI process. Key questions for a GESI analysis include:

> Who are the marginalized groups in the project area and what are their water security needs?

> How do women access and control water resources? How does this access and control compare among women across different social, economic, ethnic, and religious communities?

- What challenges do marginalized groups face in accessing and managing water resources?
- Are marginalized groups included in water security-related trainings and professional opportunities?
- Does water supply and sanitation infrastructure planning and implementation reflect gender and other disadvantaged groups' needs?
- Are there women's or youth cooperatives/associations that could be potential partners to design inclusive strategies for engagement and participation in water resource management?
- Are marginalized groups equitably represented in water-related groups and decision-making processes?
- Are changes to water-related decision-making groups or processes needed to empower marginalized groups to participate and/or to build their capacity to participate (e.g. meeting/training times and locations that work for women; childcare provided)?
- Are labor saving technologies available to help alleviate women's and girls' unpaid work burden associated with water collection and food production, including irrigation?

Guidance on Conducting GESI Analysis

- CIVICUS. 2011. The Gender and Social Inclusion Toolkit
- The Global Water Partnership (GWP). 2017. Gender Equality and Inclusion in Water Resources Management
- Food and Agriculture Organization of the United Nations (FAO). 2012. Passport to Mainstreaming Gender in Water Programmes: Key questions for interventions in the agriculture sector

ENVIRONMENTAL THREATS

In the context of water security, environmental threats refer to the human influence causing stress on the natural environment of the target geography. Examples range from human impacts and dependency on aquatic ecosystems to exploitation of natural resources to large scale hydropower development. Typically, environmental threats are assessed by dividing a basin into environmental zones and evaluating representative areas in each zone. Key questions about environmental threats include:

- What are the major environmental zones in the target geography? What is the environmental health of the delineated zones?
- What is the condition of aquatic ecosystems? How are they managed?
- Are there conservation or biodiversity reserves in or around the target geography?
- What are the major environmental threats in the target geography?
- What is causing environmental degradation? What will happen to the environmental zones/ecosystems in the target geography if the environmental threats are not resolved?
- Does exploitation of natural resources make up a significant portion of livelihoods or food security in the target geography?

NATURAL DISASTERS

Water-related disasters have comprised 90 percent of the world's natural disasters over the last 20 years (UNISDR, 2015), displacing an average of 25 million people each year (IDMC, 2018). Water-related disasters include floods, landslides, tsunamis, storms, droughts, heat waves, cold spells, and waterborne disease outbreaks. Key questions about natural disasters include:

- Is the target geography susceptible to natural disasters?
- How have natural disasters impacted water resources or water supply (quantity and quality) in the past?
- Is the existing water infrastructure designed to be resilient to natural disasters?
- Are natural disasters central to policy and planning in the target geography?
- Have past natural disasters disproportionately affected certain vulnerable groups? If so, how?

CLIMATE VULNERABILITY ASSESSMENT

Climate change will have major impacts on the water cycle because of the increasing likelihood and severity of events like floods, droughts, and heavy rainfall. According to the United Nations 2021 update on Sustainable Development Goal 6 (water and sanitation for all), "over a fifth of the world's basins have recently experienced either rapid increases in their surface water area indicative of flooding, a growth in reservoirs and newly inundated land; or rapid declines in surface water area indicating drying up of lakes, reservoirs, wetlands, floodplains and seasonal water bodies." (UN-Water 2021). A climate vulnerability assessment aims to understand the vulnerability of people and the natural and built environment when exposed to climate stressors. Vulnerability includes three elements: exposure to climate stressors, sensitivity to climate stressors, and adaptive capacity, which measures the ability of communities and institutions to prepare or respond to the impacts of climate variability and climate change. Key questions about climate change vulnerability include:

- How is climate change projected to impact the target geography within the timeline of the WSI process?
- What is the likelihood and magnitude of extreme weather events in the current and future scenarios?
- What infrastructure and/or landscapes are vulnerable to climate variability and climate change?
- How are men, women, and vulnerable groups differently impacted by climate change?
- What current actions and policies are in place to combat climate change?

Guidance on Conducting A Climate Vulnerability Assessment

- USAID. 2016. Climate Vulnerability Assessment – An Annex to the USAID Climate-Resilient Development Framework
- USAID. 2014. Climate-Resilient Development: A Framework for Understanding and Addressing Climate Change

WATER INFRASTRUCTURE

Water infrastructure includes structures and equipment for storing, treating, and conveying water, waste water, sewage, and storm run-off. It is important to assess whether water infrastructure allows effective management and distribution of water for domestic, agricultural, and industrial uses. There may be service gaps or system problems like leaks or damaged components. Infrastructure assessments are usually carried out through field visits, observations, and interviews with operators of the infrastructure. Key questions about water infrastructure include:

- Where is water infrastructure located?
- What type of water infrastructure is located in the target geography?
- What is the physical condition of the infrastructure?
- Is it part of a larger scheme (important for irrigation)?
- Does it adequately fulfill its intended functions?

- Was it designed with climate change or population growth in mind?
- Who is responsible for operating and maintaining water infrastructure and monitoring the water resources it interacts with?
- Who benefits from the water infrastructure?

Water Resource Assessment

An evidence-based understanding of the state of water resources is critical to the WSI process as this information will serve as a basis for prioritizing risks, developing water security plans, and implementing water security actions. A water resource assessment can clarify the seasonal availability and quality of surface and/or groundwater and whether water resources are sufficient to meet current and future water needs. It is preferably performed on a specific river basin or sub-catchment so that the boundaries are clear and there are limited, well-defined water flow exchanges with neighboring areas. Water resource assessments typically include analyses of water availability, water demand, and water quality.

WATER AVAILABILITY

Estimation of available water in the basin or sub-catchment includes an analysis of the entire water cycle (Figure 5): precipitation and evaporation; evapotranspiration (where vegetation and crops lose water to the atmosphere through transpiration); runoff and aquifer recharge; and return flows from shallow groundwater.

BOX 2: DATA USED TO CALCULATE PAST, PRESENT, AND FUTURE AVAILABLE WATER IN A BASIN

Meteorological data: Historical data series of daily or monthly precipitation, temperature, relative humidity, wind, and solar radiation

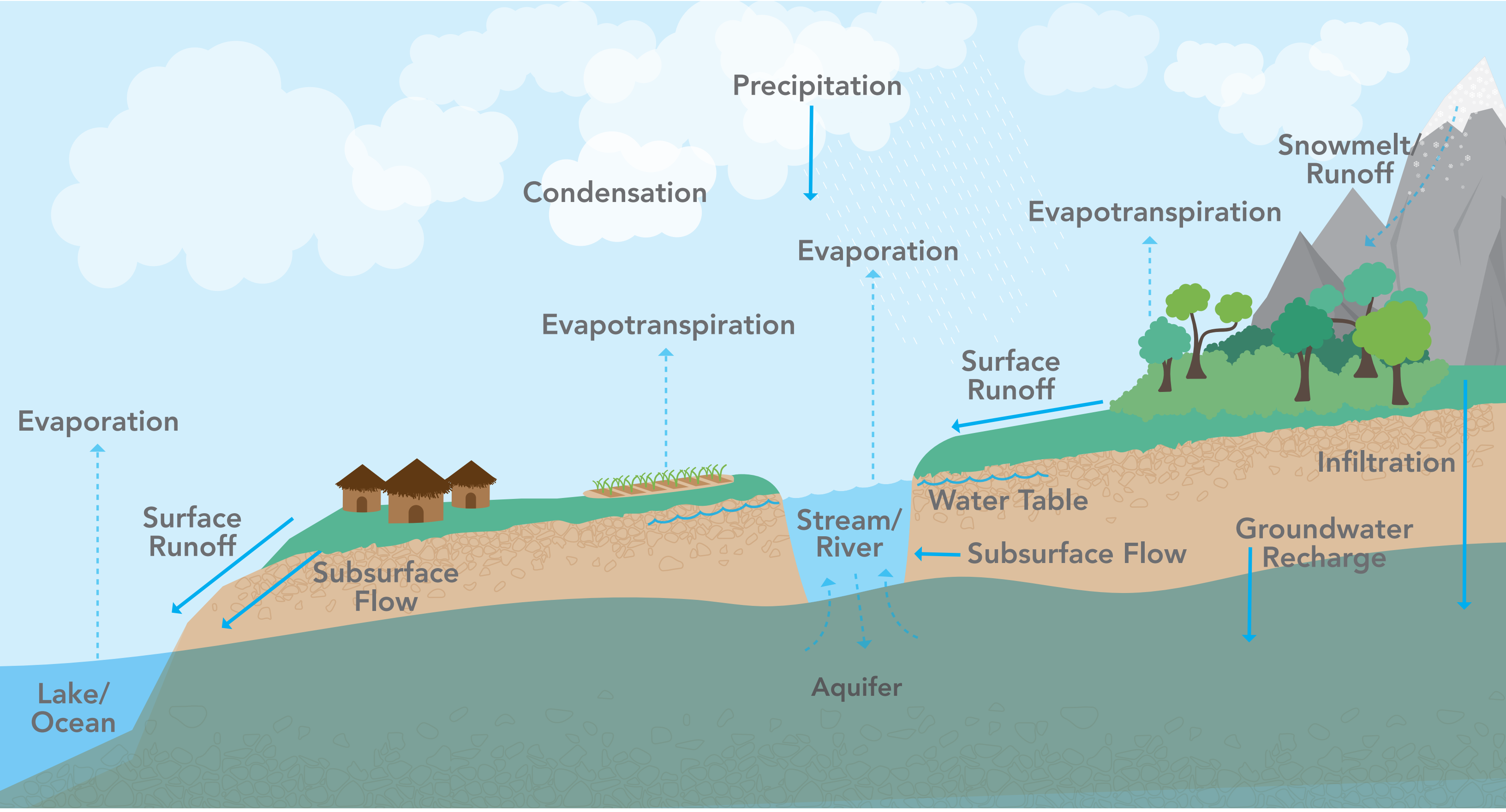
Hydrometric data: Historical data series of daily or monthly river flows at gauging stations

Physiographic data: Data on river networks, topography, elevation, soils, sub-basins borders, hydrogeology, land uses, and political boundaries

Hydrologic Analysis. Available water is calculated using rainfall-runoff hydrologic models to estimate available water throughout the basin, including areas where no measured data is available. These models rely on meteorological, hydrometric, and physiographic data (Box 2). Rainfall-runoff models use mathematical equations to represent each of the processes in the water cycle and their interrelationships to estimate surface runoff, aquifer recharge, and subsurface flows from rainfall. Watershed characteristics such as soil type, geomorphology, vegetation cover, and land use are represented as parameters within the models. Model calibration is necessary to accurately replicate historical series of measured hydrometric (river flow) data from gauging stations, simulate stream flows where no data exists, and/or to simulate the localized response of river flows from changes in land use or water abstractions in the future. Hydrologic analysis aims to answer the following questions:

- What is the streamflow at any point of the river network within the basin or sub-catchment?
- How does the streamflow vary from month to month within a year?
- What are the changes in streamflow due to variations in precipitation and temperature from climate change?
- What is the magnitude of streamflow caused by extreme precipitation events?
- How do land use changes affect the streamflow within the watershed?

FIGURE 5: THE WATER CYCLE



Future water availability. The water resource assessment should define and quantify the uncertainties in future water availability. Predictions of future water availability rely on assumptions about the continuance or variation of trends in the climate, economy, land use, demographics, and politics. Climate change has added increased uncertainty into future projections of available water (see Box 3). Climate change trends affecting available water include changes in the duration of wet and dry seasons and increases in the intensity and frequency of storm events.

BOX 3: HYDROLOGIC STATIONARITY AND CLIMATE CHANGE

Hydrologists use historic hydrologic data, going back as far as possible, to design water structures and assess risks like floods and droughts. The Nile River, for example, has 150 years of river flow data. The use of historic data is based on the principle of hydrologic stationarity, which assumes that, statistically speaking, the future will look like the past within human timescales of a few decades. Climate change is challenging hydrologic stationarity as weather patterns have started to change more quickly. Historic data remains the only available reference and can still be used to predict future conditions and guide water management, but sufficient safety margins must be included to account for the uncertainty of future weather. As climate models improve, they provide more accurate ranges for future weather conditions.

WATER BALANCE

A water balance calculation is an accounting exercise to compare the availability of water in a specific area with water demand for all uses and water reserved for specific purposes such as the environment. The goal is to define spatial and seasonal surpluses and deficits. The water balance equation is:

$$\text{Water Balance} = \text{Available Water} - (\text{Demand} + \text{Reserve})$$

A negative water balance indicates a deficit: water demand plus reserves exceeds availability. A water deficit is unsustainable and may require restrictions on water withdrawals. A positive water balance indicates that water is available for allocation to new users and/or to accommodate future increases in demand.

The water balance supports stakeholder understanding of how much water is available, where, and when, including seasonal variability. The water balance can also be used to project future changes in water supply and demand due to factors such as population growth, economic development, land use, and climate change.

FIGURE 4: PROJECTED WATER BALANCE FOR A SUB-BASIN OF THE MARA RIVER BASIN IN TANZANIA (m^3/day)

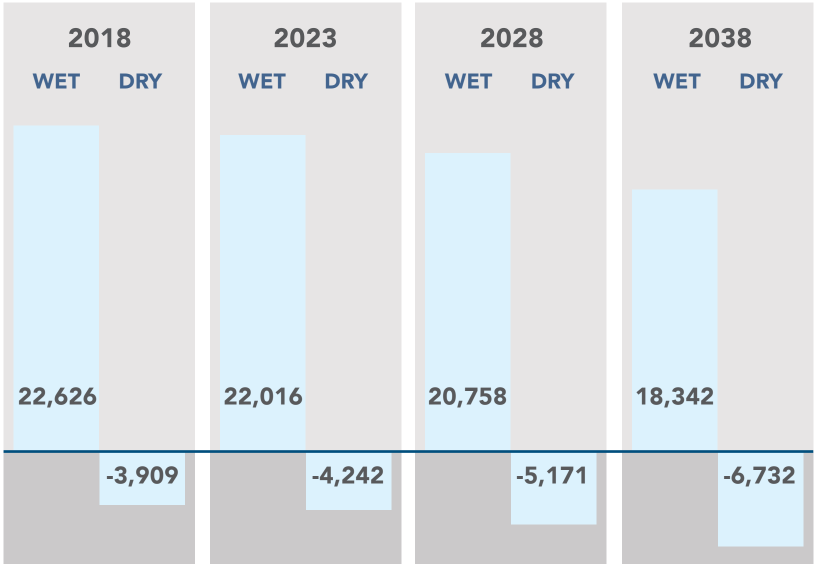


Figure 4 shows the 2018 water balance for a sub-basin in the Mara river basin in Tanzania, as well as projections of the water balance for 2023, 2028, and 2038. The current dry season deficit is expected to increase due to increased future water demand. In the wet season, the water balance is positive and is projected to satisfy future demands through 2038. Understanding the magnitude of water availability and demand is critical to solving water-related problems addressed through the WSI process.

Water demand by sector. Water demand is the volume, quality, and timing of water that users depend on for their basic needs and livelihoods. An inventory of the quantity of water used by all sectors is key to understanding the current water demand by sector in a basin and projecting future water demand. Usually it is not possible to do an inventory of all current water uses, but water use surveys can help estimate the cubic meters per day used by each sector, allowing determination of a unit factor (e.g. 200 liters/bed/day for tourism). Unit factors can be applied to estimate demand in other areas where water inventories are not available. Governments may also have guidelines which specify water demand estimates for key sectors such as domestic use, livestock, and industry; these guidelines can be used to estimate demand if water use inventories are not available.

Evaluation of environmental flows. Water resource managers may decide to set aside a certain quantity of water to support ecosystems and meet basic human needs for drinking water and hygiene. The concept of environmental flows refers to the availability of water in rivers, wetlands, lakes, and deltas to preserve ecosystems and the livelihoods of communities that rely on them. Water reserves for basic human needs (drinking and hygiene) can be calculated using factors (liters per day per person) for different economic sectors and dwelling characteristics based on government or WHO guidelines. Environmental reserves are the flow and river depth requirements for dry and wet periods based on the riparian vegetation, water quality, river geomorphology, fish habitats, macroinvertebrates, and social and cultural considerations (USAID SWP, 2018).

WATER QUALITY

Water quality can be a key risk factor in water security. Poor ambient water quality may impact ecosystem services and use of water for agriculture, industry, and energy production and increase the cost of treating water for drinking. It is important to differentiate between ambient and drinking water quality challenges as they involve different considerations of the physical, biological, and chemical characteristics of water resources for the natural environment, economic activity, and for use by humans.

BOX 4: TYPICAL DRINKING WATER TEST PARAMETERS

Physical
- Electric Conductivity
- Temperature
- Total Dissolved Solids
- Turbidity

Pathogens
- E-Coli
- Fecal coliform

Chemical
- Arsenic
- Chlorine
- Fluoride
- Iron
- Manganese
- Nitrate (as NO3)
- Sulfates
- pH

Testing drinking water quality. Water quality assessments collect data on surface and groundwater resources at water usage points (e.g., after abstraction, storage, conveyance, and treatment). If existing water quality data is insufficient, you may want to test the water quality at source and usage points. You can use testing equipment that provides real-time results, or you can collect field samples and send them to a laboratory for analysis.

To protect public health, many countries follow water quality standards set by the World Health Organization. Typical water testing parameters for drinking water are shown in Box 4. Depending on local conditions, additional parameters can be included as specified in the WHO Guidelines for Developing Drinking-Water Quality Regulations and Standards (WHO, 2018). Drinking water quality standards help determine the level of water treatment needed if local indicators exceed the permissible levels.

Testing ambient water quality. WHO has also developed guidelines for safe recreational water environments (WHO, 2003). Ambient water quality standards are a function of the designated use for the water body (e.g. drinking, recreation with and without contact, irrigation). Ambient water quality parameters (Box 5) are used to monitor the water quality in rivers, lakes, and wetlands and to guide or regulate industrial, urban, and agricultural effluent releases. Monitoring of these parameters helps detect diffuse or non-point source pollution, such as over-application of agricultural fertilizers and pesticides, which can contaminate groundwater over time.

Surface water quality modeling. Water quality models are important tools to assess the impacts of the discharge of contaminants into surface waters, and to evaluate the effectiveness of pollution control options to keep pollutant concentrations levels within permissible levels. Water quality models use mathematical equations to simulate the physical transport and chemical and biological transformations of pollutants within a water body. Water quality models can help answer the following illustrative questions:

- What is the impact of upstream pollution on downstream water quality?
- Do concentrations of contaminants in effluent discharged into surface waters exceed permissible levels? If so, how much do contaminant levels need to be reduced to meet permissible concentration levels in surface waters?
- How much would contaminant concentrations be reduced by different wastewater treatment options?
- What are the sediment or nutrient loads from upstream areas, and how would these loads increase or decrease with future land use changes or management practices?

Guidance on Conducting A Water Resource Assessment

- JMP. 2016. Manual for Water Quality Testing
- USAID SWP. 2020. Data for Water Security
- USAID SWP. 2018. Environmental Flows Technical Guidance Manual
- USAID SWP. 2020. Lower Mara River Basin Water Demand Assessment
- USAID SWP. 2020. Lower Mara River Basin Water Availability Assessment
- USAID SWP. 2020. Lower Mara River Basin Model
- USAID SWP. 2020. Lower Mara River Basin Water Abstraction Survey Report
- USAID. 2018. Designing Climate Vulnerability Assessments
- World Health Organization (WHO)/United Nations Children's Fund (UNICEF) Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP). 2016. Multiple Indicator Cluster Survey (MICS) programme
- WHO. 2018. A global overview of national regulations and standards for drinking water quality

An SWP Cambodia staff member performs water quality testing in the field.

- WHO. 2018. Developing drinking-water quality regulations and standards
- WHO. 2003. Guidelines for safe recreational water environments. Volume 1: Coastal and fresh waters
- WHO. 2012. Rapid Assessment of Drinking-Water Quality: A handbook for implementation
- WMO. 2012. International Glossary of Hydrology
- World Meteorological Organization (WMO). 2012. Technical Material for Water Resources Assessment

Tools for Conducting A Water Resource Assessment

- Food and Agriculture Organization of the United Nations (FAO). Aquastat Database
- Stockholm Environmental Institute (SEI). Water Evaluation and Planning (WEAP) System
- Texas A&M University. Soil Water Assessment Tool
- USAID SWP. 2018. Analytical Tools to Support Water Security Decision-Making
- Winrock International. The Watershed Ecosystem Services Tool (WESTool)
- WMO. 2019. Dynamic Water Resources Assessment Tool (DWAT)
- World Resources Institute (WRI). Aqueduct Tool

BOX 5: TYPICAL SURFACE WATER QUALITY TESTING PARAMETERS

Physical
- Electric Conductivity
- Temperature
- Total Dissolved Solids
- Turbidity

Pathogens
- E-Coli
- Fecal coliform

Chemical (organic and inorganic)
- Biological oxygen demand
- Dissolved oxygen
- Heavy metals
- Hydrocarbons
- Phosphorus
- Nitrogen
- Pesticides
- pH
- Salinity

Water Governance Assessment

> **BOX 6: WATER REGULATIONS AND GESI**
>
> Water laws and policies may affect gender equity and vulnerable groups in ways that are not always obvious. Examples include:
>
> - Laws that prevent women from owning or inheriting land may limit women's access to water
> - Water tariffs may not be tailored to the needs of low-income households
> - Citizenship laws may prevent immi- grant and refugee communities from securing formal water rights

Water governance is defined as the "range of political, institutional and administrative rules, practices and processes (formal and informal) through which decisions are taken and implemented, stakeholders can articulate their interests and have their concerns considered, and decision makers are held accountable for water management" (OECD, 2015). You will want to conduct a rapid, participatory assessment to understand how power, politics, and political economy influence the governance of water resources. Good governance takes place when there is transparency in the sharing of information, priorities, and decisions; when there are equitable and ample opportunities for different types of stakeholders to participate in water management; when resources are efficiently and effectively allocated and utilized; and when there are mechanisms to ensure the accountability of stakeholders and institutions. A governance assessment should examine these principles against policy frameworks, institutions, and processes.

Political economy analysis. A political economy analysis (PEA) can be a helpful first step in the governance assessment as it examines the interests and incentives that influence the WSI process, and the behaviors of champions, enablers, and inhibitors. The goal is to understand the influence or power that key stakeholders yield, and the political and economic dynamics within the target geography.

Policy review. A governance assessment should review the laws, policies, regulations, customs, and enforcement mechanisms that define how water should be managed, distributed, and used. Issues addressed by the policy framework may include permitting requirements for water abstraction and use; performance metrics for different types of service providers; water tariffs and price setting; definitions of water rights; and water quality standards. Key questions addressed by a policy review include:

- What are the key water laws and policies that govern the water sector and what do they stipulate?
- Are there gaps or inconsistencies in water-related laws and policies? If so, what effect do they have on water governance?
- How are water rights are defined, recorded, and enforced? Are water rights tied to land rights or land tenure?
- How are water service providers licensed and regulated? How well do service providers perform?

Mapping of institutions and processes. A governance assessment should map institutions and processes to identify who is involved and analyze how they interact. Institutions, which may be formal or informal groups, may include public or privately-owned or operated water service providers, local-level water user associations, cooperatives, and village-level water committees. Institutions may have national, regional, or local mandates for policy setting, permitting and enforcement, stewardship of water resources and water quality, and delivery of drinking water, irrigation water, and sanitation services. An assessment of water governance processes will examine who is included in policy and regulatory decision-making, how water-related funding is allocated, and how water-related conflicts are resolved. Key questions addressed through mapping of institutions and processes include:

- What are the technical and managerial capabilities of water management institutions?
- How are water management institutions funded? How are resources allocated to meet water management goals? Are these resources sufficient?

How are communities or stakeholders involved in water management? What role do community-based water organizations play? What are their technical and managerial capabilities and funding needs? policymaking, planning, and decision-making processes?

What mechanisms exist to ensure equitable representation of different groups (men, women, youth, elders, people with disabilities)?

What mechanisms are used to raise awareness and share information with all community members about water issues, such as resource management and climate impacts on water availability?

How do social structures such as traditions, governance, religion, rights, and the relative status of different groups promote or impede men's and women's ability to access and manage water resources and infrastructure?

FIGURE 6: SWP'S ASSESSMENT OF THE MARA RIVER BASIN JOINT MANAGEMENT COMMITTEE.

METHODOLOGY AND ANALYSIS

- Desk review on transboundary water institutions around the world
- Survey of 12 institutional stakeholders
- Focus Group Discussions with thirty key informants in Kenya and Tanzania
- Defined 15 criteria for assessing the institutional status of the Mara River Basin Joint Management Committee

RESULTS

- Clarified key barriers to implementing the transboundary Memorandum of Understanding
- Clarified stakeholder priorities for capacity building and opportunities for improved transboundary management
- Recommended actions to strengthen transboundary governance institutions responsible for the Mara River Basin

One example of an institutional assessment is shown in Figure 6. In 2015, the governments of Kenya and Tanzania signed a Memorandum of Understanding (MoU) to cooperate on the sustainable development, management, and equitable utilization of water resources in the Mara River Basin. The MoU established a Joint Management Committee (JMC) to oversee the technical, programmatic, and operations aspects of managing the Mara River Basin. SWP conducted an institutional assessment of the JMC's effectiveness in implementing the MoU. The assessment helped clarify priorities among stakeholders and identified opportunities for strengthening the JMC's efficiency and effectiveness in implementing the MoU.

Organizational capacity assessment. If there are institutions or informal groups that need strengthening in order to effectively contribute to the WSI process or to implementation of water security action plans, you may want to conduct a participatory organizational capacity assessment to create a capacity building plan.

Guidance on Conducting A Water Governance Assessment

- Water Integrity Network (WIN). 2013. User Guide on Assessing Water Governance
- Organisation for Economic Co-operation and Development (OECD). 2018. OECED Water Governance Indicator Framework
- USAID Sustainable Water Partnership.
- USAID. 2020. Water Security, Sanitation, and Hygiene Governance
- USAID. 2018. Thinking and Working Politically Through Applied Political Economy Analysis
- USAID. 2018. Applied Political Economy Analysis Reference Materials
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- USAID. Local Capacity Development: Suggested Approaches
- USAID. 2015. Measuring Organizational Capacity
- USAID. 2017. Capacity 2.0

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