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WATER SECURITY IMPLEMENTATION

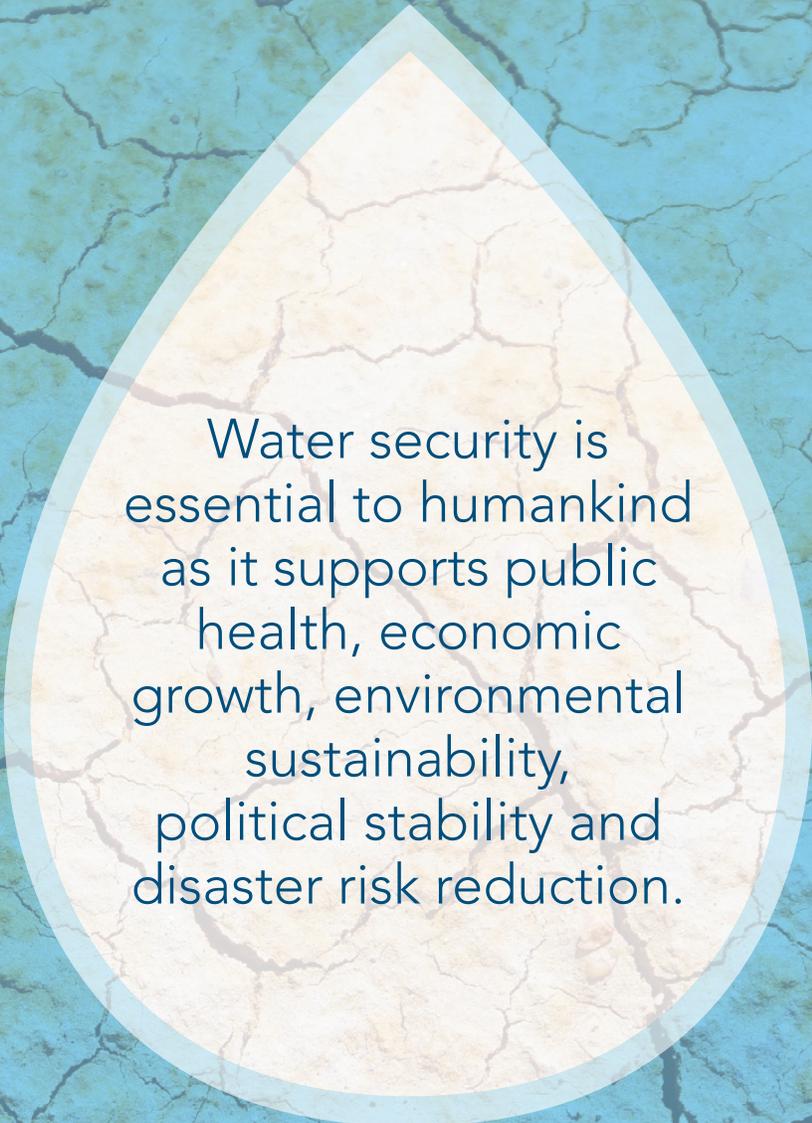
Toolkit #5



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.



The CEO Water Mandate



Water security is essential to humankind as it supports public health, economic growth, environmental sustainability, political stability and disaster risk reduction.

SWPWater.org

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PREFACE

Water Security Is Essential to Life and Humankind, by Supporting:



Public health: Safe drinking water, sanitation, and hygiene (WASH) are the most fundamental human needs.



Economic growth: Income generation and poverty alleviation heavily rely on water availability for agriculture, energy production, transportation and other livelihood activities.



Environmental sustainability: Natural ecosystems rely on water; they rapidly deteriorate when deprived of natural flows, directly affecting public health and livelihoods.



Political stability: When basic health and livelihood needs are not met, the strain on populations affects the legitimacy and sustainability of governing authorities and can lead to civil unrest.



Disaster risk reduction: Floods, landslides, droughts, tsunamis, and harmful algal blooms can be catastrophic events that claim lives, affect local economies, and may multiply due to climate variability and change.

Population growth, urbanization, industrialization, rising living standards and Westernized diets are likely to further increase the over-extraction and pollution of water resources. This will raise insecurity and uncertainty over water access and the vulnerability of communities and infrastructure to natural disasters.

This **series of toolkits** presents an effective and efficient process to address water risks, including long-term water stresses that constrain social and economic development and sudden shocks that can quickly jeopardize the health and livelihoods of vulnerable populations.

Improving water security is about focusing actors and resources on key water risks. It is also about collaboratively planning and implementing specific activities to mitigate risks and provide tangible benefits to water users. Water security activities should combine gray and green infrastructure (including improved operation and maintenance of existing infrastructure), awareness raising and behavior change campaigns, management as well as policy and institutional improvements (such as better data and better informed decision-making).

Improving water security must be a cross-sectoral theme. Development strategies and investments that ignore water security usually fall short of their objectives when water issues and conflicts undermine political and social cohesion, supply and value chains, public and environmental health, and service delivery and infrastructure operation.

The Water Security Improvement (WSI) Process



Confirm and initiate



STEP 1

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



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)



TABLE OF CONTENTS

- EXECUTIVE SUMMARY 1
- INTRODUCTION..... 2
- GUIDING PRACTICES & CONSIDERATIONS FOR IMPLEMENTATION 4
- CATEGORIES OF WATER..... 6
- SECURITY MEASURES 6
 - Supply Augmentation vs. Demand Management 6
 - Gray Infrastructure 8
 - Green Infrastructure 10
 - Policy, Regulatory, and Governance Measures 13
 - Social and Behavioral Change Measures 16
- RESOURCES 19
 - Gray Infrastructure 19
 - Green Infrastructure..... 20
 - Policy, Regulatory, and Institutional Measures 21
 - Social and Behavioral Change Measures 23



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.

EXECUTIVE SUMMARY

The success of a WSI process depends on the implementation of activities or measures defined through collaborative planning and decision-making with the purpose of addressing and mitigating priority water risks now and in the future. Implementation produces tangible results that improve water security; builds capacity and teamwork through participation; and anchors water security planning and decision-making in knowledge and evidence of what works.

Key considerations for implementing water security actions embrace and reinforce principles and themes of the entire WSI process. These include delivering “quick wins” and early results; effective communications and adaptive management; accountability by mobilizing promised resources and fulfilling responsibilities defined in action plans; and complying with regulations. A wide range of tangible actions and measures can improve water security. These can be broadly listed under four categories: gray as well as green infrastructure; policy, regulatory, and institutional measures; and social and behavioral change measures.

Table 1. Illustrative Water Security Measures



GRAY INFRASTRUCTURE

- Construction and operation and maintenance of diversion (weirs, barrages), storage (dams), conveyance (canals, pipes) and distribution (gates, valves) structures, water and wastewater treatment plants, desalination units, etc.
- Improved O&M of water structures and systems (e.g., asset management, leak detection, metering)
- Climate-proofing of infrastructure



GREEN INFRASTRUCTURE

- Agroforestry
- Afforestation and forest conservation
- Restoration and conservation of wetlands and/or coastal ecosystems
- Vegetation/bio-structural engineering for river bank or slope stabilization, erosion control, fisheries and biodiversity, and stormwater management (e.g., reduction of runoff and sedimentation)
- River and floodplain management (e.g., riparian buffers, controlled flooding, levee setback/removal)



POLICY AND INSTITUTIONAL

- Enforcement of water and related laws, decrees, bylaws, policies, etc.
- Preparation and implementation of water security strategies, action plans, etc.
- Water monitoring (e.g., data collection, storage, analysis, dissemination)
- Collection of water taxes, tariffs, and fees
- Enforcement of water and land rights, water permits
- Allocation planning and enforcement
- Establishment of and support to basin committees/boards/agencies and water user associations
- Regulation of water services



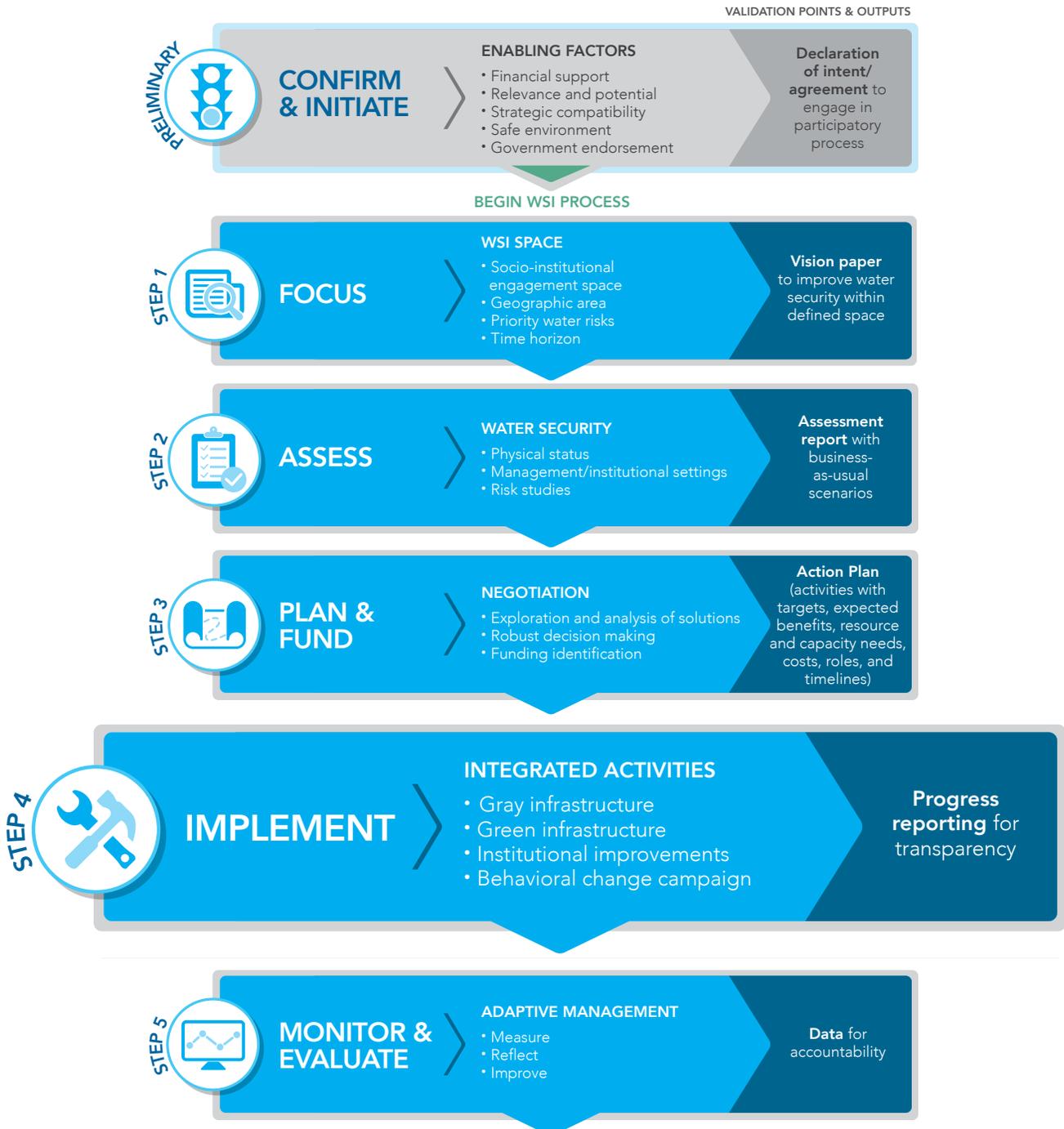
SOCIAL AND BEHAVIORAL

- Awareness-raising and social marketing campaigns (regarding water security risks, improved water use behaviors and practices, etc.)
- Capacity-building of water users (e.g., soil and water management for farmers)
- Livelihoods diversification
- Collective action, community mobilization (river bank or pond cleanups, waste and wastewater recycling and reuse, etc.)
- Education and curriculum development

INTRODUCTION

The WSI process involves an initial check-up and five steps: define the WSI space; assess the situation; plan and secure financing; implement water activities; and monitor progress. This toolkit covers Step 4: Implementation and is designed to improve stakeholder capacity to concretely improve water security in a geographic focus area. This toolkit **has two objectives:**

1. Define the key practices that should guide implementation of water security activities
2. Describe the main types of water security activities



– REPEAT, DISSEMINATE, SCALE UP –





GUIDING PRACTICES & CONSIDERATIONS FOR IMPLEMENTATION

Implementation must follow the eight WSI guiding practices:

1. Pragmatic focus on specific water risks
2. Engagement and mobilization of water users
3. A “systems thinking” approach to address causes and not just symptoms
4. Robust decision-making that considers uncertainties
5. Negotiated solutions that provide tangible benefits to different water user groups
6. Science-based actions that combine infrastructure development with watershed management, behavior change, and institutional improvements
7. Adaptive management and learning to improve over time and build the capacities of stakeholders
8. Sustainability through economic efficiency, environmental soundness, and social equity

Additional considerations, described below, embrace and reinforce these practices:

- **“QUICK WINS” AND EARLY RESULTS.** Local leaders and stakeholders, especially when it is their first experience with a WSI process, desire early actions that are visible, bring immediate benefits, and can be quickly delivered. Demonstration projects that produce early results incentivize stakeholders and improve collective learning, trust, and future iterations or expansions of the WSI process.
- **COMMUNICATION AND ADAPTIVE MANAGEMENT.** Successful implementation and the legitimacy of the WSI process require that information be shared among implementers. Information must also be reported to higher authorities and disseminated among stakeholders and the public on a timely basis:
 - Coordination mechanisms must be defined and used among implementers, with regular meetings (probably not as frequent as during previous steps) to reflect on progress and possibly decide the adjustment of actions to respond to changing conditions.
 - Reporting mechanisms to ensure that higher authorities continue to trust and support the process (technically, administratively and/or financially as agreed).
 - Dissemination of performance information to raise awareness among water users and the public to ensure support and promote the necessary water-use behavior changes.
- **ACCOUNTABILITY.** The WSI process must mobilize promised resources (e.g., finances, equipment, staff, and facilities) and fulfill the responsibilities described in the action plan. All parties are required to follow through on and be held accountable for their commitments and actions. Successes should be recognized and advertised, and failures should be corrected.
- **COMPLIANCE.** All activities should be implemented in compliance with existing standards and regulations.
 - For gray and green infrastructure activities: engineering design codes and guidelines, quality control and safety regulations, environmental regulations
 - For legal, institutional, and policy improvements: proper consultations and endorsement by legally empowered authorities
 - For social behavior change campaigns: proper analysis of current practices and respect for social and customary/traditional norms
 - For sustainability: implementation should also consider how to sustain, replicate and disseminate the water security activities carried out and the benefits being generated

Role and Importance of Demonstration Projects

In Tanzania’s Pangani River Basin, water security principles and plans were put into action when growing water scarcity, caused by over-allocation of water, led to fueling conflict and putting in peril local and national development plans. To test implementation of reforms from Tanzania’s new National Water Policy, the Pangani River Basin Management Project started demonstration projects. Water User Associations were formed to negotiate allocations, reducing local conflict over water. Evidence for the economic, social and ecological effects of alternate options for allocating water was assessed by stakeholders to build consensus. Now, results are applied basin-wide and lessons learned are guiding national implementation.

CATEGORIES OF WATER SECURITY MEASURES

Water security action plans will likely include construction measures, both gray and green infrastructure. They should also include policy, legal, or institutional changes as well as social behavior change campaigns to improve the water governance framework and allow infrastructure to achieve its full intended benefits.

Water security activities should be robust, i.e. adjustable and capable of providing satisfactory outcomes across a range of uncertain futures (unlike “optimal” actions, which can be sensitive to uncertainties).

Supply Augmentation vs. Demand Management

Options to bolster water management are usually categorized as supply augmentation or demand management. Both play an important role in improving water security, and provide a framework for discussing the categories of water security measures (i.e., gray and green infrastructure, policy, institutional and regulatory, and social and behavioral).

Supply augmentation focuses on enlarging the amount of resources available, mostly through gray infrastructure development, while **demand management** focuses on reducing the amount of water needed for consumptive purposes. Historically, civil and water engineers have focused on large-scale supply augmentation infrastructure projects — construction of physical infrastructure to capture more water for direct use. As most water resources get mobilized and tapped into, improved water security activities then have to rely on a mix of supply-side and demand-side management strategies.

As water-related risks and scarcity grow, demand management measures have become more and more relevant. Demand management reflects an important shift in the approach to WRM, away from traditional supply augmentation to an improvement in efficiency of use, conservation, recycling, and reuse. It examines changing demand and the way people use water to achieve more efficient and cost-effective water use. Water demand management different types of strategies:

1) IMPROVEMENTS IN THE TECHNICAL EFFICIENCY OF WATER STORAGE, CONVEYANCE, DISTRIBUTION AND USE.

Such improvements are usually undertaken by water providers and water users in the urban, industrial, and agricultural sectors to reduce the various losses, leaks, seepages and wastages. By meeting the existing needs of individual uses with less water, these improvements can free up significant volumes.

2) THE EFFICIENT ALLOCATION OF AVAILABLE WATER AMONG COMPETING USES.

Actual water allocation often results from a historical process of traditional rights, upstream or prior appropriation, and influential interests. Such allocation is often not transparent (i.e. recorded, monitored and enforced) and not equitable (small

Types of Questions to Consider during Implementation of Water Security Action Plans

- What is the progress and performance of water security activities being currently implemented (See Toolkit #6: Monitoring)?
- Are adjustments needed in the pace of implementation, the allocation of resources, and/or the sequencing of WSI actions?
- Are communications and interactions among stakeholders and with the public appropriate — and sufficient human and financial resources allocated — to ensure efficient and effective implementation?
- Are implementation roles and responsibilities clearly defined, appropriate and well exercised?
- Are capacity-building measures sufficient and appropriate to ensure that responsible organizations can successfully implement actions and remain up to date with evolving information and approaches?

groups may have disproportioned allocations while larger but marginalized groups have little to no water access). Optimizing allocation is a legitimate goal, but it faces difficult trade-offs between different optimization criteria:

- **Economic efficiency** calls for water resources to go to the most profitable uses that generate larger economic returns
- **Social equity (and political stability)** justifies water resources to be allocated to large groups such as rural populations and subsistence farmers
- **Environmental sustainability** requires sufficient flows (notably environmental flows) to remain in water bodies to protect both public and ecological health. to be preserved or restored to protect biodiversity and ecosystems.

Ultimately the best allocation approach is to ensure transparent procedures that allows all water user groups equivalent access to information and decision-making, with actual water allocations being decided in an accountable manner. This is what the WSI process promotes and supports.



It has been said that “without infrastructure to store and deliver water and manage flows, water managers and institutions, no matter how sophisticated, are severely constrained.” Similarly, it can be said that “without effective and accountable management and sustainable use practices, water infrastructure, no matter how sophisticated, is constrained to deliver its expected benefits.”

Water demand management in Jordan

At less than 150 m³/person/year, Jordan is one of the most water scarce countries in the world. High population growth, refugee influx, the depletion of groundwater reserves and the impacts of climate change are likely to aggravate the situation in the future. Despite Jordan’s severe water scarcity, more than 97% of Jordanians have access to an improved water source and 93% have access to improved sanitation.

Jordan’s water strategy and policies have been developed with the clear objective of promoting the sustainable use of the scarce water resources:

- Water utilities have been aggressively installing meters on all connections, and have been renovating and better maintaining their networks. Their performance is monitored through key performance indicators, notably their percentage of non-revenue water (water losses, both technical such as leakages and administrative such as unbilled or unauthorized uses).
- Households are charged for water utility services (drinking water and wastewater) based on an increasing block tariff, which provides incentives to reduce water consumption.
- The polluter pays principle is enforced via sewage charges added to the water bill.
- Treated urban wastewater is commonly used for irrigation, either directly or after mixing with freshwater.
- The building and plumbing code has been updated to favor the installation of water-saving devices in large urban buildings (schools, hospitals, office buildings, hotels).
- Recent enforcement efforts have focused on eliminating illegal connections to drinking water mains as well as illegal irrigation wells.
- Awareness raising is routinely carried out in schools, mosques, urban neighborhoods and rural communities to reduce wastages and pollutions through improved water use behaviors.

Such demand management measures have been successful in reducing demands and increasing water use efficiency, and additional measures are being considered, such as applying fees to irrigation uses, improving irrigation technology, more aggressively reducing non-revenue water, retrofitting water equipment and appliances, etc.

Gray Infrastructure



Structural and engineering activities (i.e., gray infrastructure and networks) are the conventional approach to addressing water security risks, and governments continue to prioritize them, particularly as water demand grows. Such solutions are attractive because they offer immediate, highly visible impacts. However, infrastructure will not deliver high, sustained returns if it is not effectively designed, operated and managed, which, in turn, requires policy and institutional improvements. Meanwhile, both watershed management and social behavior changes are essential to maximizing the benefits from gray infrastructure by increasing structural lifespan and securing the longevity of the water supply.

Significant infrastructure investments have been made in most developed countries. In some cases, such investments have been arguably excessive and much greater returns are now derived from improving water management, water use practices, and infrastructure operations. In some of the world's poorest countries, infrastructure stocks may be so low that infrastructure investments remain a priority. Parallel non-infrastructure water security activities should still accompany those to achieve sustainable and widely distributed benefits.

One of the most obvious drawbacks of gray infrastructure is that it tends to be expensive to build, operate, maintain, and replace. Furthermore, because gray infrastructure is often designed to address a specific water management problem, it may not adapt well to changing conditions, notably those due to climate change.

Table 2. Gray Infrastructure Water Security Measures

<p>CONSTRUCTION OF DIVERSION, STORAGE, CONVEYANCE, AND DISTRIBUTION STRUCTURES, WATER AND WASTEWATER TREATMENT PLANTS, DESALINATION</p>	<p>DIVERSION</p> <ul style="list-style-type: none"> • Weirs are barriers across rivers and canals meant to elevate upstream water levels, to divert flows, measure water discharge, or make rivers navigable. • Barrages are larger barriers across rivers, also meant to elevate upstream water levels. They are often equipped with control gates that can be opened or closed to control the amount of water that passes through. • Levees, dikes and embankments are barriers meant to canalize rivers and prevent their flooding. They can be permanent earthworks or emergency constructions (often made of sandbags) built hastily in a flood emergency.
	<p>STORAGE</p> <ul style="list-style-type: none"> • Dams are larger structures built across rivers to stop and store water volumes in their reservoirs. Small reservoirs store wet season flows for use in the dry season while larger ones can store several years of inflows in case of droughts. Dams and reservoirs provide storage for many uses, including irrigation, hydropower, supply for domestic and industrial use, flood control, and recreation. Smaller dams tend to serve one purpose, while larger ones tend to be multi-purpose dams.
	<p>CONVEYANCE</p> <ul style="list-style-type: none"> • Pipelines convey by gravity flow or pumping. (Pumping is significantly more expensive to construct, operate, and maintain than gravity systems.) Large-diameter pipelines can be used to convey water over long distances; smaller pipes can be used to provide bulk or individual supplies at the point of use. • Aqueducts and canals are used to bring water from a river or reservoir to a water distribution center. They are best suited to meeting large-scale demands in mostly flat or gently sloping landscapes suitable for conveying water by gravity. Most modern canals are concrete-lined channels that convey large quantities of water at relatively low velocities.
	<p>DISTRIBUTION</p> <ul style="list-style-type: none"> • Piped distribution networks transport and distribute water to households with appropriate quality, quantity, and pressure. It may also provide storage. Pumps, gates, and valves are usually placed at intervals to control flows throughout a distribution system.

CONSTRUCTION OF DIVERSION, STORAGE, CONVEYANCE, AND DISTRIBUTION STRUCTURES, WATER AND WASTEWATER TREATMENT PLANTS, DESALINATION

COLLECTION

- **Piped collection systems** are meant to collect storm runoff (to prevent flooding) and/or wastewaters (to protect public health). Most are gravity systems that lead to treatment facilities or to releases in natural water bodies. Gates and weirs are usually placed to control flows.

WATER SUPPLY AND WASTEWATER TREATMENT

- **Water treatment facilities** are meant to treat drinking water to specific quality standards before distribution to users, while wastewater treatment plants are meant to treat (domestic and/or industrial) sewage waters to acceptable quality for release in natural water bodies such as rivers, lakes or seas.

DESALINATION

- **Desalination plants** convert sea or brackish water into freshwater to alleviate water scarcity. However, the practical use of desalination is limited by its costs, energy requirements, and geography.

CLIMATE-RESILIENT GRAY INFRASTRUCTURE

CLIMATE-RESILIENT GRAY INFRASTRUCTURE

Climate proofing focuses primarily on building the resilience of infrastructure through the application of a vulnerability, risk assessment and adaptation planning methodology. The objective is to mitigate risks facing water sector investments and infrastructure due to climate variability and change.

Four types of strategic responses can be considered:

1. **Repair and maintain** (less expensive, pragmatic, but requires continuous monitoring, reviews and possible upgrades)
2. **Strengthen and protect** (proactive and straightforward but expensive)
3. **Relocate** (proactive but expensive)
4. **Accept or abandon** (no costs, but decreasing performance or services are to be expected)

IMPROVED OPERATING AND MAINTENANCE OF WATER STRUCTURES AND SYSTEMS (ASSET MANAGEMENT, METERING, LEAK DETECTION)

MONITORING (MEASURING AND METERING)

- **Measuring water flows** in rivers, canals and along distribution networks provides essential data for assessing water resources management and use efficiency. Metering can also be used to detect leaks and to change use-based fees to customers.

ASSET MANAGEMENT

- A process for water utilities to plan maintenance activities for capital assets (e.g., pumps, motors, pipes, etc.) to be repaired, replaced, or upgraded on time. It is about minimizing the cost of owning and operating these assets while delivering the desired service levels for customers. A performing asset management program provides water utility managers and decision-makers with critical information on capital assets and timing of investments and includes detailed asset inventories, operation and maintenance tasks, and long-term financial planning.

REDUCING NON-REVENUE WATER

- In many developing countries, half of the water supplied by water treatment plants is lost as non-revenue water (NRW), losses being technical (i.e., leaks) and administrative (i.e., unauthorized, unbilled or unmetered uses). NRW can be significantly reduced through the use of bulk and individual water meters, the detection of leaks and illegal connections, the improvement of administrative and billing processes etc.



Green Infrastructure



Green infrastructure refers to the natural or semi-natural systems that provide water resources management services that complement, augment, or replace those provided by conventional (built) gray infrastructure. Examples include wetlands, healthy soils, forest ecosystems, and snowpack and its contributions to runoff, all of which supply clean drinking water, regulate flooding, control erosion, support biodiversity and livelihoods, provide cultural and recreational services, and other similar benefits. Green infrastructure is increasingly recognized as a key measure for addressing water security risks, including climate change and variability. It is often considered more flexible and cost-effective than gray infrastructure.

Green infrastructure solutions use ecosystem services to provide a wide range of water management and associated benefits. While the value and function of gray infrastructure tend to depreciate over time, many green infrastructure solutions do appreciate by growing, disseminating, and regenerating while continuing to function as soils and vegetation.

Table 3. Green Infrastructure Water Security Measures

<p>AGROFORESTRY</p>	<p>Agroforestry includes land-use systems and technologies where woody perennials (e.g., trees, shrubs, palms, bamboos) are used alongside agricultural crops and/or animals in a spatial arrangement or temporal sequence. Agroforestry can enhance water security by increasing the amount of on-farm water coming from tree or crop transpiration. It can also improve water productivity by increasing the biomass of trees or crops produced per unit of water used.</p>
<p>SOIL AND WATER (OR "GREEN WATER") MANAGEMENT</p>	<p>Practices include techniques such as mulching or conservation tillage to reduce evaporation, and slowing water runoff to increase infiltration.</p> <ul style="list-style-type: none"> • Conservation tillage creates a suitable soil environment for growing a crop, one that conserves soil, water, and energy resources by reducing the intensity of tillage and retention of plant residues. • Runoff control techniques include ridges, broad beds, furrows, infiltration pits, stone bunds, contour bunds (semi-circular, triangular), vegetative bunds, and terraces. • Bunds, usually made of soil or stones, collect surface runoff, increase water infiltration, and prevent soil erosion. Bunds built along contour lines slows water runoff, which leads to increased water infiltration and enhanced soil moisture.

**VEGETATION/
BIO-STRUCTURAL
ENGINEERING
FOR RIVER
BANK OR SLOPE
STABILIZATION
AND EROSION
CONTROL**

Combining biological, mechanical, and ecological concepts, these measures reduce or control erosion, protect soil, and stabilize slopes using vegetation or a combination of vegetation and construction materials (e.g., live fencing, brush layering, brush mattresses, and vegetative netting).

**RIVER AND
FLOODPLAIN
MANAGEMENT**

RIPARIAN BUFFERS

These are vegetated, often forested, areas (“strips”) adjacent to streams, rivers, lakes, and other waterways that protect aquatic environments from the impacts of surrounding land use. Riparian buffers to maintain water quality in streams and rivers are a best practice in forest and conservation management in many countries. They are mandatory in some areas.

LEVEE SET-BACK OR REMOVAL

Although levees may prevent flooding at one location, they may increase the risk of flooding upstream and/or downstream. Moving levees away from the channel reduces exposure to high-velocity flood waters. This lowers maintenance costs and risk of failure, and increases the area of floodplain that benefits from periodic connections with the river.

FLOOD BYPASSES AND WETLANDS

Portions of a river’s historic floodplain are reconnected to the river. They become inundated during major flood events, providing temporary conveyance and storage.

**AFFORESTATION
AND FOREST
CONSERVATION**

FOREST CONSERVATION

Forested areas in upper watersheds can help retain water and stabilize slopes, reducing the risk of flooding. Forests also improve water quality by reducing sediment in water bodies and trapping or filtering other pollutants. Afforestation is the process of planting trees on land where there was not recent forest cover; reforestation is planting trees on land that recently had forest cover. However, intensive afforestation/reforestation activities may reduce the local total annual runoff and groundwater recharge due to increased water loss through evapotranspiration.

SPRING PROTECTION

A spring source can provide drinking water for people and livestock, and can also supply a gravity irrigation scheme. Spring water can be of good microbiological quality if well-protected. This mostly entails isolating the spring from pollution sources, mostly human and animal waste.

**RESTORATION
AND
CONSERVATION
OF WETLANDS
AND/OR
COASTAL
ECOSYSTEMS**

WETLAND RESTORATION/CONSERVATION/CONSTRUCTION

Wetlands can provide significant support (or even replacement) to traditional infrastructure for water treatment, water supply, drought mitigation, and flood control.

**PROTECTING/RESTORING COASTAL ECOSYSTEMS
(MANGROVES, MARSHES, DUNES, AND CORAL REEFS)**

These coastal ecosystems provide significant coastal protection benefits (e.g., attenuating storm surges and floods, reducing damage to infrastructure and human health). Coral reefs provide natural breakwaters that can mitigate flooding and the erosive effects of storms along low-lying shores.



Policy, Regulatory, and Governance Measures



Improving water security requires tailored policy, institutional, regulatory, and management responses that improve water planning, allocation, and pricing while ensuring equity. Managing water risks should result from well-informed trade-offs between water security and other (sectoral, environmental) policy objectives, as well as between policy, regulatory and governance instruments. These include traditional command and control instruments (e.g., regulations, standards and permits), market-based instruments (e.g., taxes, charges and tradable quota schemes), as well as institutional and policy reform.

Table 4. Policy, Regulatory, and Governance Water Security Measures (Also See Toolkit #4: Funding)

<p>ENFORCEMENT OF WATER AND RELATED LAWS, DECREES, BYLAWS, POLICIES, ETC.</p>	<p>REGULATORY INSTRUMENTS are critical for water policy, and will continue to play a key role in the future. Examples include water laws or regulations, water quality standards and diversion limits, flood plain regulations, water quality laws, and pollution fines.</p> <p>Regulatory instruments provide a necessary and essential framework for other water management improvements to perform. As an example, farm-level efforts to improve and maintain productivity will have little value unless land tenure is secure for smallholders. Farmers must be able to count on the long-term benefits of near-term investments that reduce the rate of land degradation and maintain growth in productivity.</p> <p>PUBLIC FINANCIAL SUPPORT to improve water use practices and finance water infrastructure investments can trigger significant water security improvements. However, it is important that support is provided only in cases where it will benefit the public good. Measures include direct budget allocations or grants, low-interest loans, loan guarantees, preferential tax treatment, and other types of public subsidies and incentives.</p>
<p>PREPARATION AND IMPLEMENTATION OF WATER SECURITY STRATEGIES, ACTION PLANS, ETC.</p>	<p>Many types of strategies and plans support water security at national, basin, sub-basin, catchment, and local levels. They provide a framework of water security goals and planned actions to achieve goals. Examples include water security action plans, integrated water resources management (IWRM) plans, river basin plans, watershed management plans, and local development plans.</p>
<p>COLLECTION OF WATER TAXES, TARIFFS, ETC.</p>	<p>WATER TAXES (ABSTRACTION AND POLLUTION TAXES) incentivize water users and polluters to change their water practices. Water taxes directly assign costs of mitigating negative impacts to the responsible parties and thus improve accountability and transparency. They also provide long-term incentives to innovate for improved water security.</p> <p>PAYMENTS FOR WATERSHED/ENVIRONMENTAL/ECOSYSTEM SERVICES channel payments from downstream water users (e.g., companies or water utilities acting on behalf of customers) to upstream landholders or other parties ("sellers") in exchange for conserving, restoring, or creating green infrastructure. Buyers may contract directly with sellers through bilateral agreements for watershed protection or pay into a collective action fund/water fund that pools contributions for greater impact. User-driven programs can be voluntary or a mechanism to meet regulatory compliance.</p> <p>INSURANCE SCHEMES can provide incentives (through competitive pricing) to reduce exposure and vulnerability to risk and protect against flood, drought, or crop failure, especially if premium discounts are awarded for risk reduction. Compensation can offset the economic impact of disasters and provide financing to restore damaged infrastructure and speed up recovery. Schemes include traditional indemnity-based insurance and index-based insurance.</p>

<p>ENFORCEMENT OF WATER AND LAND TENURE RIGHTS</p>	<p>WATER RIGHTS provide a legal entitlement to access and use water for specified purposes at specified times. Land tenure rights are legal rights that define the relationship between people (individuals or groups) and land. The relationship between water rights and land rights is critical: Water is necessary for most productive uses of land, and land has major impacts on the quality and quantity of water resources.</p>
<p>WATER PERMITS AND TRADING</p>	<p>WATER PERMITTING AND TRADING is about formalizing water rights (for water abstraction and for release of polluted effluents) and allowing users to sell and buy these entitlements, permanently or temporarily. It can promote efficiency in allocation and provides a flexible approach to meeting changing water demands and dealing with fluctuating commodity prices, environmental conditions, or uncertainty due to climate variability and change. Trading arrangements include surface water markets, groundwater markets, water auctions, and water banks (managed by institutions, whereby water entitlements can be saved for posterior use, or exchanged for a fee or other advantage).</p> <p>WATER QUALITY TRADING AND OFFSETS allow water users to manage their impacts on watersheds by compensating others for offsite activities that improve water quality or supply. Compensatory activities are packaged as a credit or some other unit traded in an established “market,” defined by watershed boundaries. Trading and offsets are often driven by compliance with water quality requirements.</p>
<p>ALLOCATION PLANNING AND ENFORCEMENT</p>	<p>WATER ALLOCATION PLANNING helps determine who can take water, how much they can take and from which locations, when, and for what purpose. Allocation plans usually define the total volume and reliability of water available for abstraction; guidelines for granting entitlements to the allocable water; measures to comply with allocation rules and abstraction restrictions; and roles, responsibilities, and enforcement measures. Monitored and enforced allocation prevents conflicts, and ensure transparent accountable access to water resources.</p>
<p>WATER RESOURCE MONITORING</p>	<p>WATER RESOURCES MONITORING is the regular measurement of the quantity, quality, availability, and uses of surface and groundwater with reasonable spatial and temporal resolution. Measurements should be taken regularly at the same locations (daily or hourly for automated measurement; weekly or monthly otherwise), and include quality and quantity. Such monitoring provides essential information to better manage, allocate and protect water and related resources.</p>
<p>ESTABLISHMENT OF AND SUPPORT TO BASIN INSTITUTIONS AND WATER USER ASSOCIATIONS</p>	<p>RIVER BASIN ORGANIZATIONS OR COMMISSIONS are decentralized entities supporting or leading water management in a river basin. They develop and implement pluri-annual river basin management plans or action plans to prioritize and coordinate activities of various national and/or regional government administrations. More developed river basin agencies can also involve local authorities such as regional councils and Municipalities as well as non-governmental organizations (representing water user groups, business interests, and other relevant groups). They can also collect water fees, decide infrastructure investments and water activities, and basically manage water resources on their own, of course within the framework of national laws and strategies. They constitute excellent dialogue platforms for water user groups and stakeholders to collaboratively operate. They can be much more effective, given appropriate authority and resources, than central-level administrations in managing water resources, addressing water security risks and delivering tangible and appropriate benefits to water users. River basin organizations can be transboundary and facilitate the management of shared water basins between neighboring countries.</p>

**ESTABLISHMENT
OF AND
SUPPORT
TO BASIN
INSTITUTIONS
AND WATER
USER
ASSOCIATIONS**

WATER USER BOARDS, GROUPS AND ASSOCIATIONS are water management organizations made up of irrigating farmers (landowner and/or tenants) who pool their financial, technical, material, and human resources to operate and maintain a local water system, such as an irrigation canal or system. Such organizations are established to organize and carry out maintenance works on diversion structures and canals and to organize water distribution based on agreed-upon rules and practices. Conflicts can be solved on the spot by the water master or adjudicated by the general assembly of members. Members support the organization through volunteer labor and/or fees collected to compensate staff (e.g., water master) and/or to purchase necessary equipment or supplies. They can be informal and community-based, such as those still traditionally led by farmer-selected water masters (*mayordomos* in Latin America, *mirabs* in Afghanistan and Central Asia, *aiguadier* in France and Northwest Africa). But they benefit from a more formal institutional setting that allows them to have a legal and financial presence.

Many traditional water user organizations disappeared in the recent past with the development of larger irrigation systems managed by government agencies. Today the re-establishment of such organizations can be delicate as they require the transfer of authority and capacity from reluctant public agencies to perform well. When they are uniquely seen as fee-collecting entities, they fail. In large irrigation systems, hierarchies of such organizations are being developed, with water user groups at the level of tertiary canals, water user associations at secondary level, and boards or federations at the level of entire systems (names may vary).

Another type of water user association is the water user boards or committees formed to manage small community drinking water systems, in rural or peri-urban areas. These are meant to operate and maintain the system, collect fees from users and generally ensure reliability and sustainability of these systems through accountable community ownership

Like river basin organizations, water user associations can be much more effective, given appropriate authority and resources, than government administration in managing water resources, addressing water security risks and delivering tangible and appropriate benefits to water users.





Social and Behavioral Change Measures



In many ways, a WSI process is fundamentally about social change. Therefore, behavior change (individual knowledge, attitudes, and practices) and social change (transformation of cultural practices, societal norms, and structural inequalities) are critical for building resilience to water security risks. Changing water practices to support water security requires changes in the deeply held attitudes of individuals, institutions, professionals, and social organizations. Participatory approaches in water security are powerful instruments for social change. At all levels — national, regional, and local — it is often the most vulnerable social groups that need to be involved in the participatory process.

Table 5. Social and Behavioral Change Water Security Measures

AWARENESS-RAISING AND SOCIAL MARKETING CAMPAIGNS	SOCIAL MARKETING CAMPAIGNS By understanding the diversity of barriers to adopting improved water use behaviors, mass media, combined with other channels, can quickly inform and influence many people. Advertising and publicity through television, radio, newspapers, and billboards can raise awareness of water security issues, risks, and promote and demonstrate improved practices.
	RISK COMMUNICATION Focused risk communication strives to inform the public on the existence and potential impacts of risks (e.g., floods, droughts, hurricanes, tsunamis, etc.) and on measures to mitigate these. The goal is to ensure that effective steps are taken such as early warning systems, shelters, proper siting or strengthening of critical facilities and structures, while populations learn and possibly practice appropriate behaviors in preparation for and during emergency situations.
CAPACITY-BUILDING OF WATER USERS	CAPACITY-BUILDING OF WATER USERS Developing water user capacity promotes, explains and achieves more frugal and less polluting water use behaviors. Such capacity-building can target residential users, industries and businesses, farmers, recreational users and tourists, and other types of water users, and address a range of technical topics such as solid and hazardous waste disposal, sanitation and hygiene, water harvesting, metering and water quality monitoring, upgrading or retrofitting of water appliances and equipment, soil and water management, agroforestry, integrated pest management, crop rotation, irrigation scheduling, etc. A range of participatory training and extension methods have been proven to increase the adoption and diffusion of improved water management practices, including learning-by-doing approaches such as farmer-field schools and training-of-trainers.
LIVELIHOODS DIVERSIFICATION	LIVELIHOODS DIVERSIFICATION This is the process by which households construct a diverse portfolio of activities and social support capabilities to increase their incomes, manage risks, and cope with uncertainty. Diversifying income sources and exiting from risk-sensitive livelihoods increases resilience and, indirectly, may also reduce the pressure on local water resources.
COLLECTIVE ACTION AND COMMUNITY MOBILIZATION	COLLECTIVE ACTION For water management, this refers to voluntary cooperation among stakeholders in a watershed. Multiple actors from the public, private, and/or civil society sectors voluntarily organize themselves to address WRM through information-sharing, joint decision-making, and other coordinated activities. Typically, these partners are united by common challenges or goals and recognize that collective action will deliver better outcomes than unilateral action.
LIVELIHOODS DIVERSIFICATION	COMMUNITY MOBILIZATION Used to engage communities, this measure helps to identify priorities, resources, needs, and solutions, and promote representative participation, good governance, accountability, and peaceful change. Community mobilization can support initiatives such as river bank or pond cleanups and waste/wastewater recycling and reuse.
EDUCATION AND CURRICULUM DEVELOPMENT	EDUCATION AND CURRICULUM DEVELOPMENT This measure incorporates locally relevant water security topics into formal and informal education. Bringing water security issues into education programs encourages children and youths to understand the impact of their behaviors and wider water management concepts.



RESOURCES



Gray Infrastructure

Asian Development Bank (ADB) (2006). [Guidelines for Climate-Proofing Investment in the Water Sector: Water Supply and Sanitation.](#)

The provision of water supply and sanitation services is vulnerable to projected changes in climate conditions (e.g., temperature and precipitation), in the frequency and intensity of extreme weather events, as well as the projected rise in sea level and the intensification of storm surges. Climate-proofing investment projects aims to assess the climate risk to future costs and benefits. It also involves a technical and economic analysis of options to alleviate or mitigate those risks. Accounting for climate change at the outset of the project cycle means decisions about project design and the adoption and timing of climate-proofing measures should consider the possible impacts of climate change and that those decisions should not be written in stone. This publication presents a step-by-step methodological approach to assist project teams in managing climate change risk in the context of water supply and sanitation investment projects.

Cairncross, S., & Feachem, R. (1993). [Environmental Health Engineering in The Tropics: An Introductory Text, 2nd ed.](#)

Makin, I. W. (2016). [Irrigation Infrastructure for Sustainable and Improved Agricultural Productivity.](#)

This guide provides basic information and stimulates thinking about irrigated agricultural systems and interventions to achieve sustainable increases in agricultural productivity and poverty reduction. Focused on Sub-Saharan Africa, it gives an overview of current thinking on how to identify and implement robust investments in irrigated agriculture that respond to the needs of evolving rural communities.

Organisation for Economic Co-operation and Development (OECD) (2014). [Climate Change, Water and Agriculture: Towards Resilient Systems.](#)

This report reviews the main linkages among climate change, water, and agriculture as a way to identify and discuss adaptation strategies for better use and conservation of water resources.

United Nations Environment Programme (UNEP), & International Environmental Technology Centre. (1997). [Source Book of Alternative Technologies for Freshwater Augmentation in Latin America and the Caribbean.](#)

Growing demands for water and the increasing costs of water supply are resulting in a need for countries to maximize the use of their existing water supplies and make use of unexploited freshwater resources. Numerous modern and traditional techniques for improving the use and augmenting the availability of water resources have been developed and implemented in different parts of the world. These include, wastewater reuse and recycling, desalination, and rainwater harvesting. In many developing countries, the application of these technologies has been limited by lack of information on the approaches available and how well they work.

USAID (2017). [Climate Resilient Water Infrastructure: Guidelines and Lessons from the USAID Be Secure Project.](#)

The paper guides water services providers and local government units on best practices for building and sustaining climate-resilient water supply systems. The information is intended to be used as a learning tool for securing sustainable water supplies in a climate-altered future.

Benedict, M. A., & McMahon, E. (2006). [Green Infrastructure: Linking Landscapes and Communities.](#)

Cunningham, K., Stuhlinger, C., & Liechty, H. (n.d.). [Agriculture and Natural Resources Riparian Buffers: Types and Establishment Methods.](#)

Food and Agriculture Organization of the United Nations. (n.d.). [Agroforestry.](#)

Thanks to its multifunctional properties, agroforestry is part of the solution to addressing these environmental, economic, and social issues surrounding water security. Agroforestry systems include traditional and modern land-use systems, where trees are managed with crops and/or animal production systems in agricultural settings. They are dynamic, ecologically based, natural resource management systems that diversify and sustain production to increase social, economic, and environmental benefits for land users at all scales. There is a growing body of scientific literature that demonstrates the gains accruing from agroforestry adoption.

Gartner, T., Mulligan, J., Schmidt, R., & Gunn, J. (n.d.). [Natural Infrastructure: Investing in Forested Landscapes for Source Water Protection in the United States.](#)

Staff in water utilities, municipalities, businesses, and local conservation groups can use this reference and guidance document to advance important dialogue around investing in forests for source water protection in their watersheds. It can also help inform early design and implementation efforts, such as convening stakeholders, identifying sources of finance, and prioritizing investments across the landscape. The guide can be particularly useful to source water newcomers as a primer on natural infrastructure and to source water veterans as a reference for familiar concepts and an update on innovative efforts across the country. The concepts, evidence, insights, and cases can play a role in a “source water toolkit” alongside critical local knowledge, relationships, and expertise.

Lee, J. G., Fisher, C., & Schumacher, B. (2016). [Green Infrastructure in Arid and Semi-Arid Climates: Adapting Innovative Stormwater Management Techniques to the Water-Limited West.](#)

A survey of current literature was conducted to characterize the state of the science for the application of green infrastructure to arid and semi-arid climates and to identify future research opportunities. Stormwater best management practices (BMPs) include bioswales, green roofs, permeable pavement, planter boxes, rain gardens/bioretention cells, vegetated filter strips, integrated, multi-BMP systems, land conservation, riparian buffers, and urban tree canopies; all of these have been evaluated in arid, semi-arid, and Mediterranean climates for management of stormwater quantity and quality. BMPs have been tested for their ability to improve the water quality of stormwater and to sequester carbon and nitrogen. The ability of BMPs to reduce runoff is a key performance parameter that has been evaluated under different precipitation regimes.

Oxfam (2008). [Spring Protection.](#)

This technical brief looks at spring protection, including the catchment area, the immediate area around the spring, and the construction of spring boxes. It also highlights two methods of reducing sediments in the water coming from large springs and introduces alternative protection methods to spring boxes. It does not discuss the distribution system between spring box and supply.

Ozment, S., Gartner, T., Huber-Stearns, H., DiFrancesco, K., Lichten, N., & Tognetti, S. (2016). [Protecting Drinking Water at the Source.](#)

Watershed investment programs offer promising pathways to securing safe drinking water. But what does it take to establish and grow a successful watershed investment program? Program investors and practitioners are looking for guidance and ideas on how to build a program that works for their own context. This report addresses this need by compiling experiences and lessons from 13 watershed investment programs from across the United States. Based on a 3-year com-

parative case study analysis, it serves as a roadmap to guide utilities and communities as they work together to protect precious source waters.

WaterAid (2013). [Protection of Spring Sources.](#)

WWF & USAID (2017). [Natural and Nature-Based Flood Management: A Green Guide.](#)

It was developed to support local communities around the world in using natural and nature-based methods for flood risk management. Globally, flooding is the most common disaster risk and that risk is growing with more people in harm's way as cities grow larger and rainstorms become more intense. Managing floods with a balanced, combination of methods including policy, planning and governance approaches as well as natural and nature-based methods, can reduce costs while maximizing co-benefits for people and the environment.

The Flood Green Guide, developed in partnership with the U.S. Agency for International Development Office of U.S. Foreign Disaster Assistance (USAID/OFDA), provides a step-by-step framework for flood managers to understand the factors contributing to flood risk in their region, and to pull together the appropriate policies, nature based solutions, and traditional engineering to address the problem.

UNEP, IUCN, & TNC (2014). [Green infrastructure Guide for Water Management: Ecosystem-Based Management Approaches for Water-Related Infrastructure Projects.](#)

This guide aims to raise awareness of the benefits of green infrastructure solutions for WRM. It takes a pragmatic approach to water management, showing that green infrastructure can provide significant water management benefits and co-benefits, and can support benefits from existing gray water infrastructure through a complementary mix of green and gray solutions.

USAID (2017). [Green Infrastructure Resource Guide.](#)

A comprehensive resource guide targeting practitioners, it introduces green infrastructure, relevant definitions, and interventions for various water security risks, including groundwater recharge, water retention and detention for water supply and ecosystem maintenance, urban stormwater management, and rural flood mitigation.

US EPA (2016). [Aquifer Recharge and Aquifer Storage and Recovery.](#)

This webpage summarizes information about water used to artificially recharge groundwater.



Policy, Regulatory, and Institutional Measures

Agricultural and Rural Development (2006). [Conjunctive Use of Groundwater and Surface Water.](#)

Conjunctive water use refers to simultaneous use of surface water and groundwater to meet crop demand. Every day, hundreds of thousands of farmers in canal, tank, and other surface irrigation systems combine surface water with groundwater, without oversight or regulation by any scheme or basin-level entity. Conjunctive management, by contrast, refers to efforts planned at the scheme and basin levels to optimize productivity, equity, and environmental sustainability by simultaneously managing surface and groundwater resources. In many systems and basins, such planning is needed to raise crop water productivity. Conjunctive management occurs when system administrators control ground and surface water simultaneously; it may be achieved by modifying the configuration of the surface system and its operating procedures. It is less widespread than conjunctive use because it requires institutions and coordinating mechanisms that few countries have. Conjunctive management is complex and sometimes controversial, but it can be very effective, particularly in water-scarce regions and in times of drought, because failure to integrate conjunctive water resources can result in groundwater over-exploitation.

Balasubramanya, S., Buisson, C., Saikia, P., MacDonald, K., Aslamy, S., Horbulyk, T., ... Platonov

Baseline Report, A. (2016). [Impact of Water Users Associations on Water and Land Productivity, Equity and Food Security in Tajikistan.](#)

Bennett, G., Ruef, F. (2016). [Alliances for Green Infrastructure: State of Watershed Investment.](#)

This report captures the size, scale, and scope of market mechanisms for green infrastructure for water. The diversity and often local scale of such watershed investments sometimes obscures their true impact: Although there is not a unified market for transactions for watershed protection (unlike a compliance carbon market, for example), the value of these transactions is much larger, reaching nearly \$25 billion in 2015. As global leaders struggle to meet the challenge of minimizing and adapting to climate change while lifting 1.2 billion people out of extreme poverty this century, the programs tracked in this report offer critical lessons for addressing water risk in a sustainable, cost-effective, landscape-scale manner.

Burke, L., Ranganathan, J., & Winterbottom, R. (2015). [Revaluing Ecosystems: Pathways for Scaling up the Inclusion of Ecosystem Value in Decision-Making.](#)

Ecosystems provide essential services to society, from pollination and filtering of pollution to climate and water regulation. These services are often treated as though they have no value, with ecosystems too frequently managed for short-term gain at the expense of broader, longer-term societal benefits. There is an increasing array of tools to evaluate the trade-offs associated with these developments, as well as a growing body of ecosystem service assessments that highlight the changes in value. Efforts to incorporate ecosystem values in decision-making are growing — through partnerships, in government, and in the private sector. This brief highlights barriers, opportunities, and pathways to broader consideration of ecosystem services in decision-making.

Evans, W., Evans, R., & Holland, G. (n.d.). [Conjunctive Use and Management of Groundwater and Surface Water.](#)

Conjunctive use of groundwater and surface water in irrigation means using water from the two different sources for consumptive purposes. Conjunctive use can refer to the farming practice of sourcing water from a well and an irrigation delivery canal, or can refer to a strategic approach at the irrigation command level where surface water and groundwater inputs are centrally managed for irrigation systems. This paper provides insight into the barriers to adoption, providing a new focus on an old paradigm: It intends to make progress toward improved water management and water use efficiency in support of longer-term outcomes such as improved food security in critical parts of the world.

Millennium Ecosystem Assessment (2005). [Ecosystems and Human Well-Being: Synthesis.](#)

OECD (2006). [Water and Agriculture: Sustainability, Markets and Policies.](#)

Agriculture is a major user of water and is responsible for much of its pollution. But the agricultural sector faces increasing competition for scarce water supplies from urban and industrial users and, increasingly, to sustain ecosystems. These conference proceedings explore how governments and the private sector can expand the role of markets to allocate water used by all sectors and to get agricultural producers to account for the pollution that their sectors generate.

OECD (2013a). [Water and Climate Change Adaptation: Policies to Navigate Uncharted Waters.](#)

This publication sets out the challenge for freshwater in a changing climate and provides policy guidance on how to navigate this new “waterscape.” It examines the range and complexity of possible changes in the water cycle and the challenges of making practical, on-site adaptation decisions for water. It offers policymakers a risk-based framework and guidance to “know,” “cap,” and “manage” water risks to provide flexibility and improve decisions despite the lack of reliable predictions. It draws insights from a review of current policy efforts to adapt water systems across all 34 member countries and the European Union, including water-related aspects of national adaptation plans and strategies, policy measures, and financing programs. It also examines the use of economic instruments to promote adaptation (e.g., insurance schemes, water markets and banks, water pricing), incentives for green infrastructure and ecosystem-based approaches, and financing issues.

OECD (2013b). Water Security for Better Lives.

This publication examines the critical issues surrounding water security: shortage, excess, inadequate quality, and the resilience of freshwater systems. It provides a rationale for a risk-based approach and the management of trade-offs between water and other (sectoral and environmental) policies. The report sets out a three-step process to “know,” “target,” and “manage” water risks: appraising the risks; judging the tolerability and acceptability of risks and weighing risk-risk trade-offs; and calibrating appropriate responses. It also provides policy analysis and guidance on the use of market-based instruments and the complex links between water security and other policy objectives, such as food and energy security, climate mitigation, and biodiversity protection.

OECD (2014). Climate Change, Water and Agriculture: Towards Resilient Systems.

This report reviews the main linkages between climate change, water, and agriculture to identify and discuss adaptation strategies for better use and conservation of water resources.

Olson, D., Millington, P., & McMillan, S. (2006). Creating and Empowering a River Basin Organization.

This note is one in a series explaining the attributes and practical application of integrated river basin management. It discusses typical features of a river basin organization; how to create the organization (mainly related to a domestic or national organization); how to empower the organization with a clear legal and institutional framework; and how to bring stakeholders into the institutional arrangements through appropriate participative mechanisms. It deals primarily with new or restructured basin organizations in one country, with some directions about how these concepts can be extended to international basins involving two or more countries.

Shah, T. (2016). Increasing Water Security: The Key to Implementing the Sustainable Development Goals.

Sustainable Development Goal 6, Clean Water & Sanitation (the “water goal”), puts responsibility for water management and increasing water security in the hands of the water and water-using sectors. Its agenda champions the need for an integrated approach to WRM and provides a “green light” to countries to implement their IWRM plans. This Global Water Partnership technical committee background paper is a timely response to the Sustainable Development Goals. It reviews the IWRM approach and its evolution over the past 25 years toward increasing water security, including its successes and disappointments.



Social and Behavioral Change Measures

Arnold, M., & de Cosmo, A. (2015). Building Social Resilience: Protecting and Empowering Those Most at Risk.

This paper explores progress and documents good practice related to the implementation of “policies and plans to reduce the vulnerability of populations most at risk.” It begins by explaining “vulnerability,” describing who is most at risk to natural hazards and how that risk may shift in the coming decades due to climate change. Next, it discusses approaches that improve the resilience of those most at risk, and describes examples of ongoing or completed projects that demonstrate what works. Based on these findings, the paper concludes with recommendations for principles and commitments to be included in the successor agreement to the Hyogo Framework for Action.

Datta, S., Darling, M., Gonzalez, O. C., Miranda, J. J., De, L., & Zoratto, C. (2015). A Behavioral Approach to Water Conservation: Evidence from a Randomized Evaluation in Costa Rica.

The authors designed a set of three simple and replicable behavioral interventions, using stickers that can be added to water bills, and tested their impact on water consumption in Belen, Costa Rica, using a randomized control trial. They found that two of the three interventions significantly decreased water consumption in the months following the intervention. A descriptive social norm intervention using neighborhood comparisons reduces consumption by 3.7 to 5.6 percent relative to a control group, while a plan-making intervention reduces consumption by 3.4 to 5.6 percent. The results demonstrate that behavioral interventions, which have hitherto utilized sophisticated software to deliver customized messages, can be effectively implemented by local governments in developing countries. The results further confirm that

raising awareness about how much water an individual consumes, and comparing this consumption with peers, can help change individual behavior regarding the use of a finite resource such as water.

Faures, J.-M., & Santini, G. (2008). [Water and the Rural Poor: Interventions for Improving Livelihoods in Sub-Saharan Africa.](#)

This publication details a joint effort by the Food and Agriculture Organization of the United Nations and the International Fund for Agricultural Development to address the linkage between water and rural poverty in Sub-Saharan Africa. It examines past experiences and demonstrates that there are many opportunities to invest in water in support of rural livelihoods. Its aim is to help decision-makers make informed choices on where and how to invest. It emphasizes the need for an approach where infrastructure investments are matched with interventions in institutions, knowledge, and finance in ways that maximizes poverty reduction. It highlights the extreme heterogeneity of situations facing rural people across the region and the diversity of challenges and opportunities facing different categories of rural operators, stressing the need to adapt responses to these realities. It recognizes the many dimensions of the rural water challenge, and shows how people's livelihoods depend on reliable water sources for a wide variety of uses.

Global Water Partnership (2013). [National Stakeholder Consultations on Water: Supporting the Post-2015 Development Agenda.](#)

The purpose of the national stakeholder consultations on water was to listen to country needs and priorities regarding the post-2015 agenda for water and sustainable development. The consultations aimed to get the voice of stakeholders on water issues to obtain a deeper qualitative understanding of individual country priorities. The country-level feedback adds practitioner value to the wider policy dialogues being undertaken by the United Nations and contributes to shaping potential sustainable development goals after 2015.

Hussein, K., & Nelson, J. (1998). [Sustainable Livelihoods and Livelihood Diversification.](#)

This paper is from the ODA-funded research program on sustainable livelihoods being carried out by the Institute of Development Studies and the Poverty Research Unit at the University of Sussex, in collaboration with the International Institute for Environment and Development. The program explores the alternative routes to sustainable livelihoods pursued by rural people in agro-ecological settings in four countries: Bangladesh, Mali, Ethiopia, and Zimbabwe. Its overall focus is to understand how institutional arrangements determine rural peoples' entitlements, provide the setting within which they construct their livelihoods, and determine who gains and loses in the struggle to maintain livelihoods. It is proposed that rural people construct their livelihoods using three main strategies: agricultural intensification, livelihood diversification, and migration. This paper examines livelihood diversification using evidence from Asia and Africa.

Liubinas, A., & Harrison, P. (n.d.). [Saving a Scarce Resource: A Case Study of Behavioural Change.](#)

Beginning in 2008, T155 formed part of the former Victorian Labor Government's behavioral change campaign, encouraging individuals in metropolitan Melbourne to limit water use to 155 litres per person, per day. With Melbourne facing severe water shortages and residents consuming 63 per cent of the city's water (Siriwardene, Quilliam & Roberts, 2011), action was needed to secure ongoing water supply. Water restrictions limiting outdoor water use had been in place since 2002. Therefore, the campaign focused individuals on new ways to save water, voluntarily, inside and outside the home.

Matin, N., Taylor, R., Forrester, J., Pedoth, L., Davis, B., & Deeming, H. (2015). [Mapping of Social Networks as a Measure of Social Resilience of Agents.](#)

The capacity of social network maps as a multipurpose heuristic device is very useful — indeed necessary — if we want to explore ideas of community resilience and planning in the face of natural disasters. As White (1945) put it, if "floods are 'acts of God,' flood losses are largely acts of man." Therefore, being able to present a formalized, structured understanding of social aspects ("the social") is critical to understanding, communicating, and providing truly integrative research on what community resilience to multiple hazards actually means in practice. Resilience cannot be left to hydrologists and physical planners alone; it must include the social. The authors' social network maps provide such a model of the links between significant individuals involved in key stages of the disaster planning, response, and recovery phases; furthermore, they do so in a structured manner, allowing this necessary social data to be communicated across disciplinary divides and also be

located in the context of a wider conceptual framework that links (social) knowledge networks and (institutional) decision-making structures. As a result, better decisions may be made.

Mercy Corps (2009). Community Mobilization Sector Approach.

With community mobilization, participation is about meeting the interests of the whole community. When every member of a community has the chance, directly or through representation, to participate in the design, implementation, and monitoring of community-level initiatives, there is a higher likelihood that the program accurately reflects their real needs and interests. The approach considers the different experiences, needs, and capabilities of groups in a community, including women and men, youth and the elderly, persons with disabilities and the able bodied, and ethnic/religious/language minorities and majorities. Rather than “passive participation,” Mercy Corps aims to inspire “self-mobilization,” where communities organize and take initiative independent of any external actors. Accountability is most basically the process of sharing information about actions or intentions. Groups and individuals in relationships, such as in communities, are accountable to each other when they honor their commitment to communicate plans and are responsible for what they do. In community mobilization, every community and all citizens have the right to know the procedures, decision-making processes, and financial flows of the programs Mercy Corps implements, as well as the specific community-led projects. Mercy Corps and local partner organizations sign contracts, have open selection criteria and processes for projects, and require documentation and tracking of all information to keep exchange of information open. Transparency helps ensure that decisions that affect the community are made in a socially responsible way — that particular groups, such as ethnic minorities or persons with disabilities, are not excluded from the benefits of projects or activities.

Mullins, A., & Soetanto, R. (2011). Enhancing community resilience to flooding through social responsibility. *International Journal of Safety and Security Engineering*, 1(2), 115–125.

Climate change has increased the threat of flooding to communities and presented the need for greater understanding of barriers and drivers to community resilience. This presents a significant research challenge due to complex interdependencies among the built environment, flooding, and the decisions of individuals within a community. The decisions of individuals in key community groups are of vital importance to this area because they affect perceptions, behavior, and cumulative resilience at the community level. The decision-making of community groups could be positive, resulting in resilience-enhancing actions, or negative, resulting in resilience-reducing perceptions and behavior. Therefore, understanding the factors that influence the decision-making process will help to overcome barriers and promote drivers for community resilience. This paper explores the literature in perceptions of social responsibility, one of the main areas that has the potential to affect decision-making at the community level. Differences between social responsibility and corporate social responsibility and public relation models are explored. Examples from recent flooding events suggest the important role of social responsibility in influencing community resilience. Main considerations for future research are described, including the need for establishing a common framework for measuring and monitoring social responsibility within the community. Such a framework would provide a platform for integration and joined-up thinking between key community groups.

O’Sullivan, J. J., Bradford, R. A., Bonaiuto, M., De Dominicis, S., Rotko, P., Aaltonen, J., & Langan, S. J. (2012). Enhancing flood resilience through improved risk communications. *Nat. Hazards Earth Syst. Sci*, 12, 2271–2282.

This paper presents a framework of guiding recommendations for effective pre-flood and flood warning communications derived from the URflood project (2nd ERA-Net CRUE Research Funding Initiative) from extensive quantitative and qualitative research in Finland, Ireland, Italy, and Scotland. Eleven case studies in fluvial, pluvial, coastal, residual, and “new” flood risk locations were undertaken. Results indicate that the information deficit model for flood communications that relies on the provision of more and better information to mitigate risk in flood-prone areas is insufficient, and that the communications process is very much multidimensional. The recommendations are aimed at addressing this complexity, and their careful implementation is likely to improve the penetration of flood communications. They are applicable to other risks and transferrable to jurisdictions beyond the project countries.

The World Bank. (2015). World Development Report 2015: Mind, Society, and Behavior.

US EPA. (2013). Getting in Step: Engaging Stakeholders in Your Watershed, 2nd ed.

This guide is intended for federal, state, tribal, and local agency personnel, as well as NGOs, that are involved in watershed management activities and are building a stakeholder group. It can also help private organizations interested in recruiting stakeholders and involving stakeholders in local or regional watershed efforts.



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