4C	
SUSTAINABILITY AND RESILIENCE	**Principle 15. Circular economy**

Target group / Relevant stakeholder: National Policy-Makers, Municipal Governments, Regulators, Urban Water Utilities, Medium Water Utilities, Rural Service Providers, Watershed or River Basin Organisations, User Groups, Networks or Platforms, and/or Private Sector

DESCRIPTION

Reduce water use, remove pollutants from water, reuse treated wastewater, recover nutrients and energy from wastewater, and rethink of wastewater use in a sustainable and circular way (Smol et al., 2020 in Salvetti and Focacci, 2024, 21).

EXPECTED RESULTS

Outputs:

- Existence of regulations and initiatives linking sustainable water use to circular economy practices (e.g., green infrastructure, NbS).
- Policies promoting innovation in water sector technologies and practices.
- Green bond mechanisms to finance circular economy projects.
- Inclusive design and implementation of circular economy principles in water policies.

CONDITIONS FOR SUCCESS

- Sector policy and strategy: Legal and policy frameworks promote circular economy adoption, encouraging water efficiency measures and resource recovery (World Bank, 2021). Policies also support socially and ecologically responsible practices, such as rainwater and greywater harvesting (Qtaishat et al., 2022).
- Institutional arrangements: Clear environmental regulations on water rights, discharge standards, and pollution charges encourage investments in pollution control and ecosystem restoration (World Bank, 2021). Governments and water authorities design effective governance models, such as centralised, decentralised, public, private, or hybrid, tailored to local contexts (Morseletto et al., 2022).
- Regulations address resources recovered from wastewater (Delgado et al., 2024; World Bank, 2021).
- Cross-sector and multi-scale linkages: Changes are needed at various levels, from river basins to urban and household settings, while also aligning with key industries like agriculture, energy, and manufacturing. Effective coordination is vital, particularly with high-demand water users and sectors that can benefit from reclaimed resources (World Bank, 2021).
- Implementation of appropriate economic and policy instruments supports adequate tariffs and pricing, ensuring circular solutions are competitive with traditional approaches. When possible, water pricing should reflect its local opportunity cost (World Bank, 2021).
- The policy environment supports markets for recovered resource use (World Bank, 2021).
- Planning, monitoring and review: A long-term national strategy guides the transition toward circular economy (Delgado et al., 2024; World Bank, 2021). Indicators and monitoring capacity are key for tracking progress in water circularity (Morseletto et al., 2022).
- Planning and investments for both climate-related and other uncertainties (World Bank, 2021).
- Capacity development: Strengthened institutional and regulatory capacity enforces frameworks and advances circular economy practices in the water sector (World Bank, 2021).

BARRIERS

- Water sector inclusion in high-level circular economy strategy discussions has been limited (World Bank, 2021).

- Economic, technical, and social factors, such as illegal water abstraction for irrigation or complex national standards, hinder the widespread adoption of water reuse. The absence of proper incentives further restricts this (Qtaishat et al., 2022; World Bank, 2021).
- Water sector fragmentation (Morseletto et al., 2022; Eneng et al., 2018): Circular water regulations are often dispersed across national and local authorities, resulting in inconsistencies between government departments, municipalities, and regions (Qtaishat et al., 2022).
- Literature focus on decentralised and circular solutions concerned with technologies, processes, selection criteria, and economic feasibility, while less attention is given to the practical application of existing policies and regulations (Qtaishat et al., 2022).
- Developing countries often struggle to access the resources, knowledge, and technologies required for transitioning to a circular economy (UNIDO, n.d. in World Bank, 2021).
- Circular trends might undermine resilience. For instance, a highly resource-efficient system that prioritises eliminating supply redundancies could become more vulnerable (World Bank, 2021).
- In Europe, most circular economy initiatives remain at the pilot stage and rarely transition to broader, mainstream use (Qtaishat et al., 2022).
- Despite progress, regulatory and policy limitations may persist (World Bank, 2021), as many EU regulatory frameworks and building codes do not actively encourage developers to adopt circular water and energy solutions (Qtaishat et al., 2022).
- Lack of technical competencies and knowledge about the circular economy, including its effective integration into business and financial models.
- Lack of financial tools and direct government subsidies creates a cost-benefit gap for investors. Furthermore, long payback periods, up to 20 years, hinder investment in circular water systems (Qtaishat et al., 2022).
- Circular solutions can reduce the income of water companies that rely on charging for water consumption rather than water discharge (Qtaishat et al., 2022).

SOLUTIONS

- Adoption of the fit-for-purpose water principle.
- Policy, guidelines, processes, and protocols for circular water reuse should be context-specific and aligned with application quality, and system scale.
- Mitigation of cost and financial risks by allocating investments and incentives along with three deployment scales: capture and treatment, distribution, and use.
- Enhancement of knowledge and awareness: Foster broader understanding and acceptance of the circular economy among all sectors and water users (Morseletto et al., 2022).
- Integration of resilience into circular approaches can prepare for unpredictable shocks and stresses (World Bank, 2021).
- Promotion of renewable energy and NbS while safeguarding natural resources: Support ecosystem restoration, watershed rehabilitation, and sustainable aquifer management through NbS (World Bank, 2021).
- Achievement of an inclusive circular economy (Morseletto et al., 2022) to maximise its benefits for all: If inclusiveness is not explicitly included and carefully integrated in circular economy plans and actions, poor countries and vulnerable groups risk being left behind.
- Preparation for uncertainty: Traditional “predict-then-act” strategies are inadequate for managing increasing climate risks and public health threats (World Bank, 2021).
- Demand management: Circular economy principles should include not only waste reduction and resource recovery, but also the responsible use of vital natural resources (Morseletto et al., 2022; World Bank, 2021).
- Digital solutions can enhance resilience and improve water supply and sanitation services (World Bank, 2021).

- Legislation should align with international agreements to facilitate transboundary circular economy strategies and solutions (Morseletto et al., 2022).

EXAMPLES

Blue-Green Infrastructure for Urban Climate Adaptation in Radom, Poland

SDGs linked

Water risks

Radom became one of the first cities in Poland to address climate-related urban challenges through the LIFERADOMKLIMA-PL project (2015-22). The project implemented 18 blue-green infrastructure solutions to mitigate periodic floods, urban heat islands, and water runoff issues while improving biodiversity and residents' well-being. Five large-scale ecohydrological solutions targeted river systems, while 13 microscale interventions enhanced urban water retention. These efforts reduced Radom's flood-prone areas by 20%, improved water quality, and created multifunctional green spaces. The initiative also shifted local governance perspectives on NbS, fostering collaboration between policy-makers, scientists, businesses, and the public. Radom's success has led to its recognition in UNESCO's Global Network of Ecohydrological Demonstration Projects.

Linkages to Governance Principles

The project embedded the circular economy principle by implementing NbS that minimised resource consumption while maximising urban ecosystem benefits. It enhanced environmental resilience through flood mitigation, improved water quality, and biodiversity conservation. Stakeholder engagement was also key by involving local authorities, private sector actors, NGOs, and citizens in the design and implementation of solutions. Data-driven decision-making played a key role, with scientific input from the University of Lodz ensuring that strategies were tailored to local needs.

Nature-Based Wastewater Treatment in Los Monasterios, Spain: A Model for Sustainable Water Management

SDGs linked

Water risks

Spain faces increasing water security challenges due to climate change, rising demand, and inefficient management. In Los Monasterios, a local initiative, led by a civil society association, replaced a failing wastewater treatment system with a decentralised constructed wetland system, significantly enhancing pollutant removal and enabling water reuse for irrigation. The project was implemented with technical support from the Polytechnic University of Valencia and funding from the LIFE RenaturWAT programme. Close collaboration with municipal authorities and the Júcar Hydrographic Confederation ensured regulatory compliance and long-term sustainability. The initiative successfully closed the water loop, reducing reliance on external sources while restoring aquatic ecosystems, improving biodiversity, and strengthening drought resilience. By reducing energy consumption and operational costs, the project demonstrated the economic feasibility of NbS, making it a scalable solution for decentralised wastewater management.

Linkages to Governance Principles

The Los Monasterios project highlights the role of governance frameworks in enabling NbS adoption. By integrating wastewater treatment into the urban landscape, the system promoted sustainable resource use, aligning with circular economy principles while enhancing environmental resilience through improved water retention and ecosystem restoration. The initiative strengthened roles and responsibilities, ensuring effective coordination between civil society, municipal

authorities, research institutions, and regulatory bodies. Stakeholder engagement and transparency played a key role, as scientific expertise and outreach efforts fostered trust in NbS solutions. The project also demonstrated policy coherence, aligning with Spain's updated wastewater regulations and contributing to national water reuse objectives.

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