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SWP
SUSTAINABLE WATER PARTNERSHIP

Toolkit #6

MONITORING THE IMPROVEMENT OF WATER SECURITY

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.

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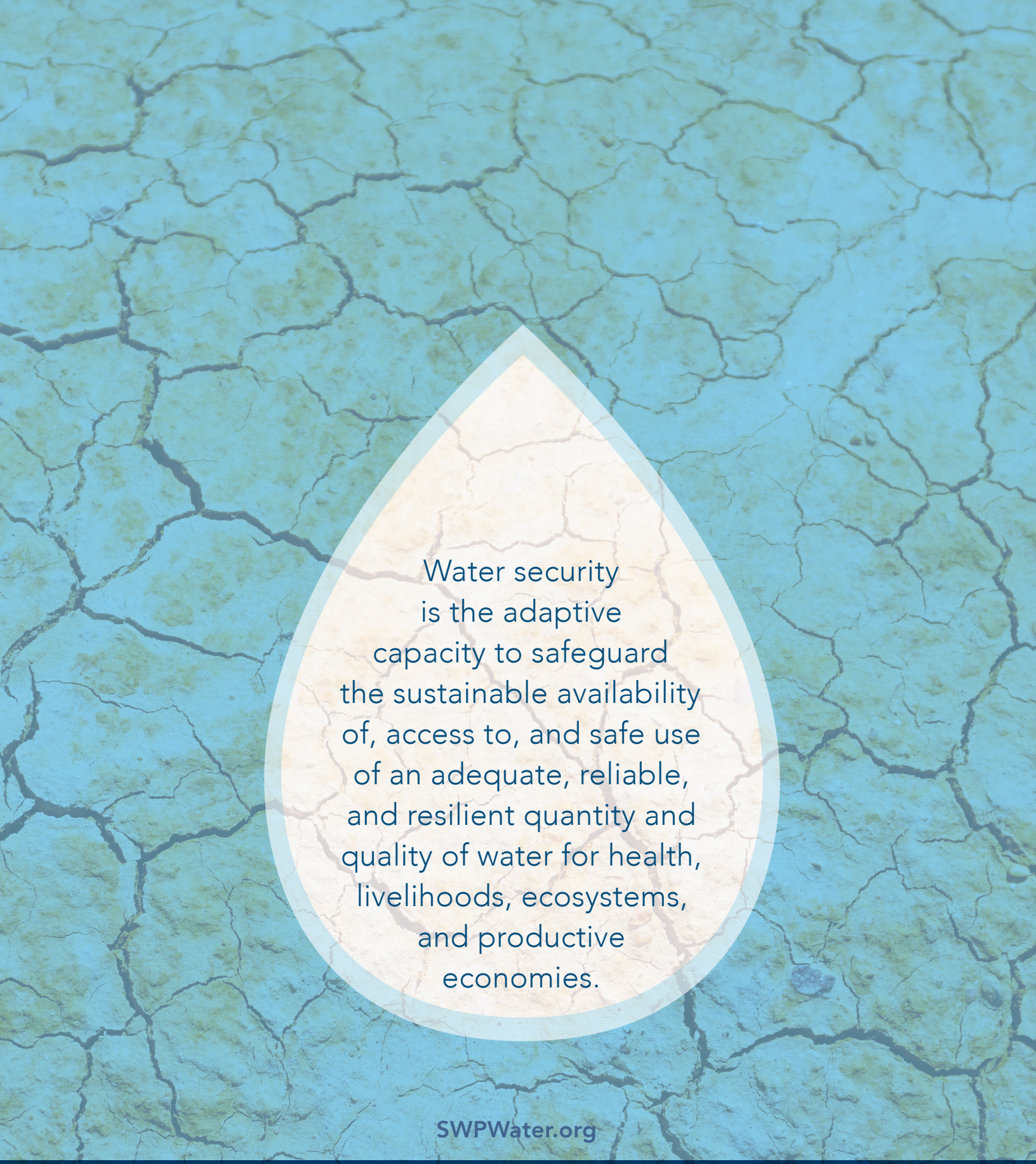

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INTRODUCTION

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 (Figure 1) to assess, plan, and implement water security interventions in a targeted geography. The WSI toolkits provide guidance, suggested activities, and examples from the USAID Sustainable Water Partnership's pilot activities in the Stung Chinit Basin in Cambodia and the Mara River Basin in Kenya and Tanzania.

This Toolkit describes key elements of water security monitoring and leveraging monitoring information for water security improvements. This toolkit is part of a series of toolkits aimed at water managers, planners, practitioners, and decision-makers within 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

Confirm and initiate

STEP 1 **Define geographic/technical/institutional/temporal space** (Toolkit #2)

STEP 2 **Assess water risks** (Toolkit #2)

STEP 3 **Prepare water security action plan** (Toolkit #3) **and fund it** (Toolkit #4)

STEP 4 **Implement water security actions** (Toolkit #5)

STEP 5 **Monitor, evaluate and adapt** (Toolkit #6)

MONITORING WATER SECURITY

Monitoring water security is a continuous process of tracking and assessing information with the intent of improving decision-making and performance to achieve better results. The goal is to monitor the status of water resources, track the capacity of stakeholders to understand water risks and make informed decisions, validate the results of implemented actions, detect changing conditions or contexts, and document successes and failures.

Measuring progress towards water security is complex because:

1. Perceptions of water security can vary between water users and decision-makers;
2. Measuring, qualifying, and quantifying water security can be resource intensive, highly technical and may involve complex interpretation of large datasets;
3. Water security can vary significantly across geographies and over time and aggregations to larger spatial or temporal scales can be misleading; and
4. There are many uncertainties that can confound assessments and predictions.

Because water security is inherently broad, it is important to consider what needs to be monitored and why. Three key areas to consider monitoring are:

1. **Water Resources:** The availability and quality of water resources across space and time and the magnitude and likelihood of key risks to water resources.
2. **Water Security Actions:** Achievements of key interventions against targets and expected outputs/outcomes.
3. **Performance Improvements:** The performance of water management entities, service providers, and stakeholder groups with respect to key responsibilities, such as water distribution, service delivery, permitting and regulation, financial performance, and risk mitigation.

Each of these are interrelated and important to the WSI process. Together, they provide insight into improvements or changes in the environmental conditions of water resources; management and governance of water resources; and the effectiveness of implemented actions. They will also help track or monitor the impacts of risk factors such as climate change, natural disasters, land use practices, and changes to political, economic, or social conditions that may impact water resources and water security.

BOX 1: SUSTAINABLE DEVELOPMENT GOAL 6: CLEAN WATER AND SANITATION

Sustainable Development Goal 6 is a useful starting point for monitoring water security as it focuses on the availability and sustainable management of water and sanitation. SDG 6 goals and indicators can provide a preliminary perspective on the degree of access to water and sanitation, water availability and water quality, and governance within a particular country. SDG 6 has several key sub-goals that pertain to water resources and water security and each sub-goal has indicators that can be used to monitor the water security improvement process:

- SDG 6.1 Achieve universal and equitable access to safe and affordable drinking water for all
- SDG 6.2 Achieve adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls in vulnerable situations
- SDG 6.3 Improve water quality by reducing pollution, eliminating dumping, and minimizing the release of hazardous chemicals and materials, halving the proportion of untreated wastewater, and increasing recycling and safe reuse globally
- SDG 6.4 Substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity
- SDG 6.5 Implement integrated water resources management at all levels, including through transboundary cooperation as appropriate
- SDG 6.6 Protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers, and lakes
- SDG 6.a Expand international cooperation and capacity building to support developing countries in water- and sanitation-related activities and programs, including water harvesting, desalination, water efficiency, wastewater treatment, recycling, and reuse technologies
- SDG 6.b Strengthen the participation of local communities in improving water and sanitation management

MONITORING WATER RESOURCES

Water resource monitoring involves regular measurement of the quantity and quality of surface and groundwater with reasonable spatial and temporal resolution. Measurements should occur at a sufficient number of fixed locations and at regular intervals. Monitoring water resources also involves tracking water abstractions by different types of water users, including service providers, irrigators, and industry.

Monitoring Stress

Monitoring water availability and water quality is a critical part of water security. Monitoring helps ensure water is reliable and adequate for domestic use and public health, economic growth, environmental sustainability, and ecosystems. Water stress and scarcity are helpful concepts for evaluating the potential risks of over-abstraction and water quality challenges. The widely referenced Falkenmark Water Stress Index classifies locations as experiencing water stress, scarcity, and absolute scarcity based on the average availability of water per person. SDG 6.4 measures water stress as the percentage of freshwater withdrawals against total renewable freshwater resources:: no stress <25%, low 25%-50%, medium 50%-75%, high 75%-100%, and critical >100%.

TABLE 1: FALKENMARK WATER STRESS SCALE

Water Availability (m^3/person/year)	STRESS LEVEL
> 1,700	No Stress
1,000 - 1,700	Stress
500 - 1,000	Scarcity
< 500	Absolute Scarcity

Composite water security indices can also be helpful for characterizing water security. The Asian Development Bank proposes a National Water Security score (0-100) based on five key indicators: household water security, economic water security, urban water security, environmental water security, and resilience to water-related disasters. The International Water Management Institute proposes a similar index that is the sum of five indicators: basic household needs, food production, environmental flows, risk management, and water independence. Other attempts have also been made to aggregate water security dimensions at the basin level. These indices incorporate access to water services, hydrology and environmental status, health and economic conditions, and policy considerations, such as the level of water user participation.

Water Quantity Monitoring

Water quantity monitoring refers to measuring the levels and flows of rivers, aquifers, reservoirs, other bodies of water, and associated weather conditions. Water quantity measurements can also focus on uses and withdrawals through metering of bulk and individual water users. This information is used to understand where water resources are conveyed and used; to enforce allocations, regulations and permits; and to improve water use efficiency.

TABLE 2: WATER QUANTITY MEASUREMENT TOOLS

MEASUREMENT	TOOL	PURPOSE
Rainfall	Rain gauge (possibly automated)	Informs water availability, groundwater recharge, flood risks, etc.
Weather (temperature, wind, humidity, evapotranspiration)	Weather station (possibly automated)	Informs crop water needs for farmers
River flows	Gauging stations record river levels, punctual flow measurements translate levels into discharges	Informs water availability and design of water structures, real-time information for water operations, flood/drought forecasting, etc.
Level of lakes, reservoirs, and surface water	Gauging stations and visual measures record increase or decrease in surface water. Satellite measurement is also used to compare seasonal and long-term changes of lakes and strategic reservoirs.	Informs water availability and design of water structures, real-time information for water operations, flood/drought forecasting, etc.
Aquifer levels	Observation wells record aquifer levels. Hydrogeological surveying to size the volume and seasonal behavior of the aquifer.	Informs water availability (current and future).

Water Quality Monitoring

Water quality monitoring focuses on the condition of rivers, lakes, aquifers as well as distributed waters and raw or treated wastewater. Water quality monitoring uses physical (e.g., temperature, conductivity, turbidity), chemical (e.g., pH, oxygen demand, presence of heavy metals, phosphates and nitrates), and biological (in particular bacteriological) indicators to measure ambient and drinking water quality. These all have significance for public or environmental health.

BOX 2: A MATTER OF PERSPECTIVE: PROTECTING AGAINST FLOODS

Planners and hydrologists must consider the level of protection or security needed against extreme flooding. Flood protection measures require stakeholders to define the threshold against designed protection measures. For example, structures may be designed to protect against the 10-year flood, which has a 10% chance of happening in any given year, or a 100-year flood. For urban areas, the 50-year or 100-year flood are often prioritized whereas protections are either ignored or limited to the 10-year flood in rural areas. Comparing protection costs to estimates of potential damage can help decision-makers but it is increasingly important to consider how climate change will impact these costs as flooding becomes more frequent and extreme.

TABLE 3: WATER QUALITY MEASUREMENTS

MEASUREMENT	SOURCES	SIGNIFICANCE
Temperature	Domestic sewage and industrial effluent	Impact aquatic ecosystems and suitability for agriculture and domestic uses
pH (acidity-alkalinity)		
Fecal coliforms	Domestic sewage and livestock	Increased public health risks, such as diarrhea
Nitrogen and phosphorus	Agriculture (pesticides, fertilizers) and sewage (domestic, industrial)	Impact aquatic ecosystems and increase public health risks and water treatment costs.
Dissolved oxygen	Sewage (domestic and industrial)	
Suspended sediment – turbidity		
Chemicals, heavy metals, and minerals (e.g., chromium, arsenic, cadmium, mercury, lead, iron, fluoride)	Naturally occurring, industrial effluent	Public health risks, such as increased risk of cancer and fluorosis

MONITORING WATER SECURITY ACTIONS

BOX 3: KEY TERMS

Goal: The higher-order objective to which a project, program, or policy is intended to contribute

Objective: A statement of the condition or state one expects to achieve.

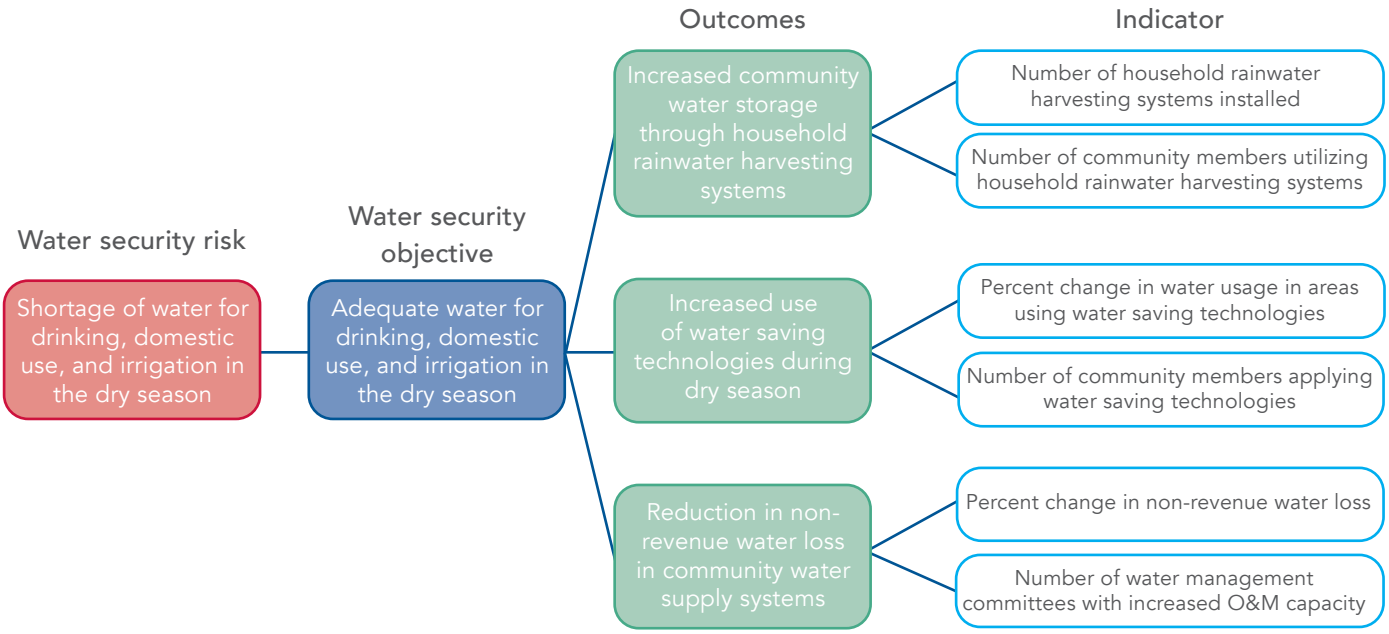
Outcome: A results or effect that is caused by or attributable to the project, program or policy. Outcome is often used to refer to more immediate and intended effects.

Indicator: Quantitative or qualitative variable that provides reliable means to measure a particular phenomenon or attribute.

Monitoring water security actions involves defining key goals, objectives, and outcomes that the actions will achieve and using indicators to track progress or improvements of these actions (See Toolkit 3). Goals, objectives, and outcomes can be organized in a results framework or theory of change diagram to show how the activities will lead to achievement of the water security goals. When selecting indicators, it is important to consider what data is available, where it is stored, and how it is managed as well as the indicator definition, the methodology for collecting the data, and frequency of data collection.

Below is an example that demonstrates the linkages between the water security risks, objectives, outcomes, and indicators used in SWP's pilot activity in the Stung Chinit Basin in Cambodia. The objective represents what stakeholders sought to achieve through the WSI process to address the risk of water shortages. The outcomes represent necessary changes to achieve the objective and the indicators measure progress of key actions or activities against the desired outcome.

FIGURE 2: INDICATOR EXAMPLE - CAMBODIA WATER SHORTAGE



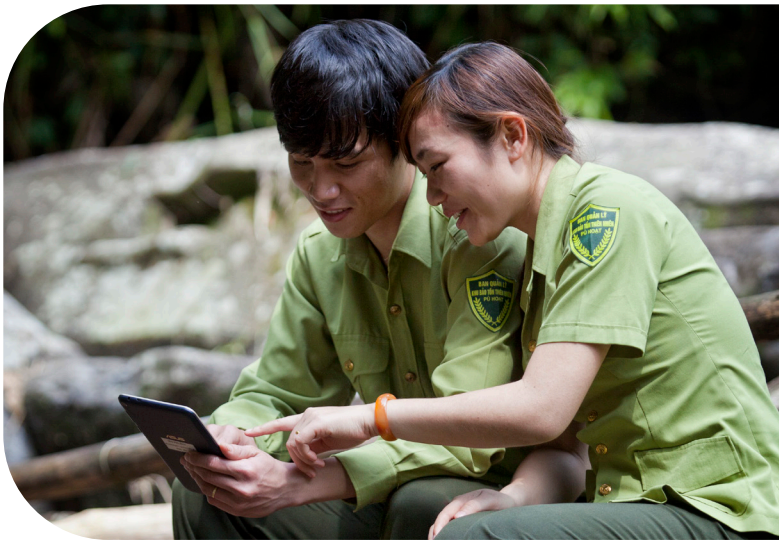
Indicators should be clearly defined and measurable for different water security risks. In some cases, it may be important to use Gender and Social Inclusion (GESI) specific indicators because women and socially marginalized groups disproportionately experience water security risks and are often excluded from planning and decision-making processes. Disaggregated indicators can also be used to monitor the impact of the water security activity on a specific group of people or demographic and identify disparities between different groups. The table below identifies illustrative indicators that can be used for the four types of water security activities.

TABLE 4: WATER SECURITY INDICATORS

WATER SECURITY ACTIVITY	EXAMPLE INDICATORS
GRAY INFRASTRUCTURE	Volume of water stored Volume of water treated Number of repairs completed Number of people served Number of hectares irrigated Number of hectares protected from flooding
GREEN INFRASTRUCTURE	Number of hectares reforested or protected from erosion Number of hectares under improved land use Number of hectares of protected wetlands Aquifer recharge in mm/year Sediment load in tonnes/ha/yr Flow rates/flow regulation Improvements in water quality
SOCIAL BEHAVIOR CHANGE CAMPAIGNS	Number of households/people applying water saving practices Number of farmers applying improved irrigation techniques Number of households/people with improved awareness of water risks (e.g., floods, droughts)
INSTITUTIONAL IMPROVEMENTS	Percent of operations/maintenance costs recovered Amount of financing leveraged for water sector improvements Number of meters installed Percent improvement in non-revenue water loss Number of water management plans implemented Percent of disadvantaged groups involved in water decision- making Number of local water user associations organized or strengthened

BOX 4: MEASURING SATISFACTION

User satisfaction surveys can be used to evaluate whether water security improvements are effectively addressing water users' concerns and priorities. Users must be reasonably aware of the benefits received and their causality (e.g., health benefits from clean water). Such household surveys can also monitor the level of knowledge and awareness of water users and help define and focus behavior change campaigns, provide feedback on the governance and functioning of institutions, and ensure participation of communities in decision processes. One example survey tool is the Household Water Insecurity Experiences (HWISE) Scale. HWISE Scale measures household feedback on a variety of issues, including satisfaction with water services and availability, water access concerns, and household health challenges.



MEASURING PERFORMANCE IMPROVEMENTS

Measuring performance improvements focuses on stakeholders and institutions as well as the broader governance framework. Stakeholder and institutional capacity is key to fulfilling key water management responsibilities including service provision of drinking water and sanitation; water resources management, planning, and allocation; organizing and regulating water uses; and managing risks such as floods and droughts. Measuring performance improvements for water management entities and water user groups requires a baseline assessment of key variables related to capacity and performance. This baseline will be used to measure or monitor progress as capacity building and institutional strengthening activities are completed. Measuring the water governance framework can also be an important tool for assessing water security improvements. This includes examining the factors like the enforcement of water laws and policies, funding or resources mobilized, and permitting systems. The tables below illustrate the types of indicators to consider when seeking to monitor performance improvements as they relate to water management.

TABLE 5: WATER UTILITIES

THEME	EXAMPLE OF INDICATOR
WATER USE EFFICIENCY	Volume of water sourced, distributed, used, and billed
QUALITY OF SERVICE	Number of hours of service per day, number of complaints, number of leaks
SERVICE COVERAGE	Percent water supply coverage, percent treated wastewater
OPERATIONAL EFFICIENCY	Number of staff per 1,000 connections, non-revenue water (physical and administrative losses)
WATER QUALITY PERFORMANCE	Number of tests performed, water quality test results
FINANCIAL PERFORMANCE	Cost recovery, percent bill collection, operation and maintenance costs

TABLE 6: IRRIGATION MANAGEMENT AGENCIES

THEME	EXAMPLE OF INDICATOR
WATER USE EFFICIENCY	Volume of water mobilized, conveyed, and delivered Ratio of crop water needs to gross abstracted volume Crop water productivity (tons per m^3)
QUALITY OF SERVICE	Number of complaints or customer satisfaction survey
FINANCIAL PERFORMANCE	Cost recovery, percent fee collection, operation and maintenance costs

TABLE 7: WATER MANAGEMENT AGENCIES

THEME	EXAMPLE OF INDICATOR
WATER MONITORING	Number of functional water quality/quantity monitoring stations Number of site visits to water quality/quantity monitoring stations
WATER INFORMATION/ COMMUNICATIONS	Number of public datasheets produced and disseminated Number of people engaged through water awareness campaigns
REGULATION	Percent of withdrawal volumes covered by water rights/permits Percent of effluent releases covered by permits Percent of water quality tests complying with standards Number of regulations enforced
STAKEHOLDER PARTICIPATION	Number of public meetings held Number of local leaders involved in water decisions Number of local water user associations engaged in water management processes Number of women and youth holding leadership positions in water management entities
PLANNING/MODELING	Number of risk management plans developed (water allocation, drought, flood)
RISK FORECASTING	Number of functional early warning systems Number of risk assessments completed (drought, flood, etc.)
FINANCIAL PERFORMANCE	Percent fee collection

LEVERAGING MONITORING FOR LEARNING AND ADAPTIVE MANAGEMENT

Adaptive management involves using information collected from the monitoring process and leveraging lessons learned to adjust or refine the scope of water security improvement activities and the WSI process. Pausing and reflecting complements the monitoring process through a deliberate review of progress against goals and assessing what has worked well and where improvements are needed in the WSI process. Pause and reflect sessions should utilize the most up-to-date information collected during the monitoring process and session discussions should be documented, analyzed, and shared among stakeholders to ensure that participants voices are heard and legitimized. Depending on the scope of the WSI space, pause and reflect sessions may involve multi-day workshops with many stakeholders or smaller and more frequent sessions with deeply involved stakeholders. The frequency of the sessions will depend on the scope of the WSI process as well, depending on stakeholder needs and progress. A skilled facilitator can be valuable in establishing an open and collaborative atmosphere for a pause and reflect. Feedback from a pause and reflect should inform potential adjustments to water security activities.

BOX 5: PAUSE & REFLECT IN PRACTICE: SWP AND THE MARA RIVER BASIN

SWP organized a Pause & Reflect workshop at the end of its third year to reflect on knowledge and learning related to the Water Security Improvement (WSI) process with representatives from the pilot activities in the Mara River Basin, Cambodia, and Southern Africa, project partners, and USAID. Participants analyzed the approaches, outcomes, and progress towards water security goals, and discussed challenges and successes in the WSI process. As a result of this effort, SWP was able to refine the Results Framework and Theory of Change for each pilot activity and draw on lessons learned on what worked well and where adjustments were needed to achieve water security goals.

Drawing on these discussions, the SWP team in the Mara River Basin refined its approach to supporting water user associations to address catchment conservation efforts. Early in the WSI process, SWP learned that deforestation was a key risk to water security in the basin but that water user associations often lacked the necessary resources to achieve catchment conservation goals. SWP also learned that communities were increasingly interested in beekeeping as an alternative, environmentally-friendly livelihood. During the Pause and Reflect session, the SWP team prepared strategy to help the water user associations to diversify funding streams through beekeeping to support catchment conservation efforts. SWP provided resources and trainings to the water user associations to set up beekeeping demonstration sites for community trainings and honey production as well as manufacture artisanal beehives that can be sold in local markets. SWP also supported the water user associations to establish indigenous tree nurseries and facilitated trainings from national forest services in Kenya and Tanzania. The water user associations committed to allocating a portion of their beekeeping revenues to reforestation and catchment conservation efforts in coordination with basin management entities in Kenya and Tanzania. SWP's case study about this activity elaborates on the intervention and lessons learned.

RESOURCES

Water security monitoring

Asian Development Bank (2016). Asian Water Development Outlook 2016: Strengthening water security in Asia and the Pacific.
Proposes a complex indicator that combines household, economic, urban, and environmental dimensions of water security, relying on both annual datasets and expert opinions, which are subjective. Although useful to compare countries, some of the index changes over the years can be attributed to changes in expert opinions as much as to real management/ structural changes.

Brown, A., & Matlock, M. D. (2011). A Review of Water Scarcity Indices and Methodologies.
A rapid review and discussion of several water scarcity indices.

GWP (2014). Assessing Water Security with Appropriate Indicators.
Seven papers presenting different approaches to measuring water security. Although thoughtful, the papers are more conceptual than practical.

Lautze, J., & Manthrithilake, H. (2014). Water Security: Converging toward common understanding through quantification.
Presents a straightforward index that sums five simple and available indicators, each scored 1 to 5.

Organization for Economic Co-operation and Development (OECD) (2015). Inventory of Water Governance Indicators and Measurement Framework.
Exhaustive listing of water and related indicators; does not provide comments or feedback on their relevance, accuracy, or feasibility/applicability.

UN Water (2018). Progress on Ambient Water Quality – Piloting the monitoring methodology and initial findings for 6.3.2.
This report presents initial findings about ambient water quality monitoring and is part of a series that track progress towards the various targets defined under SDG 6.

USAID (2015). WASH Sustainability Index Tool.
Offers a framework to assess the sustainability of 14 different types of WASH activities from institutional, management, technical, financial, and environmental perspectives. The framework uses a list of 100 close-ended questions to provide overall sustainability scores.

World Health Organization (2021). Guidelines on Recreational Water Quality: Volume 1 coastal and freshwater.
This report provides guidelines for water quality management for coastal and freshwater environments to protect public health.

References on key water indicators

Dunn, Gemma (2009). Canadian Approaches to Measuring Water Security: An inventory of indicators.
The report discusses water monitoring. Its first appendix lists 140 common freshwater-related indicators used at Canada's federal and state levels.

Cap-Net (2008). Integrated Water Resources Management for River Basin Organisations.
Provides a minimum set of 24 indicators to monitor the performance of river basin organizations. These indicators cover the main water resource management functions: water resource allocation, pollution control, monitoring, stakeholder participation, economic and financial management, information management, basin planning, and flood and drought management.

UN-Water Task Force on Indicators, Monitoring and Reporting (2010). Monitoring Progress in the Water Sector: A selected set of indicators.
Proposes a set of 15 key water sector indicators (using data from FAO, UNESCO, UNICEF, WHO, and others) that cover water availability (context), water use intensity (function), water use effectiveness (performance), and environmental sustainability (environmental performance). Also includes a discussion on assessing water governance performance.

Gender-disaggregated data

Pangare, V. (2015). Guidelines on How to Collect Sex-Disaggregated Water Data.

Seager, J. (2015). Sex-Disaggregated Indicators for Water Assessment, Monitoring and Reporting. UNESCO Publishing.

WWAP Working Group on Sex-Disaggregated Indicators (2015). Questionnaire for Collecting Sex-Disaggregated Water Data. UNESCO Publishing.
These three reports provide a comprehensive methodology for collecting gender-disaggregated data and outlines a set of priority indicators that should be considered. These tools are part of a broader effort to achieve SDG 5 to achieve gender equality and empower all women and girls, and SDG 6, to ensure availability and sustainable management of water and sanitation for all.

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