Adrian Chojan
Lazarski University
adrian.chojan@lazarski.edu.pl

SDG 6: Clean water and sanitation

Introduction

Ensuring common access to clean water and proper sanitation are the most important development challenges of the contemporary world (PAH, 2020). The sixth goal of the UN 2030 Agenda—Clean Water and Sanitation—emphasizes that water is not only a basic natural resource but also a precondition for survival and socio-economic development. Every person in the world should have access to clean water. Our planet has sufficient water resources to make this possible. But in many areas, obstacles like inadequate or outdated infrastructure, poor management, and weak water governance have disastrous results. Each year, millions of people—especially children—die from diseases caused by contaminated water, inadequate sanitation, and lack of hygiene. In the academic literature, there is a growing discussion of potential "water wars." (Kowalczyk, 2023; Pogońska-Pol, 2020).

Access to clean water is not just an issue in developing nations; highly developed areas that struggle with droughts, overuse of resources, water pollution, and the effects of climate change are also impacted. Pressure on water supplies is further increased by urbanization, globalization, and the expanding demand for water in the industrial and agricultural sectors. . Solving this problem requires coordinated action by the international community, investment in infrastructure, the implementation of innovative water treatment and conservation technologies, and educating societies on the sustainable use of this vital resource.

Challenges related to SDG 6

Providing everyone with access to clean water and proper sanitation is still one of the 21st century's most challenging development issues. Clean water and sanitation, the sixth aim of the UN 2030 Agenda, is not just a humanitarian ideal; it is a necessity for survival, public health, and steady socioeconomic growth. Clean water ought to be available to everyone on the

planet. There is enough water on our planet to accomplish this. However, diseases associated with insufficient water resources, inadequate sanitation, and poor hygiene claim the lives of millions of people annually, primarily children, as a result of inadequate infrastructure and resource governance. Although it manifests differently and has its roots in distinct institutional, technological, and physical contexts, this issue is not exclusive to low-income nations; it also arises in highly developed nations.

Geographically unequal access to water resources is the first issue node, and it has an impact on security as well. Natural water shortage is a persistent problem in the Middle East and North Africa; Jordan and Yemen are two instances, where conflicts between the municipal sector and agriculture arise due to their limited resources and expanding population needs. Deficits in Namibia, one of the driest nations in Africa, have compelled innovative solutions, such as the direct reuse of cleaned wastewater for human use. Despite its high level of development, Australia faces frequent droughts, and the Murray-Darling Basin's water governance has shown the promise of water markets as well as the boundaries of their efficacy in the face of severe climate unpredictability. In South America, Andean cities such as La Paz in Bolivia and Lima in Peru feel the effects of shrinking resources due to glacier melting, which deepens the seasonality of supplies and heightens water security vulnerabilities. (Rozprawy Społeczne, 2025).

The transboundary character of water is another structural obstacle. Flows in the Nile Basin, which includes Ethiopia, Sudan, and Egypt, show how hard it is to strike a compromise between downstream governments' water security and the right to development (such as the building of massive hydroelectric stations). In the Tigris–Euphrates system (Turkey–Syria–Iraq), the Mekong (Laos–Cambodia–Vietnam–Thailand–China), and the Indus (India–Pakistan), tensions and the need for long-term agreements are also apparent. Where coordinating institutions are weak or cooperation becomes politicized, investments in infrastructure and mechanisms for sharing hydrological risk stall, and downstream users bear the costs of decisions made upstream.

The next dimension is the degradation of water quality and ecosystems. The naturally occurring arsenic in groundwater is an issue in Bangladesh and some parts of India, necessitating expensive removal technologies and ongoing intake monitoring. In Indonesia, the Citarum River has become emblematic of industrial and municipal pressures on aquatic ecosystems, much like stretches of the Ganges in India, where the river’s sacred significance collides with the challenges of wastewater and solid-waste treatment. Rapid development in China has resulted in persistent contamination in some regions, requiring remediation and

adjustments to production methods. Degradation is frequently less dramatic but systemic in highly developed nations. For instance, during cloudbursts, combined sewer systems in Germany and the United Kingdom's expansive urbanized catchments are overloaded, causing only partially treated wastewater to be released into rivers. In response, there have been isolated drinking water quality issues in the US, most notably in Flint, which have highlighted the need for extensive network upgrading and the brittleness of public confidence. Many low- and middle-income nations continue to struggle with chronically underfunded water and sanitation facilities. Millions of people in Nigeria and the Democratic Republic of the Congo are forced to rely on private wells and water tankers of varying quality because spreading megacities are unable to keep up with the rate of urbanization and the growth of water and sewer networks. Significant advancements in sewage and toilet construction in India go hand in hand with the necessity of maintaining infrastructure and altering practices in order to actually improve public health. Aging networks cause significant water losses in transmission even in Southern Europe, including areas of Spain and Italy. During drought circumstances, these losses become crucial not so much from a technologiccal standpoint but also from a political and societal one. The hydrological cycle and related hazards are changing due to climate change (PAH, 2021). Prolonged droughts and floods alternate throughout East Africa and the Sahel, destroying infrastructure and jeopardizing food security. South Africa nearly experienced "Day Zero" in Cape Town, which served as a lesson in tariff regimes, demand management, and crisis communication. The sustainability of conventional water sources is being threatened by increasing coastal erosion and saltwater intrusion into groundwater in Pacific island nations like Kiribati and Tuvalu, necessitating expensive fixes like desalination or community relocation. Episodes of cloudbursts and flash floods in Central and Western Europe highlight the shortcomings of earlier flood-protection theories, hastening the adoption of strategies based on distributed retention and floodplain/river-valley restoration; the Netherlands, with its "Room for the River" program, has established itself as a prominent example of this paradigm shift. . (Dutch Water Sector, 2019).

The competition between sectors is heightened by the growing need for water. Low irrigation efficiency and soil salinization are problems for Pakistan, which has one of the biggest irrigation systems in the Indus Basin. Modernizing canals and switching to precision irrigation technologies is a costly and institutionally demanding task. Access to groundwater is escalating conflicts over the preservation of environmentally significant areas in Spain, particularly in Andalusian horticultural agriculture. Israel has shown that engineering may greatly alleviate scarcity in the Middle East by combining desalination with wastewater recovery and reuse.

However, this requires strong institutions, prices that signal scarcity, and social acceptability. . Singapore, pursuing a multilayered approach to water security (storage, desalination, and the recovery of so-called NEWater), shows that even a city-state with limited hydrographic endowment can build resilience if it couples technology with demand management and public education.

Ineffective water resource management is a cross-cutting problem. The problems associated with years of extraction beyond recharge rates and the intricate fragmentation of institutional skills are shown by Mexico City, which draws water from over-exploited aquifers while also battling ground subsidence. The São Paulo crisis a few years ago in Brazil demonstrated how poor communication with users and rigid allocation practices worsen the consequences of drought. Even fundamental services become inaccessible in conflict-affected states like Yemen, South Sudan, or Syria due to the breakdown of public institutions (Ambukita, 2016; Paterek, 2018) and the devastation of water infrastructure, while cholera and diarrheal illnesses resurface as systemic risks.

Social and cultural barriers are another type of obstacle. Women and girls in many South Asian and Sub-Saharan African nations spend a large amount of time every day fetching water, which restricts their access to education and the workforce and so prolongs poverty. In India, for instance, a major program of building toilets and improving hygiene has resulted in significant improvements. However, the sustainability of these benefits depends on the upkeep of the infrastructure, habit modifications, and consideration of local cultural contexts and social hierarchy. Residents of informal settlements in Global South cities, such as Lagos and Dhaka, frequently pay more for inferior water from private vendors; controlling these markets calls for a combination of economic tools and a human rights-based strategy. Solutions do exist but implementing them requires coherence and determination. Germany and the Netherlands demonstrate that “green infrastructure,” landscape preservation, and river restoration are efficient ways to reduce the risk of flooding and enhance water quality. Namibia leads the world in direct potable reuse, Israel and Singapore lead in recycling and desalination, and cities like Cape Town lead in managing demand in the face of severe scarcity. Australia's experience with the Murray-Darling Basin highlights the need for strong environmental controls and monitoring to ensure that water markets don't have unforeseen effects on farming communities and ecosystems. Social inclusion, robust institutions, and long-term funding are the shared denominator. Public–private partnerships can accelerate the construction and modernization of infrastructure, but they require transparency, appropriate risk sharing, and protection for vulnerable consumers. Digitalization—from smart meters to hydrological modeling—boosts

efficiency, provided it is accompanied by capacity building in public administration and water utilities. Policies promoting equality and education are crucial for altering hygiene habits and consumption patterns as well as relieving women and girls of the unequal duties related to water collecting.

1. In the end, reaching Goal 6 necessitates a strategy that blends local agency with the global scale (Florczak, 2023). Additionally, it advocates for highly focused interventions in cities and villages, integrated spatial and hydrological planning at the national level, and water diplomacy in transboundary river basins. Clean water becomes a true right when states, regardless of their riches, are able to integrate technology, incentive-based economics, law, and education. Even the greatest success islands, like Singapore and the Netherlands, will continue to serve more as examples than as a universal norm in the absence of such a comprehensive change. The WASH (water, sanitation, and hygiene) service gap must be addressed when establishing the facts pertaining to SDG 6. This service gap extends from the level of households and healthcare facilities to environmental quality, disaster resilience, and water resources management. Deep disparities, overstressed ecosystems, and institutional weaknesses—as well as health and economic repercussions that disproportionately impact women, girls, and children—are what unify them. First, a persistent breach of fundamental safety regulations for both patients and employees is the fact that one in four medical facilities do not have access to essential water services. Perinatal mortality, the spread of waterborne diseases, and healthcare-associated infections are all directly increased when water, soap, and appropriate wastewater disposal are unavailable. It worsens the issue of antibiotic resistance and impairs the system's ability to respond to epidemics. In terms of the economy, it leads to increased drug consumption, prolonged hospital stays, and decreased output. WASH investments in healthcare facilities are one of the most economical public health measures because they prevent illnesses before they become serious enough to require expensive treatment.
2. Second, there is a significant, service-level gap in reaching SDG 6 given that 3 out of 10 people do not have access to safe drinking water and 6 out of 10 do not have access to safe sanitation. Definitions are crucial in this context: "safe" (safely managed) refers to infrastructure as well as quality (no contamination), availability on-site, and dependability. Because "improved" does not equate to safe, the historic rise in the percentage of persons using "improved" sources (from 76% to 91% between 1990 and 2015) does not necessarily imply safety. This distinction explains why many

communities continue to experience supply outages or consume water of questionable quality even after network development.

3. Third, the prevalence of open defecation affects society and the environment in addition to sanitation. Fecal pollution in the open environment provides "exposure pathways" for pathogens (food, water, and home) that sustain a high prevalence of parasites, diarrhea, and neglected diseases. Infrastructure (toilets, latrines, systems for gathering and safely processing fecal sludge) and actions that alter societal norms and behavior (CLTS-type programs, hygiene education, operations and maintenance management) must be combined in order to reduce this problem.
4. Fourth, more than 40% of the population suffers from water scarcity, and 1.7 billion people reside in river basins where water usage exceeds replenishment. This indicates ongoing overexploitation and a conflict between the demands of industry, agriculture, and cities and those of ecosystems (environmental fluxes). Given current irrigation practices, agriculture is the primary area for improvement. This includes improving groundwater management (caps, measurement, charges, permits), cropping patterns (fewer "water-hungry" species in deficit regions), and irrigation efficiency (drip, precision). Approximately 70% of irrigation water comes from rivers, lakes, and groundwater. Excessive withdrawals without these adjustments reduce food security, increase the price of energy and water transportation, and heighten the likelihood of conflict.
5. Fifth, more than 80 percent of raw wastewater finds its way into rivers or the ocean. This is a significant source of contamination (pathogens, nutrients, chemicals) as well as a waste of resources (water and recoverable nutrients). Algal blooms, dead zones, fishery deterioration, and increased water treatment expenses are the outcomes. In terms of the economy, this leads to a vicious cycle: the more expensive it is to deliver water that satisfies requirements, the worse the raw water quality, which lowers affordability. Before large-scale, costly central systems are constructed, a practical repair pathway begins with intermediate solutions (fecal sludge collection and safe management, “fit-for-purpose” technological thresholds for reuse in agriculture and industry), as well as with circular economy practices (recovery of biogas, phosphorus, and nitrogen).
6. Sixth, women and girls bear the task of carrying water in 80% of families without on-site water access. This leads to "time poverty," restricts access to education and the labor market, and raises the possibility of violence while traveling to water sources. From the standpoint of public policy, enhancing on-site access and reducing travel time to sources

results in immediate equality and financial benefits, and involving women in local water system management enhances solution adoption and maintenance.

7. Seventh, diarrhea and its complications—diseases that can be prevented—cause the deaths of 1,000 children on average each day. This is concrete proof that one of the most expensive (and morally repugnant) obstacles to growth is still the absence of clean water, proper sanitation, and hygienic habits. Safe water at the point of use (treatment/filtration), access to sanitation, handwashing with soap at important times, along with treatment (ORS, zinc), immunizations (e.g., against rotavirus), and better diet are the components that have the biggest health benefit. Each component contributes independently, but only when combined can they effectively lower morbidity and death.
8. Eighth, statistics demonstrating the increase in the percentage of people using “improved” water sources from 1990 to 2015 (from 76% to 91%) demonstrate how quickly infrastructure improvements can increase service coverage. However, they also draw attention to the limitations of indicators: focusing on "coverage" without accounting for affordability, quality, or supply continuity makes some progress "illusory" from the perspectives of fairness and public health. To facilitate efficient policy correction, monitoring must include indicators of “safely managed” access and service quality (such as the percentage of water that satisfies microbiological criteria, downtime, and non-revenue water/leakage).
9. Ninth, 70% of all fatalities brought on by natural hazards are attributable to floods and other water-related catastrophes. This indicates that SDG 6—which includes distributed retention, river and wetland restoration, early warning systems, risk education, green-blue infrastructure in cities, and spatial planning (no development in floodplains)—is connected to the climate resilience agenda. Otherwise, a flood that ruins intakes, treatment facilities, and networks might wipe out any gains made in water availability in a single day.

Finally, the dimension of finance and governance connects all of the aforementioned threads. In addition to missing pipes and treatment facilities, issues with scarcity, quality, and service delivery also include ineffective rates and subsidies, large amounts of non-revenue water, disjointed institutional capabilities, inadequate monitoring, and a lack of transparency. From the standpoint of public policy, the priorities are evident: : (1) WASH in healthcare facilities and schools as an ethical and epidemiological priority; (2) rapidly closing “open” transmission pathways by eliminating open defecation and ensuring safe fecal sludge

management; (3) improving efficiency in agriculture and protecting environmental flows to reduce chronic overexploitation; (4) a gradual, circular approach to wastewater that links health protection with resource recovery; (5) strengthening gender equality through on-premises access and women's participation in governance; (6) disaster risk management as an integral part of water planning.

In other words, the figures depicted constitute a map of a single systemic dilemma rather than a collection of disparate issues. Closing the gap in basic services, enhancing quality and dependability, and reorienting water management toward efficiency and climate resilience are all necessary to meet Goal 6. Child mortality lowers, productivity increases, and ecological stress is reduced when these three axes—services, quality, and resilience—are promoted in tandem. When they function independently, advancement is brittle and unsustainable.

Tasks related to SDG 6

Within the sixth Sustainable Development Goal, the United Nations have defined several specific tasks to be accomplished. Tasks 6.1–6.6 include concrete deadlines by which they should be achieved, while tasks 6.a and 6.b pertain to more general issues. It is worth briefly outlining their specifics.

Goal 6.1 Three requirements are combined in Goal 6.1: affordability, universality (coverage), and safety (quality and dependability). This entails going beyond basic "network connections" to provide a service that is consistent, complies with standards, and is affordable for all populations, including those living in rural and informal settlements. Key challenges include: (1) a high share of non-revenue water, which raises unit costs; (2) weak mechanisms for subsidizing connections and tariffs for the poorest; (3) a lack of quality monitoring (microbiology, metals, pesticides) and Water Safety Plans. Block tariffs with a "lifeline block" (a cheap minimum consumption bundle) are one example of a policy tool. Other tools include subsidies for new connections rather than for consumption, professionalization of rural operators (a shift from purely volunteer "community management" to models with maintenance and service), micro-networks, and hybrid solutions (combining central networks with local treatment systems). According to Korcelli (2008), integrating commercial tanker providers within a regulatory framework enhances quality and reduces the "last mile" cost in the Global South's megacities, such as Lagos and Dhaka. Namibia and other resource-constrained nations demonstrate that, with strict regulations and unambiguous public outreach, potable-standard reuse may be both economical and safe.

Task 6.2 According to Task 6.2, open defecation must be eradicated and universal access to appropriate and equitable sanitation and hygiene must be guaranteed by 2030, with special consideration paid to the needs of women, girls, and those in vulnerable situations. The complete sanitation chain is covered by this activity, which extends beyond the construction of toilets. It includes safe fecal containment (on-site/sewer), emptying, transport, and treatment, as well as safe end use or disposal. Treating sewered and non-sewered systems equally, regulating desludging services, zoning technology and tariffs, and contracting services in "white spots" are all important aspects of the Citywide Inclusive Sanitation (CWIS) approach in urban areas (Citywide Inclusive Sanitation, 2025). In order to eradicate open defecation, infrastructure must be adjusted to reflect shifts in hand hygiene, school-based education, and social norms (such as CLTS). India's Swachh Bharat projects have demonstrated that in order to produce long-lasting health advantages, rapid toilet expansion must be accompanied by maintenance and "beyond the toilet" services (fecal sludge management). Access to restrooms is only one aspect of gender sensitivity; other aspects include managing menstrual hygiene, ensuring safety and privacy in educational institutions and medical facilities, and implementing inclusive design (for older individuals and people with disabilities). Modularity, mobility, and energy independence of solutions are crucial in vulnerable environments (South Sudan, Yemen) where minimum WASH standards are necessary to reduce diarrhea and cholera. **Task 6.3** According to Task 6.3, we should reduce pollution, close illegal dumpsites, limit the use of dangerous chemicals and other hazardous materials, cut the amount of untreated wastewater in half, and greatly increase recycling and the safe reuse of materials globally to improve water quality by 2030. Implementing 6.3 entails a deliberate change from a "discharge" mentality to comprehensive pollutant load management, where pollution sources are located, reduced, and handled with consideration for resource recovery and environmental quality. First and foremost, regulation and enforcement are essential. This includes risk-based monitoring that addresses micropollutants, pharmaceuticals, and vectors of antimicrobial resistance, as well as precise emission permits and sectoral standards supported by pre-treatment programs for high-risk industries (such as tanneries, mining, and chemical manufacturing).

Second, context-appropriate infrastructure is required. Decentralized wastewater treatment systems (DEWATS) are effective when combined with biogas and nutrient (nitrogen and phosphorus) recovery in areas where traditional sewer networks are ineffective or too expensive. In agriculture, landscape filters and buffer zones are required to reduce nutrient runoff into waterways. Third, a circular economy strategy serves as the basis for the safe, appropriate reuse of treated wastewater in industry and agriculture. This method is based on

pay-for-performance treatment models and well-defined quality requirements for various applications.

International practice offers tangible proof of effectiveness. Spain and Italy have created comprehensive reuse rules for arid regions, Israel has adopted agricultural wastewater reuse nationwide, and Indonesia is testing DEWATS along small, highly contaminated waterways. However, improving municipal solid-waste management—which includes closing all routes by which waste enters water bodies and getting rid of illegal dumpsites—is a crucial prerequisite for success because without it, even the best treatment systems won't produce long-lasting improvements in water quality.

According to Task 6.4, to solve water scarcity and drastically lower the number of people affected by it, we must assure sustainable withdrawals and supplies of drinking water by 2030 and greatly boost water-use efficiency across all sectors. Achieving Goal 6.4 necessitates combining municipal, industrial, agricultural, and energy policies within a river-basin management framework in order to stabilize hydrological balances (abstractions not exceeding resource renewal) and increase water productivity (more value added per cubic meter used). In order to protect fundamental requirements and environmental flows, the first step is to shift from “sectoral” thinking to a portfolio strategy, which combines supply-side interventions (new sources, retention, controlled aquifer recharge, MAR) with consistent demand management (efficiency, price, standards). The key to increasing actual, not just technical, efficiency in agriculture—which uses the majority of “blue water”—is to modernize irrigation (drip, precision irrigation, optimizing timing and doses based on evapotranspiration), introduce price signals that reflect resource scarcity, and change cropping patterns in deficit basins (moving away from highly “water-hungry” species). To prevent poverty from getting worse, these signals must be used in conjunction with safeguards for smallholders, such as social quotas, blended tariffs, or vouchers.

A further condition for balancing the water budget is controlling and licensing wells and expanding managed aquifer recharge (MAR): infiltration basins, retention ponds, and aquifer storage and recovery (ASR) systems that store surpluses in the wet season to reduce pressure on water bodies in the dry season.

Systematic consumption audits, the use of closed-loop systems and condensate recovery, a move to low-water cooling (dry or hybrid), and less "water-hungry" technologies and diversification of the mix toward sources with a minimal water footprint are some examples of organizational and technological solutions that improve water productivity in industry and energy without sacrificing output. Reducing non-revenue water is a top priority for the water

utility industry, and this includes smart metering, pressure control, active leak detection (such as acoustic techniques), and network division into DMAs. Without constructing additional intakes, these actions simultaneously increase service reliability, reduce operating expenses, and open up a "virtual source" of water. In order to maintain a minimal consumption bundle for households (the lifeline), economic regulatory tools such as progressive tariffs, consumption standards, and pay-for-performance savings contracts should be created to send a strong efficiency signal. Experiences from several areas demonstrate that the quality of institutions and strict environmental restrictions determine how effective a tool is. Both the potential and the limitations of water rights markets are demonstrated by the Murray-Darling Basin in Australia. Trading mechanisms are effective and increase allocative efficiency, but only when they are combined with strict environmental caps, thorough abstraction metering, oversight to prevent abuses, and consideration of externalities for farming communities and ecosystems. As demonstrated by Israel and Jordan, desalination can permanently enhance the water balance when paired with reliable demand control, wastewater recycling, and source diversification. However, this requires strong regulatory frameworks, energy intensity solutions, and responsible brine management. In turn, Cape Town demonstrates how intelligent demand management—progressive tariffs, close resident communication, quick leak repairs, and pressure reduction—can postpone “Day Zero.” However, institutionalizing conservation practices and making investments in resilience (retention, MAR, alternative sources) are necessary for this effect to last over the long run. The integration of policy and water accounting at the river-basin scale is what unites these pathways: public permit registries, consistent data on abstractions and recharge, frequent quality monitoring, and a defined allocation hierarchy that prioritizes people and ecosystems. Only then, from small-scale farm irrigation to large-scale investments, do individual actions culminate in a macro effect of stable balances and increased water yield. To put it another way, when efficiency, fairness, and ecology are planned as complementary components of a single strategy, Goal 6.4 is successful.

The implementation of integrated water resources management (IWRM) at all levels, especially through transboundary collaboration, is assumed in Task 6.5 by 2030. Goal 6.5 is the “backbone” of SDG 6 since it combines environmental and development goals, grounds them in real stakeholder participation and water diplomacy, and arranges water administration according to the logic of the river basin. In actuality, this entails shifting from sectoral, disjointed decisions to hydrological-scale planning, in which water is distributed among users only when acceptable environmental loads and flows have been established. .

At the national level, the most important things are accurate hydrological data, public permit registries, clear allocation rules that prioritize water for people and ecosystems, and the consolidation of competencies (to prevent "many owners" of the same river). Institutions can only be held responsible for results rather than only inputs in such a system, which also allows for the development of a logical decision hierarchy from drought and flood plans to tariffs and incentives to local expenditures in retention and network upgrades. Treaties based on benefit-sharing (energy from storage, irrigation, navigation, and flood protection), cooperative early-warning systems, and long-term basin organizations like the Mekong River Commission are all part of 6.5, which is about institutionalizing dependency at the transboundary level. In practice, there are two extremes: effective coordination on the Rhine (ICPR) and Danube (ICPDR), where shared monitoring, quality standards, and emergency protocols reduce transaction costs; and challenging disputes in the Tigris-Euphrates, Indus, or Blue Nile basins, where a lack of trust and insufficient data impede investment and climate adaptation. Hard analytical skills (water accounting, scenario modeling, environmental flow assessment), stable funding (including mechanisms that combine water, agricultural, and energy funds), and the integration of water plans with spatial planning, agriculture, and energy are thus necessary for the implementation of IWRM. The “soft” components—involving women, Indigenous peoples, and local communities in decision-making; openness and dispute-resolution procedures; interoperable data systems; and reporting standards—are equally crucial. The only way to guarantee that the other elements of SDG 6 (service access, water quality, efficiency, and ecosystem protection) do not conflict but rather support one another is to combine basin-scale planning, rule-based allocation, shared information infrastructure, and cooperation institutions. By 2020, we must preserve and restore water-related ecosystems, such as wetlands, rivers, lakes, groundwater, mountains, and forests, according to Task 6.6, the final one in this category. Since wetlands, rivers, lakes, groundwater, forests, and mountain regions form the biogeophysical "foundation" of water services—stabilizing flow regimes, filtering pollutants, and storing water—protecting and restoring aquatic ecosystems remains a prerequisite for the success of the other SDG 6 components, even though the deadline for 6.6 passed in 2020. To link the water agenda with the climate agenda, an analytical approach must first identify the key hydromorphological and biogeochemical mechanisms and then translate them into concrete interventions. These interventions include re-establishing river connectivity by removing or upgrading barriers, creating fish passages, and re-establishing floodplain corridors that lower flood peaks while increasing retention and the ability of watercourses to purify themselves; re-naturalizing river valleys and wetlands to improve landscape retention and ecosystems' capacity

to absorb nutrients; protecting buffer zones and riparian vegetation to reduce agricultural runoff; and protecting and restoring peatlands, which are excellent stores of both water and carbon. Environmental flows are a crucial component; basin plans that determine and enforce them allow for the reconciliation of ecosystem needs and human water security. At the same time, invasive species control (by prevention, early detection, and prompt action) keeps food webs stable and water quality from deteriorating. Practice demonstrates that it is possible to combine conservation objectives with climate adaptation: in Central Europe, restoring landscape retention—small retention features, afforestation, and flood meadows—buffers both drought and flood episodes, lowering the costs of hydrological extremes for water management and agriculture. The Dutch "Room for the River" program has become a model for combining flood protection with ecosystem improvement by setting levees back, restoring floodplains, and giving rivers more space. Economic mechanisms like payments for ecosystem services (PES), which incentivize upstream landowners to take retention actions, remote monitoring and Earth observation to report indicator 6.6.1 and track changes in the extent of water-related ecosystems, and a deep integration of agricultural policies with water protection—through conditionality of payments, subsidies for retention solutions, buffer-strip standards along watercourses, and incentives to reduce nutrient pressures—are all necessary for the effective implementation of this agenda. To put it another way, Goal 6.6 is the “binding agent,” not a "add-on." Without re-naturalized wetlands, landscape buffers, restored river connectivity, and enforced environmental flows, it will be challenging to maintain water quality (6.3), balance withdrawals and recharge (6.4), and guarantee dependable water and sanitation services (6.1–6.2). Conversely, well-designed monitoring, financing, and cross-sector integration instruments can turn ecosystem protection into a real, measurable improvement in water security.

Tasks 6.A and 6.B serve as complementary pillars for achieving Goal 6; the former organizes the movement of resources, technologies, and competencies on a global scale, while the latter grounds them in the local fabric where daily decisions regarding infrastructure maintenance and operation are made. 6.A mainly focuses on the architecture of support, which includes knowledge and technology transfer, blended and concessional financing, the development of regulatory institutions and human capacity in developing nations, and the capacity to organize, carry out, and sustain projects related to water storage, desalination, effective water management, wastewater treatment, and reuse. There are a number of boundary criteria that affect how effective such assistance is. First, a fit-for-context strategy and technological neutrality are required. To prevent "technology dumping," which is the deployment of sophisticated solutions in environments without financial or service support,

technologies must align with local hydrological, energy, and institutional realities. Second, capacity building needs to encompass the entire state capability cycle, including investment programming, multi-criteria analysis, public procurement, supervision and quality control, operations and maintenance, laboratories and water-quality monitoring, tariff mechanisms, and consumer social protection. It cannot be limited to one-time trainings. Third, grants, concessional loans, and private funding should all be used in mixed models with transparent and well-defined risk-sharing. Durability in capital-intensive fields, like desalination, depends on integrated energy policy (cost and carbon footprint), brine management, and user-side demand reduction; in wastewater management, it depends on quality frameworks for industrial pre-treatment, fit-for-purpose reuse, and resource-recovery pathways (biogas, nitrogen, phosphorus). Supporting nature-based solutions in addition to "grey" infrastructure is essential for storage and retention, as is the advancement of digital technologies such as hydrological modeling, remote sensing, integrated SCADA systems, and open data standards. Last but not least, donor fragmentation and “projectization” compromise 6.A's efficacy; harmonization frameworks and the use of national planning and budgeting mechanisms boost assistance absorption and the longevity of outcomes. Task 6.B puts more emphasis on the agency of local institutions and end users, without which even the most well-funded programs remain vulnerable. Enhancing community involvement entails co-ownership of choices and duties throughout the whole water and sanitation service chain, not simply discussions. Water user associations, maintenance committees, and operators of non-sewered sanitation systems play an important role in rural and peripheral areas; there, durability depends on professionalized management, financial transparency, service procedures, and equitable compensation—rather than placing all the burden on volunteers.

Bringing in “last-mile” providers, controlling fecal sludge collection and treatment services, establishing technology zones, and establishing tariffs that are both socially acceptable and communicate efficiency signals are all necessary components of an inclusive approach to sanitation (CWIS) in urban areas. Because they typically bear the time and safety costs of fetching water and using infrastructure, women's and girls' participation is not an add-on but rather a functional requirement. Their presence in decision-making bodies results in designs that take menstrual hygiene, safety, and privacy into consideration. Additionally, participation increases bill collection, speeds up response times to failures, boosts the “social license” for investments, and makes it easier to enforce use rules (such as abstraction limitations during drought). Social accountability tools, such as citizen-participatory water budgets, grievance and mediation systems, and social audits, as well as citizen tools for water quality and outage

monitoring are complementary measures. However, they must be connected to data-quality standards and privacy protection to support official oversight rather than producing an unreliable, parallel information stream. 6.A and 6. B 's shared denominator is the principle of co-producing services: investments are transformed into long-lasting service quality only when they are rooted in local structures, which include clear water rights, intelligible allocation rules, transparent tariffs, and true co-governance. International cooperation and capacity building create the financial, technological, and institutional "skeleton." Stated differently, 6.A without 6.B runs the risk of technology transfer without acceptance and maintenance, whereas 6.B without 6.A may become trapped in a cycle of chronic underfunding and poor capacity. For water and sanitation to become a stable, robust system of public services rather than a project event, both activities must be integrated and implemented at the river-basin scale in accordance with spatial, agricultural, and energy plans.

Summary

This section demonstrates how tasks 6.1–6.6 and 6 together form a cohesive structure within SDG 6.A and 6.B are dependent on each other. First, the idea of “access to infrastructure” must give way to the provision of safe and dependable services, such as universal, reasonably priced drinking water (6.1) and respectable, inclusive sanitation and hygiene (6.2), which are created with women, girls, and vulnerable populations in mind. Alongside this, there has been a paradigm shift in water quality (6.3), moving away from straightforward wastewater discharge and toward pollutant-stream management, which includes decentralized solutions, a circular economy, safe reuse, and standard regulation and enforcement. Simultaneously, Goal 6.4 encourages the stabilization of balances and the increase of water productivity: in agriculture through groundwater management (including MAR), modernized irrigation, and cropping pattern changes; in industry and energy through closed-loop systems and less "water-hungry" technologies; and in municipal networks through smart demand management and loss reduction. The foundation is integrated basin-scale management (6.5), which includes transboundary collaboration based on benefit-sharing and cooperative early-warning systems, explicit allocation rules that prioritize people and ecosystems, environmental flows, and transparent data. Water-dependent ecosystems, such as buffer zones, peatlands, river and wetland re-naturalization, restoring river connections, and enforcing environmental flows, are the ecological foundation (6.6). Implementation factors bind the operational goals together: international cooperation and capacity building (6.A) are meant to provide context-appropriate

financing, technologies, and competencies, while genuine community-level co-governance (6.B) ensures operational sustainability, acceptance, and equity. A cross-cutting element is modern monitoring, tariff regulation with social protection, institutional transparency, and the integration of water plans with spatial, agricultural, and energy policies.

The SDG 6 agenda must include an adaptation program since climate change exacerbates all risks: longer and more frequent droughts and cloudbursts disrupt water balances, deteriorate quality, and harm infrastructure; supply sources are threatened by glacier melt and seawater intrusion. Demand management, source diversification (including reuse and, when necessary, desalination in conjunction with energy policy), the development of green-blue infrastructure, the pursuit of ecological restoration and distributed retention, the implementation of drought and flood plans, and early-warning systems are all part of the response. In this context, SDG 6 is framed as a strategy for creating a resilient, equitable, and low-emission water and sanitation system that concurrently safeguards ecosystems, the economy, and human health rather than a collection of related projects.

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