Water reuse and resource recovery Innovation, best practices and policies

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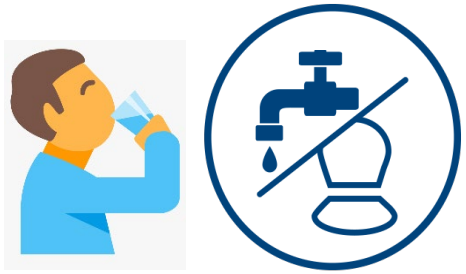
Global water challenges



2 billion people lack access to safely managed drinking water, including 1.2 billion people lacking a basic level of service. **2 billion people lack basic sanitation**.

Water pollution is worsening worldwide. Discharges of untreated sewage and **nutrient runoff** from agriculture are main causes of **eutrophication** in surface waters. **Emerging pollutants** (plastic and microplastic pollution) present new water quality challenges

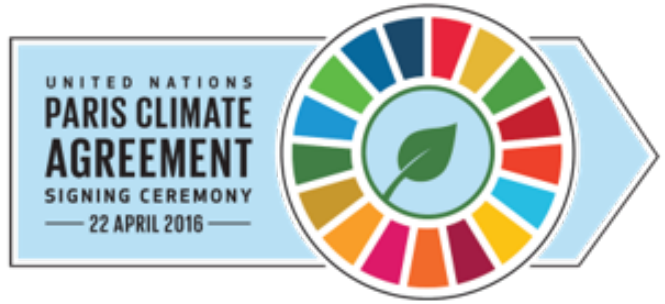
Food security is at risk due to water scarcity versus growing water demands for more food production

Water-related disasters are increasing in intensity and frequency due to climate change, with 90% of natural disasters being water-related.

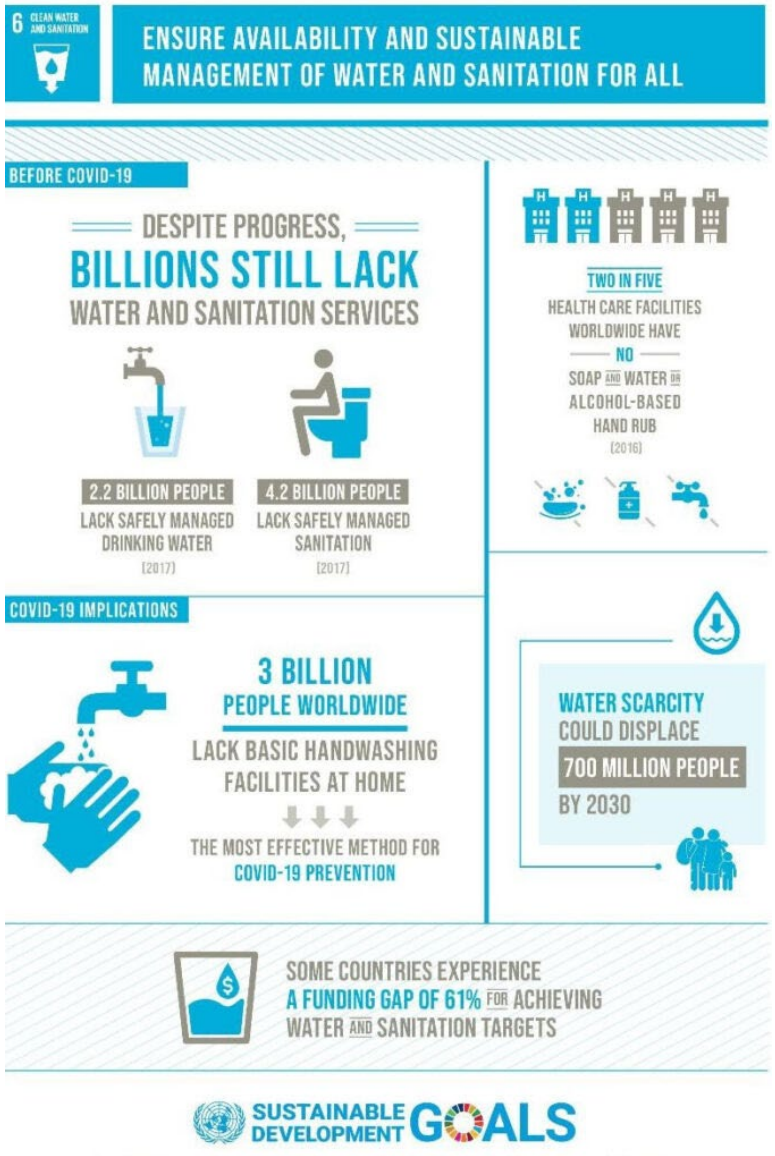
Significant future **reductions in renewable water** will affect the quantity, quality and reliability of water resources

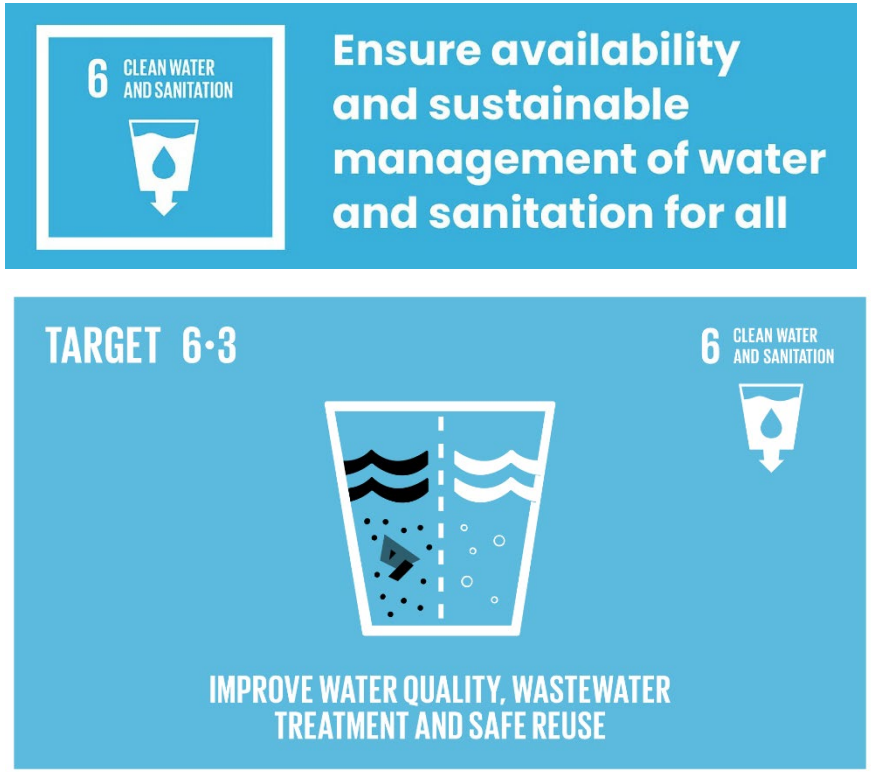
Competing water uses are exacerbated at the local, regional and global levels with potential conflicts between different users

Water for sustainable development: UN SDGs



SDG 6:Clean water and sanitation





SDG 6 – Target 6.3:
Improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and **substantially increasing recycling and safe reuse globally**

Water reuse and resource recovery

Technological and policy innovation and best practices

Shifting the paradigm of wastewater management

from **disposal**

to **reuse & resource recovery**

- Growing water demand
- Climate change (droughts)
- Demand (market) for energy and nutrients

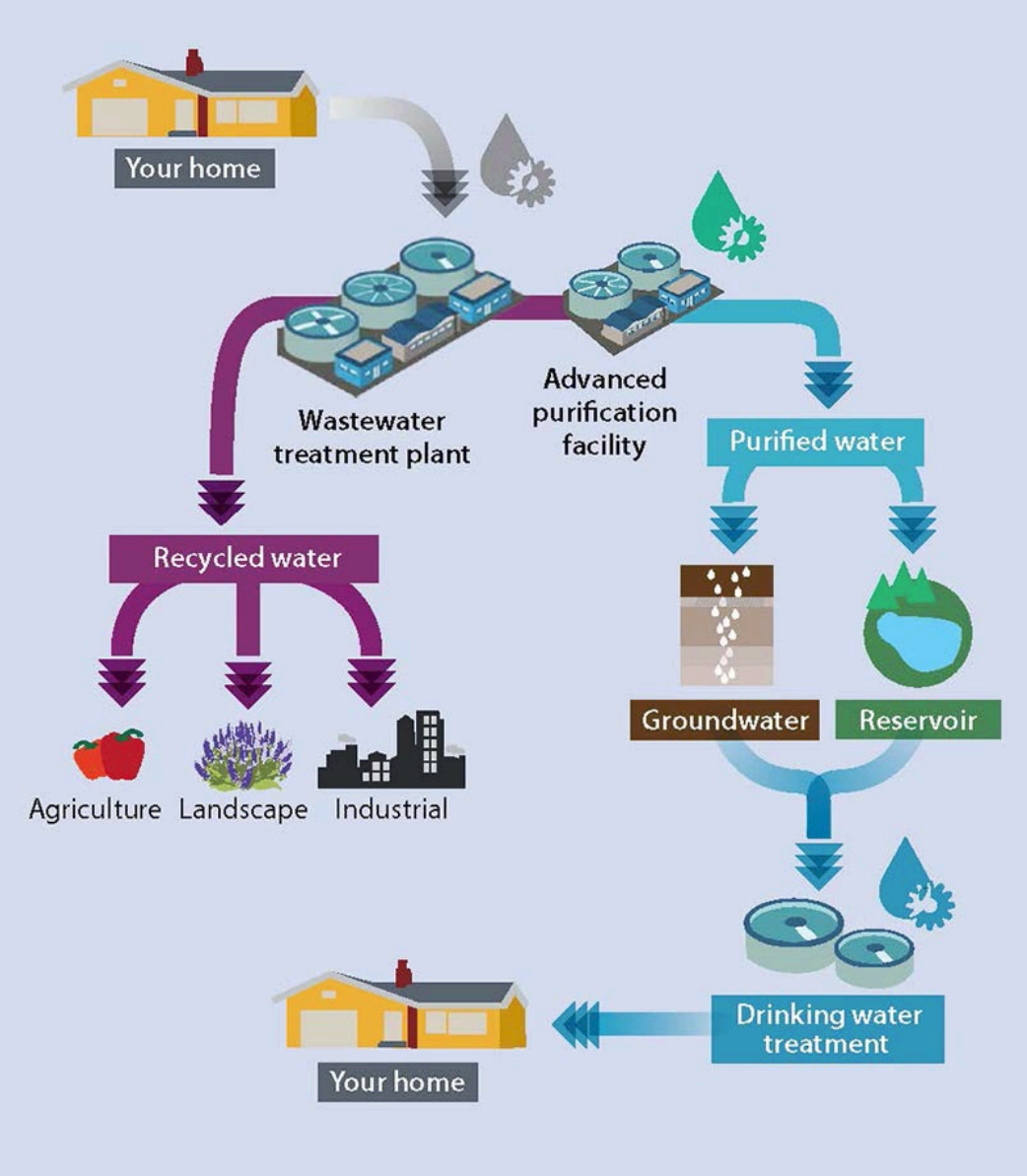
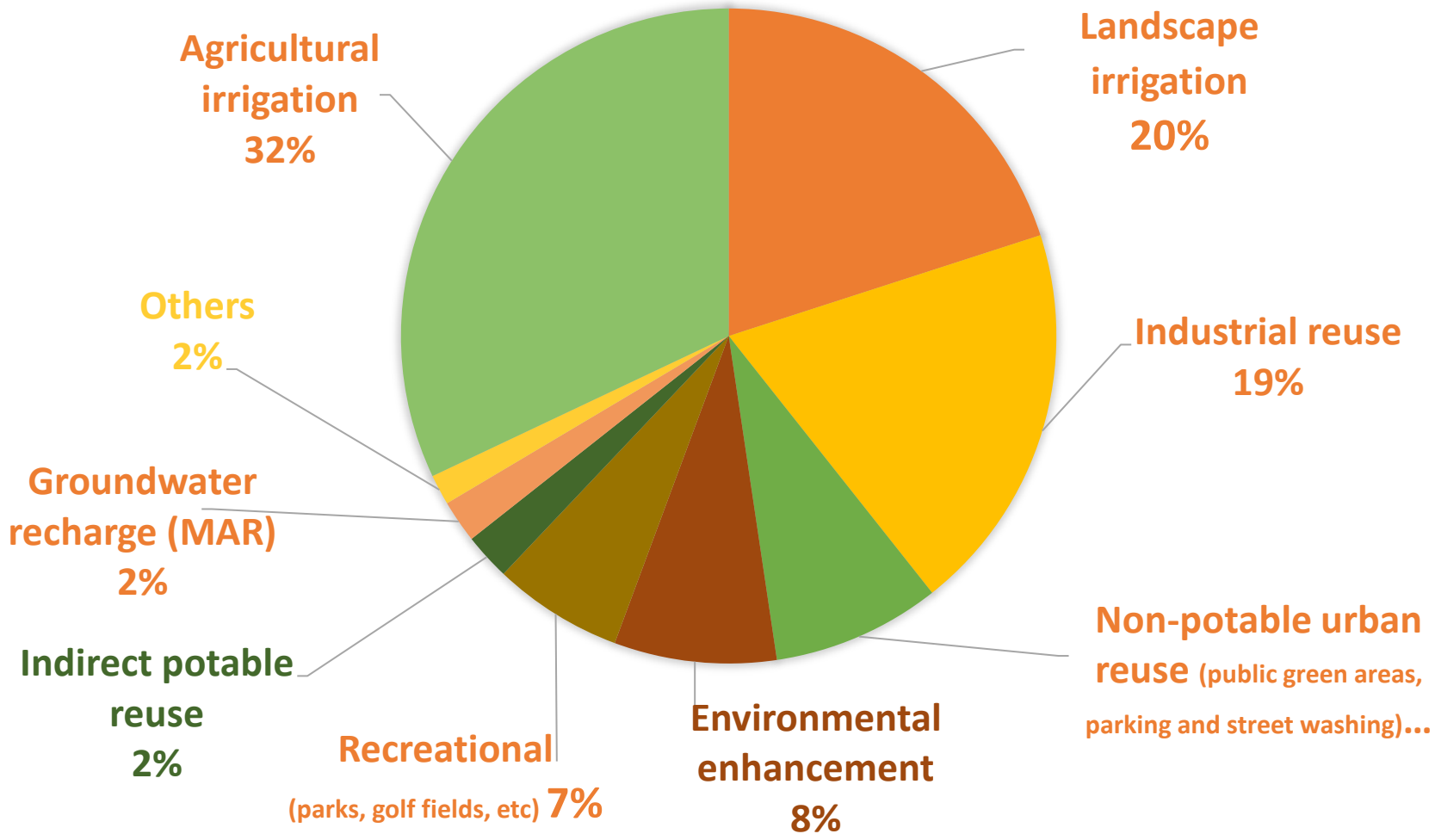


Image source: http://www.sdcwa.org

Water reuse

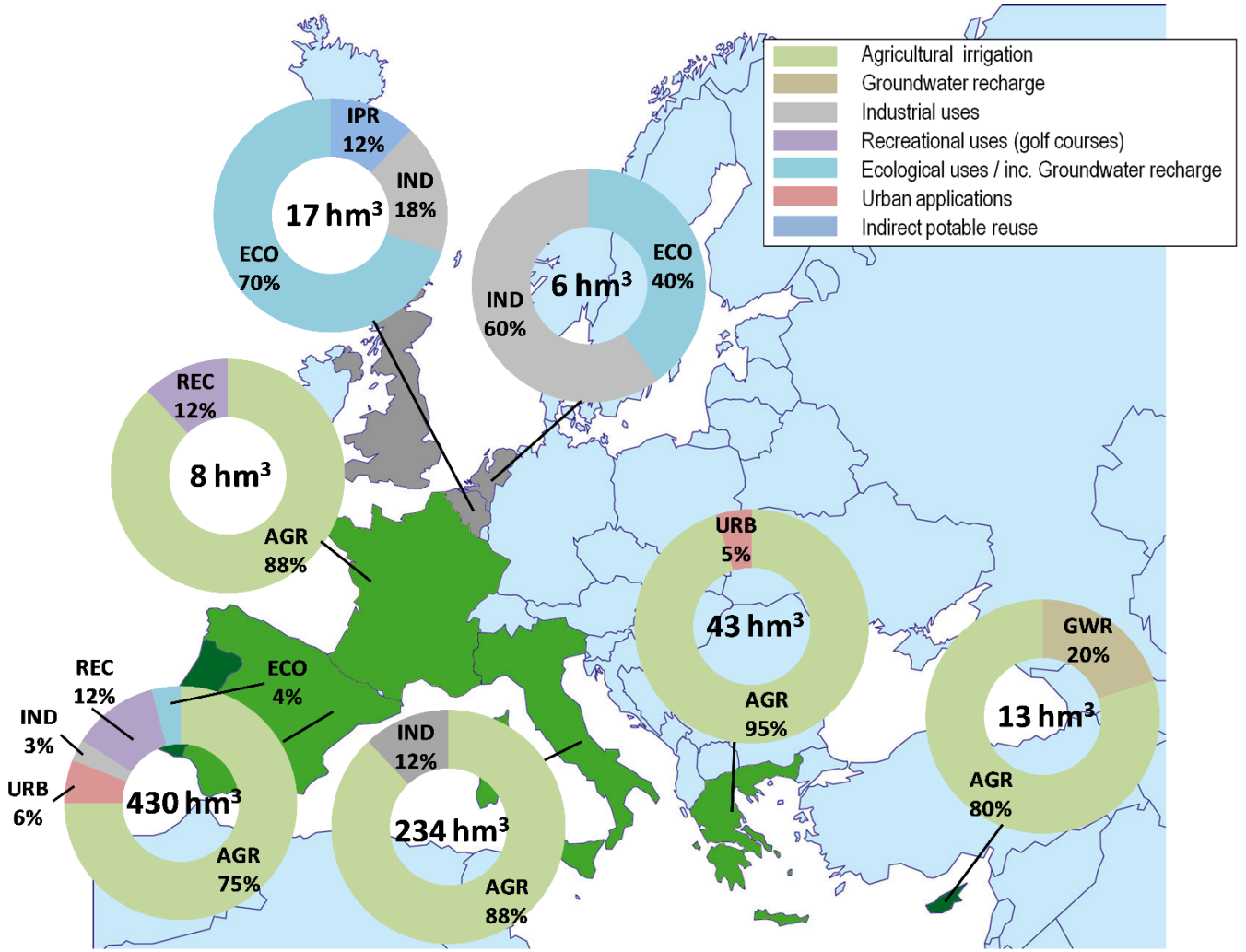
A reliable alternative water resource

Global water reuse after advanced (tertiary) treatment: Market share by application



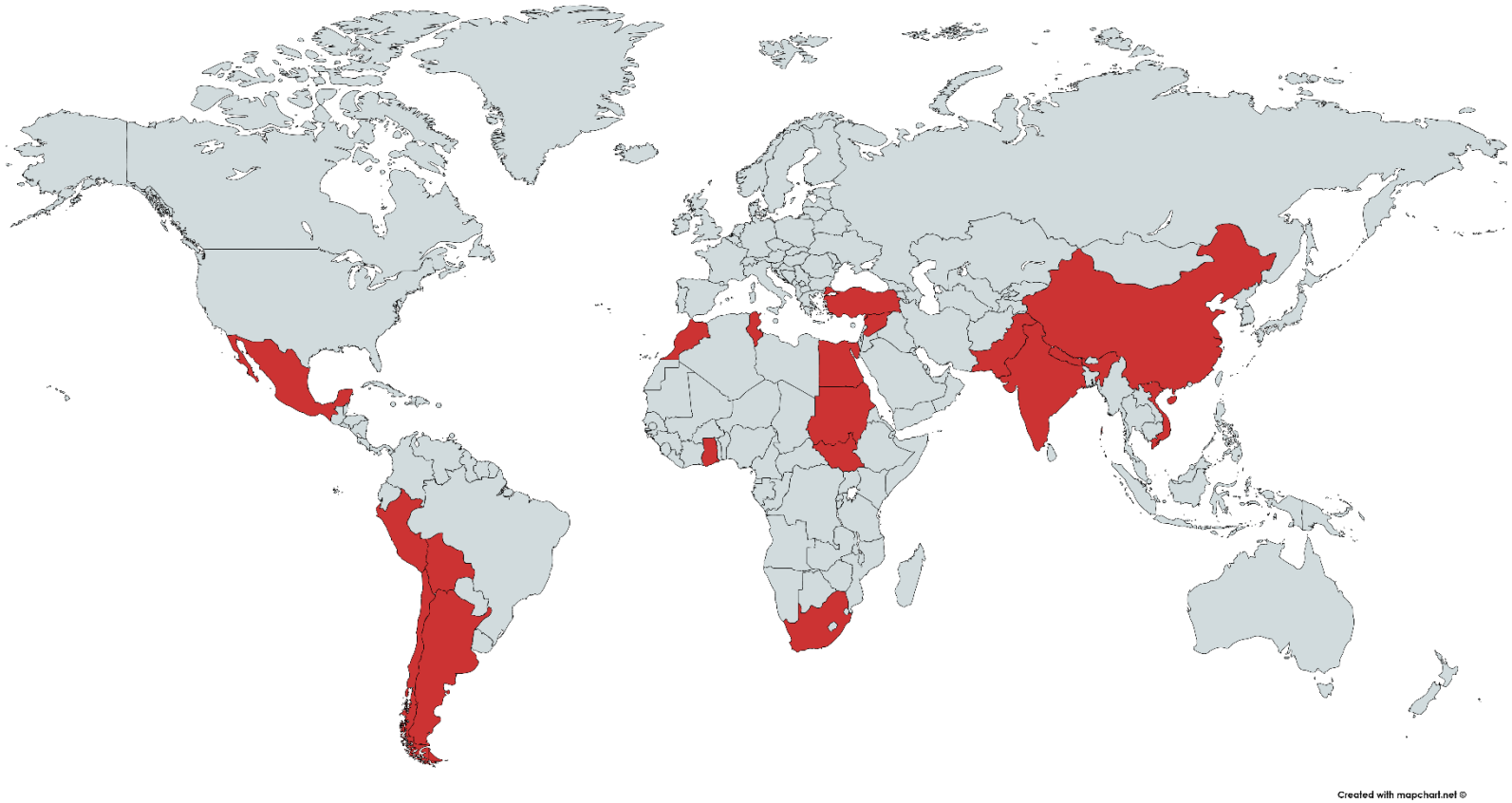
Source: Lautze et al. (2014, Figure 2. p.5 based on Global Water Intelligence data)

Water reuse in Europe



Source: EU Project DEMOWARE - Innovation demonstration for a competitive and innovative water reuse sector (http://demoware.eu/)

Water reuse in agriculture: Informal wastewater irrigation

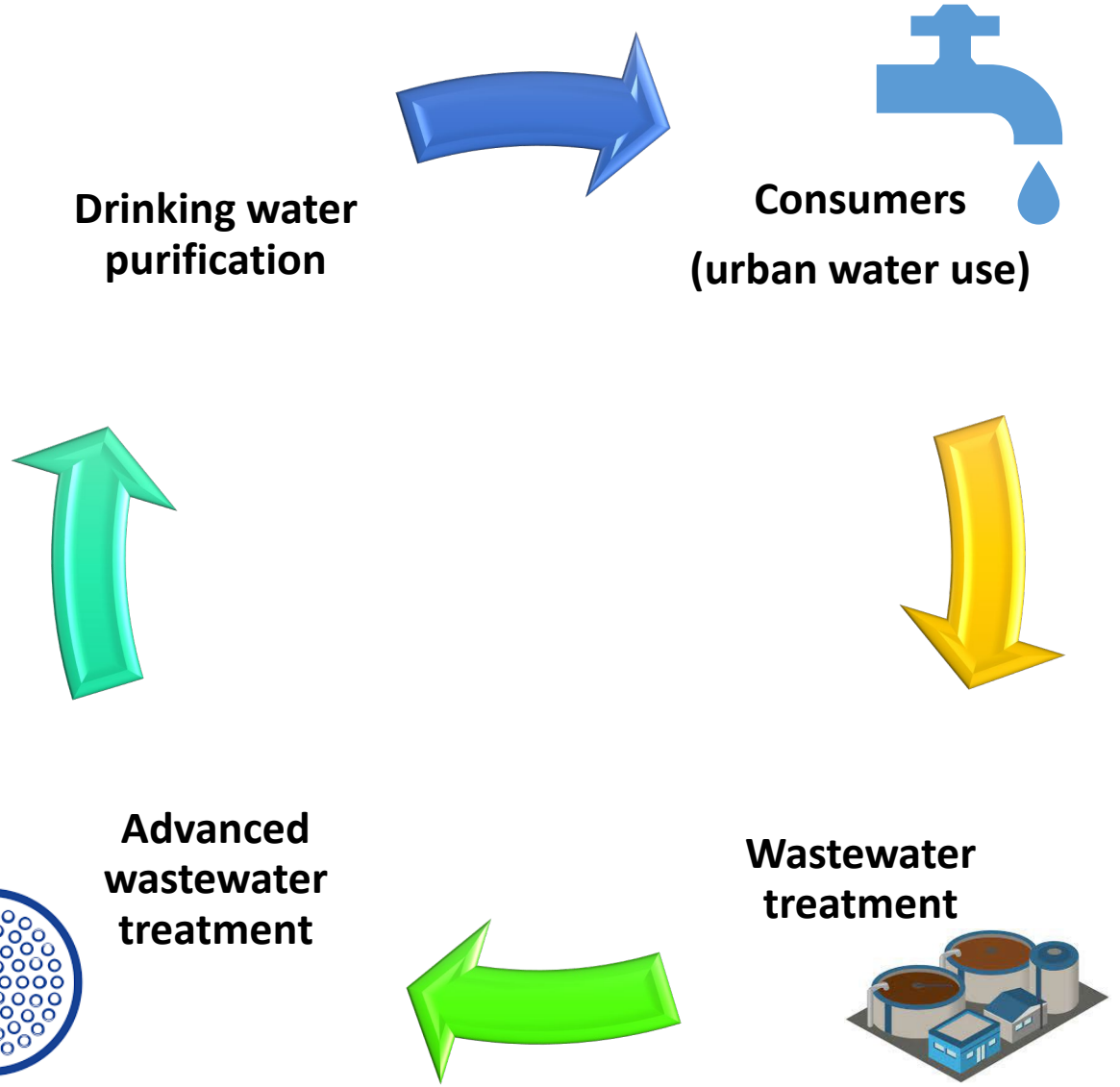


20 countries using the largest volume of raw wastewater for agricultural irrigation

Based on Durán–Álvarez, 2014

A need to shift from informal, unplanned, **unsafe uses of untreated or partially treated wastewater** to **planned safe uses**.

Direct potable reuse



Advantages

- **Secure alternative water resource:** Treated reclaimed water is available, which is reliable, to meet water demands
- **Reduced capital and operating costs** compared to indirect potable reuse

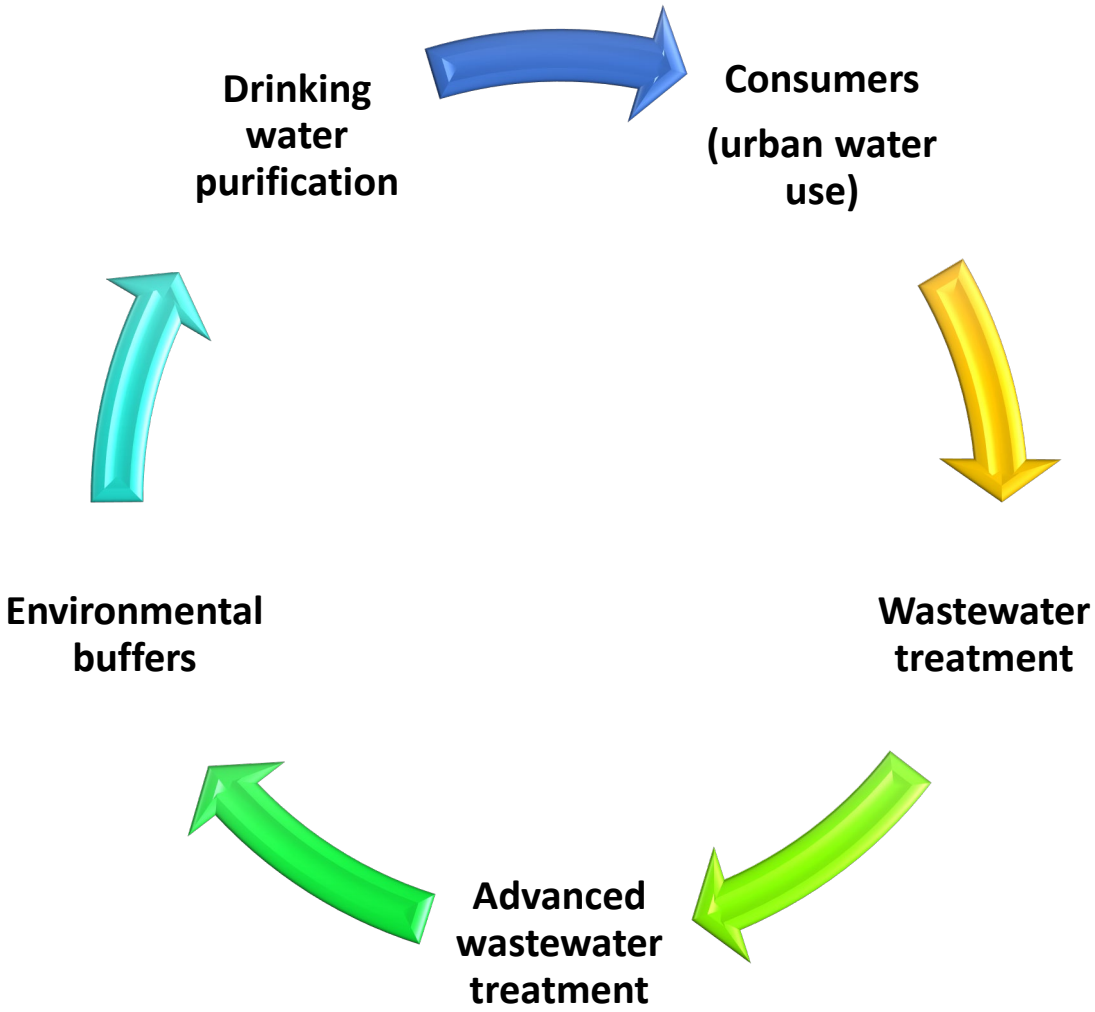
Disadvantages

- The **strictest water quality requirements for the reclaimed water** to eliminate risks to the public health
- **Safety concerns** require **the most rigorous water quality monitoring** of recycled water
- Affordability and availability of **advanced water treatment** technologies
- **Public acceptance** concerns require public education and awareness raising programmes to overcome negative public perception

Direct potable reuse:
The pioneering experience of Windhoek Namibia

- Vision and great dedication of potable reclamation pioneers
- Excellent information policy and education campaigns supporting buy-in
- The absence of water-related health problems
- A multi-barrier approach
- Reliable operation
- Online process and water quality control
- The near absence of practicable alternative water resources

Indirect potable reuse (IPR)



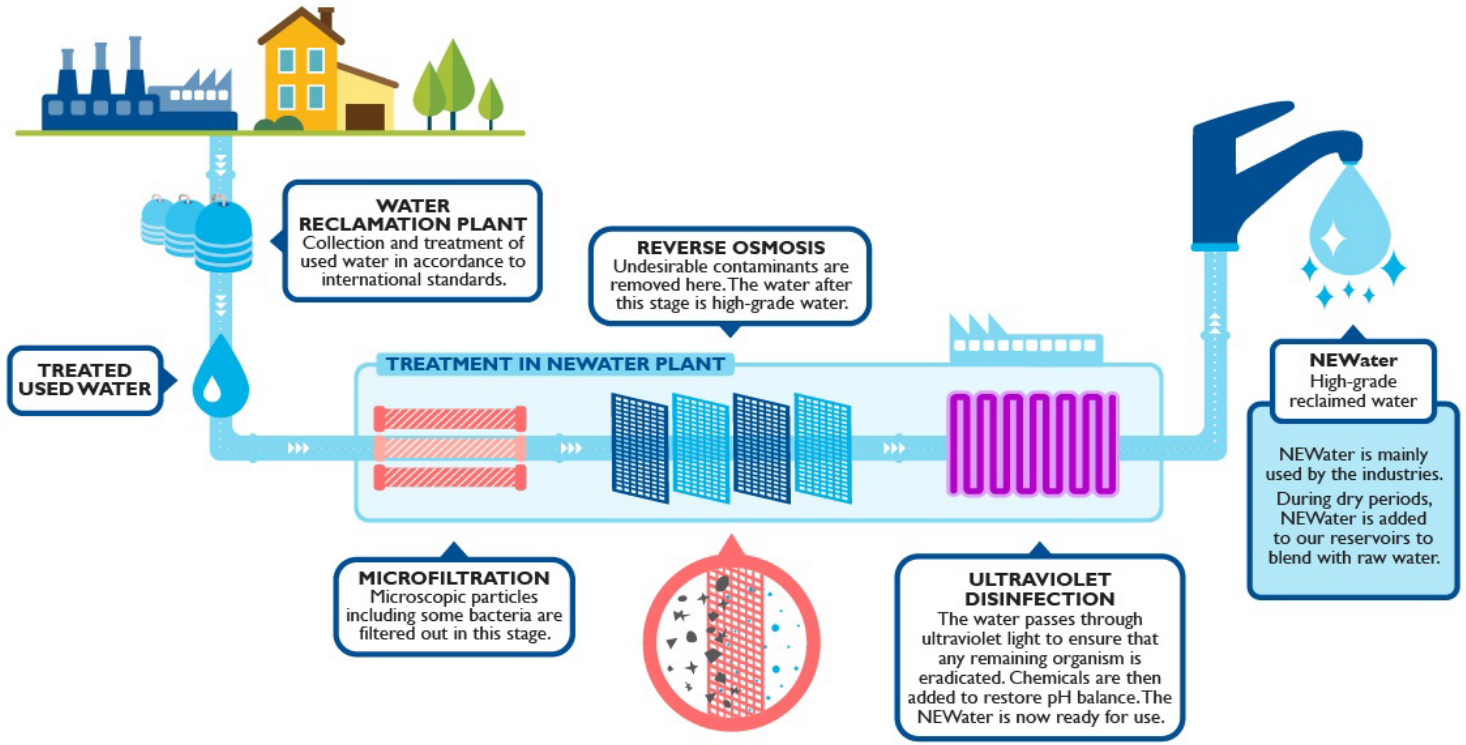
Advantages

- **Environmental purification and use of n environmental buffer** (a lake, river, or a groundwater aquifer) before the water is treated at a drinking water treatment plant and reused
- **Less strict water quality requirements**
- **Well-established method**: widely used in the USA, Europe Singapore and other countries
- **Positive public perception**: Consumers are more comfortable with indirect potable reuse (IPR) than direct potable reuse (DPR)

Disadvantages

- **More expensive:** require high capital and operational costs to move water from WWTP to the environmental buffer

Indirect potable reuse: Singapore PUB NEWater
Technological innovation and awareness raising



- Mainly used by industries
- Added to reservoirs to blend with (raw) source water during dry periods

Source: https://www.pub.gov.sg

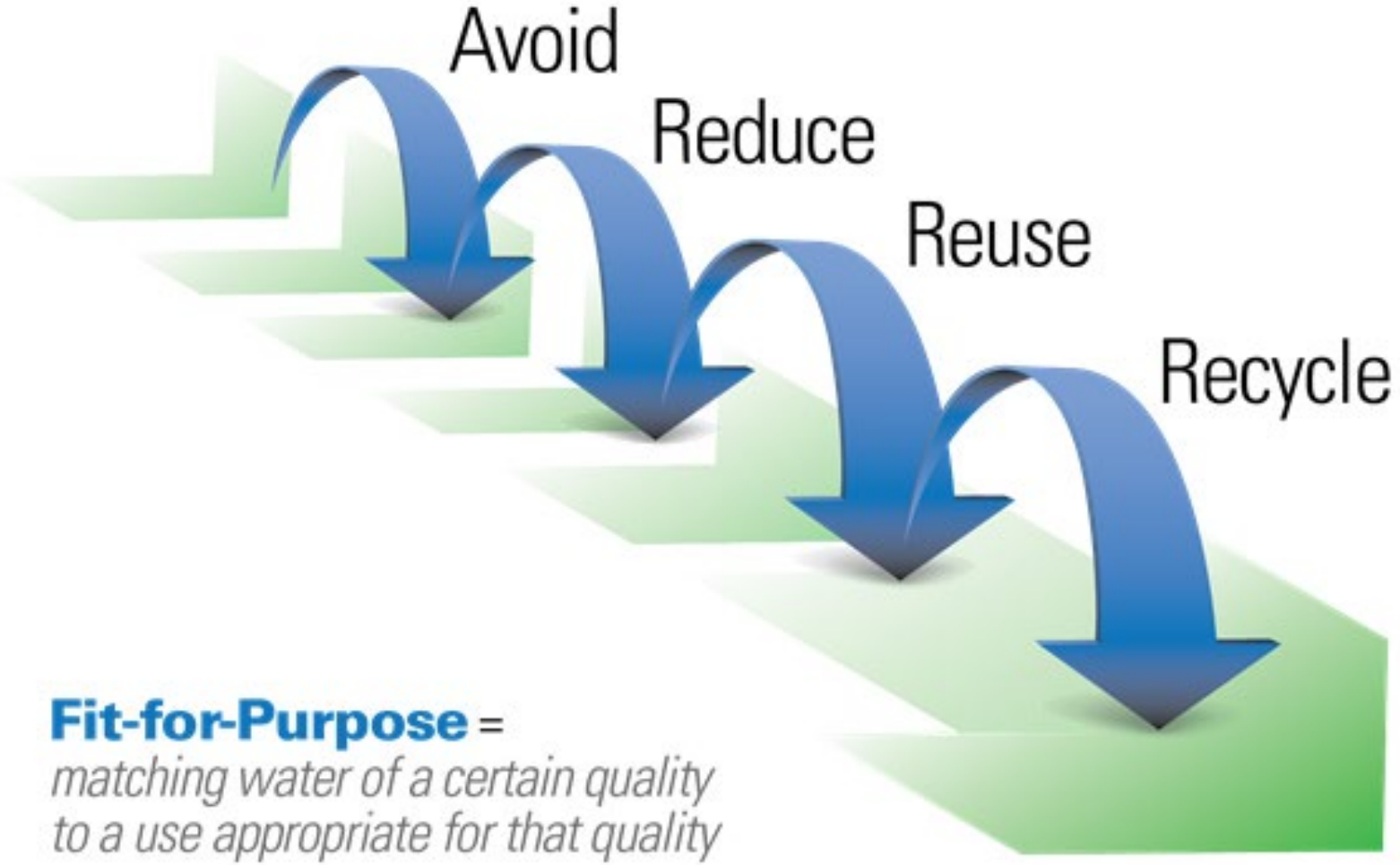
Indirect potable reuse: The Torreele Facility, Belgium
Aquifer recharge and environmental benefits

- Groundwater recharge in sand dune aquifers of St Andre for indirect potable reuse
- Environmental co-benefits:
  - Saline water intrusion prevention
  - Sustainable groundwater management
  - The enhancement of natural values

Non-potable reuse

- A rapidly expanding application of water reuse
- The reclaimed water does not necessarily need to comply with strict water quality standards (‘*fit-for-the-purpose*’ treatment)
- Health risks related to direct contact or cross-connection contamination
- High costs of building and maintaining adequate infrastructure (dual-piped distribution systems)

‘Fit-for-purpose’ water reuse



Non-potable reuse:

San Francisco, USA - A regulatory approach

In the absence of the federal regulation, SFPUC launched a local programme “Non-potable Water Programme” for regulating on-site water use

- Creates a streamlined process for collecting, treating and reusing alternative water sources (including grey and blackwater) to meet non-potable needs in urban areas
- Establishes guidelines for developers interested in installing non-potable water (dual) systems in new buildings
- Allows for micro-markets to share, buy or sell water among two or more buildings without a public agency providing the service

Source: OECD case study, 2015

Resource recovery

Wastewater is a valuable resource

Nutrients recovery from wastewater

Phosphorus recovery

A **multinutrient fertilizer** based on sewage sludge ash incineration

A commercial fertilizer produced by **P recovery as crystalline struvite pellets** by transforming the unwanted struvite formation in the pipes.

Energy recovery from wastewater

Energy recovery from wastewater has **significant business potential** in terms of **reducing energy use, operational costs** and **carbon footprint** of wastewater treatment plants

Japan's comprehensive policy approach

- A target to increase biosolids recovery to 30% of potential biomass energy
- By the Sewerage Act of Japan (2015), wastewater operators are required to utilize biosolids as a carbon-neutral energy
- Promotes innovation by subsidizing breakthrough technologies in biosolids reuse

Heat recovery from wastewater

Wintower is a 28-story high-rise building in Winterthur (Zürich, Switzerland)

- Wastewater is used to heat the building in cold winter months and to cool in summer
- About 600 kW heating energy is extracted from wastewater taken from the sewer

Water reuse and resource recovery

Challenges

- Ineffective wastewater management
- Lack of regulatory policies
- Lack of robust monitoring frameworks
- Environmental and public health risks
- Negative public perception
- Lack of business models
- Lack of markets for recycled water & recovered resources

Opportunities

- Effective management practices
- Technological innovation
- Appropriate regulatory policies
- Awareness raising (positive public perception)

Water reuse and resource recovery:
Innovation and future trends

Future research and innovation trends in wastewater technology and policy will focus on water reuse and resource recovery

Innovations in wastewater technology and research:

- Membrane filtration
- Membrane bioreactors
- Microbial fuel cells
- New developments in biological treatment processes
- Nanotechnology
- Innovative wastewater monitoring and contro systems
- Natural treatment systems
- Modelling

Water reuse and resource recovery:
Business models and economic approaches

Water reuse is economically feasible and attractive when there is a potential for cost recovery by treating wastewater to a water quality standard acceptable to users.

Economic approaches for

water reuse:

- Intersectoral water transfers
- Replenishing natural capital
- Marketing reclaimed water
- Hedging future water markets

resource recovery:

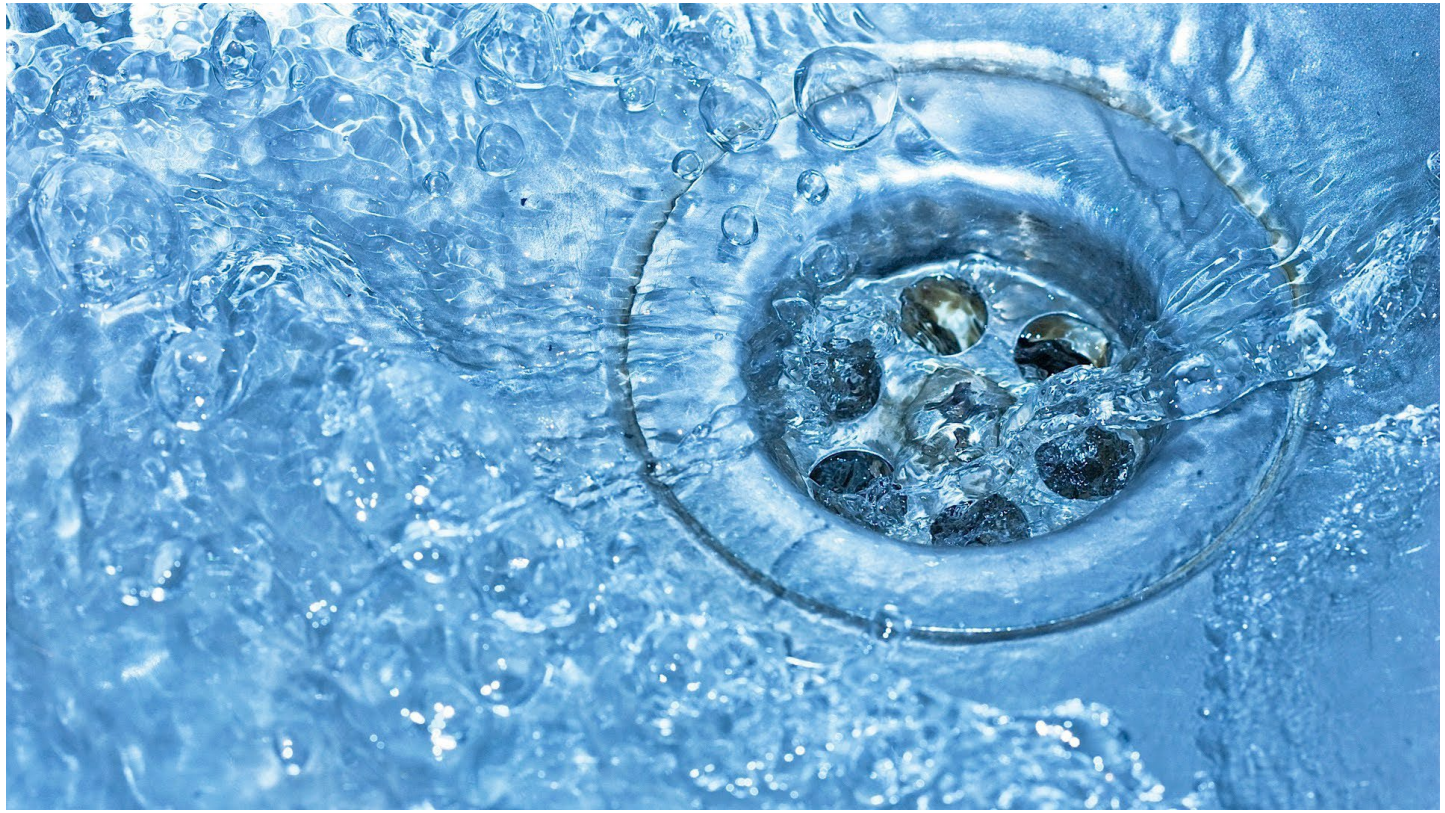
- Nutrient and energy recovery from wastewater are among the most advanced in terms of technical and financial feasibility

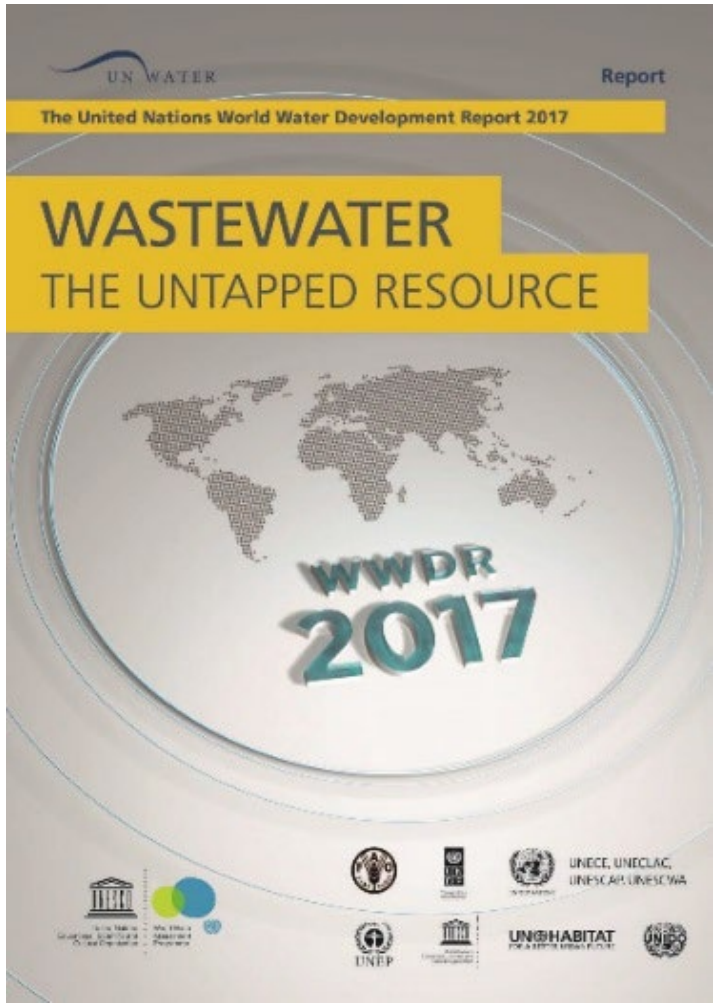
Water reuse and resource recovery:
The way forward

- Develop **appropriate and affordable technologies**
- Create **business models** and **economic approaches**
- Minimize **risks to human health and the environment** (emerging pollutants, microplastics, nanoparticles and nanoplastics, etc.)
- Develop and implement **regulations** supporting water reuse
- Promote awareness raising and education campaigns to overcome barriers to **social acceptance of water reuse**

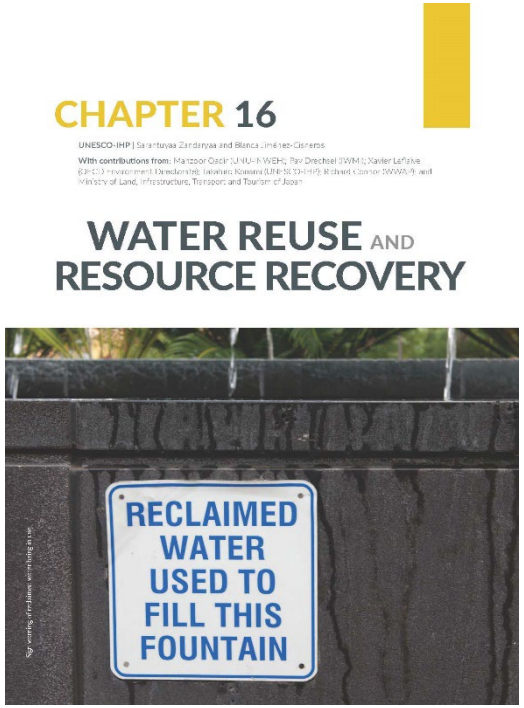
Wastewater is a valuable resource.

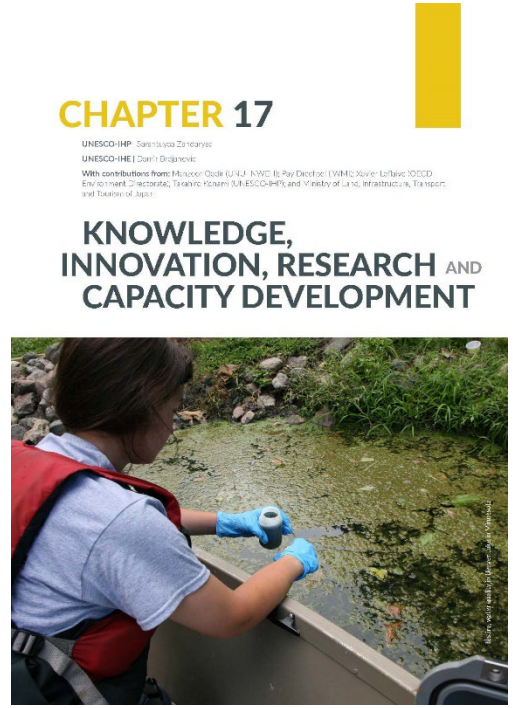
Let us not waste it!



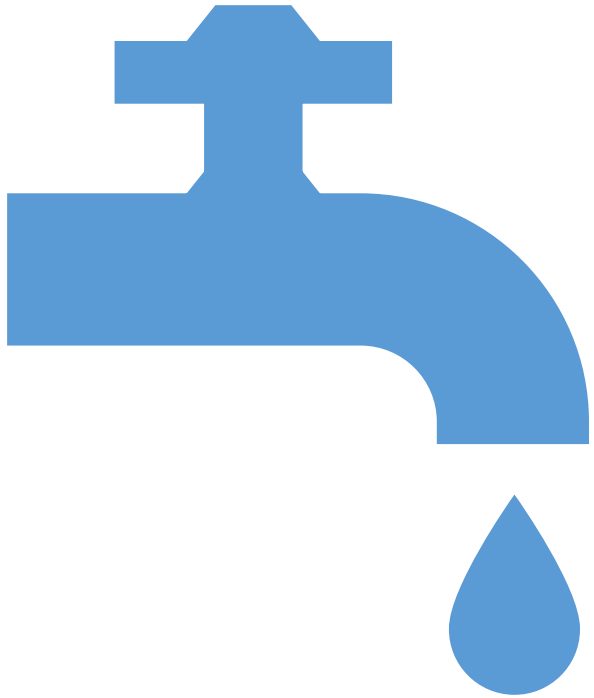


Best practices, policy approaches and innovation in wastewater technology and water reuse and resource recovery





Lead author and contributor: Sarantuyaa Zandaryaa, UNESCO



Emerging pollutants and microplastics in freshwater

Emerging pollutants and microplastics in water

any synthetic or naturally-occurring chemical pollutant or any microorganism

not monitored as part of routine water monitoring programmes

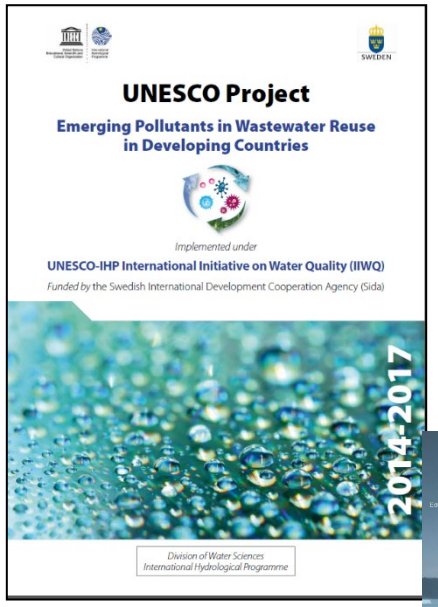
not regulated in the environment

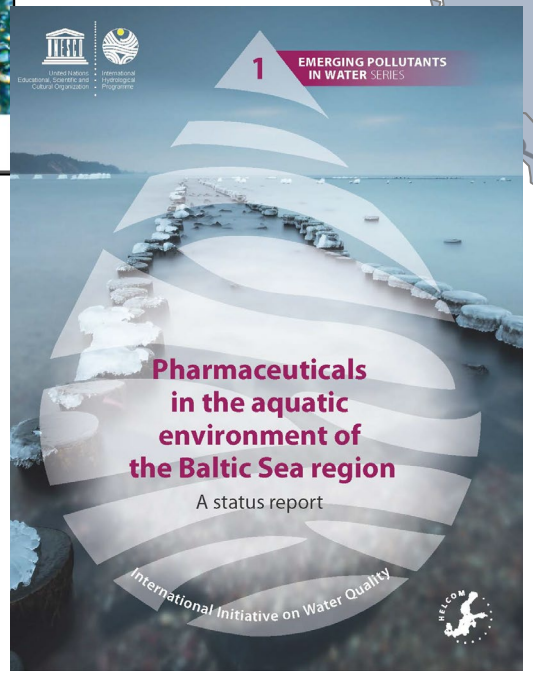
with potentially known or suspected adverse **ecological or human health effects**

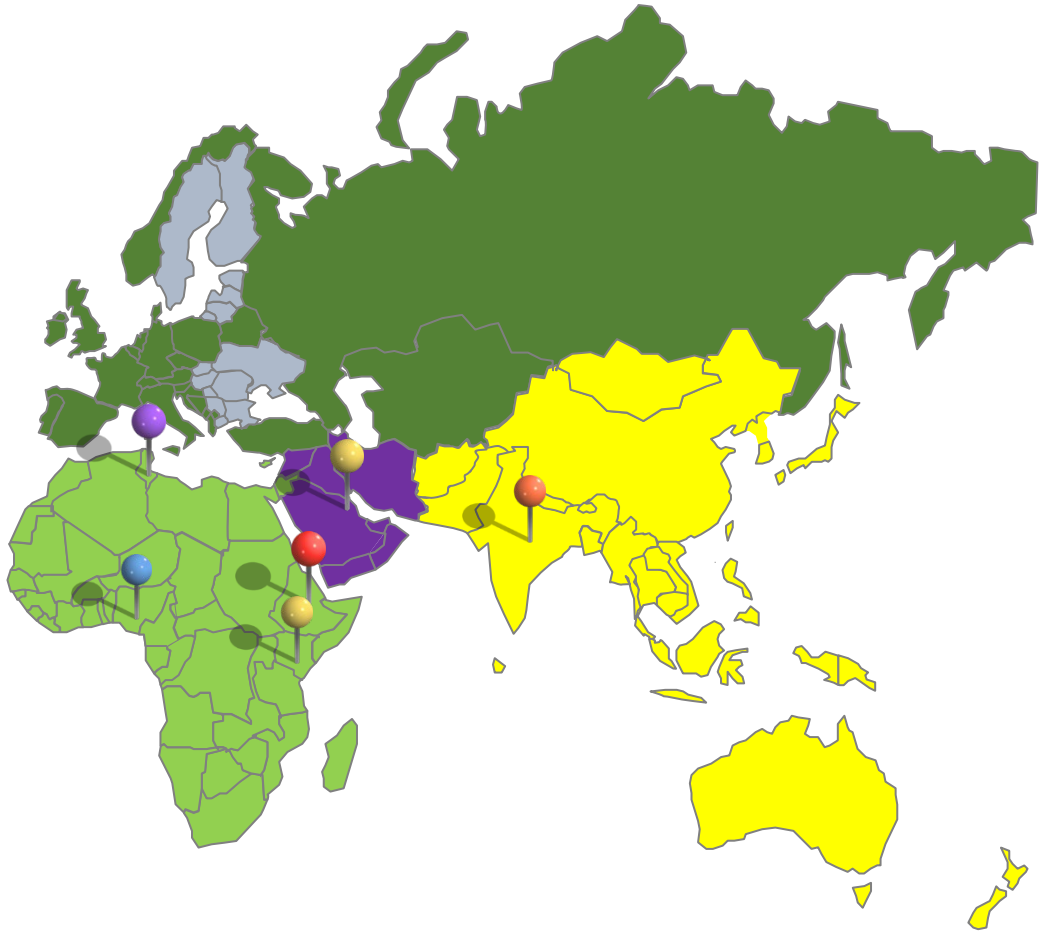
Limited **scientific understanding**

Lack of **regulations and policies** to manage emerging pollutants and **reduce potential risks to the health of people and ecosystems**

UNESCO Project on Emerging pollutants in water







16 case studies covering over 20 countries

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Thank you!

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Natural Sciences Sector

Paris, France