DOI: https://doi.org/10.46793/6461-101.216VB
Original Scientific Article

WATER AS A KEY PILLAR OF SUSTAINABLE AGRICULTURE AND THE GREEN ECONOMY

Marijana Vidas-Bubanja
Faculty of Finance, Banking and Auditing, Alfa BK University, Belgrade, Republic of Serbia

e-mail: marijana.vidas@alfa.edu.rs
https://orcid.org/0000-0003-4257-1066

Iva Bubanja Rudaković
Belgrade Academy for business and art applied studies, Republic of Serbia

e-mail: iva.bubanja@bpa.edu.rs
https://orcid.org/0000-0003-3440-7418

Abstract: Water is the essence of life, and the modern global economy depends fundamentally on the continuity of reliable water supply**.** Ensuring sustainable water availability is not only an environmental necessity but also a cornerstone of economic stability, business continuity, and prosperity. The increasing demand for water, driven by population growth, shifting consumption patterns, and the ongoing energy transition, is placing unprecedented pressure on already strained freshwater resources. At the same time, global environmental challenges are intensifying the frequency and severity of extreme water-related events**, i**ncluding droughts, floods, and pollution. The economic value of water is immense, estimated at approximately $58 trillion globally**,** or roughly 60% of global GDP**,** reflecting its central importance across all sectors of human activity. Achieving a secure and resilient water future requires the modernization of water systems, including the adoption of digital technologies to optimize water use, monitor quality, and improve efficiency. Furthermore, coordinated global action is essential to foster innovation in circular water systems, energy-neutral solutions, and sustainable agricultural production, which together form the foundation for a circular green economy. By integrating technological, ecological, and policy solutions, the world can ensure water security, enhance economic resilience, and protect freshwater ecosystems for generations to come.

Keywords: *water resources, sustainable development, sustainable agricultural production, green economy, digitization.*

INTRODUCTION

In an era defined by climate change, rapid population growth, and accelerated urbanization, fresh water has become one of the most critical and contested resources of the 21st century. As the foundation of all life on Earth, water sustains human societies, economies, and global biodiversity. Beyond its physical necessity, water also represents a source of economic and geopolitical power, with implications comparable to those of energy resources. However, widespread lack of awareness and inadequate management of water resources have intensified the global water crisis. Although access to safe drinking water is recognized by the United Nations as a fundamental human right, researchers project that by 2050, between 5 and 6 billion people – over half the world's population - will live in water-stressed regions (WWAP, 2018). Furthermore, the World Bank estimates that by 2030, up to 40% of global water demand may remain unmet (WB, 2022).This article examines the economic and strategic significance of water and explores the role of digital technologies in fostering a resilient global freshwater system.

1. Water Market

Water is one of the most valuable yet consistently undervalued resources on the planet. The total quantifiable economic use value of water is estimated at approximately $58 trillion annually**,** representing around 60% of global GDP (WWF, 2023)**.** Increasing demand coupled with declining availability has made the contemporary water market highly competitive.

Demand Side

Global shifts in consumption patterns, technological innovation, and the water demands associated with decarbonisation pathways are intensifying pressure on freshwater resources. Over the past three decades, total per capita water withdrawal has increased by more than 650% worldwide (FAO, 2025). All sectors are projected to experience increased water demand, though regional variations depend on differing economic and environmental drivers.

Currently, global freshwater withdrawals total approximately 4.3 trillion cubic metres (m^3) per year (WWF, 2023), with agriculture accounting for 70%, industry 20%, and municipal use 10% (Hundertmark, T. et al., 2020). Regional patterns reflect distinct economic structures: agricultural water use dominates in Africa and Asia (80%), whereas industrial use is higher in Europe (60%) (FAO, 2025a).

Moreover, global digitalisation is emerging as a new driver of water demand. The expanding need for data processing, storage, and connectivity has led to a rapid increase in the number and size of data centres, which require substantial water for cooling. A one-megawatt data centre can consume up to 25.5 million litres of water annually for cooling (Mytton, D., 2021), equivalent to the daily water use of approximately 300,000 people (WEF, 2024).

Supply Side

Freshwater ecosystems are increasingly affected by multiple pressures that reduce both the availability and quality of water resources. Key contributing factors include unsustainable surface and groundwater withdrawals, human alterations to river flows, water pollution from agricultural runoff, industrial effluents, and sewage, as well as the impacts of climate change on rainfall patterns and glacier melt.

Per capita water availability has steadily declined in most countries (FAO, 2025). For example, China experienced a 50% decrease in per capita water resources between 1964 and 2020 (Fujs, T. & Kashiwase, H., 2023). As a result, half of the global population faces water scarcity at least once per month, and 55 million people are affected by droughts each year (UNCCD, 2022). Looking ahead, the main environmental risks to global water security include extreme weather events, biodiversity loss, climate change, natural resource depletion, and pollution.

Developing appropriate water valuation and pricing mechanisms is essential to foster resilient and sustainable water systems. As shown in Table 1, cost, value, and price are the three fundamental components of water valuation, forming the basis for well-functioning water markets that can deliver the economic and social benefits required for long-term water security.

Table 1. Fundamental components of water valuation

COST	The total costs associated with providing and using water, accounting for all inputs and externalities
VALUE	Total benefit derived from water, reflecting how water is important to and used by all humans and the environment
PRICE	Amount paid for a given quantity, accounting for full cost recovery, efficiency, equity & justice and water conservation

Source: WEF, 2025.

2. Economc Value of Water

Economic stability and prosperity fundamentally depend on freshwater resources and the ecosystems that store and supply them, given their central role in agriculture, trade, transport, industry, and energy production. Ensuring water resilience – the capacity of water systems to withstand and adapt to future disruptions and shocks – is therefore essential for business continuity and sustainable economic growth.

Without adequate protection of water supplies, the GDP of high-income countries could decline by up to 8% by 2050, while lower-income countries could experience losses of 10–15% (GCEW, 2024). Furthermore, weather-, climate-, and water-related disasters have caused significant economic damage, amounting to $4.3 trillion globally between 1970 and 2021. Over that period, total losses increased by nearly 700%, with approximately 30% (around $1.5 trillion) occurring between 2010 and 2019 (WMO, 2023).

2.1. Industry and transport

Every industry relies on water. For centuries, water has been a critical factor not only in industrial production but also in the transportation of goods via inland waterways. Globally, industries – from manufacturing to mining – use approximately 600 billion cubic metres of water annually to support a wide range of industrial processes. In manufacturing, water is essential for cooling, cleaning, and as a production component across multiple sectors. It plays a vital role throughout the entire industrial value chain, from the extraction of raw materials and supply networks to direct operations and product use. Sectors with particularly high-water demand include mining and upstream oil and gas (WEF, 2025).

Nearly every modern business depends on a reliable water supply – from heavy industries and manufacturing to the operation of vast data centres that store, process, and distribute global digital information. Beyond quantity, water quality is equally crucial, particularly in beverage and food processing, automotive manufacturing, and textile production. Globally, approximately $77 billion in value is at risk from water-related supply chain disruptions, with the manufacturing, materials, and food and beverage industries being especially vulnerable (Asia Garment Hub, 2024). Industrial water use generates an estimated US$5.1 trillion in annual value, underpinning livelihoods, food and energy security, economic growth, and international trade (WEF, 2025). Despite this value, industries are major drivers of over-extraction and pollution, causing severe degradation of freshwater ecosystems. Subsidised pricing and limited awareness of water risks have led to poor water stewardship, further exacerbating the global water crisis and increasing both social and ecological risks.

Water is equally indispensable for transportation**.** Rivers, canals, and other inland waterways serve as crucial connectors between port cities**,** coastal regions, and inland industrial hubs**,** enabling the efficient movement of goods. Yet only one-third of major rivers remain free-flowing, and one-third of wetlands have disappeared since 1970 (Convention on Wetlands, 2021). In Europe, wetland loss exceeds 90% in some countries since 1700 (Etienne Fluet-Chouinard et al., 2023). Still, inland navigation remains vital: in 2021**,** 524 million tons of goods were transported along 37,000 km of waterways connecting European cities and industrial regions (Eurostat, 2022). The 2022 drought, which brought record-low levels to rivers such as the Rhine and Po**,** illustrated the growing risks that climate change poses to water-based transport (WWF, 2023a).

2.2. The Water–Energy Nexus: Interdependencies and Implications for Sustainability

Water and energy are two fundamental resources at the heart of modern civilisation, essential for human well-being, economic prosperity, and environmental sustainability. Recognising their significance, the United Nations includes universal access to sustainable water and energy among its Sustainable Development Goals (SDGs).

Water and energy are closely interdependent. Water supply, wastewater treatment, and distribution systems require substantial energy inputs, while energy production relies heavily on water availability. Globally, the energy sector accounts for nearly 10% of total freshwater withdrawals, as about 90% of global electricity production is water-intensive (Oliveira Bredariol, 2023). By 2050, global energy demand is projected to increase by approximately 60%, further intensifying the water–energy nexus (World Water Council).

Freshwater ecosystems play a key role in energy security. They power the turbines of hydropower plants, which contribute nearly 15% of global electricity generation (United Nations University, 2014), and provide cooling water for coal, gas, and nuclear-fired power plants. Water is also critical for bioenergy crops, the production of solar cells, the operation of solar thermal plants. Additionally, water is required for the extraction and processing of fossil fuels (see Table 2).

The interdependencies between water and energy also extend to climate impacts. Energy production and consumption contribute to carbon emissions, which drive climate change, affecting the frequency and severity of droughts and floods, and ultimately water availability. Conversely, water-related risks increasingly threaten energy security. For example, droughts have significantly reduced hydropower generation worldwide, while extreme floods pose serious risks to the safety of ageing and vulnerable hydropower dams (WWF, 2023a).

Table 2. Water for Energy

Hydropower plants	They extract energy from the water flowing through them, without altering it.
Thermal power plants	They need water to cool the steam that drives the turbines generating the electricity.
Nuclear plants	They withdraw the most water, from rivers or the sea. Water is kept in a secondary circuit isolated from the reactor and is returned to nature after being cooled to a temperature that will not affect the ecosystem.
Concentrated solar power plants	Water is needed for some types of solar power, such as solar thermal plants, and for the production of solar cells.
Biofuels	Water is used in the cultivation of crops grown for biofuels like biodiesel or biogas. Producing biofuels requires large quantities of water for irrigation purposes, outdoing coal, oil, and gas.

Source: Planete Energies, 2025, https://www.planete-energies.com/en/media/article/energy-and-water-are-closely-intertwined

Energy, in turn, is required throughout the water sector - to extract, convey, and deliver water of appropriate quality and to treat wastewater. Table 3 highlights the three primary uses of energy in the water sector: extraction, distribution, and treatment. Global energy consumption for water management is projected to double by 2040**,** illustrating the growing interdependence of these two critical systems (Federal Ministry for Economic Cooperation and Development, 2025).

Table 3. Energy for Water

Extraction and pumping	Energy is required to lift water from sources like rivers, lakes, and underground aquifers.
Distribution	Energy is used to pump water through pipes and canals to deliver it to homes and industries
Treatment	Energy is necessary to purify and treat water to make it safe for consumption and use, and to treat wastewater for return to the environment

Source: Federal Ministry for Economic Cooperation and Development, 2025 https://www.bmz.de/en/issues/water/nexus-perspective/water-and-energy-225830

The symbiotic relationship between water and energy is increasingly critical. The world now faces a global water crisis while advancing the energy transition. Rising demand for both resources places severe pressure on ecosystems, causing habitat loss and pollution from extraction and use. Climate change is expected to worsen water scarcity, which in turn threatens energy production that relies on water.

Enhancing energy efficiency can generate substantial water savings, while improving water efficiency can conserve energy. Only technologies and strategies that address both water and energy together can achieve truly sustainable outcomes. The water and energy sectors must operate in concert, as impacts on one system directly affect the other. Globally, it is essential to understand the complex dynamics of energy–water systems, identify vulnerabilities, and explore opportunities to strengthen resilience. The focus must be on innovative solutions that optimise water resources while maximising energy efficiency.

3. Water and Sustainable Agriculture

Water is indispensable to agriculture, accounting for approximately 70% of global freshwater use. Both global food production and food security depend on rainfall and irrigated water drawn from surface and groundwater sources. Rivers also play a critical role, supporting over one-third of the world's food production directly (WWF, 2021). The agricultural sector faces a dual challenge. On one hand, growing food demand, increasing competition for water resources, and the risks of droughts and floods threaten production. On the other hand, the degradation of freshwater ecosystems – often linked to over-extraction for agriculture – further intensifies pressure on irrigated farming systems. Although only 16% of cultivated land is irrigated globally, irrigated cropland contributes 44% of food production worldwide. Alarmingly, over 60% of irrigated cropland is already highly water-stressed, with increasing numbers of rivers, lakes, wetlands, and aquifers suffering from over-extraction (WWF, 2022).

To address these challenges, effective water management strategies are essential. Irrigation requirements are rising due to increasingly erratic rainfall, exacerbating water insecurity and desertification risks. Research suggests there is potential to convert approximately 200 million hectares of rain-fed cropland to sustainable irrigation, offering a significant opportunity to enhance food security. Conversely, poor water management undermines sustainable agricultural gains, contributing to salinisation, land degradation, water pollution, and increased greenhouse gas emissions. Water insecurity already imposes substantial economic costs, estimated at up to US$94 billion annually for agricultural irrigators, with the probability of crop yield failures projected to increase by up to 4.5 times under current trends by 2030 (Monica Caparas et al., 2021). Key challenges in agricultural water management are presented in Table 4, beginning with climate change, over-extraction, and poor irrigation.

Table 4. Key challenges in agriculture water management

Climate Change	Altered precipitation patterns and increased frequency of droughts or floods significantly affect productivity levels and yield instability
Over-extraction	· Excessive freshwater withdrawal for agricultural production increases water insecurity for people and the environment.
Inefficient Irrigation	Medium and large irrigation systems are often poorly maintained or constructed, resulting in significant water losses. Furthermore, inefficient water application on the farm leads to higher evaporation, runoff, percolation, and potentially salinity.
Soil Degradation	Poor soil health reduces water infiltration and holding capacity, exacerbating plant water stress during unreliable rainfall.
Lack of equitable and reliable irrigation access	Where water resources exist, farmers often lack the economic means to access them (e.g., borehole drilling, irrigation technologies), or irrigation supply chains are underdeveloped

Source: CGIAR, 2025. https://www.cgiar.org/news-events/news/sustainable-farming-cultivating-a-water-wise-future/

3.1. Transforming Agriculture for Sustainable Water Management

Promoting agricultural transformation toward productive, resilient, and sustainable farming systems is essential for addressing water scarcity and ensuring long-term food security. Effective water conservation techniques include (CGIAR, 2025):

- Drip irrigation, which delivers water directly to plant roots, minimizing losses from evaporation and runoff.
- Rainwater harvesting, which collects and stores excess water for use during dry periods.
- Drought-tolerant crops adapted to local climatic conditions, reducing irrigation requirements.

Soil health is essential for efficient water use. Practices such as cover cropping, reduced tillage, and organic amendments improve soil structure, enhance water infiltration, and increase moisture retention. By maintaining healthy soils, farmers can reduce irrigation requirements and ensure crops have adequate access to water. Additional techniques include conservation tillage to minimise soil disturbance and evaporation, mulching to retain moisture and suppress weeds, and crop rotation, which alternates crops with different water requirements across seasons. Crop rotation not only optimises water use but also maintains soil fertility, reduces pest and disease pressures, and enhances resilience to climate variability and market fluctuations (WWF, 2023a).

Unsustainable agricultural practices, however, contribute to the degradation of rivers, lakes, wetlands, and aquifers. Poorly planned agricultural expansion, combined with low water pricing and extensive subsidies, often results in inefficient choices regarding crop selection and farming methods. The relatively low cost of water for agriculture in many countries encourages over-extraction and pollution, further threatening freshwater ecosystems.

Sustainable water management in agriculture requires responsible water allocation, limiting water withdrawals, and promoting efficient irrigation technologies. Implementing these measures enables agricultural systems to maintain high productivity while protecting the freshwater ecosystems on which they depend (WWF, 2023a).

4. The Role of Freshwater Ecosystems in Climate Resilience

Freshwater ecosystems – including rivers, lakes, wetlands, and aquifers – provide essential services that underpin human well-being, ranging from water purification and sediment delivery to biodiversity conservation and the protection of communities from droughts and catastrophic flooding. The key ecological benefits of healthy freshwater ecosystems are as follows (WWF, 2023a):

1. *Climate mitigation and disaster resilience:* Healthy freshwater wetlands play a critical role in climate mitigation by reducing the impact of extreme floods, enhancing resilience to droughts, protecting against storms and erosion, regulating local temperatures and microclimates, and sustaining deltas. Water-related disasters, including flooding and landslides significantly degrade water quality and account for 70% of all deaths caused by natural disasters**.**
2. *Biodiversity preservation:* Rivers, lakes, and wetlands are biodiversity hotspots**,** supporting almost 40% of all known species. Approximately one-third of vertebrate species**,** including over half of all known fish species, depend on freshwater habitats. Over the past fifty years, one-third of the world's remaining wetlands have been lost**,** while freshwater species populations have declined by an average of 83%. Freshwater ecosystems remain among the most threatened globally, with roughly one-third of freshwater species now at risk of extinction**.**
3. *Support for terrestrial and marine ecosystems*: The health of freshwater ecosystems is essential to the well-being of terrestrial and marine ecosystems. Rivers provide vital freshwater, nutrients, and sediments that sustain deltas, mangroves, coastal wetlands, and oceans. For example, nutrients such as nitrogen and phosphorus support phytoplankton at the base of the marine food web. Freshwater systems also support almost all terrestrial species, while connected rivers offer critical migration corridors for fish between freshwater and saltwater habitats.

A persistent challenge is "water blindness" – a lack of awareness of the diverse ecological, social, and economic values of freshwater ecosystems. This has long contributed to unsustainable management and degradation of these systems. Addressing this knowledge gap is essential for achieving sustainable resource use, conserving biodiversity, and promoting nature-positive and net-zero goals. Protecting freshwater ecosystems is therefore central to building a resilient, balanced future, where human development is in harmony with the planet's natural systems.

5. Digitalisation and Rebuilding the Healthy Freshwater System

The water sector is undergoing a transformative shift through digitalization, integrating advanced technologies such as Internet of Things (IoT) devices, artificial intelligence (AI), and digital twins into water management and policy practices. The market for digital water solutions is projected to grow by 35%, from approximately $37 billion in 2023 to $50 billion by 2028**,** with technologies specific to the water industry expected to account for more than half of this growth (WEF, 2025).

Digital technologies are essential for achieving sustainability and efficiency goals**,** addressing challenges in water availability, process efficiency, and water quality. Examples include (WEF, 2025):

- Fibre-optic leak detection to improve operational efficiency.
- AI-driven wastewater treatment, such as artificial neural networks, to predict water quality, optimizes processes, and enhance pollutant removal.
- IoT-based irrigation systems to monitor soil moisture, salinity, and turbidity, improving water and nutrient efficiency and increasing crop productivity, particularly in resource-limited regions.

The application of digital technologies in the water sector creates significant value in multiple areas (Union for Mediterranean, 2024):

1. Data Analytics and Increased Operational Efficiency: Real-time monitoring systems and predictive analytics enable water utilities to optimize operations proactively, improving productivity and reducing energy and chemical consumption.
2. Reduced Water Losses: Smart sensors and monitoring devices detect leaks and anomalies in real-time, minimizing water loss and supporting sustainable management of water supplies.
3. Enhanced Resource Management: Advanced monitoring systems and smart meters provide precise data on water consumption patterns. This enables demand-driven strategies, efficient resource allocation, and equitable distribution, thereby supporting long-term sustainability goals.
4. Improved Resilience to Climate Change: Predictive analytics and modelling equip water management systems to anticipate and respond to changes in water availability, ensuring reliability in the face of increasing extreme weather events and climate-related challenges.
5. Better Environmental Conservation: Digital technologies reduce environmental footprints, optimize resource use, and contribute to the protection of aquatic habitats, ecosystems, and biodiversity.

Despite these benefits, digitalization presents several challenges and limitations (Union for Mediterranean, 2024):

- Equity concerns: Unequal access to digital technologies can exacerbate disparities in water management.
- Data privacy and security: Sensitive water infrastructure and consumption data must be protected from cyberattacks.
- Technological integration and interoperability: Outdated infrastructure and fragmented governance frameworks can hinder the deployment of standardized digital solutions.
- Investment and capacity gaps: Effective implementation requires significant investment in infrastructure, training, and technical skills.

In conclusion, while digitalization offers unprecedented opportunities to enhance water efficiency, resilience, and sustainability, coordinated efforts are needed to address technological, social, and regulatory barriers to ensure equitable and secure adoption

CONCLUSION

With the global population projected to reach 9.8 billion by 2050, the need to preserve natural resources is more urgent than ever. Freshwater systems are increasingly stressed by climate change, over-extraction, pollution, and ecosystem degradation. Despite their crucial role in supporting human well-being, economic growth, and environmental resilience, chronic underinvestment, fragmented financing, and limited private sector participation prevent water systems from achieving their full economic, social, and ecological potential.

Policymakers, civil society, and leaders from business and finance must recognise the risks of freshwater degradation and coordinate efforts to fundamentally redefine the value of water and invest strategically in the restoration, protection, and sustainable management of rivers, lakes, wetlands, and aquifers. There is no single solution to the world's worsening water crisis; instead, urgent action is needed across multiple domains (Union for Mediterranean, 2024):

1. Water Stewardship: Promoting responsible water use across industries, agriculture, and municipalities, with an emphasis on efficiency, pollution reduction, and ecosystem protection.
2. Finance for Adaptation: Mobilising public and private capital to support resilient infrastructure, innovative technologies, and nature-based solutions that enhance water security.
3. Ending Water Blindness: Raising awareness of the ecological, social, and economic value of water to inform decision-making and promote transformative policies.

Practical solutions already exist, ranging from technological innovations – such as big data analytics, IoT-based water monitoring, and efficiency systems for utilities

– to nature-based solutions, including river reconnection, wetland restoration, and sustainable agricultural practices. Corporate water stewardship, innovative financing structures, and ambitious country-led initiatives such as the Freshwater Challenge further demonstrate how integrated, multi-stakeholder approaches can deliver measurable impact.

Addressing the global water crisis will require bold, coordinated, and forward-looking action that balances human needs with ecological preservation, harnesses technological and natural solutions, and prioritises long-term resilience. By fundamentally reshaping how societies value, use, and invest in water, it is possible to safeguard freshwater resources for present and future generations.

REFERENCES

1. United Nations World Water Assessment Programme (WWAP). (2018). The United Nations World Water Development Report 2018: Nature-based Solutions for Water. UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000261424.
2. World Bank Group (WB). (2022). Water Resources Management. https://www.worldbank.org/en/topic/waterresourcesmanagement.
3. WWF. (2023). WWF Report: Water crisis threatens US$58 trillion in economic value, food security and sustainability.
4. Food and Agriculture Organization of the United Nations (FAO). (2025). Aqua stat Dissemination System – Total water withdrawal per capita. https://data.apps.fao.org/aquastat/?lang=en
5. Hundertmark, T., Lueck, K., & Packer, B. (2020). Water: A human and business priority. McKinsey & Company. https://www.mckinsey.com/capabilities/sustainability/our-insights/water-a-human-and-business-priority.
6. Food and Agriculture Organization of the United Nations (FAO). (2025a). AQUASTAT - FAO's Global Information System on Water and Agriculture. https://www.fao.org/aquastat/en/overview/methodology/water-use.
7. Mytton, D. (2021). Data center water consumption. npj. Clean Water, 4(11). https://www.nature.com/articles/s41545-021-00101-
8. World Economic Forum. (2024). Why circular water solutions are key to sustainable data centres. https://www.weforum.org/stories/2024/11/circular-water-solutions-sustainable-data-centres/
9. Fujs, T. & Kashiwase, H. (2023). Strains on freshwater resources: The impact of food production on water consumption. World Bank Blogs. https://blogs.worldbank.org/en/opendata/strains-freshwater-resources-impact-food-productionwater-consumption

10. UNCCD, “Drought in Numbers 2022,” 2022, https://www.unccd.int/sites/default/files/2022-06/Drought%20in%20 Numbers%20%28English%29.pdf.
11. World Economic Forum in cooperation with McKinsey and Company (WEF). (2025). Water Futures: Mobilizing Multi-Stakeholder Action for Resilience, White paper, March.
12. Global Commission on the Economics of Water (GCEW). (2024). The Economics of Water: Valuing the Hydrological Cycle as a Global Common Good. https://economicsofwater.watercommission.org/report/economics-of-water.pdf.
13. World Meteorological Office (WMO). (2023). Atlas of Mortality and Economic Losses from Weather, Climate and Water related Hazards (1970-2021).
14. Asia Garment Hub. (2024). CDP: At least $77 billion under threat from supply chain water risk https://asiagarmenthub.net/news/2024/cdp-at-least-77-billion-under-threat-from-supply-chain-water-risk
15. Convention on Wetlands. (2021). Global Wetland Outlook - Special Edition 2021.
16. Etienne Fluet-Chouinard et al. (2023). “Extensive Global Wetland Loss over the Past Three Centuries,” *Nature* 614, no. 7947 (February 2023): 281–86,
17. Eurostat. (2022). Inland Waterway Transport Statistics https://ec.europa.eu/eurostat/statistics-explained/index. php?title=Inland_waterway_transport_statistics
18. World Wide Fund for Nature (WWF). (2023a). High Cost of Cheap Water: The True Value of Water and Freshwater Ecosystems to people and Planet, Gland, Switzerland.
19. Tomás de Oliveira Bredariol (2023). Clean Energy Can Help to Ease the Water Crisis Internation Energy Agency (IEA). https://www.iea.org/commentaries/clean-energy-can-help-to-ease-the-water-crisis
20. World Water Council, Water and Energy, https://www.worldwatercouncil.org/en/water-and-energy
21. United Nations University. (2014). World Water Day: Focus on the Water–Energy Nexus - Our World 2014, https://ourworld. unu.edu/en/world-water-day-focus-on-the-water-energy-nexus
22. Planate Energies. (2025). Energy and Water Are Closely Intertwined. https://www.planete-energies.com/en/media/article/energy-and-water-are-closely-intertwined
23. Federal Ministry for Economic Cooperation and Development, (2025) Water and energy, nexus approach, Germany, https://www.bmz.de/en/issues/water/nexus-perspective/water-and-energy-225830
24. WWF. (2021). “Rivers of Food: How Healthy Rivers Are Central to Feeding the World,” 2021, https://rivers-of-food.panda. org/#intro.
25. WWF. (2022). “Sustainable Groundwater Management for Agriculture,” 2022, https://files.worldwildlife.org/ wwfcmsprod/files/Publication/file/9bzpayei7i_ Sustainable_Groundwater_Management_for_Agriculture_ ONLINE2.2.pdf?_ga=2.41283748.7036598.1689320351- 566603267.1682418030
26. Monica Caparas et al. (2021). “Increasing Risks of Crop Failure and Water Scarcity in Global Breadbaskets by 2030,” Environmental Research Letters 16, no. 10

27. CGIAR (Consultative Group on International Agricultural Research). (2025). Sustainable Farming: Cultivating a Water-wise Future, https://www.cgiar.org/news-events/news/sustainable-farming-cultivating-a-water-wise-future/
28. Union for Mediterranean. (2024). Digital Transformation for Water and Sustainable Development Final Report, January.