Blueprint TCAF – Water Sector

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Table of Contents

List of figures

List of tables

List of boxes

Abbreviations

AWD: Alternative Wet and Drying
BAU: business-as-usual
CDM: Clean Development Mechanism
CH4: methane
Ci-Dev: Carbon Initiative for Development
CO2: carbon dioxide
CRI: Climate-Resilient Irrigation
CWIS: City Wide Inclusive Sanitation
EE: Energy Efficiency
ETS: Emissions Trading System
FCPF: Forest Carbon Partnership Facility
GCF: Green Climate Fund
GDP: Gross Domestic Product
GHG: Greenhouse Gas
GIFs: Climate Investment Funds
GP: Global Practice
GWP: Global Warming Potentials
GWSP: Global Water Security & Sanitation Partnership
IEA: International Energy Agency
IPCC: Intergovernmental Panel on Climate Change
ITMOs: Internationally Transferred Mitigation Outcomes
ITMO-VER MOPA: Internationally Transferred Mitigation Outcome Verified Emission Reduction Mitigation Outcome Purchase Agreement
JI: Joint Implementation
LDCs: Least Developed Countries
MRV: Measurement, Reporting and Verification
MOPA: Mitigation Outcome Purchase Agreement
N2O: nitrous oxide
NDCs: Nationally Determined Contributions
RE: Renewable Energy
RBCF: Results-Based Climate Finance
RBCF-VER ERPA: Results-Based Climate Finance Verified Emission Reductions Emission Reduction Payment Agreement
SCADA: supervisory control and data acquisition
SCF: Standardized Crediting Framework
SDGs: Sustainable Development Goals
SIDS: Small Island Developing States
SRI: System of Rice Intensification
TCAF: Transformative Carbon Asset Facility
VERs: Verified Emissions Reductions
VCM: Voluntary Carbon Market
WASH: Water, Sanitation, and Hygiene
WRM: Water Resource Management
WSS: Water Supply and Sanitation

Glossary

Baseline: GHG emissions reduction from a project activity are quantified relative to baseline emissions for the project duration. Baseline GHG emissions are derived from the baseline scenario.

Carbon Dioxide equivalent: The universal unit of measurement used to indicate the global warming potential of greenhouse gases. It is used to evaluate the impacts of releasing (or avoiding the release of) different greenhouse gases, expressed as the equivalent amount of Carbon Dioxide. In this document this is expressed as CO_2e.

Carbon Footprint: This is the emissions of an activity or product, and a shorthand for describing its climate footprint.

Ecosystem Services: The diverse range of services that we derive from the natural environment. Four categories of ecosystem service have been identified: provisioning; regulating; cultural and supporting.

GEST: Greenhouse Gas Emission Site Types - A combination of plant species indicating long-term water table depths and other characteristics relevant to GHG fluxes (e.g., peat type, pH, nutrient status), associated with annual mean GHG fluxes of carbon dioxide and methane (expressed as CO_2e) based on literature or country-specific measurements. In absence of vegetation, water table depth is used as the main proxy.[1]

Global Warming Potential: is a measure of how much heat a greenhouse gas traps in the atmosphere up to a specific time horizon, relative to carbon dioxide. It compares the amount of heat trapped by a certain mass of the gas in question to the amount of heat trapped by a similar mass of carbon dioxide and is expressed as a factor of carbon dioxide (whose GWP is standardized to 1). Commonly a time period of 100 years is used.

Greenhouse Gas (GHG): A collective term for gases that are causing the warming of the Earth’s atmosphere that is leading to climate change. From six gases mentioned in the Kyoto Protocol, carbon dioxide; methane; nitrous oxide are of interest for the water sector.

Leakage: GHG emissions occurring outside the project boundary as a result of the project e.g. displacement of agricultural activities might result in peatland degradation or intensification of use of non-degraded peatlands elsewhere.

Net Ecosystem Exchange (NEE): This is the measure of how much carbon is released or stored by an ecosystem over a year. This is a net figure as all ecosystems will both release and absorb carbon. For example, a system may absorb carbon dioxide but release methane. The Net Figure is the balance between the release and storage. A Negative figure indicates that more Carbon is stored than released. This measure will be expressed as CO_2e, or CO2e (Carbon Dioxide Equivalent.)

[1] **Couwenberg, J. et al. (2011):** Assessing greenhouse gas emissions from peatlands using vegetation as a proxy. Hydrobiologia 674: 67–89.

Shunt Species: Species with an Aerenchyma can allow methane to pass through them (acting as a 'shunt' or 'chimney') directly to the atmosphere, rather than passing through the aerobic zone in the topsoil.

WSS - Water Supply and Sanitation: Water Supply and Sanitation refers to development around water supplies and hygiene. Water is at the center of economic and social development; it is vital to maintain health, grow food, manage the environment, and create jobs. Despite water's importance over 663 million people in the world still lack access to improved drinking water sources.[2]

Water Supply: Supply is used to capture support for source works, collection, treatment, transmission and distribution of water to household, industrial, commercial or other users.[3]

NRW - Non-Revenue Water: Non-revenue water (NRW) is water that has been produced and is lost before it reaches the customer. Losses can be real losses (through leaks sometimes also referred to as physical losses) or apparent losses (for example through theft or metering inaccuracies).[4]

Global Water Partnership: The Global Water Partnership supports countries in the sustainable management of their water resources.[5]

Solar Water Disinfection

Solar water disinfection is a type of portable water purification that uses solar energy in one or more ways to make contaminated water safe to drink by ridding it of infectious disease-causing biological agents such as bacteria, viruses, protozoa and worms. However, disinfection may not make all kinds of water safe to drink due to non-biological agents such as toxic chemicals or heavy metals. Consequently, additional steps beyond disinfection may be necessary to make water clean to drink.

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[2] WBG External Web.

[3] WBG External Web.

[4] Wikipedia

[5] WBG External Web.

Executive Summary

Context & Background

Aware of the global challenges, Water Global GP seeks to address water insecurity by working with governments to help achieve the World Bank's goals of ending poverty and boosting shared prosperity in a sustainable way.

Water plays an important role in life as a central sector linked to key sectors, notably agriculture, energy, health and the environment. In addition, due to various factors, water resources face multiple challenges including greenhouse gas emission (GHG). Opportunities to address each challenge are presented in Table 1.

Table 1: Water challenges versus opportunities

Factors	Challenges	Opportunities
1.Urbanization	Urban water challenges	-Water in Circular Economy and Resilience (WICER) Framework
2.Population growth	Increased and unmet water demand	-Utility of Future (UoF) Program -Water in Circular Economy and Resilience (WICER) Framework
3.Climate Change	Unstable Water cycle	- Climate-smart intervention: Energy efficiency (EE), Renewable energy (RE), improved sanitation, Nature based solutions (NBS), storage dam hydroelectric retrofit, climate smart agriculture (CSA), watershed and land management, fertilizer use efficiency.
4.Global water crisis	Uncovered water demand	-Climate-smart intervention: EE, RE, improved sanitation, NBS, storage dam hydroelectric retrofit, CSA, watershed and land management, fertilizer use efficiency.
5.GHG Emission	GHG emission by water infrastructure and resources	-Climate-smart intervention: EE, RE, improved sanitation, NBS, storage dam hydroelectric retrofit, CSA, watershed and land management, fertilizer use efficiency. -Global water framework: Sustainable Development and its specific Sustainable Development Goals (SDGs) 6 and 13, Paris Agreement, Sendai Framework for Disaster Risk Reduction 2015-2030, National Determined Contributions (NDCs)
6. GHG Management	Tools to manage GHG are under-development for water mitigation	- WB internal GHG Accounting tool, - EPA Simplified GHG calculator, - IPCC GHG inventories
7. Funding	Lack of water funding compared to other sectors	-Potential climate fundings: Climate investment funds (CIF), Transformative carbon asset facility (TCAF), Global environment facility (GEF,) etc.
8. Water policy & Governance	-Weak policy and governance -Weak water utility performance	-Utility of Future (UoF) Program -PPP partnership
9. Non-revenue water (NRV)	-Loss of water and income loss -High energy consumption	-Utility of Future (UoF) Program -Water in Circular Economy and Resilience (WICER) Framework

In light of these opportunities, this report, which is a knowledge product of the Transformative Carbon Asset Facility (TCAF), aims to facilitate water sector projects' access to TCAF funding, namely the results-based climate financing in blueprinting potential water sector carbon crediting programs towards verified greenhouse gas emission reductions.

For the interest of the World Bank task teams and government technical experts, this report focuses on three (3) major water sector business lines, namely: (1) Water Supply and Sanitation (WSS), (2) Water Resources Management (WRM), and (3) Climate Resilient Irrigation (CRI).

TCAF and Results-Based Climate Finance in the Water sector

As a contribution to the World Bank's Climate Change Action Plan 2021-2025, the Climate Change Fund Management Unit is coordinating climate finance initiatives to reaffirm the World Bank's commitment to financing initiatives that are aligned with the goals of the Paris Agreement to "strengthen the global response to the threat of climate change in the context of sustainable development and efforts to eradicate poverty."

TCAF is among the climate finance initiatives and aims to support transformative climate action through results-based payments for verified emission reductions (VERs) in order to assisting countries in achieving and surpassing the mitigation targets outlined in their NDCs. Two-phase structures are defined under TCAF, i.e., (1) Results-Based Climate Finance (RBCF), (2) carbon market transaction.

TCAF adopts diverse crediting approaches that align with the level at which activities are undertaken jurisdictional, sectoral, or policy-oriented in departure from the conventional project-based and programmatic approaches commonly utilized in both carbon markets and RBCF as summarized in Table 2.

Table 2: Baseline emissions, project emissions and MRV in different crediting approaches

Crediting Approach	Baseline emissions	Project emissions	MRV
Jurisdictional	Total project emissions in the jurisdiction	Total reported emissions in the jurisdictional ex-post	Detailed bottom-up jurisdiction-level GHG inventory, with clear boundaries
Sectoral	Total project sector emissions	Total sector emissions reported ex-post	Detailed bottom-up sectoral inventory, with clear boundaries
Policy based	Based on economic comparison of economy-wide emissions or sectoral emissions in the absence of policy (e.g., carbon tax, performance standards, regulation)	Based on economic comparison of economy-wide emissions or sectoral emissions with the policy	Comparison baseline and program emissions using ex-post input parameters (e.g., GDP, sectoral GDP, fuel prices)

In terms of operationalization, TCAF support unfolds across several phases. Initially, it involves identifying a proposal and preparing the crediting program. In an optional subsequent phase, the host country engages in negotiations for an Internationally Transferred Mitigation Outcome Verified Emission Reduction Mitigation Outcome Purchase Agreement (ITMO-VER MOPA).

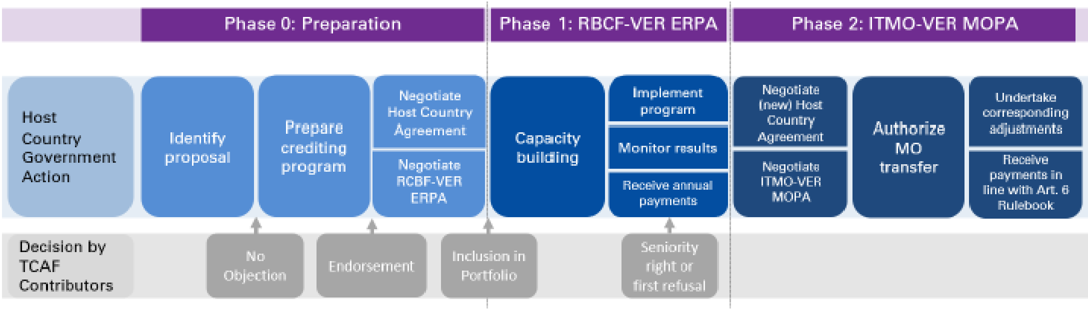


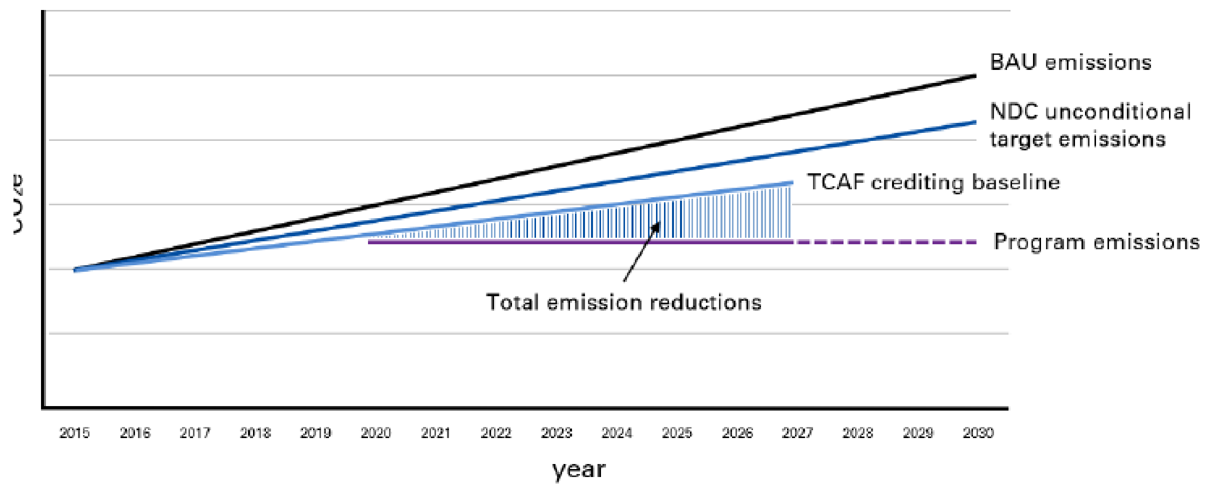
Figure 1:TCAF Program Operationalization Phases (adapted from TCAF)

TCAF's two-phase structure yields several key benefits for host countries, namely: (i) flexibility to shape their collaboration during the implementation of the crediting program, (ii) no-regret Engagement to achieve its NDC target, by opting to negotiate an ITMO MOPA without the risk of overselling emission reductions, and (iii) capacity building for leveraging international carbon market resources.

Payments for verified emission reductions are administered by TCAF in various tranches over the course of the crediting program's implementation. (i) TCAF, acting on behalf of its Climate Finance Providers, (ii) TCAF provides technical assistance to host countries supporting a potential additional ITMO operation, and (iii) TCAF, purchasing ITMOs on behalf of carbon market buyers.

To be eligible for TCAF funding, several essential criteria must be satisfied. These encompass:

- Sustainable development: by defining indicators based on the SDGs to measure progress, evaluate results, and identify co-benefits.
- Transformational change: by adopting global economic and societal shifts necessary for achieving the goals of the Paris Agreement.
- Baseline(s) setting (see Figure 2): by establishing program baselines, which are under the baseline determination in TCAF involving a comparison of the emissions trajectory based on the unconditional target with a BAU emissions trajectory calculated by TCAF.
- Additionality: by paying for emission reductions that surpass the NDC targets of host countries and the mitigation activities funded by international climate finance.
- MRV: by designing meticulous TCAF's MRV systems, which complement host countries' national MRV frameworks.
- Crediting periods: by referring to the timeframe during which a mitigation activity generates TCAF monitored emission reductions.



Source: Adapted from TCAF (2021) Core Parameters for TCAF Operations

Figure 2: TCAF approach to baseline setting

General Framework for Implementing TCAF in the Water Sector

The convergence of urbanization, climate change, global water crisis, GHG emissions, funding issues, and water policy implementation creates a complex landscape for water management. TCAF's support has the potential to instigate transformative shifts in both the structuring and financing of water projects.

Referring to TCAF parameters, **transformational change** on WSS, WRM, CRI, considers, both in terms of scale and sustainability, projects that integrate technological innovation with the highest impact on the reduction of carbon emissions and align effectively with TCAF objectives. Examples of these technologies are summarized in table 3.

Table 3: Examples of WSS, WRM, and CRI climate smart innovative technologies

Water sector business lines	Innovative Technologies
WSS	- Methane Capture - Renewable energy integration and energy efficiency improvement in wastewater and water treatment processes.
WRM	- Management of natural landscapes, - Hydropower Dams, - Hydro-electric Retrofitting; and - Energy Floating Solar.
CRI	- Alternative Wet and Drying (AWD); and - System of Rice Intensification (SRI) for irrigated rice, balanced fertilizer usage efficiency, and energy efficiency in groundwater irrigation.

Common factors for **baseline setting** across various projects in the water sector include: (1) current situation assessment, (2) historical emissions data, (3) technology and management practices evaluation, (3) policy compliance, (4) integration of renewable energy and energy efficiency, and (4) scenario comparison.

Common factors for **MRV** across the different programs in the water sector include: (1) emission sources and processes, (2) on-site monitoring, (3) standardized methodologies, (4) quantification of parameters, (5) conversion factors, (6) measurement tools, (7) verification procedures, (8) alignment with national MRV systems, (9) consideration of transformational change, and (10) adherence to reporting requirements.

Most prevalent **policy measures** for the water sector are:

- **Prescriptive measures**: including regulatory standards and enforcement, promotion of sustainable practices, and incentive mechanisms and penalties.
- **Economic measures**: including taxation and subsidies, user fees and tariffs, and economic instruments for pollution control.
- **Supportive policies**: including policy development and implementation, capacity building and technical expertise enhancement in RE and EE technologies, and stakeholder collaboration and partnerships with utilities and private sector for instance.
- **Direct investments**: including the government funds allocation, the international financing mobilization, and the private sector investment encouragement.
- **Effective business model**: including performance-based contracting, public-private partnerships (PPP) and innovative financing mechanisms.

1. Context & Background

1.1. Water Global Practice

Inspired by the World Bank's twin goals of ending extreme poverty and promoting shared prosperity, the Water Global Practice (GP) addresses water security issues for development outcomes. The WBG is in a unique position to help governments take such an integrated and strategic approach to solve water problems through partnership, finance and knowledge. The Water GP places Water Resource Management (WRM) and an understanding of water in the context of the broader economy, including climate change, at the center of its efforts to help countries address the challenge of managing water. The Water GP seeks to ensure that water issues are effectively addressed in all related sub-sectors, such as water supply & sanitation, agriculture, disaster risk management, energy, and management of rivers and lakes. In each sub sector an integrated approach is adopted which considers investment and operations in the context of governance, institutions and policies. The Water GP also administers the Global Water Security and Sanitation Partnership (GWSP), which is a multi-donor trust fund. It is as an international partnership to support countries to meet the targets related to water and sanitation under the Sustainable Development Goals, particularly those of SDG6. GWSP acts as the Water GP's "think tank," providing client countries and other development partners with global knowledge, innovations, and country-level technical support while also leveraging World Bank resources and financial instruments.

The water sector plays a cross-cutting role over different sectors. Water is a necessity to sustain life and has a central role in the provision of a wide range of services, including food, health, energy, and ecosystems. Water's centrality is mapped to key sectors, mainly agriculture, energy, health and environment. The Water Supply and Sanitation (WSS) sub-sector has a social co-benefit with improving health conditions. WRM contributes to the promotion of both energy through renewable energy types of namely hydropower and floating solar, and environment through the ecosystem development using water as a vehicle of nutrient. Given this linkage, the water-food-energy nexus lies at the heart of sustainable, economic and environmental development and protection. The demand for all three resources continues to grow for various reasons: a growing population, ongoing population movements from farms to cities, rising incomes, increased desire to spend those incomes on energy and water intensive goods/varying diets, international trade, urbanization, and climate change.

1.2. Water availability and demand

Global water resources availability trends to depletion by 2050. The spatial and temporal distribution of available surface water resources will change, and its quality will deteriorate at continental level by 2050. More likely, aquifers will shrink, and salt intrusion in coastal areas will be very dramatic. More than 30% of the world's largest groundwater systems are now in distress. The largest groundwater basins are being rapidly depleted. In many places, there is no accurate knowledge about how much water remains in these basins and people are consuming groundwater quickly without considering when it will run out[6]. The world's supply of fresh water may be much more limited than what is thought because unlimited groundwater was assumed[7].

In contrast, water demand will increase due to rapid population growth, mainly in developing countries. By 2050 the global population will increase to between 9.4 to 10.2 billion people, an

[6] Boretti, 2019. Reassessing the projections of the World Water Development Report

[7] Ferguson, G., McIntosh, J. C., Perrone, D. & Jasechko, S. Competition for shrinking window of low salinity groundwater. Environ. Res. Lett. 13, article114013 (2018).

increment of 22% to 32%. Most of the population growth will occur in developing countries, first in Africa, +1.3 billion, or +108% of the present value, and then in Asia, +0.75 billion, or +18% of the present value (See Figure 3[8]). Projections suggest that by 2050, global demand for water will increase by 20 to 30 percent[9]. By 2100, Africa's per capita freshwater resources are projected to be 64 percent lower than today[10]. Most likely, the water quality will no longer meet the water demand at global level by 2040[11].

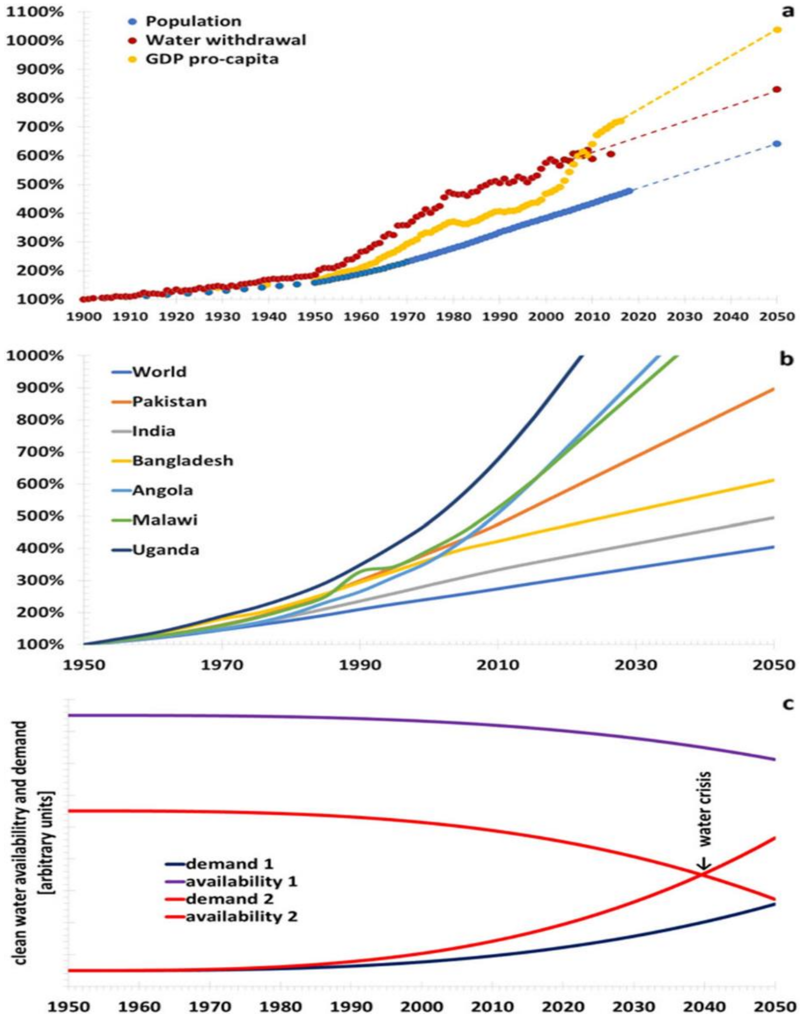


Figure 3: presents in (a) the global water withdrawal, the GPD pro-capita and the world population since the year 1900, and in (b) the population of the world and of selected countries of Asia and Africa since the year 1950. The figure also presents in (c) the graphical concept of water scarcity, resulting from a more that linear growing demand, and a similarly more than linear reducing availability of clean water. It is intuitive that growing demand and shrinking availability will ultimately cross each other, locally earlier than globally.

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[8] Boretti, 2019. Reassessing the projections of the World Water Development Report
[9] WWAP 2019
[10] Zhang, Fan, and Christian-Borja-Vega. 2024. "Water for Shared Prosperity." World Bank, Washington, DC. © World Bank.
https://documents1.worldbank.org/curated/en/099051624105021354/pdf/P50138117773d00d31858114955019bdfcc.pdf
[11] Boretti, 2019. Reassessing the projections of the World Water Development Report

The highest global water demand is attributed to agriculture, water supply and sanitation, and water storage, in which agriculture is the main contributing sector to global GDP in developing countries. Global water use for agriculture, mainly for irrigation, accounts for 68% of the total. Domestic global water use currently accounts for 19% of the total[12] (see Figure 4), while water storage accounts for 10%[13]. Agriculture is among key sectors to production and economic activity in developing countries. Growth in the agriculture sector is two to four times more effective in raising incomes among the poorest compared to other sectors. Agriculture is also crucial to economic growth: accounting for 4% of global gross domestic product (GDP) and in some least developing countries, it can account for more than 25% of GDP. The increase in demand in the agriculture sector increases the water demand, which subsequently plays a major role in increasing the GDP in developing countries.

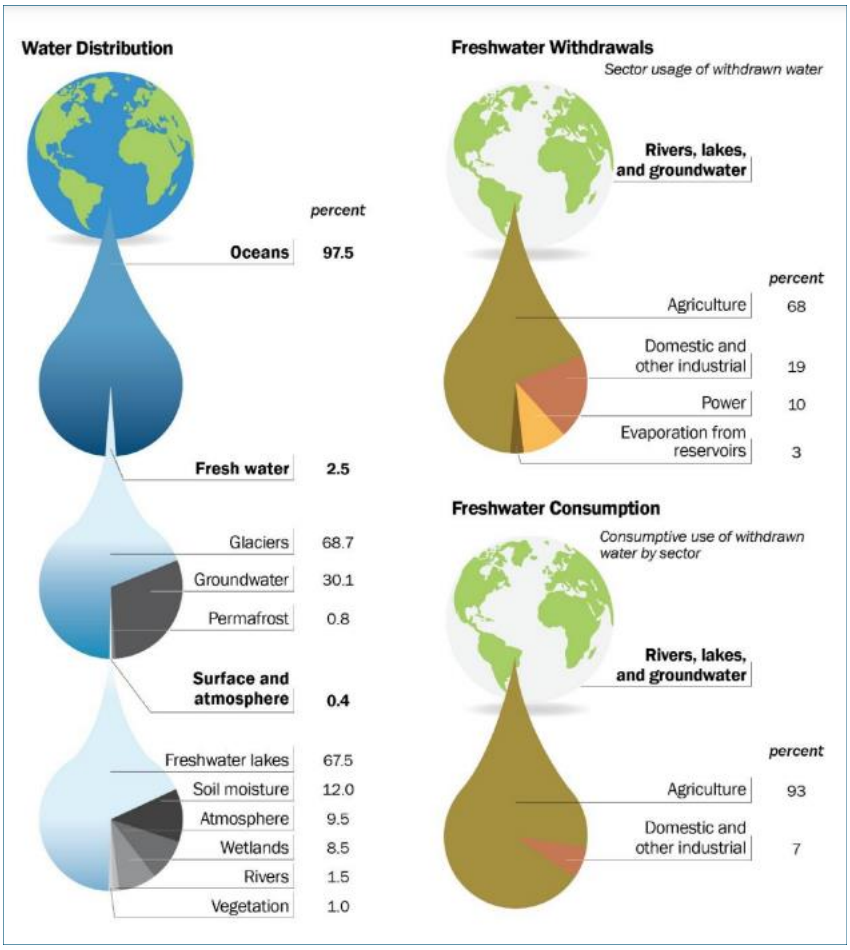

Figure 4: The earth's water and current human use[14]

[12] Boretti, 2019. Reassessing the projections of the World Water Development Report

[13]Global Trends report, April 2021: "Water Insecurity Threatening Global Economic Growth, Political Stability" https://www.dni.gov/files/images/globalTrends/GT2040/NIC_202102489_Future_of_Water_18nov21_UNSOURCED.pdf

[14] Multiple sources as quoted by World Bank in 2010 in the Global Trends report, April 2021: "Water Insecurity Threatening Global Economic Growth, Political Stability" https://www.dni.gov/files/images/globalTrends/GT2040/NIC_2021-02489_Future_of_Water_18nov21_UNSOURCED.pdf

1.3. Water challenges

Urbanization: **Two-thirds of the world population will live in cities by 2050, with an increase of 80% of the current domestic water demand**. Water supply services in urban areas will need to increase significantly over the period 2010–2050 in all the world regions, except for Western Europe. The greatest increment, 300%, will occur in developing countries, mainly in Africa and Asia. Many countries already face challenges in meeting the needs of their growing urban populations. The situation is particularly difficult in low- and middle-income countries, where urbanization is occurring more rapidly, often with less planning. Even though water and sanitation access rates are generally higher in urban than rural areas, planning and infrastructure have not kept pace in the cities[15]. There is still a lack of adequate and inclusive water and sanitation infrastructure and services for all, especially in informal settlements. The global urban population facing water scarcity is projected to double from 930 million in 2016 to 1.7–2.4 billion people in 2050[16].

Climate change: Climate change manifests itself mainly through its impact on the water cycle. As global temperatures rise, water supply will become more unpredictable, droughts will increase in frequency and severity, and disease outbreaks after floods will become more likely[17]. These water shocks can lead to crop damage, lower food supplies and income, higher food prices, and increased risk of waterborne disease. Rainfall anomalies are shown to be associated with increased incidences of conflict and social unrest, particularly in countries where rainfed agriculture is the dominant source of income[18].

Global water crisis: Uncovered water demand poses a global water crisis. Globally, in 2022, 2.2 billion people lacked access to safely managed drinking water services; 3.5 billion people lacked access to safely managed sanitation[19]; 1.7 billion people lacked basic water services at their health care facility[20]; and close to 550 million children attended schools without basic water and sanitation services[21],[22]. Besides, when water resources, infrastructure, and services are not adequately managed, developed, and delivered, water-related challenges—issues with too much, too little, or too polluted water—can exacerbate inequalities and fragility.[23]

GHG emissions: Existing water infrastructure to cover the water demand gap is among the sources of GHG emission. Water use and management are estimated to be responsible for up to 10 percent of global greenhouse gas emissions. making them key to the net-zero transition [24],[25]. Water sector projects - which span water and sanitation services, water resources management, irrigation/agriculture, energy production, electricity, and industrial production - also contribute significant greenhouse gasses, or CO2e, to the atmosphere[26] along the service chain. Recent studies on sanitation in Kampala show an emission of 189 kt CO2 e per year, which may represent more than half

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15 WHO and UNICEF 2019.
16 https://www.unesco.org/en/articles/imminent-risk-global-water-crisis-warns-un-world-water-development-report-2023
17 IPCC 2023
18 Raleigh, Linke, and Dowd 2012; Hsiang, Burke, and Miguel 2013; Sarsons 2015; Koubi et al. 2021
19 WHO/UNICEF JMP 2023
20 WHO/UNICEF 2022a
21 WHO/UNICEF 2022b
22 Zhang, Fan, and Christian-Borja-Vega. 2024. "Water for Shared Prosperity." World Bank, Washington, DC. © World Bank.
https://documents1.worldbank.org/curated/en/099051624105021354/pdf/P50138117773d00d31858114955019bdfcc.pdf
23 https://documents1.worldbank.org/curated/en/099051624105021354/pdf/P50138117773d00d31858114955019bdfcc.pdf
24 https://uswateralliance.org/communities-of-practice/utility-greenhouse-gas-ghg-reduction-cohort/#:~:text=Water%20use%20and%20management%20are,of%20global%20greenhouse%20gas%20emissions.
25 https://www.waterrf.org/resource/greenhouse-gas-emissions-water-sector-lets-uncover-basics
26 Common direct (Scope 1) greenhouse gas emissions (GHG) associated with water projects are methane and nitrous oxide, along with direct and indirect (Scope 1 and 2) carbon dioxide (CO2) emissions. This report uses carbon dioxide equivalent (CO2e) as a standard unit for expressing GHG emissions.

of the total city-level emissions, and in which 49% of emission from the long periods of storage of fecal waste in sealed anaerobic tanks, 4% from the discharge from tanks and pits direct to open drains, 2% from the illegal dumping of fecal waste, 6% from sewers leakage, 7% from wastewater bypassing treatment, and 31% from the uncollected methane emissions at treatment plants.

GHG emission management is limited. GHG management starts by inventorying the emitted GHG emissions. Various tools have been developed to measure and/capture the GHG emissions, including the WB-developed GHG Accounting tools, the EPA Simplified GHG calculator, and the IPCC GHG inventories. The application of these tools to the water sector has developed recently.

Funding issues: Water financing is lower compared to other sectors[27]: A key, enduring challenge facing water infrastructure investments can be understood as its positioning as a separate "sector" generating basic public goods, while also providing benefits for other "sectors" like electricity, agriculture, and industrial uses that generate more direct financial benefits. Too often, water requirements for these other sectors are taken as given, and considered separate from the infrastructure that generates and delivers water (of varying quality). Urban water supply and sanitation service providers, which are often public entities, face the brunt of these challenges, on top of poor financial performance. Low willingness to pay, low operating efficiency (such as high non-revenue water and low energy efficiency, usually linked to aging infrastructure), inefficient investments, and low tariffs make it difficult for water utilities to recover costs and improve service sustainability. This has resulted in the water supply and sanitation sector relying on public sector financing and subsidies for its investment, operations, and maintenance needs.

Water policy implementation issue: Water governance adds a complex layer to the effective implementation of climate-related water policy. A wide diversity of policy areas and stakeholders are often involved in defining water priorities, among which a decentralized water policymaking, a sectoral fragmentation of water-related tasks across the ministries and public agencies, a diversity of actors involved in water policy-making and policy-makers facing conflicting objectives[28]. Poor performance of urban water utility is usually caused by this complex and multidimensional problems that stem from a vicious cycle of dysfunctional political environments, inefficient practices, and a lack of dedicated leadership[29].

Huge non-revenue water: Poor performance of water utilities tends to increase the non-revenue water. In developing countries, roughly 45 million cubic meters of water are lost daily with an economic value of over US$3 billion per year[30]. The technical and financial performance of water utilities is often weak, resulting in a huge financial cost of treating and pumping water only to see it leak back into the ground, and the lost revenues from water that could have otherwise been sold. If the water losses in developing countries could be halved, the saved water would be enough to supply around 90 million people.

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[27] OECD, July 2022. The Challenge of Financing Water-related Investments. https://www.oecd-ilibrary.org/sites/c2ec6726-en/index.html?itemId=/content/component/c2ec6726-en

[28] UN World water Report, 2023

[29] Soppe, Janson, and Piantini 2018.

[30] World Bank, 2016. What is non-revenue water? How can we reduce it for better water service? (worldbank.org)

1.3 Water opportunities

Water infrastructure is necessary for most other social and productive sectors to function and is an urgent requirement for climate adaptation to reduce GHG emission. Designing water investments for mitigation, while accommodating adaptation, may allow for more and new funding to advance progress towards the water-related SDGs, along with the many other SDGs that depend on water for their success. **A wide range of climate smart water financing is available which is attributed to developing countries.** The World Bank's Climate Change Action Plan[8] represents an ambitious effort to align new operations with the Paris Agreement, starting in July 2023. This effort is supported by the Bank's GHG accounting system and the requirement that all Task Teams developing projects conduct climate impact assessments, which analyze a project's GHG emissions against a "no project" or defined alternative. Findings from the climate impact assessment are used to inform final project design choices and investment decisions. The Global Water Security & Sanitation Partnership (GWSP) works to support the Bank's climate agenda by identifying mitigation opportunities through water investments and by establishing relationships with climate funders including the Transformative Carbon Asset Facility (TCAF).

Global climate-related water frameworks contribute to water financing projects through countries partnership: To advance on sustainable development and climate action, a number of global frameworks have been adopted. These include the 2030 Agenda for Sustainable Development and its specific Sustainable Development Goals (SDGs) 6 and 13, to ensure availability and sustainability management of water and sanitation for all, and to take urgent action to combat climate change and its impacts, respectively. The Paris Agreement on climate change and the Sendai Framework for Disaster Risk Reduction 2015-2030 have also set ambitious climate-related goals and targets[31]. These agreements can, in many ways, be considered as an opportunity to develop water partnerships among countries to advance water financing projects. Most importantly, the National Determined Contributions (NDCs) are commitments that countries make to reduce their greenhouse gas emissions as part of climate change mitigation. NDCs embody efforts by each country to reduce national emissions and adapt to the impacts of climate change.

Climate mitigation focus can create upstream opportunities to strengthen water governance and reform policy. Under results-based financing modalities, climate funders are calling for routine monitoring, verification, transparency, and accountability throughout a large part of the lifecycle of an investment's operations - not just at the design phase. This can and should be understood as an opportunity to strengthen underlying governance weaknesses in water sector policy and implementation, while also contributing to global climate goals and targets.

Non-revenue water (NRW) management allows utilities to expand and improve service, enhance financial performance, make cities more attractive, increase climate resilience and reduce energy consumption. NRW is manageable**.** At city level, to guide WSS utilities to reinvent and strengthen themselves, the World Bank has developed Utility of the Future (UoF), a program designed to ignite, materialize, and maintain transformation efforts in WSS utilities. The goal is to become the Utility of the Future — a future-focused utility, which provides reliable, safe, inclusive, transparent, and responsive WSS services through best-fit practices that allow it to operate in an efficient, resilient, innovative and sustainable manner. This is achieved by strengthening the essential processes of a WSS utility to meet its current challenges and developing forward-looking strategies to stay ahead in a fast-

[31] UN World Water Report, 2023.

changing environment[32]. In addition, the WB developed the Water in Circular Economy and Resilience (WICER) Framework[33], which can be implemented for energy efficiency and non-revenue water reduction programs that have recovered the investments in a short period of time while saving water and energy and increasing the amount of people with access to services. WICER helps on scaling up water reuse and resource recovery in cities to address urban water challenges.

1.4. Objectives

This report is a knowledge product of the Transformative Carbon Asset Facility (TCAF). TCAF supports implementation of large-scale mitigation programs in a broad range of economic sectors, including the water sector, through providing results-based payments for verified greenhouse gas emission reductions.

The purpose of this report is to facilitate access of water sector projects to TCAF funding and in general to results-based climate financing in blueprinting potential water sector carbon crediting programs. This report is of interest for task teams aiming to access these funding sources to improve the climate profile of their operations, and technical experts from governments receiving or providing climate finance interested in results-based opportunities. This report focuses on three (3) main water sector business lines namely: (1) Water Supply and Sanitation (WSS) (including water supply, desalination, wastewater and sanitation, and wastewater reuse); (2) Water Resources Management (WRM) (including water storage, multipurpose reservoirs, dam safety, flood management, watershed and landscape management, and hydromet systems); and (3) Climate Resilient Irrigation (including irrigation, drainage, agriculture, and landscape management).

2. TCAF and Results-Based Climate Finance in the Water Sector

Chapter 2 delves into the significant impact of the Water Sector on carbon emissions. This chapter will elucidate how Results-Based Climate Finance (RBCF), particularly through the Transformative Carbon Asset Facility (TCAF), can play a pivotal role in financing projects within the Water Sector aimed at reducing carbon emissions.

2.1. Overview of Results-Based Climate Finance

The Paris Agreement aims to "strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty." It outlines ambitious goals, including keeping the rise in global temperatures well below 2°C above pre-industrial levels and striving to limit it to 1.5°C. Additionally, the agreement emphasizes the imperative of fostering adaptation, resilience, and low-carbon development without jeopardizing food production. Furthermore, it underscores the necessity of aligning financial flows with a trajectory towards low-carbon, climate-resilient development.[34]

[32] Utility of the Future Program (worldbank.org)
[33] Circular Economy: An Opportunity to Transform Urban Water Services (worldbank.org)
[34] UNFCCC, "Paris Agreement," FCCC/CP/2015/10/Add.1, (Paris: United Nations Framework Convention on Climate Change, 2015), http://unfccc.int/paris_agreement/items/9485.php, Art. 2.

The World Bank's Climate Change Action Plan 2021-2025 reaffirms its dedication to funding initiatives aligned with the Paris Agreement's objectives. This strategic blueprint acknowledges the critical importance of addressing the climate crisis while simultaneously addressing immediate development priorities, recognizing it as a foremost challenge of our time.[35]

To combat the climate crisis, the Climate Change Fund Management Unit coordinates climate finance initiatives aimed at fostering innovation and scalability in climate and environmental sustainability. These efforts are fundamental to the World Bank's overarching mission of reducing net carbon emissions in developing nations in line with the Paris Agreement. **One tool employed by the World Bank in this endeavor is RBCF.** This approach involves disbursing funds based on the achievement of climate outcomes, which are verified emission reductions according to the TCAF methodological requirements.[36] These targets encompass mitigation outcomes and may include additional indicators of progress toward mutually agreed decarbonization objectives.

Monetizing the value of emission reductions or achieved milestones **through RBCF presents a potent mechanism to bolster the financial viability of water sector mitigation actions.** This approach becomes particularly appealing to incentivize widespread mitigation efforts. For client countries, the infusion of additional revenue can fortify the sustainability of policies or measures and incentivize stakeholders to ramp up climate action. For instance, these revenues can underwrite operational costs for extension services or other mechanisms facilitating practice change and GHG emission reductions at the farm level.[37]

The process of developing and negotiating Results-based Payments can empower governments to delineate the costs associated with implementing low-emission policies or measures across various scales, thereby fostering increased ambition in climate action. Moreover, a secured commitment to RBCF payments can serve as leverage for host countries to attract upfront investments from alternative sources. By tethering payments to interim milestones, RBCF revenue streams can be synchronized with the financing requirements of transformative climate initiatives, ensuring a seamless alignment between funding and action.[38] RBCF can also prepare countries and implementing agencies to access potential funding from carbon markets.

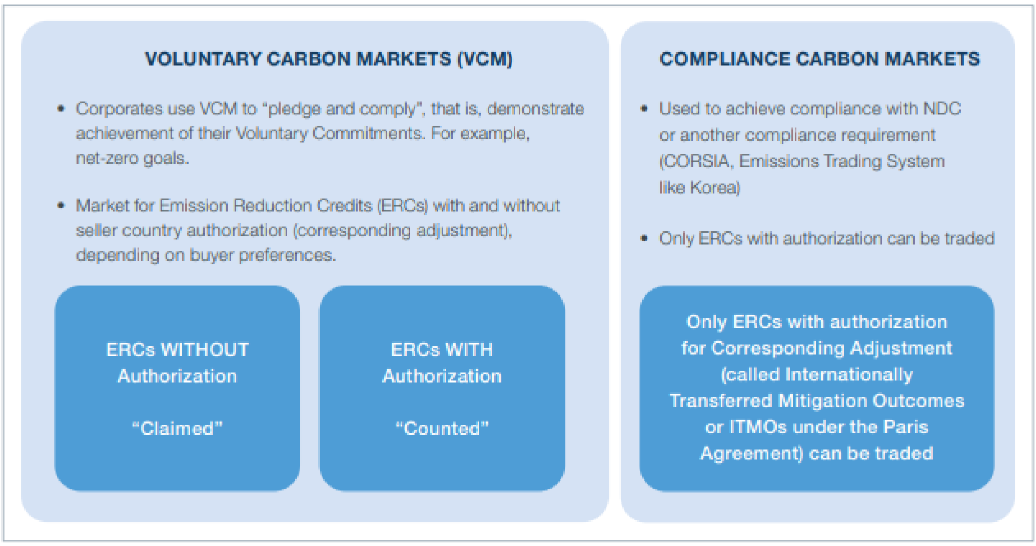
Table 4: Other Climate and Carbon Finance Mechanisms

Other Climate and Carbon Finance Mechanisms
Activity-based climate finance: Typically provided as upfront finance in the form of grants, concessional or market-rate debt, equity or guarantees. Examples include the Climate Investment Funds (CIFs) and the Green Climate Fund (GCF), which support countries to implement their NDC commitments.[39]

[35] World Bank, "Climate Change Action Plan 2021-2025," accessed at https://www.worldbank.org/en/news/infographic/2021/06/22/climate-change-action-plan-2021-2025.
[36] "NDC's is a climate action plan to cut emissions and adapt to climate impacts. Each Party to the Paris Agreement is required to establish an NDC and update it evert five years." United Nations Framework Convention on Climate Change, "All about NDCs," accessed at https://www.un.org/en/climatechange/all-about-ndcs
[37] World Bank, "Climate Explainer: Social Inclusion in Results-based Climate Finance," accessed at https://openknowledge.worldbank.org/server/api/core/bitstreams/0d55d00c-cb34-5b6c-97aa-c9c237fdba9b/content.
[38] Ibid.
[39] Ibid.

Carbon Markets: Carbon Markets require transfer of ownership of carbon assets through a compliance market or the voluntary market. A key provision within Article 6 of the Paris Agreement establishes the framework for a regulated or compliance carbon market, facilitating the international trade of Internationally Transferred Mitigation Outcomes (ITMOs). In this market, buyers range from governments acquiring ITMOs to fulfill their NDCs to private sector entities. The Voluntary Carbon Market (VCM) operates in parallel to compliance carbon markets. Buyers are corporates with net zero or other voluntary corporate commitments or pledges (i.e., emission reductions are not required under any regulatory mechanism).[40]

FIGURE 2. International Carbon Markets



Source: World Bank

2.2. Introduction of TCAF (Tool for Results-Based Climate Finance)

TCAF aims to support transformative climate action through results-based payments for verified emission reductions (VERs). Approximately half of TCAF's funds will be channeled through RBCF, used to pay for VERs that can be used by the host country to meet targets under its NDC. The other half is intended for the acquisition of emission reductions that will be transferred outside the host country as Internationally transferred mitigation outcomes (ITMOs) under Article 6 of the Paris Agreement, which cannot be used by the host country to meet domestic climate targets.[41] **The two-phase structure of TCAF, i.e., RBCF and carbon market transaction,** offers a distinctive approach to assisting countries in achieving and surpassing the mitigation targets outlined in their NDCs.

2.2.1. Different Carbon crediting approaches

To optimize the effectiveness of TCAF, it adopts diverse crediting approaches that align with the level at which activities are undertaken: jurisdictional, sectoral, or policy-oriented. This marks a departure from the conventional project-based and programmatic approaches commonly utilized in both carbon markets and RBCF. Domestically, this involves supporting the enactment of sectoral mitigation

[40] Ibid.

[41] Jason Smith, Klaus Oppermann, and Nuyi Tao et al., "Transformative Carbon Asset Facility (TCAF): Supporting transformative mitigation action in developing countries through results-based payments for verified emission reductions," November 2021.

policies or regulations, the implementation of carbon pricing instruments, and the development of robust MRV (Measurement, Reporting, and Verification) and accounting methodologies for both mitigation outcomes and broader NDC achievement. Internationally, TCAF can aid in testing the accounting, transparency, and integrity parameters associated with international assets.[42]

Project-based and programmatic crediting

In project-based and programmatic crediting, the baseline setting process, additionality assessment, and MRV focus on actions at specific sites, such as power plants or landfill sites. These processes determine the emissions reductions achieved by the project or program compared to a baseline scenario, which represents the likely outcomes without the incentives provided by the crediting mechanism.

Jurisdictional crediting

In jurisdictional crediting, the boundary is defined by the physical borders of a national or sub-national jurisdiction, rather than specific facility sites. Baseline emissions for the entire jurisdiction are established prior to the crediting intervention, although they may be updated based on monitored changes like GDP. These baselines serve as targets against which emission reductions are measured. Project emissions are determined post-implementation based on a comprehensive emissions inventory of the entire jurisdiction, accounting for boundary considerations.

Sectoral crediting

This approach resembles jurisdictional crediting. In sectoral crediting, the boundary is delineated by economic or industrial sectors or sub-sectors, ranging from broad categories like the "energy sector" to more specific ones like "building heating and cooling energy" or "municipal solid waste management." Similar to jurisdictional crediting, it's imperative to clarify which indirect emissions are encompassed within the boundary definition.

Policy-based crediting

In policy-based crediting, the mitigation impact of a policy is evaluated by comparing both the baseline counterfactual and the project scenario, with the sole difference being the introduction of the policy intervention, like a carbon tax or emission-related incentives. For national policies such as an economy-wide carbon tax, macroeconomic modeling tools project the economy and emissions with and without the policy. This approach does not solely rely on post-implementation emissions inventories due to the influence of various factors on actual emissions. Instead, modeling isolates the specific policy's effect on national emissions based on assumptions embedded in the modeling tools and inputs.

Different crediting approaches handle the role of emissions drivers distinctively. Project-based and programmatic crediting are less susceptible to external emissions drivers due to their narrower scope and reliance on ex-post parameters. Jurisdictional and sectoral aggregated crediting, on the other hand, include the impacts of both the crediting intervention and other emissions drivers within the relevant

[42] Ibid.; World Bank, "Transformative Carbon Asset Facility (TCAF): Crediting Blueprint Synthesis Report," February 2021.

boundary. Policy-based crediting uses models to isolate the intervention's impact from other factors, ensuring that only the intervention's impact is credited.[43]

Table 5 provides a concise summary of TCAF's crediting approaches. [44]

Crediting Approach	Baseline emissions	Project emissions	MRV
Jurisdictional	Total project emissions in the jurisdiction	Total reported emissions in the jurisdictional ex-post	Detailed bottom-up jurisdiction-level GHG inventory, with clear boundaries
Sectoral	Total project sector emissions	Total sector emissions reported ex-post	Detailed bottom-up sectoral inventory, with clear boundaries
Policy based	Based on economic comparison of economy-wide emissions or sectoral emissions in the absence of policy (e.g., carbon tax, performance standards, regulation)	Based on economic comparison of economy-wide emissions or sectoral emissions with the policy	Comparison baseline and program emissions using ex-post input parameters (e.g., GDP, sectoral GDP, fuel prices)

2.2.2. Operationalization of TCAF

TCAF support unfolds across several phases (see Figure 5). Initially, it involves identifying a proposal and preparing the crediting program. Subsequently, the implementing entity within the host country negotiates a Results-Based Climate Finance Verified Emission Reductions Emission Reduction Payment Agreement (RBCF-VER ERPA), executes the crediting program, and receives annual results-based payments for the verified emission reductions. These reductions remain within the host country and can be utilized for NDC compliance.

In an optional subsequent phase, the host country engages in negotiations for an Internationally Transferred Mitigation Outcome Verified Emission Reduction Mitigation Outcome Purchase Agreement (ITMO-VER MOPA). This agreement authorizes the international transfer of verified emission reductions generated by the crediting program, with the country undertaking a 'corresponding adjustment' to receive payments for the transfer in line with the modalities outlined in the Article 6 Rulebook. These transferred reductions are directed to TCAF and are ineligible for host country NDC compliance.

[43] Ibid.
[44] Ibid.

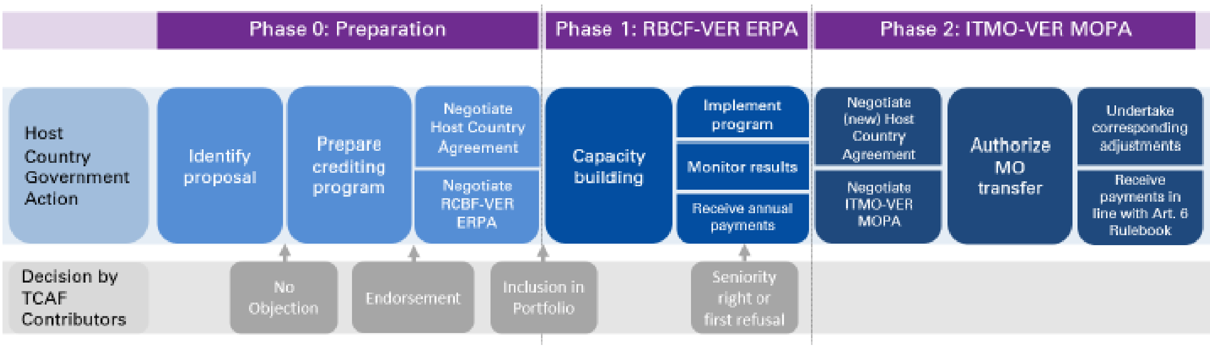


Figure 5: TCAF Program Operationalization Phases (adapted from TCAF)

TCAF's two-phase structure yields several key benefits for host countries:

- **Flexibility:** Engagement with TCAF affords host countries the flexibility to shape their collaboration during the implementation of the crediting program. Participation in phase 1 does not obligate host countries to transfer mitigation outcomes internationally through Article 6 of the Paris Agreement in phase 2.
- **No-regret Engagement:** The hybrid support mechanism allows host countries to engage without regrets. If a country is on course to achieve its NDC target, it can opt to negotiate an ITMO MOPA without the risk of overselling emission reductions.
- **Capacity Building:** TCAF support offers host countries an opportunity to enhance their experience and build capacity in leveraging international carbon market resources. This includes monitoring NDC and policy progress, preparing MRV systems, and fostering inter-agency coordination and collaboration. Capacity-building is driven by the host country and tailored to its needs, empowering governments to make informed decisions regarding participation in Article 6 transactions and implementing related reporting requirements.[45]

2.2.3. Disbursement of payments

Payments for verified emission reductions are administered by TCAF in various tranches over the course of the crediting program's implementation.

- **TCAF, acting on behalf of its Climate Finance Providers,** pays for verified emission reductions as results-based finance throughout the duration of the crediting program.
- **TCAF provides technical assistance to host countries** supporting a potential additional ITMO operation. **TCAF, on behalf of carbon market buyers,** pays for ITMOs throughout the purchase period if the host country decides to engage in an ITMO transaction.[46]

2.3. Core Parameters of TCAF

For eligibility for TCAF funding, several essential criteria must be satisfied. These encompass sustainable development, transformational change, baseline(s) setting, additionality, MRV, crediting periods, and pricing considerations.

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[45] Ibid.

[46] Ibid.

2.3.1. Sustainable Development

The TCAF Framework emphasizes adherence to social and environmental standards aligned with the World Bank's country engagement model and the SDGs. **Each TCAF program is expected to define indicators based on the SDGs to measure progress, evaluate results, and identify co-benefits.** These indicators encompass diverse aspects, such as health benefits from reduced air pollution, positive impacts on disposable income for low-income households, reduced traffic accidents, and gender benefits.[47]

When selecting sustainable development indicators, TCAF programs should consider practicality and synergy with existing monitoring plans. For instance, a program distributing biogas digesters can track households served, contributing to SDG indicators on clean fuels and technology adoption or small-scale food producers' income. The **closer the link between the intervention and sustainable development impacts**, the easier it is to measure them credibly. However, measuring impacts with complex relationships may be costly. **Managing transaction costs** is crucial, especially considering the potential complexities of tracking sustainable development impacts alongside GHG emissions reductions. Innovative data collection techniques and proxies for development impacts can help in this regard.[48]

2.3.2. Transformational Change

Transformational change is central to TCAF program selection and assessment, defined as the global economic and societal shifts necessary for achieving the goals of the Paris Agreement. The framework identifies **four criteria** for assessing transformative potential, integrated into a program's theory of change, and measured through specific indicators over its lifespan.

Size is crucial, with programs expected to achieve significant emission reductions over time, typically targeting a minimum of 5 million tons (Mt) over 5-7 years or approximately 1 Mt annually once matured.

Sustainability encompasses technological, political, and economic dimensions. Programs must employ sustainable technologies suitable for their sector and era, avoiding lock-in to short-term solutions that hinder long-term mitigation benefits. Policies should align with domestic policies and stakeholder acceptance, while financial sustainability entails long-term viability, including gradual phasing out of public funding as external markets develop.

Leverage refers to the program's capacity to bolster host countries' climate ambition over time, whether through revenues generated by TCAF activities or by enhancing domestic planning and MRV capabilities.

Carbon pricing plays a vital role, with programs directly or indirectly contributing to the development and implementation of domestic carbon pricing mechanisms, be they implicit or explicit.[49]

[47] Ibid.
[48] Ibid.
[49] Ibid.

2.3.3. Baseline setting

Under the Paris Agreement, signatory nations universally pledged to diminish their GHG emissions and amplify their dedication progressively. **Developing nations generally committed to reducing emissions compared to a business-as-usual (BAU) scenario** or decreasing the intensity of emissions in future growth. Typically, their NDCs outline a single-year target (often for 2030) representing a percentage reduction from projected BAU emissions.

In TCAF transactions, emission reductions accounted for in countries' NDC targets cannot be credited. Thus, these reductions must be factored into the establishment of program baselines. **Baseline determination in TCAF involves comparing the emissions trajectory based on the unconditional target with a BAU emissions trajectory calculated by TCAF.** The lower volume trajectory between the two is adopted as the baseline. However, not all emission reductions relative to this baseline are credited; rather, crediting parameters are set to align with TCAF and host country objectives. This approach results in a crediting baseline below both the BAU and target trajectories, ensuring program emissions reductions exceed existing decarbonization targets and provide environmental integrity.

TCAF implementation varies by country and program type, necessitating flexible baseline setting mechanisms (See Figure 2.). Some countries differentiate between conditional and unconditional NDC targets. In cases of unconditional targets, TCAF starts baseline calculation from this point. For conditional targets, adjustments are made to the BAU trajectory based on the extent of external support for reaching the conditional target, alongside an own effort component agreed upon by the host country and TCAF. This adaptable approach ensures accurate baseline determination in diverse implementation contexts.[50]

2.3.4. Additionality

TCAF adopts a stringent approach, exclusively paying for emission reductions that surpass the NDC targets of host countries and the mitigation activities funded by international climate finance. To ascertain additionality, TCAF employs a two-tiered strategy, delineating the influence of both market mechanisms and climate finance in its operations. For that purpose, TCAF uses an attribution methodology ensuring to only pay for emission reductions not yet paid for by other sources of climate finance based on financial contribution shares in total climate finance a program receives.[51]

2.3.5. MRV

To successfully reach their NDC targets, countries need a comprehensive MRV framework aimed at progressively strengthening monitoring and reporting systems, extending from national to sectoral levels[52]. The Paris Agreement mandates all parties, with flexibility for Least Developed Countries (LDCs) and Small Island Developing States (SIDS), to biennially report on three key aspects: i) progress in NDC implementation; ii) advancements in support provision/receipt; and iii) identification of capacity building needs. **TCAF's MRV systems are meticulously designed to complement host countries' national MRV frameworks,** utilizing a flexible approach adaptable to each unique context.

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[50] Ibid.

[51] Ibid.

[52] Ibid.

2.3.6. Crediting Period

TCAF's crediting parameters focus on two main factors: the duration of payment periods, lasting five to seven years , and the proportion of emission reductions procured, exceeding 5 MtCO2e over the entire operational period. Flexibility is integral to the framework, allowing for a tailored, bottom-up approach.

The crediting period refers to the timeframe during which a mitigation activity generates eligible emission reductions for NDC target fulfillment. It can span from the start to the end of the host country's NDC implementation period, typically aligning with or preceding the conclusion of the NDC target period, which often extends until 2030.

This period need not align with the lifespan of program mitigation activities or the TCAF-ERPA payment period. Mitigation activities employed by TCAF may have commenced prior to the crediting period, including historic policy crediting scenarios, without compromising environmental integrity. TCAF's methodological approach ensures the crediting of historic policies while ensuring emission reductions during the NDC implementation period surpass the unconditional NDC target.[53]

3. Identifying Result-Based Climate Finance Opportunities in the Water Sector

The water sector plays a significant role in a country's greenhouse gas emissions, both directly and indirectly, offering opportunities for transitioning to low-carbon outcomes while restoring the natural environment. Chapter 2 underscores the importance of recognizing the potential for emission reduction within the water sector, emphasizing the dual benefits of mitigating climate change and enhancing environmental sustainability.

According to the International Energy Agency (IEA), the water sector could reduce its energy consumption by 15% in 2040 by leveraging economically available energy efficiency and energy recovery potentials. This estimate highlights the substantial impact that targeted initiatives within the water sector could have on global efforts to mitigate climate change. However, realizing this potential requires overcoming financial barriers that often hinder investments in emission reduction projects.

Financial constraints frequently impede the integration of GHG emissions mitigation into water sector projects, despite the significant potential for reducing emissions. To incentivize such investments, climate finance mechanisms, such as result-based financing for emissions reductions, can play a crucial role. By aligning financial incentives with environmental objectives, these mechanisms encourage the implementation of sustainable practices within the water sector.

World Bank Carbon Funds, such as TCAF discussed in Chapter 2, offer opportunities to secure funding for future water sector projects. However, the alignment of project opportunities with the core parameters of TCAF is essential for successful funding acquisition. Analyzing whether different

[53] Ibid.

projects meet these criteria is crucial for determining their eligibility for support from TCAF and similar climate finance mechanisms.

This chapter will examine various activities within the Water Sub-Sectors of WSS, WRM, and Climate-Resilient Irrigation to identify the essential criteria for eligibility for support from the TCAF. Each sub-sector presents unique opportunities for emissions reduction and environmental sustainability, and understanding the specific requirements for TCAF funding is vital for aligning projects with its core parameters.

3.1. Water Supply and Sanitation

3.1.1. Project Background

Within the Water Supply and Sanitation sub-Sector, key activities encompass water supply, sanitation, desalination, and wastewater reuse, offering substantial potential for savings. Analyzing the physical activities involved in water supply networks, sanitation networks, and wastewater reuse/resource recovery reveals diverse opportunities for emissions reduction and energy efficiency improvements.

In water supply networks, physical activities include water abstraction, drinking water treatment, transmission, and storage, as well as efforts to minimize water loss through leakage. These activities are essential for ensuring the safe delivery of drinking water to homes and businesses, highlighting opportunities for optimizing energy use and reducing greenhouse gas emissions throughout the water supply process.

Sanitation encompasses a wide array of activities crucial for public health and environmental sustainability. **It involves managing wastewater networks for safe disposal and redistributing treatment byproducts such as effluent and sludge.** Physical tasks include maintaining sewer systems, transporting wastewater via pipes and pumping stations, and implementing various treatment processes involved in wastewater treatment and sludge management. **Bioresources management within wastewater reuse and resource recovery includes sludge treatment, energy extraction, recycling, and disposal.** This involves transporting liquid and dried sludge, employing methods like anaerobic digestion and composting, and generating power from bioresources. Activities in the sanitation service chain and in common sanitation solutions also encompass latrines, septic tanks, and container-based sanitation, alongside initiatives for using treated wastewater in water supply, irrigation, and aquifer recharge activities.

This Chapter will delve into two specific activities within the Water Supply and Sanitation Sub-Sector and their impact on reducing greenhouse gas emissions, as well as the necessary parameters to qualify under TCAF: Sanitation and Wastewater Treatment, as well as Energy Efficiency (EE) and using Renewable Energy (RE) for desalination plants, as well as Pumping Stations and Well Fields.[54]

[54] World Bank, "Climate Finance Diagnostic – Water Sector" (April 14, 2022).

3.1.2. GHG Emissions

Direct Emissions - Sanitation and Wastewater Treatment

Sanitation, particularly Methane Capture from Fecal Sludge Management and Wastewater Treatment, alongside Fecal Sludge Management (FSM) in peri-urban and rural areas, has emerged as a crucial activity for climate mitigation. Currently, an estimated 1.4 billion urban dwellers lack access to safely managed sanitation, relying on latrines, septic tanks, or open defecation. By 2050, this number is projected to increase to 2.4 billion, predominantly in Asia and Africa, exacerbating unsafe sanitation-related methane and GHG emissions.[55]

Recent analyses highlight the substantial GHG emissions stemming from unsafe urban sanitation practices. For instance, a city of 1.5 million people in a low- or middle-income country could generate over 189,000 tCO2e annually from unsafe sanitation alone, suggesting global emissions of at least 148 million tCO2e/year. City Wide Inclusive Sanitation (CWIS) emerges as a promising strategy to maximize methane capture while concurrently enhancing public health. CWIS-based climate mitigation would require improving latrine design to increase the volumes of treated sludge, municipality-wide subscription or scheduled desludging for latrines and septic tanks, and methane capture and use at wastewater and FS treatment plants. Sanitation projects therefore tackle the carbon and methane emissions generated directly by the Water Sector.[56]

Indirect Emissions - Renewable Energy and Energy Efficient Utilities

In many cities worldwide, WSS utilities stand as significant electricity consumers, with energy often constituting the largest portion of non-labor operating costs, ranging from thirty-three percent to eighty-two percent. Desalination, particularly prevalent in water-poor coastal countries, further escalates energy demands due to the need to remove higher salinity levels. Factors contributing to high energy usage include aging equipment, inadequate maintenance practices, limited awareness of energy efficiency opportunities, and insufficient access to finance for optimization.[57]

Experience indicates that utilities can enhance energy efficiency by twenty to forty percent through comprehensive energy audits and subsequent implementation of recommended changes. Opportunities for improvement include replacing aging equipment, deploying smart pumps, transitioning to gravity-based systems, and managing pressure to minimize non-revenue water. Initiatives such as campaigns, incentives to reduce energy consumption, training programs, and implementing supervisory control and data acquisition (SCADA) systems further enhance efficiency.[58]

Additionally, the adoption of Renewable Energy sources presents a promising avenue to further eliminate the indirect emissions generated by fossil fuel-based energy sources in the water sector.

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[55] Rachel Cardone and Sean Nelson, "Climate smart: emerging opportunities to leverage climate finance for water infrastructure investment" (2023).
[56] Ibid.
[57] Ibid; Gustavo Saltiel, Kristoffer Welsien, Nate Engle, Sean Nelson, and Alex Lazar. "How Energy Efficient Utilities of the Future Save Money and Help the Planet." *World Bank Blogs*, May 7, 2020. https://blogs.worldbank.org/en/water/how-energy-efficient-utilities-future-save-money-and-help-planet; "Improvement of Energy Efficiency in the Jordanian Water Sector (IEE)." UNFCCC. Accessed June 20, 2024. https://www4.unfccc.int/sites/PublicNAMA/Lists/NAMA/DispForm.aspx?ID=18&ContentTypeId=0x01003B4CF715B8FE417E9D0111FE94499E9E00F8F07D54A0A55D46B3EC5BF21CA967CE00055BD2D662B2B348A075905B2D0703B2; "Promoting Renewable Energy in the Water Sector." GIZ. Accessed June 20, 2024. https://www.giz.de/en/worldwide/69019.html.
[58] Ibid.

By transitioning to Renewable Energy, utilities can significantly reduce their environmental footprint while enhancing sustainability and long-term costs in water supply and sanitation systems.

The upcoming Boxes will spotlight a Water Sector TCAF Project, illustrating the application of the aforementioned activities in a real-world context. This case study aims to enhance comprehension and practical knowledge, facilitating our analysis to identify the core parameters essential for each activity.

Box 1: GHG Emissions in Country A

TCAF Project in the Water Supply and Sanitation Sector
The TCAF crediting program encompasses two sub-programs: Water, Sanitation, and Hygiene (WASH) activities in rural areas of region B implemented by a Municipal Services company, **and urban water and sanitation services in region C** implemented by a Water and Sewerage Corporation. The program's scope includes residential wastewater treatment, improved collection and treatment of residential wastewater, energy efficiency and renewable energy for water supply, and integrated solid waste management. In region C, **wastewater treatment** involves sewer network rehabilitations and the use of trickling filter and activated sludge treatment processes to avoid methane emissions. In region B, the program focuses on building sewage conveyance systems and treating wastewater in Anaerobic Baffled Reactors (ABR), with biogas produced during anaerobic digestion used for energy generation. The proposed program aims to enhance **energy efficiency** in centralized water pumping complexes and displace electricity consumption from the grid through the construction of solar PV systems. In rural areas, centralized water pumping stations will replace inefficient electrical pumps, with a total of 65 MW solar PV systems installed to reduce emissions from grid electricity displacement. The **integrated solid waste management**, as part of integrated **WASH services**, encourages household waste segregation in region B, with organic waste treated in centralized composting plants under aerobic conditions to avoid methane emissions. The program addresses various aspects of transformation, including technology adoption, policy support for tariff reforms, financing for operations improvement, and institutional capacity building. **Country A faces challenges in providing proper wastewater and sanitation infrastructure, with many urban and rural areas lacking access to safe facilities.** Existing infrastructure is old, insufficient, and in need of rehabilitation, resulting in low wastewater collection and treatment rates, exacerbating water-borne diseases and public health issues. Programs like these could be replicated in other countries grappling with similar challenges related to wastewater and sanitation infrastructure, particularly in light of population growth and limited financial resources.

3.1.3. Transformational Change

As shown in Chapter 3, achieving transformational change is paramount for a Project to be recognized and credited by TCAF. This necessitates the Project's capability to reduce a minimum of 5Mt over a 5–7-year period or approximately 1Mt per year, along with reducing emissions through sustainable technological, political, and economic means. Additionally, the Project must align with the host country's climate ambitions and contribute to the establishment of domestic carbon pricing mechanisms.

Size

As highlighted in 4.1.2, **Sanitation and Wastewater Treatment have a significant potential to reduce methane and carbon emissions, with individual projects capable of achieving a reduction**

of 1 Mt per year, as an investment project in WSS can have a 5 to 10 year horizon. A theoretical project analysis has concluded that a city-wide FSM adaptation in a city of 2.25 million people could reduce CO2e emissions by between 102,000 and 130,000 tons per year and methane capture at Urban Wastewater Treatment (WWT) plants by between 39 and 50 million tons per year.[59] Another project analysis for a World Bank Project, aimed at improving sanitation access from 20% to 80% for 2.2 million people by constructing water supply infrastructure, estimated that the project could reduce CO2e emissions by approximately 3 MtCO2e per year.[60]

According to 4.1.2, **the integration of RE and EE into WSS utilities has significant potential for reducing carbon emissions generated by fossil-fuel-based electricity, a key indirect emission in the water sector.** A theoretical analysis of a WSS utility with a treatment capacity of 10,000 m3/day of conventionally-treated and 10,000 m3/day desalination water has shown that switching from grid electricity to solar-powered groundwater pumping, combined with energy efficiency improvements yielding 25% energy savings and 20% energy savings in desalination processes, could result in a reduction of up to 15,000 tCO2e over a ten-year period,[61] with larger systems and/or systems powered by more carbon-intensive grids achieving higher levels of GHG emissions reductions. A World Bank Project, which aims to develop a solar photovoltaics (PV) powered seawater desalination providing up to 150-200 MCM of treated water, estimated that the project could reduce CO2e emissions by 200-225 kt per year (0.2 – 0.25 Mt) if it were powered entirely by solar energy.[62]

Sustainability

Sustainability initiatives prioritize climate-smart innovative technologies over conventional interventions. These innovations, geared towards mitigation efforts, boast lower greenhouse gas emissions compared to business-as-usual approaches, presenting a global opportunity. Projects focusing on such technologies, like anaerobic wastewater treatment methods and upgraded water transmission systems, promise enduring benefits. Policy reforms accompany infrastructure upgrades, ensuring longevity. Additionally, revenue from carbon credit sales can offset infrastructure costs. The integration of renewable energy and energy-efficient technologies into water supply systems yields lasting efficiency gains, supported by evolving policies and market dynamics.[63]

Treated Wastewater Reuse for Agricultural Irrigation

This program focuses on establishing infrastructure and practices for the reuse of treated wastewater in agricultural irrigation. By treating wastewater to meet quality standards suitable for irrigation, the project enhances water security and reduces the energy required for freshwater treatment and supply, as well as the need for on-farm groundwater pumping (which often relies on diesel). Additionally, by substituting freshwater with treated wastewater, the project conserves valuable freshwater resources and promotes agricultural resilience in water-stressed regions.

Implementation of Nature-Based Solutions in Wastewater Treatment

This program involves the implementation of nature-based solutions, such as constructed wetlands or natural filtration systems, in wastewater treatment processes. By harnessing natural processes and

[59] Rachel Cardone and Sean Nelson, "Climate smart: emerging opportunities to leverage climate finance for water infrastructure investment" (2024).
[60] World Bank, "Climate Finance Diagnostic – Water Sector" (April 14, 2022).
[61] Rachel Cardone and Sean Nelson, "Climate smart: emerging opportunities to leverage climate finance for water infrastructure investment" (2024).
[62] World Bank, "Climate Finance Diagnostic – Water Sector" (April 14, 2022).
[63] World Bank, "Climate Finance Diagnostic – Water Sector" (April 14, 2022).

ecosystems, nature-based solutions offer environmentally friendly alternatives to traditional, energy-intensive treatment methods.

Biogas Recovery and Utilization in Wastewater Treatment

This program focuses on implementing anaerobic treatment processes in wastewater treatment plants to capture biogas generated during organic waste decomposition. The captured biogas can be utilized to power onsite treatment operations or converted into biomethane for various applications, such as electricity generation, heating, or transportation fuel.

Enhanced Sludge Management for Methane Reduction

This program aims to improve sludge management practices in wastewater treatment facilities to minimize direct CH4 leakage into the atmosphere. Strategies may include implementing covered anaerobic digestion systems for sludge treatment, which capture methane emissions and prevent their release into the air. Additionally, the project may involve upgrading sludge storage and handling facilities to minimize methane leakage during storage and transportation. Alternatively, the implementation of aerobic treatment technologies can avoid methane emissions altogether (though there can be tradeoffs in terms of greater electricity costs or sludge production).

Non-Revenue Water Reduction / Water Loss Reduction Initiative

This program aims to reduce water losses in distribution networks through infrastructure upgrades, leak detection technologies, and improved maintenance practices. By minimizing the volume of water lost during distribution, this initiative reduces the energy required for pumping, treating, and transporting water, resulting in lower GHG emissions. Additionally, it enhances water resource efficiency and improves the overall sustainability of water supply systems.

Decentralized Water Supply Expansion

This program aims to expand decentralized water supply systems to reduce the energy required for pumping and transporting water over long distances. It involves the construction of smaller-scale water supply infrastructure closer to end-users, such as decentralized water treatment plants and local water distribution networks, therefore, minimizing the energy-intensive processes associated with centralized water supply systems.

Demand Management Implementation Across Sector

This program focuses on introducing demand management measures across sectors to reduce water consumption, thereby lowering the energy needed for water supply and treatment. Strategies may include promoting water-efficient technologies, implementing water pricing mechanisms to incentivize conservation, and raising public awareness about the importance of water conservation.

Energy Efficiency Improvement in Water Infrastructure

This program focuses on improving energy efficiency in water infrastructure to reduce overall energy consumption and associated GHG emissions. Measures may include retrofitting water treatment plants with energy-efficient equipment, optimizing pumping systems, and implementing energy management or SCADA systems to monitor and control energy usage.

Renewable Energy Integration in Wastewater Treatment

This program aims to integrate renewable energy sources, such as solar or wind power, into wastewater treatment processes to reduce reliance on fossil fuels. By installing renewable energy systems onsite or nearby treatment facilities, the project decreases greenhouse gas emissions associated with energy-intensive treatment processes.

<u>Renewable Energy Integration in Water Treatment</u>

This program focuses on integrating renewable energy sources, such as solar or wind power, into water treatment processes to reduce reliance on fossil fuels. It involves installing renewable energy systems, such as solar panels or wind turbines, to power water treatment plants and pumping stations. By harnessing clean energy sources, this project reduces GHG emissions associated with water treatment and enhances energy security.

Box 2: Transformational Change in Country A

TCAF Project in the Water Supply and Sanitation Sector

Size:

Country's A waste sector emissions, constitutes around 5% of the nation's overall GHG emissions, with wastewater contributing the largest share. Given the significant volumes of wastewater generated daily by domestic, commercial, and industrial sectors, the program targets emission reductions through strategic interventions. Under World Bank programs in region B and C, initiatives are identified to mitigate emissions, including improving sanitation and water supply infrastructure in region B, which could yield emission reductions of up to 132 ktCO2e per year. Moreover, the promotion of solar energy for water supply operations, covering 2000 villages, could lead to reductions of up to 131 ktCO2e per year, effectively displacing household pump usage.

In region C, the program focuses on enhancing wastewater treatment and energy efficiency measures, offering substantial potential for emissions reduction. Rehabilitation and expansion plans for sewage treatment plants, including TP-I, TP-III, and TP-IV, are projected to yield notable reductions. For instance, the rehabilitation of TP-I and its expansion under a public-private partnership scheme could generate emissions reductions of 120 ktCO2e/year and 48 ktCO2e/year, respectively, by 2026 and 2027. Additionally, improvements in energy efficiency at the one water pumping complex, through low-cost interventions and the installation of a 2.5 MW solar PV system, are estimated to result in average emission reductions of 16 ktCO2e/year. These initiatives collectively signify a concerted effort to address emissions from wastewater and improve energy efficiency in region's C water infrastructure.

Table: Ex-ante estimates of emission reductions from region B and region C

Component/Year	2024	2025	2026	2027	2028	2029	2030	Total
Region B	35,192	102,043	186,489	278,004	351,922	351,922	351,922	1,657,494
Region C	-	-	66,463	110,002	448,592	448,592	448,592	1,522,239
Total ERs (tCO2e)	25,192	102,043	252,952	288,006	800,513	800,513	800,513	3,179,733

Sustainability:

Technology Sustainability: The program promotes key technologies like aerobic and anaerobic wastewater treatment, composting, and renewable energy measures. These technologies effectively remove pollutants, generate biogas, and align with low-carbon development pathways.

Policy Sustainability: Aligned with national policies, the program addresses water scarcity, WASH initiatives, and urban planning for emission reduction. It also supports regional policies to enhance water and sanitation services while addressing climate change impacts.

Financial Sustainability: Efforts to ensure financial sustainability include increased investments in the water sector, commitments from provincial governments, and strategies like robust tariff systems and private sector participation, particularly in region C.

Leverage:

Both the Government of region B and C have sought support from the WB to address challenges in the water and sanitation sectors. Both regions have received funding for a series of Infrastructure Development, including in for the Water Supply and Sanitation Sector. Private sector financing is anticipated for region C, with plans for Public Private Partnerships (PPP) to mobilize additional funds and enhance project efficiency. Technical assistance and capacity building initiatives are underway to support project implementation and enhance monitoring, reporting, and verification (MRV) systems, ensuring sustainable outcomes and aligning with future climate commitments.

Carbon Pricing:

Country A is actively exploring various carbon pricing mechanisms, including an Emissions Trading System (ETS), to capitalize on low-cost abatement opportunities and encourage investment in low-carbon technologies.

Supported by the UNFCCC and the World Bank, efforts are underway to develop an MRV roadmap and establish a national ETS framework. These initiatives aim to attract climate finance, enhance governance, and update infrastructure, aligning with national and international climate objectives.

Sustainable development co-benefits:

In addition to mitigating greenhouse gas emissions, the TCAF program's initiatives in water supply and sanitation contribute to SDGs, including promoting good health and well-being, gender equality, clean water and sanitation, affordable and clean energy, sustainable cities and communities, and climate action. By improving wastewater treatment, enhancing water resource management, and promoting renewable energy technologies, the program addresses key environmental and social challenges while supporting Country's A climate goals.

3.1.4. Baseline and Crediting

Reflecting both TCAF and the host country's objectives, the crediting parameters outlined in Chapter 3 establish a TCAF baseline below both the BAU emissions trajectory and target emission trajectory. **Establishing a TCAF crediting baseline for Sanitation and Wastewater Treatment and incorporating RE and EE measures into water supply utilities relies on several critical factors.**

Historical emissions data serves as a foundational element, offering insights into emission trends and guiding opportunities for improvement. Concurrently, **assessing the current sanitation and wastewater treatment infrastructure**, including technologies and management practices, is paramount to determine the baseline emissions level based on the existing state of affairs. When evaluating the impact of RE and EE measures, it is essential to comprehensively assess and calculate their utilization across wastewater plants, desalination facilities, pumps, and well fields, while also considering the current energy source and usage, such as fossil fuels, within water supply infrastructure like pumps or desalination plants.

Moreover, evaluating the potential impact of implementing new technologies or improving operational efficiencies within the sector allows for projecting emission reductions forward compared to the BAU scenario. The assessment incorporates the integration of technologies new to the project site, such as anaerobic wastewater treatment plants and biogas production from sludge. This presents additional opportunities for emission reduction in the sanitation and wastewater treatment sector. To assess the impact of **RE and EE measures**, it's crucial to quantify the **energy reduction achieved via efficiency upgrades** like optimized pump systems and advanced control technologies, alongside determining the reduction in carbon emissions facilitated by the adoption of renewable energy sources, even if partially utilized, such as solar.

Considering existing and proposed policies, regulations, and targets related to emissions reduction in the water supply and sanitation sub-sector is essential for establishing a baseline that aligns with governmental objectives. Policy alignment ensures that emission reduction efforts are in sync with broader national and international climate goals, facilitating the development of robust baselines and effective mitigation strategies.

Box 3: Baseline and Crediting in Country A

TCAF Project in the Water Supply and Sanitation Sector

Country's **A** emissions trajectory presents a significant challenge, with projections indicating a tripling of emissions from 2018 to 2030. To achieve a 50% reduction below this trajectory, concerted efforts across sectors are imperative. While the NDCs primarily focus on the energy sector, aiming for a transition to 60% renewable energy and 30% electric vehicles by 2030, emissions from the waste sector remain significant.
Collaboration with the relevant line Ministry will determine suitable baselines and implementing effective ER payment mechanisms to drive sustainable emission reduction outcomes.

The Table describes the Baseline approach:

Scenario	**Description**	**Justification**
Baseline Scenario 1: BAU	Large portion of untreated wastewater in urban and rural areas. Inadequate clean water supply and solid waste management in rural communities	Based on NDC 2021 and BUR 2022, highlighting current deficiencies in wastewater and waste management infrastructure.
Baseline Scenario 2:	Gradual increase in wastewater collection rates and construction of new WWTPs, operating under anaerobic conditions due to technical and financial constraints. Basic solutions for rural wastewater and water supply, without renewable energy integration or advanced waste management.	Reflects projected improvements by 2030 but lacks renewable energy integration and advanced waste management, reflecting ongoing challenges and limited resources.
Program Scenario:	Investments in wastewater treatment and biogas management. Introduction of waste segregation and composting. Upgrading rural drinking water infrastructure with solar energy integration. Requires additional investment, sustained financing, and trained personnel.	Aims to address shortcomings of previous scenarios by implementing advanced solutions for wastewater treatment, waste management, and renewable energy integration, necessitating sustained financial support and skilled workforce.

3.1.5. Measurement, Reporting, and Verification

MRV is a critical requirement for TCAF Projects, with the approach varying depending on the sector and specific project characteristics.

Sanitation and Wastewater Treatment:

GHG emissions for wastewater treatment plants and sewerage systems entails a thorough assessment of diverse emission sources and treatment processes. In aerobic wastewater treatment plants, emissions primarily originate from biological processes like aerobic decomposition of organic matter, CO2 and nitrous oxide (N2O). Anaerobic treatment plants additionally produce more methane (CH4) than aerobic treatment plants. Monitoring gas emissions on-site using gas analyzers and protocols, along with quantifying methane capture if applicable, aids in emission measurement. Additionally, emission estimation utilizes standardized methodologies such as those provided by the Intergovernmental Panel on Climate Change (IPCC). For sewerage systems, emissions result from anaerobic decomposition in sewage pipes and treatment facilities, estimated based on factors like flow rates and organic content. A combination of on-site measurements, emission factor calculations, and standardized methodologies ensures accurate measurement.

Renewable Energy and Energy Efficiency Measures:

Measuring GHG emissions associated with desalination plants or electrically powered pumps involves several steps. Initially, accurate quantification of electricity consumption for the plant or pump over a specified period is essential, achievable through electricity meters or monitoring systems. Subsequently, determining the carbon intensity of the electricity source is imperative, considering factors such as power generation type and regional energy policies. This involves assessing emissions factors associated with the electricity generation mix. Once electricity consumption and carbon intensity are determined, GHG emissions are calculated using the formula: Emissions (kgCO2e) = Electricity consumption (kWh) × Emissions factor (kgCO2e/kWh).[64] This methodology enables stakeholders to precisely measure and monitor GHG emissions, facilitating informed decision-making and mitigation strategies to reduce the carbon footprint in these sectors.

Reporting and verification procedures are consistent across the entire Water Sector.

Monitoring under the Paris Agreement entails biennial reporting on NDC implementation progress, support provision/receipt, and capacity building needs. National MRV systems are gradually strengthened, with TCAF MRV aligning with them where possible to enhance national capacity. TCAF contributes to building MRV capacity while ensuring periodic verification by an independent third party. For different interventions, MRV may include sectoral/jurisdictional emissions measurement and modeling of baseline/program emissions using key parameters like GDP, fuel prices, and population growth. TCAF programs require MRV not only of emission reductions but also of transformational change and sustainable development benefits.

[64] Paul Davis, "How to Calculate and Evaluate a Carbon Intensity Score," PCI Energy Solutions, accessed November 1, 2023, https://www.pcienergysolutions.com/2023/11/01/how-to-calculate-and-evaluate-a-carbon-intensity-score/.

Verification under the Paris Agreement mandates periodic assessments by independent third parties to validate reported data accuracy and compliance with goals. **TCAF verification aligns with national MRV systems.** Verification assesses emission reduction, transformational change, and sustainable development benefits. It ensures transparency and accountability, strengthening confidence in reported data and contributing to global climate efforts. Through alignment with national systems and independent verification, TCAF ensures credibility and effectiveness in achieving climate objectives.

Box 4: MRV in Country A

TCAF Project in the Water Supply and Sanitation Sector

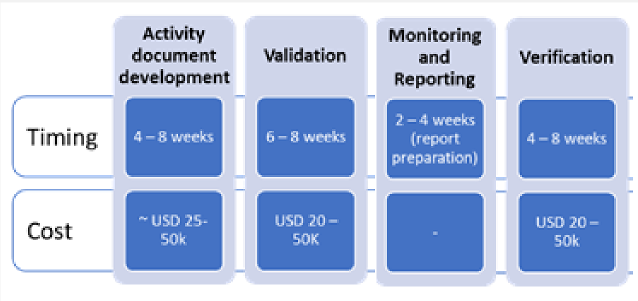
Ex-post emission reductions are determined through thorough monitoring during project operation, where only measured, reported, and verified emission reductions are claimed. A comprehensive set of parameters is monitored ex-post to estimate emission reductions accurately. These parameters include the quantity of wastewater treated in the Anaerobic Baffled Reactor (ABR), measured with a flowmeter and monitored continuously on monthly and annual bases. The chemical oxygen demand (COD) in the wastewater treated in the ABR is also monitored regularly, with measurements aligned with national or international standards and averaged monthly and annually.

For the renewable energy component, parameters such as the amount of electricity consumed by household pumps displaced by the project (ECPJ,y) and the amount of fuel consumed by household pumps (FCPJ,y) are crucial for baseline determination and monitored through surveys. These surveys are based on the number of households, household pumps, and pump characteristics used in the baseline.

Parameters for the composting component, if implemented, are also monitored meticulously. The total quantity of waste composted in a year (Qy or TWCOMy) is measured and monitored using a weighbridge to ensure accurate quantification. Additionally, the amount of electricity consumed by composting facilities (ECPJ,composting,y) is measured and monitored with electricity meters, providing insights into the energy consumption associated with composting activities.

The validation and verification of the program will follow the TCAF Validation & Verification Protocol.

Figure: Tentative costs and timelines



3.1.6. Policy Measures

Various policy measures can be implemented to attain Project Targets. The table below provides examples of different types of policy measures for Sanitation and Wastewater Treatment, as well as RE and EE Utilities.

Table 6: Examples of Policy Measures for WSS sector

Typology of policy measures	Sanitation and Wastewater Treatment	RE and EE Utilities in the Water Sector
Prescriptive Measures	▪ Regulatory standards mandating the installation and operation of wastewater treatment systems. ▪ Enforcement of pollution control laws to ensure compliance with effluent quality standards. ▪ Implementation of best management practices of waste disposal and sludge management. ▪ Adoption of water conservation measures and pollution prevention strategies.	▪ Mandates requiring the integration of RE and EE measures in water sector infrastructure projects. ▪ Regulatory standards stipulating energy efficiency targets for desalination plants, pumps, and other utilities. ▪ Implementation of building codes and standards promoting energy-efficient design and construction practices for water facilities. ▪ Adoption of renewable energy procurement policies mandating the use of solar, wind, or other clean energy sources for water pumping and treatment.
Economic Measures	▪ Implementation of user fees or tariffs for wastewater treatment services to (at least partially) cover operational costs and encourage conservation. ▪ Establishment of subsidies or grants to incentivize the adoption of environmentally friendly treatment technologies. ▪ Introduction of pollution taxes or fines for non-compliance with wastewater discharge regulations. ▪ Implementation of economic instruments such as tradable pollution permits to allocate pollution allowances efficiently.	▪ Introduction of feed-in tariffs or incentives to produce renewable energy from water sector facilities. ▪ Establishment of energy performance contracts to finance EE upgrades in water treatment plants and distribution systems. ▪ Implementation of tax incentives or rebates for investments in renewable energy and energy-efficient technologies. ▪ Creation of green financing mechanisms or funds to support RE and EE projects in the water sector.
Supportive Policies	▪ Development of national sanitation and wastewater management strategies and action plans. ▪ Promotion of public-private partnerships to leverage private sector investment in infrastructure.	▪ Development of national energy and water sector integration policies to promote synergies between RE and EE initiatives. ▪ Implementation of net metering or grid interconnection policies to

	▪ Implementation of capacity-building programs to enhance technical skills and knowledge in the sanitation sector. ▪ Adoption of incentive programs to encourage innovation and research in wastewater treatment technologies.	enable water utilities to sell excess renewable energy back to the gird. ▪ Adoption of capacity-building programs to enhance technical expertise in RE and EE technologies among water sector professionals. ▪ Establishment of partnerships between government agencies, utilities, and private sector stakeholders to support the development of RE and EE solutions.
Direct Investment	▪ Allocation of government funds for the construction expansion, and maintenance of wastewater treatment facilities. ▪ Mobilization of international financing through loans, grants, or development assistance to support sanitation projects. ▪ Establishment of dedicated funding mechanism or investment funds to finance sanitation infrastructure projects. ▪ Encouragement of private sector investment through tax incentives, subsidies, or public-private partnerships.	▪ Allocation of government funds for the installation of renewable energy systems, such as solar panels or wind turbines, at water treatment plants. ▪ Mobilization of private sector investment through public-private partnerships for EE retrofits and upgrades in water distribution networks. ▪ Accessing international financing sources, such as climate funds or development banks, to support RE and EE projects in the water sector. ▪ Creation of revolving loan funds or grant programs to provide financial assistance for RE and EE initiatives in water utilities.
Effective Business Models	▪ Adoption of performance-based contracting for wastewater treatment services to ensure accountability and efficiency. ▪ Development of fee-for-service models where users play for the volume and quality of wastewater treated. ▪ Implementation of outcome-based financing mechanisms where payments are linked to the achievement of specific sanitation targets. ▪ Promotion of community-based management approaches, such as cooperatives or local ownerships models, for sustainable sanitation service delivery.	▪ Implementation of performance-based contracting for RE and EE projects, where payments are tied to energy savings or renewable energy generation. ▪ Adoption of energy service company (ESCO) models to provide energy efficiency services to water utilities on a performance-based payment structure. ▪ Development of public-private partnerships for the operation and maintenance of renewable energy systems integrated into water infrastructure. ▪ Promotion of innovative financing mechanisms, such as green bonds or energy savings agreements, to fund

		RE and EE investments in the water sector.

Box 5: Policy Measures in Country A

TCAF Project in the Water Supply and Sanitation Sector
The program will align with the Government of Country A and collaborate with two utilities and provincial governments to initiate tariff reforms. These reforms aim to enhance the competitiveness of the WASH sector, ensuring financial sustainability and delivering high-quality services that households are willing to invest in.

3.2. Water Resource Management

3.2.1. Project background

Water Resource Management (WRM) refers to the activity of planning, developing, distributing and managing the optimum use of water resources. WRM includes the planning, development, sustainable use, and operation of water resources to improve productivity and resilience. WRM projects are composed of watershed management, multipurpose reservoirs, and surface water bodies management.

Two projects, focusing on Watershed Services Improvement Project and Resilient Water Management for Community and Household Irrigation Project in country B and country C, respectively, are presented as case studies along this WRM section.

Box 6: WRM projects in Countries B and C as case studies

Country B Watershed Services Improvement Project
The Project Development Objective (PDO) is to increase adoption of sustainable landscape management practices and improve watershed services in targeted watersheds. The project scope focuses on supporting the implementation of the National Forest Landscape Restoration Strategy (NFLRS), which is a powerful vehicle that can help to address unpredictable climate shifts manifesting as natural hazards composed primarily by flood and droughts, and landscape degradation in country B, through scaling up landscape restoration and improving watershed services.
Country C Resilient Water Management for Community and Household Irrigation Project
The Project Development Objective (PDO) is to improve integrated water resources management in selected basins and increase the resilience to climate variability of vulnerable rural families in selected micro basins. The project scope focuses on supporting the implementation of the first phase of the Government of country C's Climate Smart and Resilient Program, which is a comprehensive rural development program, covering actions from water conservation, irrigation and risk management investments to information, knowledge management and water governance.

3.2.2. GHG emissions

Direct emissions

Surface water sources, including dams, reservoirs, rivers, lakes, wetlands, peatlands, and canals and watershed entities including land and ecosystems, produce (or sequester) GHG emissions directly. This can happen through different mechanisms, namely: (i) the decomposition of organic matter in water body emits CO2, N2O, and CH4, (ii) the presence of fertilizers or untreated/partially treated wastewater in water bodies increases nitrogen and phosphorus levels, leading to eutrophication (harmful algal blooms) which further decompose to create CH4 and CO2, and (iii) as ambient temperatures rise, gas solubility decreases, increasing the rate at which GHGs are emitted.

Dams and reservoirs

Dams and reservoirs are often considered ‘green’ sources of energy as they can reduce GHG emissions through renewable energy production, namely hydroelectricity and floating solar. However, although consideration is paid to the ecological impact of construction, growing evidence is showing that they can also account for significant GHG emissions depending on the specifics of reservoir and dam design. The flooding of reservoir areas fuels microbial decomposition, leading to GHG emissions. At present, it is estimated that reservoirs already contribute roughly 1.3% of the world's annual human caused GHG emissions[65].

Rivers and Lakes

Eutrophication of surface waters enhances greenhouse gas (GHG) emissions[66]. Lakes, rivers, and other waterways also experience degassing (as described above) and are susceptible to eutrophication from wastewater and fertilizers. Increased pollutants in natural water bodies also increase the need for intensive water/wastewater treatment for supply downstream (See chapter 4.1 for details). This is likely to be more energy intensive, thereby producing more GHG emissions[67].

Wetland and peatland

Wetlands are an ecosystem where land is flooded by water, either seasonally or permanently, leading to carbon sequestration through the prevalence of oxygen. In controversy, wetlands are the largest natural source of methane in the atmosphere, contributing about 20–30% of the world's atmospheric methane[68,69],[70] Peatlands, made of partially decomposed organic matter, are a form of wetland that act as carbon sinks. Human activities on peatlands (e.g. drainage, agriculture, forestry, peat extraction.) and their effects (e.g. oxidation of soil organic matter) significantly affect the carbon and nitrogen balance and, thus, the GHG emissions and nutrient removal from these lands.[71]

Watershed entities

Overexploitation of land and climate change-related shocks have contributed to land degradation, erosion, and removal of coastal environments. This degradation reduces the ability of land and ecosystems to sequester carbon. Local actors often lack a financial incentive to protect or restore natural environments. However, improved watershed management, including active forest management, can play an important role in carbon sequestration.

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[65] The World Bank, 2022. Climate finance diagnostic – Water Sector
[66] NCEE Working paper, 2024, “The Climate Benefits of improving Water Quality. https://www.epa.gov/system/files/documents/2024-05/2024-02.pdf
[67] The World Bank, 2022. Climate finance diagnostic – Water Sector
[68] Bobyock, J., February 2024. Methane Emissions from Wetlands Increase Significantly over High Latitudes. Berkeley Lab. https://newscenter.lbl.gov/2024/02/15/methane-emissions-from-wetlands-increase-significantly-over-high-latitudes/
[69] Carbon Brief, March 2023. ‘Exceptional’ surge in methane emissions from wetlands worries scientists. Climate modelling. scientists/#:~:text=From%20the%20Arctic%20to%20the,growth%20in%20wetland%20methane%20emissions.
[70] Wikipedia. Greenhouse gas emissions from wetlands. https://en.wikipedia.org/wiki/Greenhouse_gas_emissions_from_wetlands#:~:text=Article,wetlands%20from%201980%20to%202021
[71] https://northsearegion.eu/canape/measuring-greenhouse-gases-in-wetlands/

Indirect emissions

Indirect emissions are primarily from the use of energy in the production, transport, and equipment use when constructing dams and reservoirs[72], and associated auxiliary activities namely vehicle fleet.

Box 7: Potential sources of GHG emissions in Countries B and C

Country B Watershed Services Improvement Project
Land degradation in country B's most important watersheds has reached alarming levels, with major impacts on water security, agricultural productivity, and hydropower generation. Recent studies suggest that land degradation hotspots cover about half (41 percent) of the land area in the country. Soil erosion and nutrient depletion are major forms of land degradation that are reported to affect more than 60 percent of the entire land area. The average annual national soil loss rate in 2014 was 29 tons per hectare. Chemical land degradation, including soil pollution and salinization/alkalization, has led to a 15 percent loss in the arable land in country B in the last decade alone. Projections for future land degradation and soil loss under different climate and population growth rate scenarios suggest that land degradation will become increasingly severe, with one study suggesting that overall rates of soil loss will increase by between three and four times 2010 baseline levels. Within such degradation, about half of the land area in country B becomes a source of GHG emissions. In 2021, country B emitted 20.31 million tonnes (Mt) of CO_2 equivalent representing 0.04% of global emissions placing country B at World's 125th largest emitter. Emissions per capita and per GDP represented 1.06 tonnes of CO_2 equivalent/person and 1,668.22 tonnes of CO_2 equivalent/million $GDP, respectively. Major emissions come from agriculture (45.16%, 9.93 MtCo2e) and land-use change and forestry (37.27%, 8.2 MtCo2e)
Country C Resilient Water Management for Community and Household Irrigation Project
Country C is highly exposed to the impacts of climate change, especially to the hazards of floods and droughts. The poorest communities in the country are the most vulnerable. These hazards threaten the country's water and food security, mainly through inadequate water for irrigation of rain-fed crops, and exacerbate land use and forest degradation. In 2021, country C emitted 131.43 million tonnes of CO_2 equivalent representing 0.28% of global emissions placing country C at World's 48th largest emitter. Emissions per capita and per GDP represented 11.26 tonnes of CO_2 equivalent/person and 3,588.10 tonnes of CO_2 equivalent/million $GDP, respectively. More than half of the emission is from land-use change and forestry sector (56.83%, 77.77 $MtCo_2e$) followed by agriculture (21.99 %, 30.1$MtCo_2e$) and energy (17.52 %, 23.98 $MtCo_2e$) sectors.

3.2.3. Transformational change

Size

WRM projects' implementation lifetime usually span between 5-7 years. GHG emissions reduction of about 1 $MtCo_2e$ per year within 5-7 years is required to access TCAF crediting. Typical WRM activities with GHG emission reduction size are summarized in the "sustainability section" below.

Sustainability

Sustainability focuses on program type and climate smart innovative technology compared to BAU interventions.

Potentially low GHG emission WRM programs include renewable energy (hydropower), storage dam energy hydro-electric retrofits and energy floating solar, watershed and landscape management, nature-based solutions, and improving materials sourcing.

[72] WSAA, 2024. Guide to Scope 3 Emissions Management for the Water Sector (draft) (wsaa.asn.au)

The innovative technology focuses on "climate smart innovation" as a global opportunity technology mainly on mitigation areas and has low GHG emissions compared to the usual approach "business as usual" (global challenge) when designing the WRM project.

Renewable energy: Hydropower dams

Hydropower is a low-carbon source of renewable energy and a reliable and cost-effective alternative to electricity generation by fossil fuels. The Trung Son Hydropower Plant development experience in Vietnam reduced GHG emissions by 1 million metric tons/year compared to a thermal plant supplying a same volume of electricity on average of 1 billion kilowatt-hours (kwh)/ year of electricity[73]. In addition, site selection of new dams to account for potential environmental impact plays major role on reducing the emitted GHG. Management of existing dams and reservoirs limits seasonal fluctuation, which causes further CH4 emissions.

Renewable energy: Hydroelectric retrofits

Hydroelectricity provides energy sources that emit zero emissions during electricity production. Pumped storage can ease integration of renewable sources into a country's energy mix. Given that most emissions associated with new dams are emitted in the early years after flooding, the retrofitting of existing hydro-electric facilities contributes minimal *additional* GHG emissions associated with new flooding. Hydroelectric retrofits can provide renewable energy at existing storage dams without producing significant new emissions. A theoretical study shows that optimizing existing facilities through retrofits could mitigate between 16 and 22 million tCO2e/year over a 10-year period[74]. In addition, hydropower retrofits can be combined with floating solar, pumped storage, and other renewable interventions. Putting several smaller hydropower plants in a geographic area can support creating a microgrid, which can strengthen resilience.

Renewable Energy: Floating solar[75]

Floating Solar (FS) systems offer potential to boost power production at hydroelectric dams by harnessing existing transmission and distribution infrastructure. When integrated with hydropower, FS systems can be used to balance energy loads and optimize efficiency (e.g., the PV generates power in the daytime, hydropower at night). FS systems can also be applied[1] to irrigation reservoirs and natural water bodies and can also connect to existing grid systems. Furthermore, FS systems can lower evaporation rates and may improve water quality by inhibiting algae growth. The reservoir can also contribute to higher panel efficiency by cooling panel temperatures.

Nature-Based Solutions[76]

Nature-based solutions are among the most efficient ways to protect watersheds and ecosystems. Besides, investing in nature-based solutions is a way to directly remove carbon from the atmosphere.

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[73] World Bank, 2020. Powering up Vietnam with clean and affordable energy: The Trung Son Hydropower Plant development experience. https://www.worldbank.org/en/results/2020/12/18/powering-up-vietnam-with-clean-and-affordable-energy-the-trung-son-hydropower-development-experience

[74] World Bank, 2024.

[75] Source: World Bank Group; Energy Sector Management Assistance Program; Solar Energy Research Institute of Singapore. 2019. Where Sun Meets Water : Floating Solar Market Report. World Bank, Washington, DC. © World Bank

[76] Sources: Nature 4 Climate (2021) N4C pathways; WWF (2020) Bankable nature solutions; Browder, Greg; Ozment, Suzanne; Rehberger Bescos, Irene; Gartner, Todd; Lange, Glenn-Marie. 2019. Integrating Green and Gray : Creating Next Generation Infrastructure. Washington, DC: World Bank and World Resources Institute. © World Bank and World Resources Institute. https://openknowledge.worldbank.org/handle/10986/31430; Bernoux, Martial; Bockel, Louis; Rioux, Janie; Tinlot, Marianne; Braimoh, Ademola K. Carbon sequestration as an integral part of watershed management strategies to address climate change issues. FAO Policy Brief. July 11, 2011.

Financial arrangements, such as direct payments for verified carbon sequestration, can provide financial incentives to pursue nature-based solutions, which can be complemented by existing grey infrastructure, while also building resilience against climate change-related shocks.

Watershed management

Management of watersheds to reduce the organic matter content in surface water sources, thus limiting GHG emissions associated with the nutrient enrichment of water. In addition, specific activities can include control of fertilizer use, appropriate use of manures (See Chapter 4,3), and forest and grassland management.

Wetland and peatland management

Protection and conservation of wetlands reduces the risk of their degradation and prevents the loss of their use as carbon sinks. This is also referred to as ecosystem-based mitigation. Restoration of degraded wetlands by addressing sources of degradation is among the innovative technologies for low GHG emission. In addition, fire prevention in degraded peatland areas prevents the release large amounts of stored carbon.[77][78]

Box 8: Transformational Change in Countries B and C

Country B Watershed Services Improvement Project
Component 1 of this project aims to scale up landscape restoration interventions at a watershed level while enhancing the livelihoods of small holder farming communities, addressing climate change vulnerabilities and improving and/or preserving the carbon sequestration capacity of the watershed. Activities include advisory services and capacity building on sustainable landscape management practices, including climate-smart agriculture practices and silvicultural techniques, targeting multiple stakeholders of the watershed. Component **2** aims to maximize the benefits people and communities obtain from managing watersheds sustainably, as a basis for developing institutional and financing mechanisms needed to sustain restoration activities beyond the project period. Activities include a technical assistance and the initial capital required to establish a pilot market-based mechanism for the provision and maintenance of selected watershed services; and a package of enabling infrastructure and climate information services to maximize the livelihood benefits from improved watersheds, and to enhance the resilience of both the farming community and the watershed. These components will contribute to country B's commitment to reduce GHG emissions by 6% (unconditional) and 51% (conditional) by 2040 compared to BAU.
Country C Resilient Water Management for Community and Household Irrigation Project

[77] Country B Climate Change Data | Emissions and Policies | Climate Watch (climatewatchdata.org)
[78] Country C Climate Change Data | Emissions and Policies | Climate Watch (climatewatchdata.org)

Component 1 of this project aims to develop **water resource planning and pre-investment studies** by developing an IWRM and pre-investment studies and detailed engineering designs for the subprojects, related to **water conservation, irrigation, and risk management infrastructure**, identified in each basin water management plan.
Component 2 focusing on **climate resilient infrastructure investments** aims to fund works and the supervision of investments related to water conservation, soil and land management, irrigation, and risk management to adapt to the impacts of and to build resilience against climate change exacerbated floods and droughts. Activities include investments in household and community irrigation systems by developing infrastructures for water capture, the installation of water storage solutions, the conveyance of water to the field, and the equipment necessary for water distribution on the plots.
Component 3 aims to fund **technical assistance (TA) and capacity building activities to enhance water governance** at the national, macro, regional and basins level Capacity building for water governance and enhanced productivity.
These components contribute mainly to the climate adaptation role of the water sector. However, improving the water governance enhances climate mitigation.

3.2.4. Baseline and Crediting

The baseline should be below the TCAF crediting baseline (crediting threshold), which is calculated to be lower than the BAU and NDC unconditional targeted emissions, as highlighted in Chapter 3.

Through the Clean Development Mechanism (CDM) process[79], most carbon crediting was project-based, with support for individual investment projects where baselines, and monitoring, reporting, verification (MRV) systems were based on technology.

Referring to the project-based/programmatic approach, the baseline can either be based upon the current situation or on a reference situation including historical trend of the GHG emissions, technology, economic and performance analysis. The baseline scenario describes what the future development of the area would be if the project were not carried out, for the project crediting period. In terms of technology approach, the baseline levels are then used to compare with carbon emissions generated from changes by the project. For WRM projects, the baseline setting depends on the project type.

Dams and reservoirs[80, 81]

The baseline considers the landscape corresponding to the area that will be inundated by the creation of a reservoir and the indirect emissions associated with the production of an equivalent amount of energy through alternative sources in place of hydroelectricity, such as natural gas. This baseline will be compared with the GHG emissions caused by the new reservoir, i.e., mainly methane emissions produced by decaying biomass and the associated land use change.

Rivers and Lakes[82]

The baseline considers the direct GHG emissions with the current situation of the eutrophication of surface waters without the project (no change scenario) and will be compared with the GHG emission from the energy used for intensive water treatment to decrease pollutants for supply downstream (See

[79] https://unepccc.org/wp-content/uploads/2024/06/cdm-pipeline.xlsx
[80] WB, GHG Accounting methodology
[81] WB, GHG Accounting methodology
[82] The World Bank, 2022. Climate finance diagnostic – Water Sector

chapter 4.1 for details) (scenario with the project) [83] during the project lifetime. Please see the relevant sections for water supply and sanitation projects for more information.

Wetland and peatland

The baseline considers the direct GHG emissions with the current situation of the degradation of wetland and peatland (no change scenario) in comparison with the GHG emission from a change in wetland and peatland management, i.e. drainage, rewetting, extraction, and restoration (scenario with the project) [84].

Watershed entities

The baseline considers the direct GHG emissions with the current situation of the land and ecosystems degradation (e.g. erosion and removal of coastal environments) (no change scenario) and will be compared with the GHG emissions from the intervention to protect or restore natural environments (scenario with the project).

In addition, the baseline setting should comply with the existing policy measures in place. Potential Policy measure types per WRM subsectors are developed in section 4.2.6.

Box 9: Potential Baseline and Crediting in Countries B and C

Country B Watershed Services Improvement Project
Based on the project components, potential baseline for mitigation would be the direct GHG emissions with the current land degradation at the watershed level. This baseline will be compared with the direct and indirect GHG emissions by applying climate-smart agriculture practices and silvicultural techniques to improving and/or preserving the carbon sequestration capacity of the watershed.
Country C Resilient Water Management for Community and Household Irrigation Project
Based on the project components, potential baseline for mitigation would be the direct GHG emissions with the current water resources management with weak water governance. This baseline will be compared with the direct and indirect GHG emissions **resulting from improved water productivity**.

Crediting as highlighted in chapter 3 is the difference between the emissions from project conditions and TCAF crediting baseline.

3.2.5. Measurement, Reporting, and Verification (MRV)

MRV measure emissions or other drivers of emissions at project site(s). GHG emissions are calculated and reported in GHG metrics, which is metric tons (mt) of each relevant GHG (CO2, CH4, and N2O, before being converted to CO_2 equivalent (CO_2e) using Global Warming Potentials (GWPs). GWPs can be found in the IPCC 5th Assessment Report conversion factors. This includes Climate Feedback effects. [85] The World Bank has an internal approved GHG accounting tools measuring the GHG emissions in line with the three business lines presented in this report.

[83] https://northsearegion.eu/canape/measuring-greenhouse-gases-in-wetlands/
[84] https://northsearegion.eu/canape/measuring-greenhouse-gases-in-wetlands/
[85] Climate Feedback effects refer to the feedbacks caused by Global Warming. For example, the increase in moisture in the air, which will raise temperatures beyond the initial impact of releasing the original Greenhouse Gas.
Without Climate Feedback effects these conversions would be CH_4 – 28, N_2O – 265.

Table 7: GHG Equivalents

Gas	CO_2e Conversion factor
CO_2 (Carbon Dioxide)	1
CH_4 (Methane)	34
N_2O (Nitrous oxide)	298

Dams and reservoirs

Emissions measurement for reservoirs considers the project gross emissions from freshwater reservoirs which is the summation of emissions from conversion to flooded land and after conversion to flooded land[86].

Rivers and Lakes

Emissions measurement for eutrophicated rivers and lakes consider the emissions during the process of wastewater treatment as shown in chapter 4.1[87].

Wetland and peatland

Emissions measurement for degraded wetland and peatland depend on the type of anthropic conversion namely drainage, rewetting, extraction, and restoration generating CO_2. However, quantification of these CO_2 emissions is still uncertain. While estimates of global peat extraction areas are converging (1 to 2 M ha), the emission factors (EFs, t CO2-C ha−1 yr−1) used to estimate the total emissions from the field (excludes the decomposition of extracted peat and particulate emission during the extraction) differ substantially[88].

Watershed entities

For measuring emissions from watershed by reducing the organic matter content in surface water sources, refer to chapter 4.1. For measuring emissions by controlling the fertilizer use and implementing the appropriate use of manure, refer to chapter 4.3.

For reporting and verification, refer to chapter 4.1.

Box 10: GHG measurement in Countries B and C

Country B Watershed Services Improvement
GHG emissions measurement would be linked to the type of climate-smart agriculture practices and silvicultural techniques. This activity could include the control of using fertilizer or the use of manures.
Country C Resilient Water Management for Community and Household Irrigation
GHG emissions measurement would focus on the GHG emissions before and after the strong **water governance was in place.**

[86] WB, GHG Accounting methodology
[87] The World Bank, 2022. Climate finance diagnostic – Water Sector
[88] Communications Earth & Environment, 2023. Improved estimates of carbon dioxide emissions from drained peatlands support a reduction in emission factor | Communications Earth & Environment (nature.com)

3.2.6. Policy measures:

A wide range of policy measures are available to support the low GHG emissions from WRM projects/programs. Table 2 summarizes some examples of policy measures for WRM subsectors.

Table 8: Examples of Policy Measures for WRM sector

Policy measures	Surface water bodies (dams, reservoirs, rivers, and lakes)	Wetland and peatland	Watershed entities
Prescriptive Measures	• Agreement or regulatory standards to offer rewards and/or promotion of program types as hydropower, energy hydro retrofit, energy floating solar (Refers to chapter 4.1.6 Sanitation and wastewater treatment)	• Agreement or regulatory standards to offer rewards and/or promotion of program types as protection and/or restoration of wetland and peatland, protection of ecosystem, etc. • Attribute penalties or fees for degraded wetland, peatland, and ecosystem.	• Agreement or regulatory standards to offer rewards and/or promotion of program types as nature-based solution, land restoration, etc. • Attribute penalties or fees for degraded land
Economic Measures	• Tax on diffused nutrients (Refers to chapter 4.1.6 Sanitation and wastewater treatment)	• Tax on the type of exploitation of wetland and peatland (drainage, extraction, etc.).	• Subsidy for farmers achieving the role on protecting and/or restoring of the watershed while improving productivity.
Supportive policies	• Policies that ameliorate eutrophication by limiting nutrient loadings to surface waters • Evaluation of nutrient management policies (Refers to chapter 4.1.6 Sanitation and wastewater treatment)	• Strengthen policies on wetland/peatland protection and restoration	• Promote policy regulating land and ecosystem protection • Apply a policy regulating the watershed overexploitation

Direct Investment	• Allocate specific renewable energy funds for energy related mitigation measures: funds with the target of reducing GHGs specifically in the WRM sector or for water end users. (Refers to chapter 4.1.6 Sanitation and wastewater treatment)	• Allocate investment funds on conserving the wetland and peatland, while offering an alternative source of income for surrounding local people to avoid exploiting the wetland and peatland.	•Use e-vouchers for farmer applying an agriculture practice to protect land, soil, and the environment to avoid soil erosion. •Allocate direct funds for protecting watershed vegetation cover and forests.
Effective business models	Refers to chapter 4.1.6 Sanitation and wastewater treatment	• Promote partnership with nature conservancy organizations or private sector large emitters of GHGs to finance the protection and restoration of wetland and peatland given their large capacity as carbon sinks.	•Put in place a performance-based conditional program to protect and/or restore the watershed, which will reward farmers for effectively protecting/restoring land and ecosystems. Support wood charcoal farmer and users with alternative source of income and energy (e.g. biochar).

Policy measures for indirect GHG emissions fall under the RE and EE measures in the water sector (see chapter 4.1.6.)

Box 11: Policy Measures Case Studies in Countries B and C

Country B Watershed Services Improvement Project

Economic measures will be applied to achieve the objective on scaling up the land restoration. The project offers performance-based grants **for 200 farmer groups and 60 agri-enterprises** for restoration of approximately 95,000 ha of degraded landscapes to enhance agricultural-based livelihoods and boost household incomes.

Effective business model will be applied to maximize the benefits people and communities obtain from managing watersheds sustainably. The project seeks to develop an institutional and financing mechanisms by establishing a pilot market-based mechanism for the provision and maintenance of selected watershed services.

Country C Resilient Water Management for Community and Household Irrigation Project
Direct investment will be applied through the climate resilient infrastructure investments using an integrated water basins management, which will enhance soil and crop carbon stock. **Effective business models** will be applied by addressing the water governance issues. This model leads to different levels of control over the activities that cause GHG emissions.

3.3. Climate-Resilient Irrigation (CRI)

3.3.1. Project background

Climate resilient irrigation (CRI) refers to equipping farmers to produce more abundant harvests while preserving water, conserving land, improving resilience to climate shocks, and mitigating climate change. CRI is a cost-effective and scalable innovation to feed more people and boost incomes[89]. For the last 6 years (FY19-FY24) the Water Global Practice (GP) has 30 CRI approved climate co-benefits projects with a total investment for mitigation of US$ 952.52 million (IDA+IBRD). CRI projects are composed by irrigated rice and fertilizer use efficiency and groundwater for irrigation.

Box 12 shows a Climate Resilient and Low Carbon Agriculture Development project in country D as a case study through this CRI chapter.

Box 12: CRI project case study in Country D

Country D Climate Resilient and Low Carbon Agriculture Development
The Project Development Objective (PDO) is to **increase productivity, resilience and adoption of low carbon agriculture approaches** of the targeted commodities in selected project locations. The project scope focuses **on three commodity groups namely a) rice; b) livestock; and c) high-value tree crops**, both estate crops (e.g., coffee, cocoa, coconut, rubber) as well as horticulture crops (e.g., mango, durian, citrus, rambutan).

3.3.2. GHG emissions

Water is critical for food production and plays an important role in food security. Globally, irrigated agriculture represents 20% of total cultivated land and contributes 40% of total food production worldwide. At present, agriculture accounts for 70% of all freshwater abstraction globally. In addition to its use of water resources, irrigation contributes to GHG emissions through its effect on soil microbial activity and through energy demand to produce water for irrigation.

Direct emissions

<u>Irrigated crops mainly rice</u>

Rice is among the most dominant crops used primarily as food[90,91] at worldwide level. The global supply may need to grow by 100 million tonnes/year to meet demand by 2050[92]. Rice is a water-intensive crop, requiring 3,000–5,000 liters of water to produce 1 kilogram of rice and its growing consumes 40% of the world's irrigation water. Water security threatens most major rice-growing regions, with water scarcity already present.[93] In addition, rice farming accounts for 2.5% of global GHG emissions due to

[89] https://wam.ae/en/article/13yhgap-world-bank-spotlights-climate-resilient
[90] https://www.statista.com/topics/1443/rice/
[91] https://agronomag.com/challenges-global-rice-market/
[92] Ibid.
[93] Paddies for the Planet & Producers (P4P&P): Climate mitigation in rice cultivation. Discussion Note as of December 15, 2020. *Discussion note written by Pieter Waalewijn, Global Lead Water in Agriculture, with contributions by Erick Fernandes, Global Lead Climate Smart Agriculture, CSA team; Cuong Hun Pham, Sr. Water Resources Management Specialist; and Sean Nelson, Climate Change Specialist.*

CH4 and N2O emissions[94] that form under anaerobic conditions in flooded rice paddies. Globally, rice farming produces an estimated 615 to 900 million tonnes of CO_2e (tCO_2e)/year to the atmosphere. It is estimated that CH4 emissions from rice could double by 2100 due to global warming.

Fertilizer use

Farmers tend to extensively use fertilizer to maximize yields and income. However, overuse of fertilizers not only pollutes soil and water sources, but also can contribute to GHG emissions (CO_2, N_2O) from its field use in agricultural systems. Globally, direct N_2O soil emissions due to fertilizer use is estimated to 379.9±160.5 Mt CO_2e[95] and at 86.0±39.1 Mt CO_2 for urea application to soils[96].

Indirect emissions

Groundwater for irrigation

In many countries, groundwater is the primary source for irrigation, with a large energy requirement for abstracting water from the ground and pumping to the end use point. There is limited global data available on the energy used for this purpose, but it is known to be significant due to lack of clean energy used for pumping. The GHG emission potential varies based on the distance water is required to be pumped, the level of the water table in that location, and the fuel source used for the pumps.

Irrigated rice

Although most emissions from rice cultivation are associated with the flooding regime used, it is estimated that ~10% of the total GHG emissions from rice originate from fertilizer use and water pumping.

Fertilizer use:

Fertilizer use releases GHG emissions from its manufacture, transportation, and in-field use. FAO estimates indicate that in 2019, N fertilizer manufacturing accounted for about 0.41 $GtCO_2$e, or 0.7% of global GHG emissions[97]. When N fertilizers are applied to the soil, only a portion is uptaken by crops. Another portion is used by soil micro-organisms, which produce N_2O as a by-product of their metabolism, while another part of the N applied may end up leaching or volatilizing from the application site[98]. Globally in 2018, indirect N_2O soil emissions from volatilization and redeposition are estimated at 66.3±11.3 Mt CO_2e and at 130.1±31.4 Mt CO_2e for indirect N_2O emissions from leaching.

94 Source: https://www.nature.com/articles/srep39855

95 Menegat et al, 2022. Greenhouse gas emissions from global production and use of nitrogen synthetic fertilisers in agriculture | Scientific Reports (nature.com)

96 Sources: Mckonnen and Hoekstra. 2017. "Global Anthropogenic Phosphorus Loads to Freshwater and Associated Grey Water Footprints and Water Pollution Levels: A High-Resolution Global Study." Water Resources Research 54 (1): 345–358 (https://doi.org/10.1002/2017WR020448); Tian, H., Xu, R., Canadell, J.G. et al. A comprehensive quantification of global nitrous oxide sources and sinks. Nature 586, 248–256 (2020). https://doi.org/10.1038/s41586-020-2780-0; European Science Foundation. European Nitrogen Assessment. http://www.nine-esf.org/node/360/ENA-Book.html; FAO. Climate Smart Agriculture Sourcebook: Mitigating climate change. http://www.fao.org/climate-smart-agriculture-sourcebook/concept/module-a2-adaptation-mitigation/chapter-a2-3/en

97 Menegat et al, 2022. Greenhouse gas emissions from global production and use of nitrogen synthetic fertilisers in agriculture | Scientific Reports (nature.com)

98 Menegat et al, 2022. Greenhouse gas emissions from global production and use of nitrogen synthetic fertilisers in agriculture | Scientific Reports (nature.com)

3.3.3. Transformational Change

Size

CRI project GHG emissions reduction should meet the TCAF crediting baseline, which is about 1 $MtCo_2e$ per year within 5-7 years. Typical CRI activities with GHG emission reduction size are summarized in the "sustainability section" below.

Sustainability

Sustainability focuses on programs type and climate smart innovative technology compared to BAU interventions.

Potentially low GHG emission CRI programs include Climate-Smart Agriculture (CSA) through low methane emission programs, fertilizer use efficiency, and EE for groundwater irrigation.

Irrigated crops : Low methane emission

Box 13: GHG emissions case study

Country D Climate Resilient and Low Carbon Agriculture Development
The agricultural sector is also a contributor to Country D's GHG emissions. Historically, **land use change** and forestry had been a major contributor of country D's GHG emissions[1], **accounting on average 40.4 percent of national GHG emissions between 2000 and 2020**. In 2020, this share was 17.5 percent. **Palm oil plantations** had been one of the **largest drivers of land use change**[1]. The implementation of a moratorium on the issuance of new permits in primary forests and peatlands, introduced initially in 2011 and made permanent in 2019, had contributed to a **deceleration in the rate of deforestation in recent years**. Separately, agricultural production contributed **9 percent of national GHG emissions in 2020**[1], with **rice cultivation and livestock being the main emitters**. In addition, **food loss and waste** are also significant contributors with Ministry of National Development Planning estimating that the average annual contribution of emissions associated with food loss and waste equaled **7.29 percent of country D's GHG emissions between 2000-2019**.

Research suggests CO_2e emissions could be reduced 20-90% through various methods called Alternative Wet and Drying (AWD) and System of Rice Intensification (SRI). AWD/SRI was accepted as a methodology for CO_2e mitigation under the CDM (AMS-III.AU). AWD can also reduce water use by 30-40%, which could support water security goals in key rice-growing countries including China, Vietnam, and Indonesia. Use of AWD on rice paddies can result in reduced water consumption and CH4 emissions by up to 80% (region dependent).[99]

Fertilizer Use efficiency

Efficient fertilizer usage has a high potential to reduce emissions while maintaining and enhancing production. To achieve emission reductions at scale to fulfil TCAF requirements, the initiative would have to change the behavior of many small farmers. For example, a program that reached 200,000 small farmers targeted for receiving e-voucher subsidies could achieve the desired scale of emissions reductions[100]. Furthermore, climate finance can be a pathway to offer farmers financial incentives to reduce fertilizer overuse. In addition, training programs can teach farmers the most effective and efficient fertilizer use practices beyond high intensity usage. For instance, training farmers to recover and valorize bio-waste and treated sludge as a fertilizer or soil conditioner replacement (directly or after

[99] WB, Arup report
[100] TCAF synthesis blueprint report

composting) can reduce GHG emissions while supporting farmer livelihoods. Reduced nutrient loads in waterways can increase the climate change resilience capacity of local water sector infrastructure[101].

Box 14: Transformational change CRI case study

Country D Climate Resilient and Low Carbon Agriculture Development
Climate-Smart interventions are applied for the three scopes: • **Climate-Smart Rice:** seven integrated practices including: i) water-saving practices, such as intermittent irrigation and Alternate Wetting and Drying (AWD); ii) use of high-yielding, resilient, and low-emission rice varieties; iii) balanced fertilizer application; iv) use of organic fertilizer; v) optimum spacing between rows; vi) application of site-specific cropping calendar for agronomic practices; and vii) optimum application of biopesticides and integrated pest and disease management. • **Climate-Smart Livestock:** practices include: i) enhanced feed management practices (e.g., changing feed mix, increasing protein content, use of green forage and seaweed supplements) to improve productivity and reduce emissions from enteric fermentation; ii) livestock health interventions (e.g., improving veterinary services, vaccination services, interventions around Anti-Microbial Resistance (AMR), improving diagnostics and surveillance capabilities for zoonotic diseases)[1]; iii) improved animal husbandry practices; iv) improved manure management; v) pasture improvement and rehabilitation; vi) improved herd management; and vii) supply chain interventions to improve culling/slaughterhouses/cold chains, etc. • **High-Value Tree Crops:** The intervention could include: a) provision of resilient and high yielding planting material; b) demonstration plots; c) farmer field schools and provision of advisory services; d) facilitation of tools and equipment for pruning and tree management; e) improved soil and tree fertility management practices; f) intercropping for revenue generation; g) support for value chain integration and post-harvest infrastructure; and i) integration with livestock to promote circularity.

<u>Groundwater for irrigation: Energy Efficiency (EE)</u>

A key climate-smart practices for groundwater management for irrigation is improving energy efficiency, as a reduction in overall energy consumption lowers harmful GHG emissions. To reduce energy consumption, decentralized water supply should be expanded to reduce energy used to pump and/or transport water over long distances. In addition, demand management measures across agriculture sectors should be introduced given, the reduction in water requirements intrinsically reduces energy demand. Most importantly, the use of renewable energy can be used to replace fossil fuels for pumping.

3.3.4. Baseline and Crediting

Irrigated rice

The baseline considers ex-post GHG emissions from the current situation using rice farming under anaerobic conditions in flooded rice paddies with its water pump equipment (no change scenario). This baseline will be compared with the ex-post GHG emissions from project conditions using the CRI

[101] Sources: Mckonnen and Hoekstra. 2017. "Global Anthropogenic Phosphorus Loads to Freshwater and Associated Grey Water Footprints and Water Pollution Levels: A High-Resolution Global Study." Water Resources Research 54 (1): 345–358 (https://doi.org/10.1002/2017WR020448); Tian, H., Xu, R., Canadell, J.G. et al. A comprehensive quantification of global nitrous oxide sources and sinks. Nature 586, 248–256 (2020). https://doi.org/10.1038/s41586-020-2780-0; European Science Foundation. European Nitrogen Assessment. http://www.nine-esf.org/node/360/ENA-Book.html; FAO. Climate Smart Agriculture Sourcebook: Mitigating climate change. http://www.fao.org/climate-smart-agriculture-sourcebook/concept/module-a2-adaptation-mitigation/chapter-a2-3/en

methods, namely Alternative Wet and Drying (AWD) and System of Rice Intensification (SRI) (project scenario).

Box 15: Baseline and Crediting CRI in Country D

Country D Climate Resilient and Low Carbon Agriculture Development
Potential baseline that could be applied for the three scopes are: • **Climate-Smart Rice:** GHG emission generated by i) water-use in irrigated rice (flooded paddy); ii) use of high-emission rice varieties; iii) overuse of fertilizer; iv) use of N fertilizer; v) large spacing between rows; vi) cropping without agronomic practices calendar; and vii) overuse of biopesticides. • **Climate-Smart Livestock:** GHG emission generated by i) low quality of feed management practices; ii) weak livestock health interventions; iii) uncontrolled animal husbandry practices; iv) lack of manure management; v) low quality of pasture; vi) weak herd management; and vii) low quality of supply chain interventions. • **High-Value Tree Crops:** GHG emission generated by: a) lack of management of tree crops; e) lack of improvement of its value chain and its integration with livestock.

Fertilizer use

The baseline considers ex-post GHG emissions from the current situation overusing fertilizers, including from manufacturing, transportation, and field use in agricultural systems (no change scenario). This baseline will be compared with the ex-post GHG emissions from project conditions using efficient fertilizer practices beyond high intensity usage, and/or using bio-waste and/or treated sludge as a fertilizer replacement, and/or a project condition with farmers having e-voucher subsidies for emissions reductions (project scenario).

Groundwater use for irrigation

The baseline considers ex-post GHG emissions from the current situation with existing energy sources used for pumping and the energy required to pump water long distances (when relevant), the level of the water table in that location, and the fossil-fuel used for the pumps (no change scenario). This baseline will be compared with the ex-post GHG emissions from project conditions trying to improving energy efficiency by reducing energy consumption on pumping and transporting the water over long distances through expansion of decentralized water supply, and/or measuring demand management across agriculture sectors to reduce water requirements and subsequently the energy demand, and/or using RE in replacement of fossil fuels for pumping.

3.3.5. Measurement, Reporting, and Verification

Irrigated rice

Multiple measurement methods are available. This report considers EX-ACT inputs as an example of measurement of irrigated rice agriculture. EX-ACT method considers both ex-post GHG emissions measurement from change in land use and direct GHG emissions from cultivated rice. Measurement parameters include rice type, areas (ha) of new irrigated rice (e.g. area burned in conversion to cropland) and continued forest/land use that would be removed in baseline (forest baseline growth: carbon sink for counterfactuals), cultivation period (days), water regime during cultivation period and before cultivation period.

Fertilizer Use

Measurement parameters for fertilizer use include organic amendment type, application rate of organic amendment (kg/ha/day), CH_4 emissions rate in metric tonnes/year, and the emission rate equivalent in metric tonnes (CO_2 eq/year) [102].

Groundwater for irrigation

Measurement parameters consider the distance between the water point and the crop, the pump type, pump capacity, pump efficiency, and the type of fuel.

For reporting and verification, refer to chapter 4.1.

Box 16: MRV CRI Case Study

Country D Climate Resilient and Low Carbon Agriculture Development
Measurement to achieve the PDO focuses on the following parameters: 1. **percentage increase in yield per hectare for rice and percentage increase output per unit of livestock (in %)** for increased productivity; 2. **land areas adopting climate smart agricultural practices** (area under climate-smart rice, area under sustainable pasture management, and area under sustainable intensification of tree crops) (**in ha**) for increased resilience 3. **reduction in GHG emission (in metric tons of carbon dioxide equivalent [MTCO2e])** as a result of project activities for adoption of low carbon agriculture approaches

3.3.6. Policy Measures

Some examples of CRI policy measures are recapitulated in Table 3.

Table 9: Examples of Policy Measures for CRI sector

Policy measures	Groundwater for irrigation	Irrigated rice	Fertilizer use efficiency
Prescriptive Measures	•Regulatory standards mandating the expansion of	•Regulatory standards promoting AWD. •Regulatory standards mandating the use of EE and RE for large-	•Enforcement of fertilizer quality control laws from its manufacturing, transportation, and field use.

[102] Sources: Mckonnen and Hoekstra. 2017. "Global Anthropogenic Phosphorus Loads to Freshwater and Associated Grey Water Footprints and Water Pollution Levels: A High-Resolution Global Study." Water Resources Research 54 (1): 345–358 (https://doi.org/10.1002/2017WR020448); Tian, H., Xu, R., Canadell, J.G. et al. A comprehensive quantification of global nitrous oxide sources and sinks. Nature 586, 248–256 (2020). https://doi.org/10.1038/s41586-020-2780-0; European Science Foundation. European Nitrogen Assessment. http://www.nine-esf.org/node/360/ENA-Book.html; FAO. Climate Smart Agriculture Sourcebook: Mitigating climate change. http://www.fao.org/climate-smart-agriculture-sourcebook/concept/module-a2-adaptation-mitigation/chapter-a2-3/en

	decentralized water supply[103]. •Implementation of standards promoting EE and RE design for large-scale groundwater pumping.	scale irrigation water pumping.	•Adoption of bio-fertilizer procurement policies mandating the use of bio-waste, treated sludge for large-scale agriculture.
Economic Measures	• Apply tax on the use of fossil fuel for large-scale groundwater pumping. • Subsidize expanded decentralized water supply systems.	• Tax on the fuel use for large-scale water pumping. • Tax for the fertilizer type and intensity use. • Subsidies for farmer opting for AWD. • Cancel/reduce subsidies for flooded rice cultivation and provide other forms of support to rice farmers.	• Eliminate subsidies to the agriculture sector, such as reductions on the diesel fuel tax paid by farmers, subsidies to fertilizer production and consumption, or unsustainable biofuels and provide other forms of support to households to avoid loss of household income. • Apply tax on the use of fossil fuel, fertilizer production and consumption, or unsustainable biofuels namely biofuels from food crops and monoculture plantations (e.g. soy or canola) if the carbon sequestration ability is far higher than an acre the annual harvest[104].
Supportive policies	Policy to promote EE and RE for water use efficiency	•Policy that promotes water-saving irrigation technologies and	• Policy that subsidizes low carbon fertilizers

[103] Pradip P K and Shweta L., April 2023. Need to adopt scaled decentralized systems in the water infrastructure to achieve sustainability and build resilience. Water Policy (2023) 25 (4): 359–378. https://doi.org/10.2166/wp.2023.267

[104] EnPowered, consulted on June 2024, Are biofuels really sustainable? https://enpowered.com/are-biofuels-really-sustainable/

	with another form of support not to lower water prices for irrigation.	increase water use efficiency.	namely food waste fertilizers, low-carbon urea, and low carbon ammonia[105] • Support to developing more efficient fertilizer subsidy schemes in line with existing national and provincial agricultural policies. • National legislation requirements on the type of fertilizer allowed to be marketed.
Direct Investment	• Offer grants to support farmers using RE for groundwater pumping. • Allocate funds to measure demand management by crops to reduce water and energy requirement.	• Allocate funds to support farmers using water saving irrigation methods. • Offer grants for start-up farmers to test water saving irrigation methods.	• Use of electronic vouchers targeted at small farmers, to provide direct support to certain fertilizers, which then affects the agricultural producer incentives.
Effective business models	• Promotes the PPP partnership to ensure financing on EE and RE option for groundwater pumping.	• Establish a pilot-based mechanism to change farmers' practices by using AWD with efficient production instead of flooded rice.	• Promote partnership with private sectors supporting the use of bio-fertilizers including treated sludge and bio-waste as a fertilizer replacement. • Use of performance-based conditions to reward the farmer with verified emission results using the balanced

[105] Nutrient, December 2023. Low-Carbon Fertilizer. https://www.nutrien.com/sustainability/strategy/low-carbon-fertilizer#:~:text=emissions%20intensity%20target.-,Low%2Dcarbon%20ammonia,and%20Joffre%2C%20AB%20Nitrogen%20facilities.

			fertilizer and/or bio-fertilizers.

4. General Framework for Implementing TCAF in the Water Sector

4.1. Project Background

The convergence of urbanization, climate change, global water crisis, GHG emissions, funding issues, and water policy implementation creates a complex landscape for water management. Urban growth strains water supply services, particularly in low- and middle-income countries, exacerbating inequalities and challenges in infrastructure development. Climate change further intensifies water scarcity, leading to agricultural disruptions, economic instability, public health problems, and social unrest. Meanwhile, inadequate water sector infrastructure or outdated ways of providing water service delivery contributes to global GHG emissions, underscoring the importance of sustainable water management in achieving net-zero goals. However, financing for water projects remains disproportionately low compared to other sectors, hampering infrastructure development. Additionally, fragmented water governance complicates policy implementation, hindering effective responses to water-related challenges. These interconnected issues highlight the need for comprehensive strategies, innovative financing mechanisms, and improved governance frameworks to address the complexities of water management in a rapidly changing world.

TCAF's support has the potential to instigate transformative shifts in both the structuring and financing of water projects. Additionally, by emphasizing the development of projects that yield multiple co-benefits, such as enhancing the quality of life for individuals while concurrently contributing to climate change mitigation efforts, TCAF can play a pivotal role in fostering sustainable outcomes.

Box 17: Policy Measures CRI Case Study in Country D

Country D Climate Resilient and Low Carbon Agriculture Development

Based on the project components, policy measures could be:

- **Prescriptive measures:** scaling up the adoption of climate-resilient and low-carbon agricultural technologies and practice.
- **Economic measures:** by creating circularity between livestock and tree crops using manure to enrich tree crops soil.
- **Supportive policies:** policies supporting the developing climate-smart agricultural infrastructure.
- **Effective business models:** strengthening agricultural institutions and dissemination, as well as human resources empowerment.

4.2. Transformational Change – Projects with the Highest Impact

In Chapter 3, three sub-sectors have been extensively examined: WSS, WRM, CRI. Across these sectors, diverse activities have been scrutinized against TCAF parameters. Considering impact, **both in terms of scale and sustainability, projects that integrate technological innovation stand out as having the greatest potential to make a significant difference and to align effectively with TCAF objectives.**

4.2.1. Water Supply and Sanitation

The projects with the highest impact on the reduction of carbon emissions are those focused on:

- Methane Capture at Urban Wastewater Treatment Plants
- Renewable energy integration and energy efficiency improvement in wastewater and water treatment processes.

The common factor among these projects is their focus on mitigating GHG emissions associated with wastewater and water treatment processes. Each project implements specific strategies to either capture methane emissions, recover and utilize biogas, or integrate renewable energy sources and improve energy efficiency.

4.2.2. WRM

The projects with the highest impact on the reduction of carbon emissions are:

- Management of Natural Landscapes,
- Hydropower Dams,
- Hydro-electric Retrofitting; and
- Renewable Energy Floating Solar.

A common factor among three of these projects is their utilization of renewable energy sources. These projects leverage existing infrastructure and natural resources to generate clean energy.

4.2.3. CRI

Among the projects with the highest impact on the reduction of carbon emissions are:

- Alternative Wet and Drying (AWD); and
- System of Rice Intensification (SRI) for irrigated rice, balanced fertilizer usage efficiency, and energy efficiency in groundwater irrigation.

A common factor among these projects is their focus on implementing climate-smart practices to reduce greenhouse gas emissions. For example, AWD and SRI techniques can significantly reduce methane emissions from rice paddies while also conserving water. Balanced fertilizer usage ensures that nutrients are applied efficiently, reducing emissions associated with fertilizer overuse. Moreover, improving energy efficiency in groundwater irrigation through decentralized water supply and renewable energy adoption reduces overall energy consumption and associated emissions.

4.3. Baseline Setting for the Water Sector

The common factors for baseline setting across various projects in the water sector include:

1. **Current Situation Assessment**: Baselines are established by first assessing the existing state of affairs in each specific project area. This involves evaluating the prevailing conditions, technologies, management practices, and emission levels related to water management, wastewater treatment, irrigation, or energy usage. The baseline scenario can then be established using different approaches including trend extrapolation, benchmarking, or financial/economic analysis. TCAF guidance on baseline and crediting line setting (see above) apply where projects aim to access TCAF funding.
2. **Historical Emissions Data**: Historical emissions data serves as a foundational element for establishing baselines. This data provides insights into emission trends over time, guiding projections and opportunities for improvement in emission reduction strategies.

3. **Technology and Management Practices Evaluation**: Evaluating the current infrastructure, technologies, and management practices within the sector is essential. It helps in determining the baseline emissions level based on the existing situation and identifying opportunities for emission reduction through the adoption of new technologies or operational efficiencies.

4. **Policy Compliance**: Baseline setting considers existing policy measures, regulations, and emission reduction targets relevant to the water sector. Aligning baseline assessments with governmental objectives ensures that emission reduction efforts are in line with broader national and international climate goals.

5. **Integration of Renewable Energy and Energy Efficiency**: Assessing the potential impact of integrating renewable energy sources and improving energy efficiency measures is crucial. This involves quantifying energy reduction achieved through efficiency upgrades and determining the reduction in carbon emissions facilitated by the adoption of renewable energy sources.

6. **Scenario Comparison**: Emission Reductions are determined by comparing the crediting baseline with the projected emissions under the project conditions (project scenario).

4.4. Monitoring, Reporting and Verification

Common factors for MRV across the different programs in the water sector include:

1. **Emission Sources and Processes**: Understanding the diverse emission sources and treatment processes specific to each sub-sector/program, such as biological processes in wastewater treatment plants or emission factors associated with fertilizer use.

2. **On-Site Monitoring**: Conducting on-site measurements using gas analyzers and protocols to monitor emissions directly at project sites, ensuring accurate measurement.

3. **Standardized Methodologies**: Utilizing standardized methodologies provided by organizations like the IPCC to estimate emissions and ensure consistency in measurement approaches.

4. **Quantification of Parameters**: Quantifying key parameters relevant to each sector/project, such as electricity consumption for renewable energy projects or application rates of organic amendments for fertilizer use.

5. **Conversion Factors**: Converting emissions of different greenhouse gases to CO2 equivalent (CO2e) using established conversion factors like Global Warming Potentials (GWPs).

6. **Measurement Tools**: Employing approved GHG accounting tools to measure emissions in line with project objectives and sectoral requirements.

7. **Verification Procedures**: Implementing periodic verification by independent third parties to validate reported data accuracy and compliance with goals, ensuring transparency and accountability.

8. **Alignment with National MRV Systems**: Aligning MRV approaches with national MRV systems where possible to enhance consistency and build national capacity.

9. **Consideration of Transformational Change**: Incorporating MRV not only of emission reductions but also of transformational change and sustainable development benefits, reflecting broader project impacts beyond emissions.

10. **Adherence to Reporting Requirements**: Ensuring compliance with reporting requirements under the Paris Agreement, including biennial reporting on progress and support provision/receipt.

4.5. Most Common Policy Measures

When comparing the different policy measures, one can see that for the water sector the following measures are the most prevalent:

4.5.1. Prescriptive measures

Regulatory Standards and Enforcement: This includes mandates for the installation and operation of wastewater treatment systems, enforcement of pollution control laws, and implementation of regulatory standards for energy efficiency and renewable energy integration in water sector infrastructure projects.

Promotion of Sustainable Practices: This involves the adoption of various measures aimed at promoting sustainability, such as the adoption of water conservation measures, pollution prevention strategies, and best management practices for waste disposal and sludge management.

Incentive Mechanisms and Penalties: This encompasses the use of incentive mechanisms, such as rewards, promotions, and subsidies, to encourage the adoption of specific programs or practices that contribute to environmental protection and restoration. Conversely, penalties or fees may be imposed for activities that degrade natural ecosystems or fail to meet regulatory standards.

4.5.2. Economic measures

Taxation and Subsidies: This includes measures such as taxes on discharged pollutants, fossil fuel use for large-scale groundwater pumping, and fuel use for pumping water, as well as subsidies for farmers achieving roles in protecting or restoring watersheds, and subsidies for expanded decentralized water supply actions.

User Fees and Tariffs: Implementation of user fees or tariffs for wastewater treatment services, along with the establishment of subsidies or grants to incentivize the adoption of environmentally friendly treatment technologies, are common economic measures to ensure sustainable funding for water infrastructure and encourage conservation practices.

Economic Instruments for Pollution Control: Introduction of pollution taxes or fines for non-compliance with wastewater discharge regulations, as well as the implementation of economic instruments such as tradable pollution permits, are effective measures to internalize the environmental costs of pollution and incentivize pollution reduction efforts.

4.5.3. Supportive policies

Policy Development and Implementation: This includes the development and implementation of national strategies, action plans, and legislation aimed at improving sanitation and wastewater management, promoting water-saving technologies, and regulating nutrient loadings to surface waters.

Capacity Building and Technical Expertise Enhancement: This involves the implementation of capacity-building programs to enhance technical skills and knowledge among professionals in the water sector, particularly in RE and EE technologies.

Stakeholder Collaboration and Partnerships: This encompasses the promotion of public-private partnerships and the establishment of collaborative arrangements between government agencies, utilities, private sector stakeholders, and research institutions. These partnerships facilitate knowledge sharing, resource mobilization, and the development of innovative solutions to address challenges in the water sector. Additionally, policies promoting collaboration can leverage private sector investment and expertise to enhance infrastructure development and improve service delivery.

4.5.4. Direct investments

Government Funds Allocation: This involves allocating government funds for various purposes related to water management, including the construction, expansion, and maintenance of wastewater treatment facilities, as well as the installation of renewable energy systems at water treatment plants. These investments aim to improve infrastructure, enhance service delivery, and promote sustainability in the water sector.

International Financing Mobilization: This includes mobilizing international financing through loans, grants, or development assistance to support sanitation projects and infrastructure development in the water sector. Accessing international financing sources, such as climate funds or development banks, helps supplement domestic resources and enables countries to address water-related challenges more effectively.

Private Sector Investment Encouragement: This encompasses encouraging private sector investment in the water sector through tax incentives, subsidies, or public-private partnerships. By leveraging private sector resources and expertise, governments can enhance the efficiency and effectiveness of water infrastructure development and service provision. Additionally, facilitating private sector participation can spur innovation and promote sustainable practices in the water sector.

4.5.5. Effective business model

Performance-Based Contracting: This involves adopting performance-based contracting for wastewater treatment services, RE, and EE projects. Payments are linked to the achievement of specific targets or outcomes, ensuring accountability and efficiency in service delivery.

Public-Private Partnerships (PPP): Promotion of PPPs is another common measure, facilitating collaboration between public and private sectors to finance, operate, and maintain water infrastructure and services. PPPs can leverage private sector expertise and resources to improve the sustainability and effectiveness of water projects, including those related to RE and EE.

Innovative Financing Mechanisms: Innovative financing mechanisms, such as green bonds, energy savings agreements, and outcome-based financing, are promoted to fund RE and EE investments in the water sector. These mechanisms provide alternative sources of funding and align financial incentives with desired environmental and sustainability outcomes.