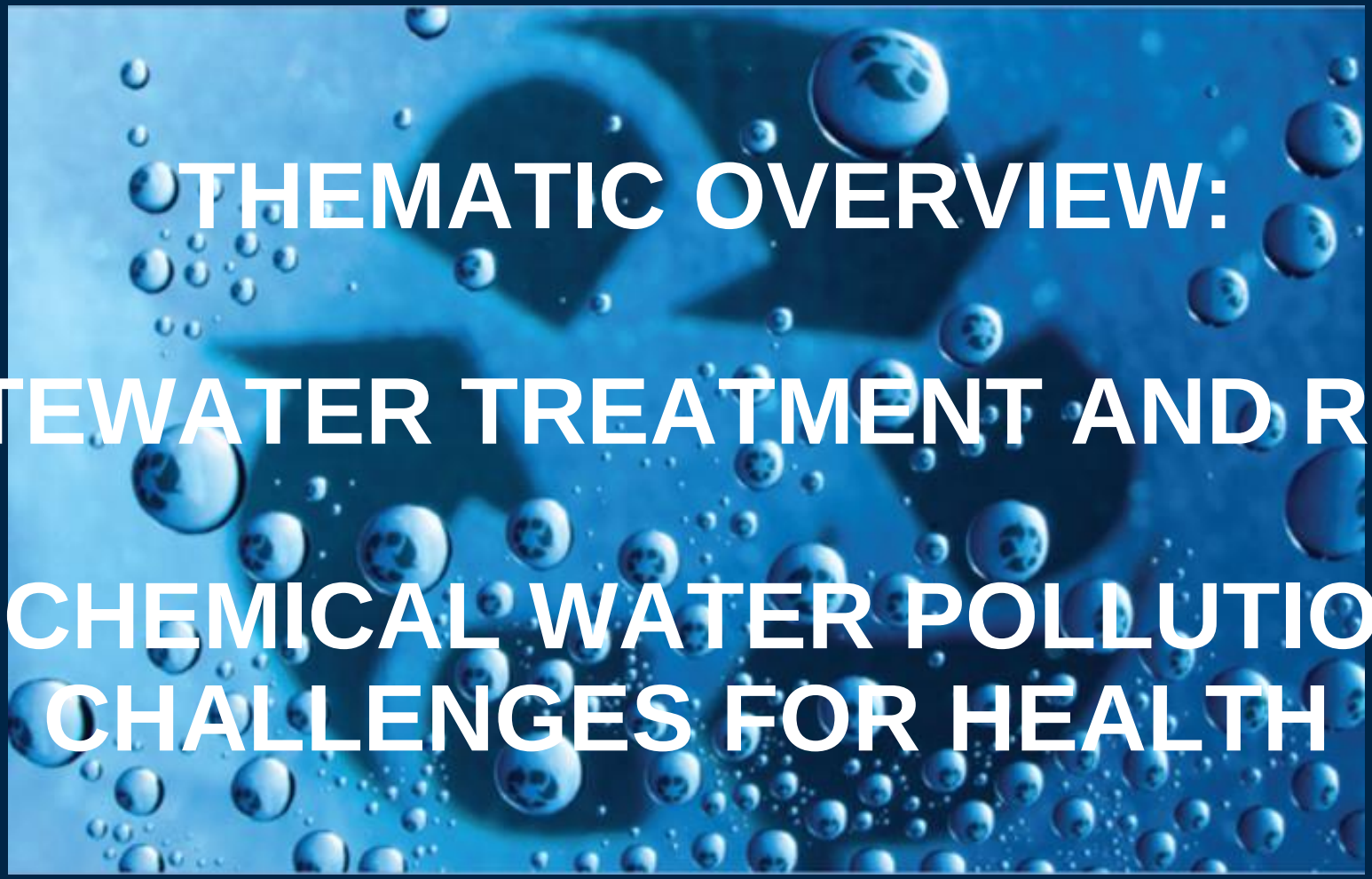


# THEMATIC OVERVIEW:

# WASTEWATER TREATMENT AND REUSE

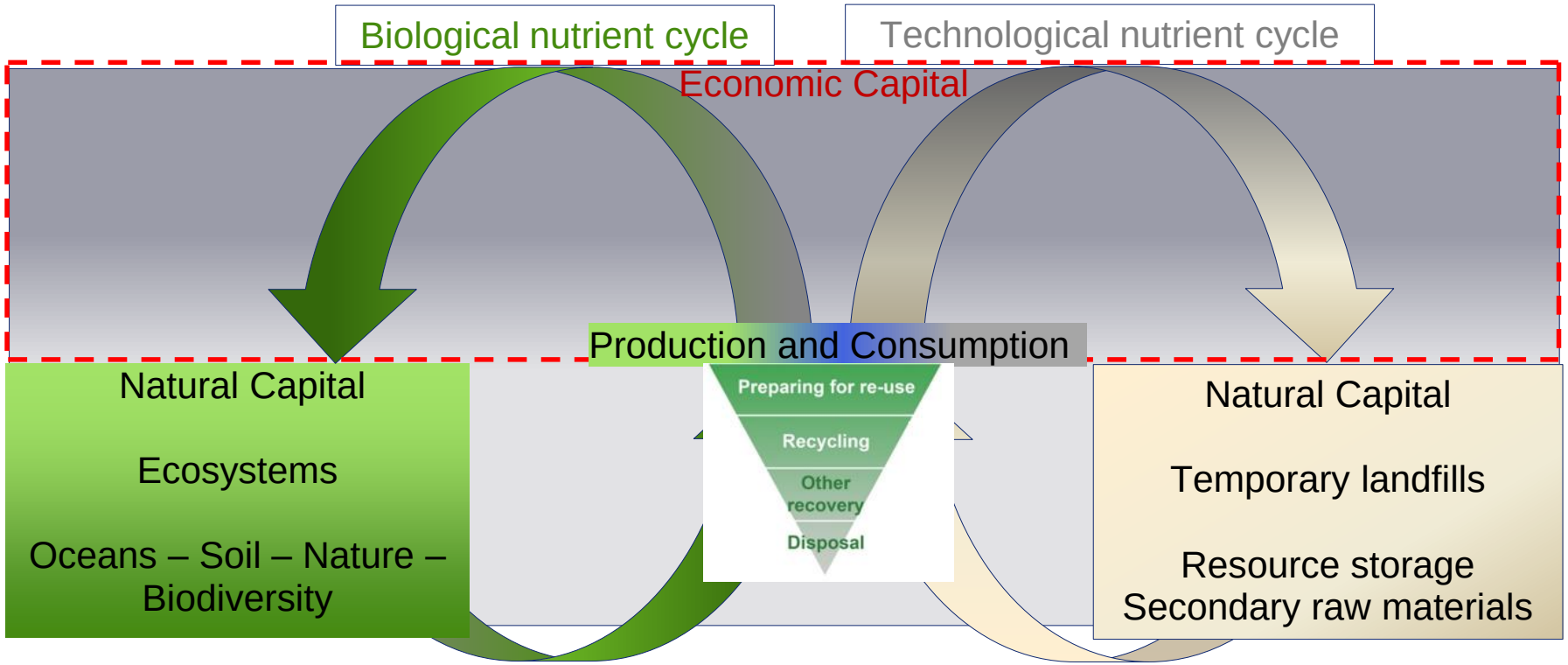
# – CHEMICAL WATER POLLUTION CHALLENGES FOR HEALTH

AARHUS UNIVERSITY
DEPARTMENT OF ENVIRONMENTAL SCIENCE

SIWI WORLD WATER WEEK
30 AUGUST 2017

MARIANNE THOMSEN
PROFESSOR

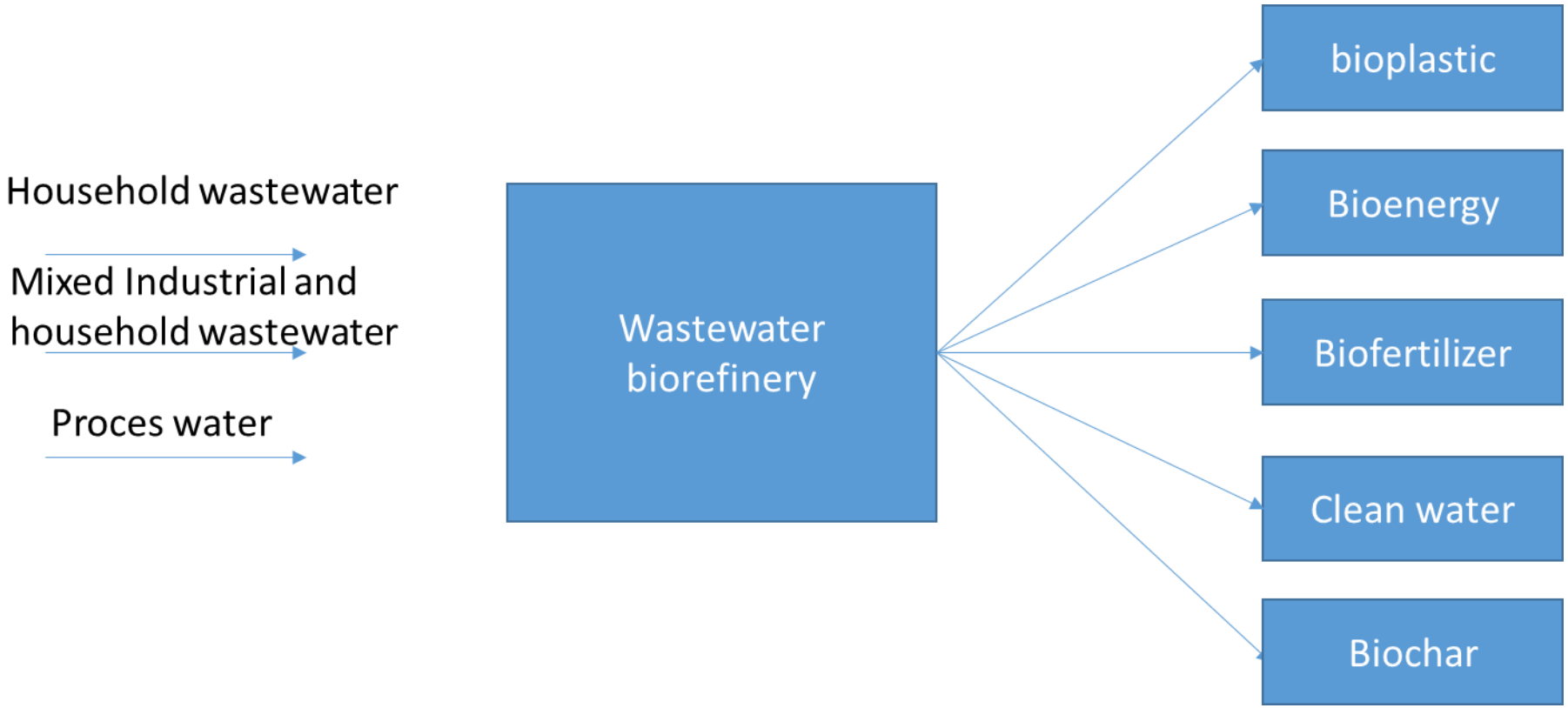
# REUSE OF RESOURCES IN WASTEWATER IN A CIRCULAR ECONOMY



# WASTEWATER TREATMENT PLANTS TRANSFORMING INTO BIOREFINERY PLANTS

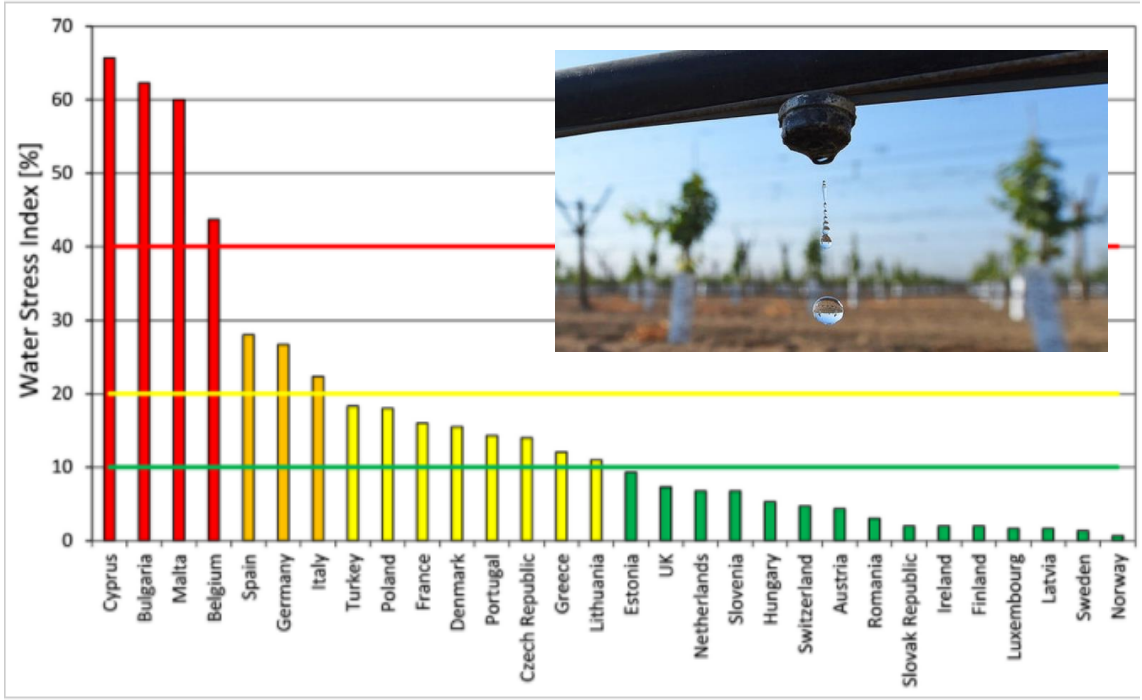
- Wastewater = substrate for biobased production
- Assimilating, extracting and recycling nutrients while producing biomass
  - E.g. autothrophic algae or phosphorous bioaccumulating bacteria
- Energy self-supplying WWTPs by implementing anaerobic treatment for energy production
- Introducing pollutant destruction technologies as a final sludge and water treatment step
  - e.g. oxonation, pyrolysis

# RESSOURCE MANAGEMENT STRATEGIES



# SAFE WASTEWATER TREATMENT & REUSE

- **Why is it important ?**
  - **Water scarcity**
    - Today more the 1 billion people live in water-scarce areas
    - By 2025, 3.5 billion people will live in water scarce or water stressed areas
  - **Water quality**
    - Inefficient existing water systems
    - Loss of freshwater ressource
    - Pollution

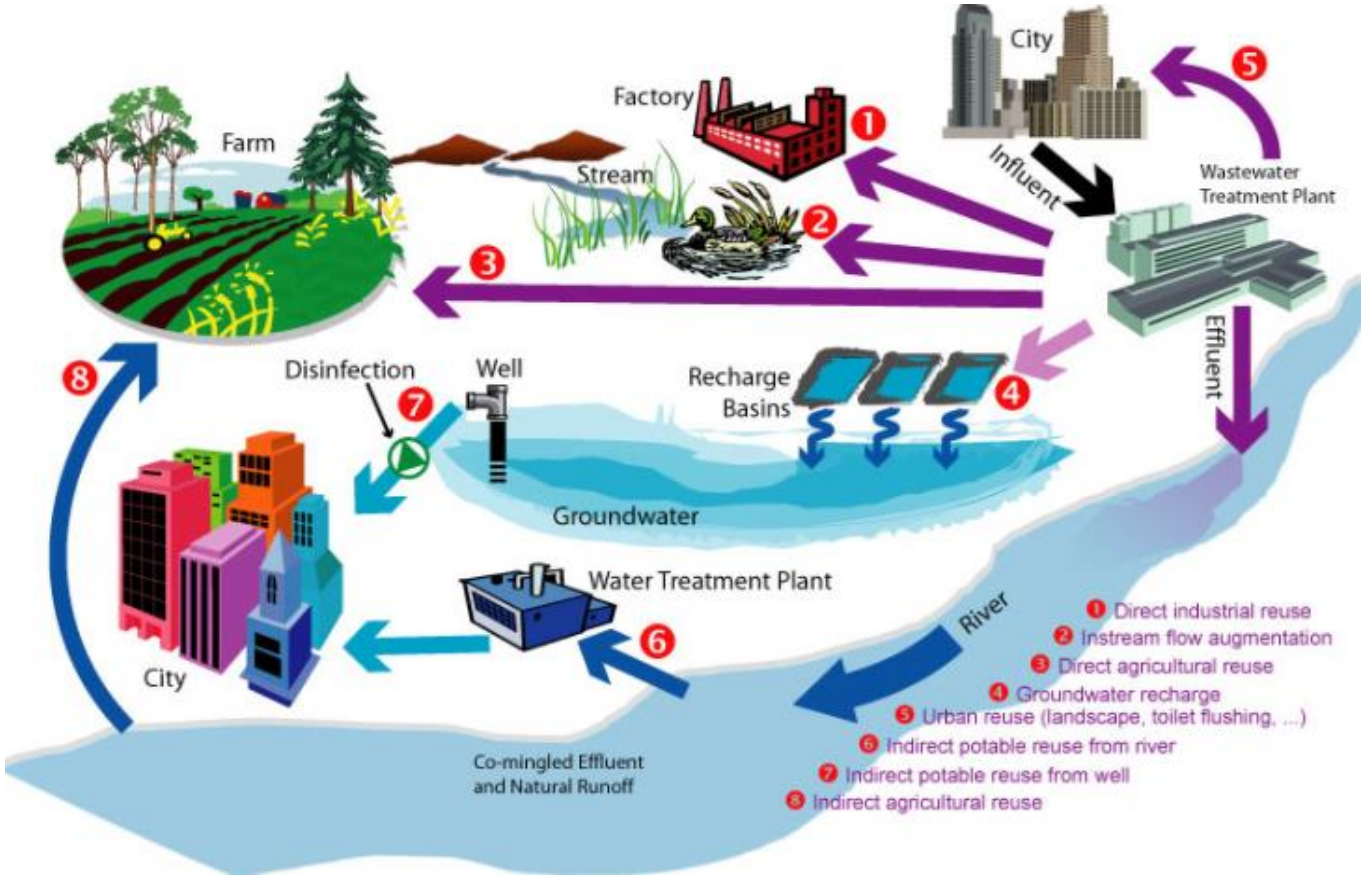



- **Resource capture and reuse**
  - e.g. closing the phosphorous and nitrogen cycles

# WASTEWATER REUSE CIRCLES

- **Direct reuse**
- via pipelines, storage tanks, directly from a water treatment plant to a distribution system; e.g. in agricultural irrigation and industry

- **Indirect reuse**
- wastewater gets diluted but still remains a dominant component of surface water flows
- Such situations account for the majority of agricultural water reuse worldwide



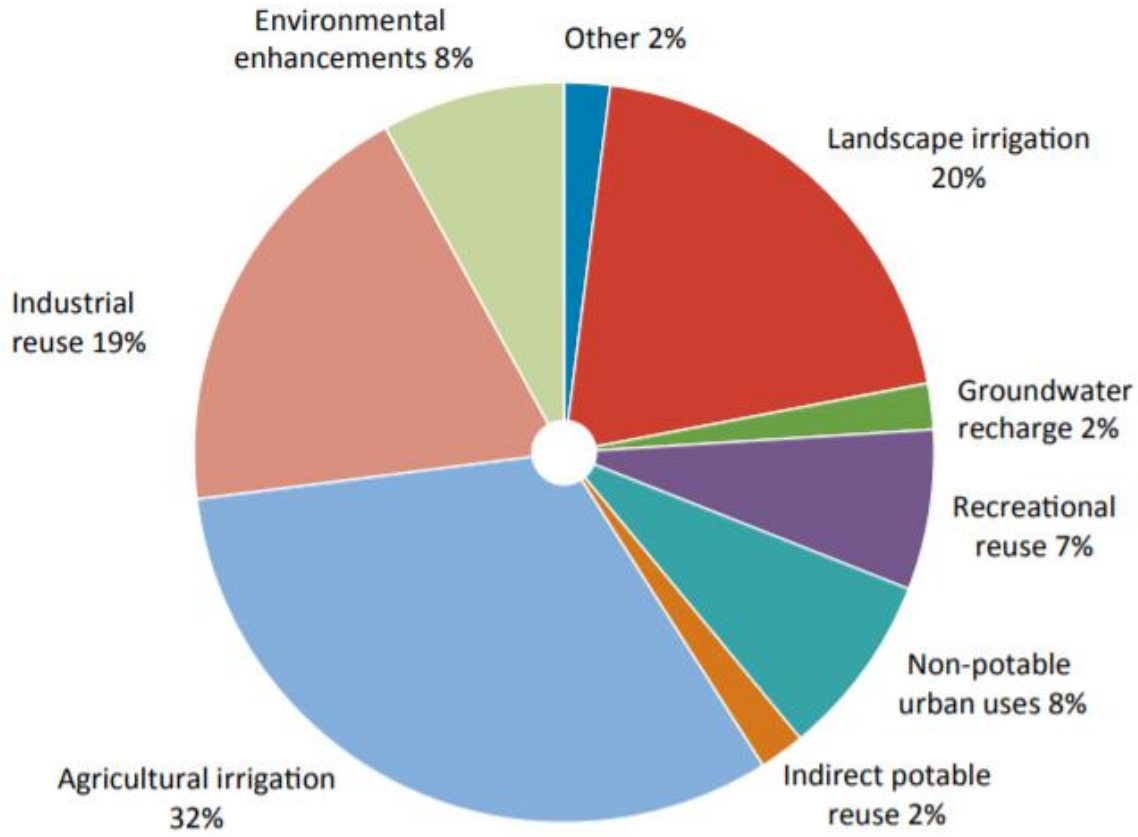

California Department of Water Resources. About Recycling (2013). Retrieved from http://www.water.ca.gov/recycling/

# GLOBAL WASTEWATER REUSE

- At present, **direct use** of municipal wastewater constitutes **5 %** of the total municipal wastewater production

- 32% of the wastewater is used for agricultural irrigation, while 20% is used for landscape irrigation and 19% is used within the industrial sector

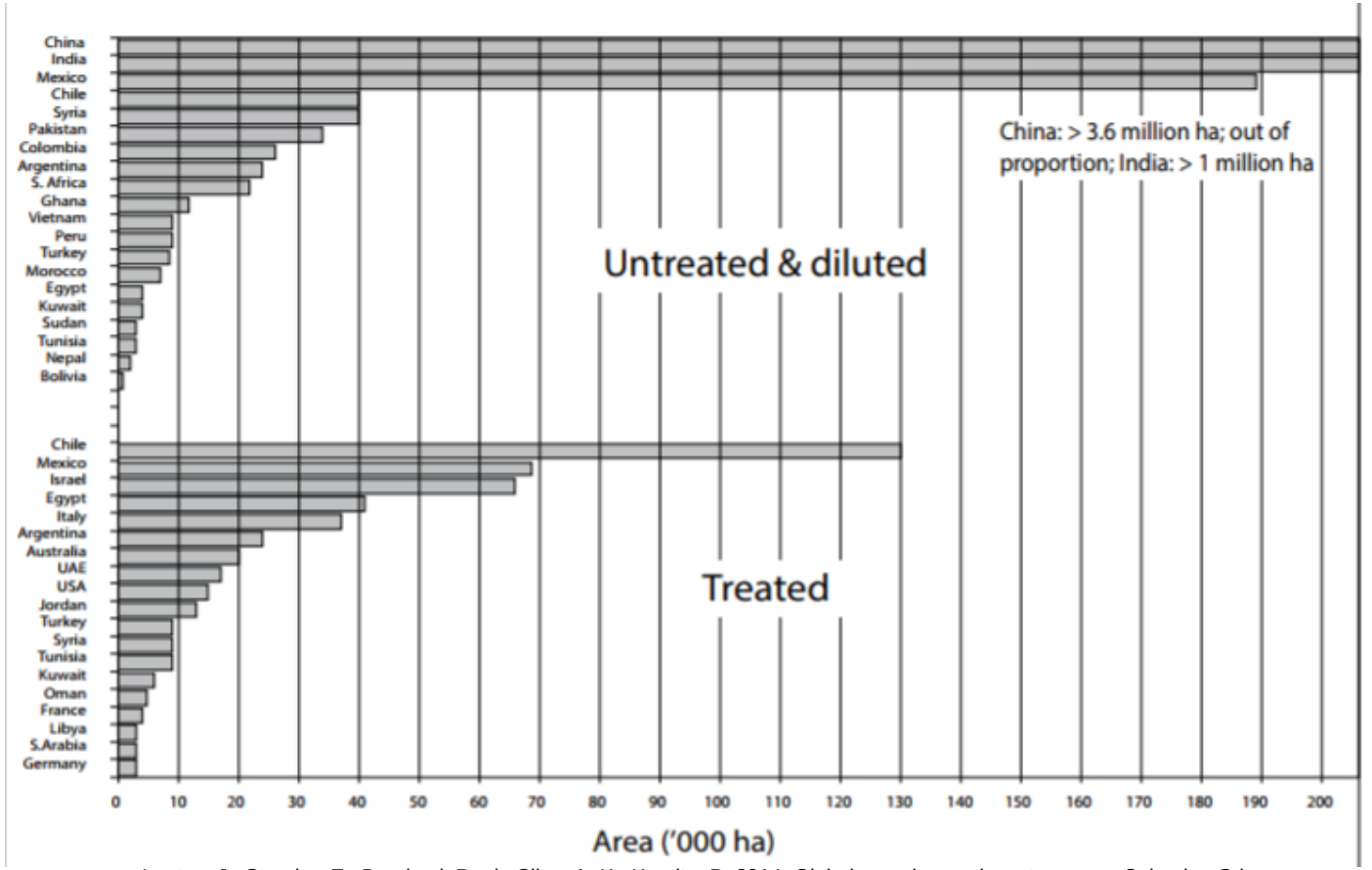
- In 2030, the reuse of wastewater is estimated to represent close to 2% of the global water use




GWI (Global Water Intelligence). 2009. Municipal water reuse markets 2010. Oxford, UK: Media Analytics Ltd

# REUSE OF UNTREATED VS. TREATED WASTEWATER IN AGRICULTURE

- The area of land irrigated with untreated wastewater is more than 10 times as great as the area irrigated with reclaimed water
- Crops produced from such irrigation comprise10 percent of global agricultural production from irrigation




Lautze, J.; Stander, E.; Drechsel, P.; da Silva, A. K.; Keraita, B. 2014. Global experiences in water reuse. Colombo, Sri Lanka: International Water Management Institute (IWMI). CGIAR Research Program on Water, Land and Ecosystems (WLE). 31p. (Resource Recovery and Reuse Series 4). doi: 10.5337/2014.209

# WATER QUALITY

- The global municipal wastewater generation is around 350 km³/year
- 80% of wastewater is discharged into the natural environment without any form of treatment

- Around 5% treated  at advanced level prior to reuse
- Yearly global increase in the advanced treatment for reuse < 1%  (IWA, 2009)

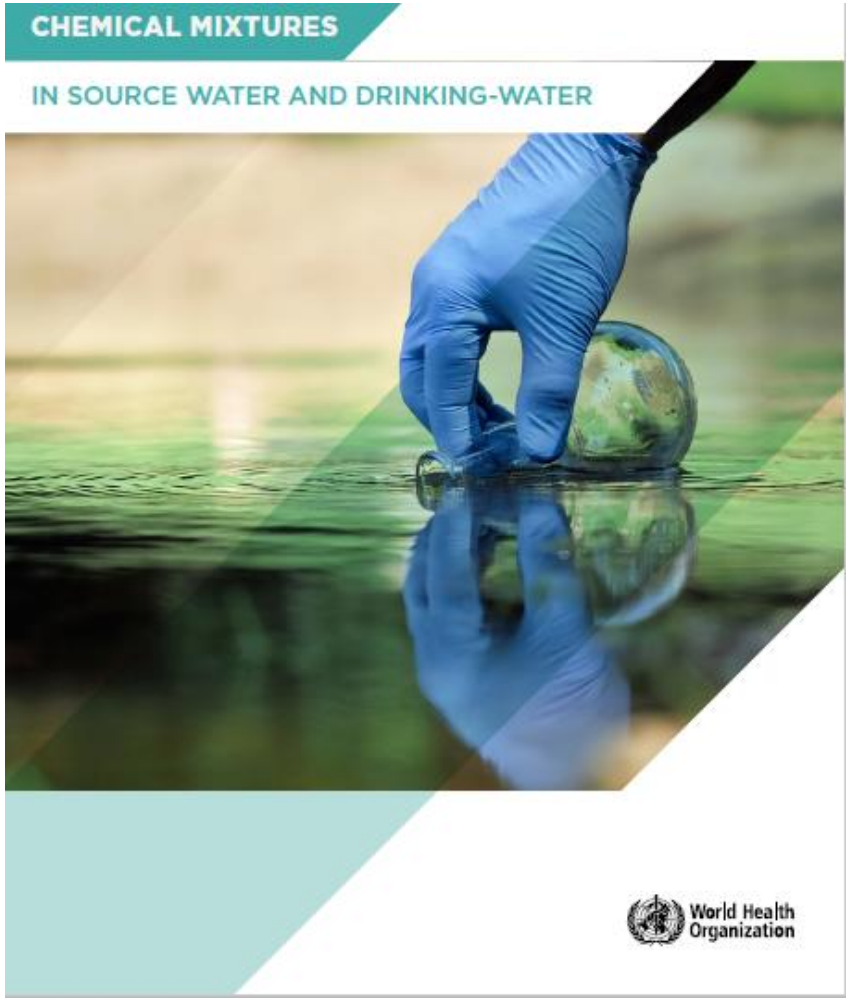
- The main sources of water pollution are inadequate treatment of human wastes and inadequately managed and treated industrial and agricultural wastes

# THE CHEMICALS RISK CYCLE

Technical nutrients of modern life style should be recycled within the technosphere (closed loop) and, when lost to the environment, reabsorbed in rates equal to their dispersion; **exchanged at levels below any adverse health effect level**

# CHEMICAL WATER POLLUTION

- **Emerging pollutants**
  - pollutants **not commonly monitored** or regulated in the environment
  - with known or suspected adverse **ecological and human health effects**
    - Pharmaceuticals
    - Personal care products
    - Pesticides
    - Industrial and household chemicals, metals, surfactants, industrial additives and solvents.

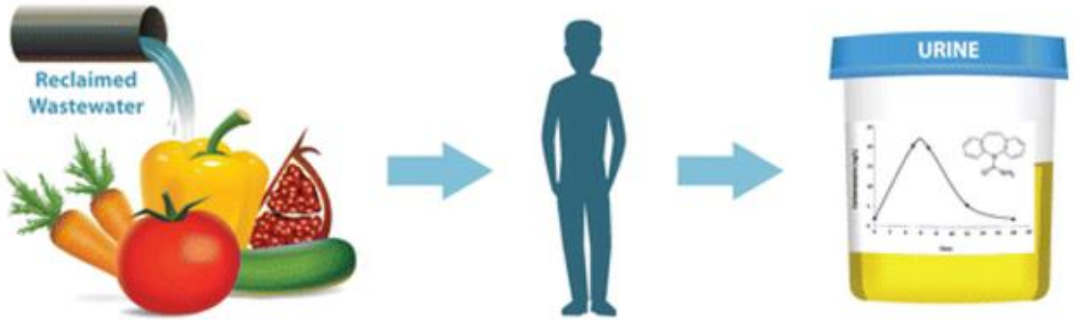



Chemical mixtures in source water and drinking-water ISBN 978-92-4-151237-4 © World Health Organization 2017

# INDIRECT AND DIRECT WASTEWATER REUSE IN AGRICULTURE

- Integration of municipal and agricultural water management systems through use of reclaimed wastewater (RWW) to irrigate crops have been implemented to solve the water scarcity challenge in several countries
- But to what extent do the fate of RWW-derived organic micropollutants in agro-ecosystems pose a risks of chronic exposure to these pollutants

- PPCP and industrial chemicals have been detected in reclaimed wastewater, some of them highly persistent in soil, and taken up by crops and subsequently measured in urinary samples




*Paltiel et al., 2016. Environ. Sci. Technol.*, **2016**, *50* (8), pp 4476–4482. **DOI:** 10.1021/acs.est.5b06256

# MANAGEMENT OPTIONS / NEEDS

(1) REDUCING USE

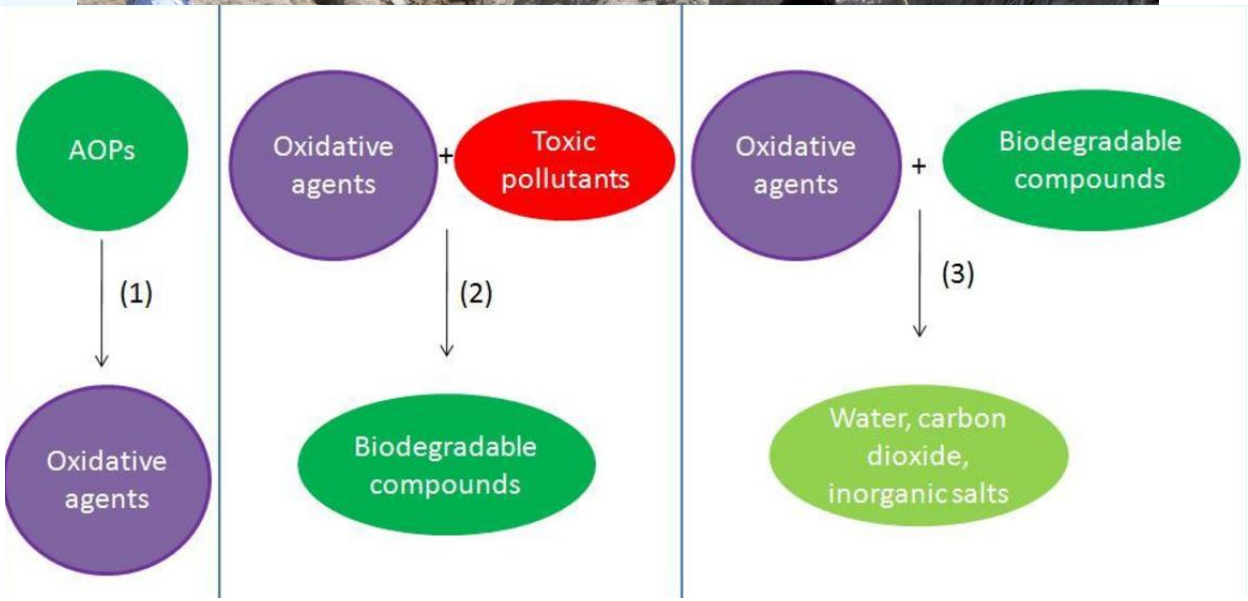
- decreasing human pressure on natural reservoirs by cutting per-capita consumption and collecting rainwater for domestic uses;

(2) REDUCING LOSS

- reducing loss of drinking water due to leakages via technological improvements

(3) **UPCYCLING PRIOR REUSE**

-reducing the pollutant load of the water circles by wastewater treatment such as advanced oxidation processes

# TO CREATE A WATER-SECURE FUTURE

- We need to reverse increasing pollution from degrading freshwater and coastal aquatic ecosystems
- Need to mitigate public health risks through measures taken along the entire food supply chain / bioeconomic value chains
- Investments in water treatment / biorefinery technologies
- Benefits across multiple sectors and at all levels
  - Water, food, feed, fiber, energy nexus

# CONCLUSIONS

- Pharmaceuticals, industrial chemicals and chemicals from consumer products in wastewaters are not monitored and not regulated.
- Emerging pollutants not commonly monitored represent a threat towards the natural water cycle and wastewater reuse as well as freshwater resources
- Pollutant detection, treatment, and recovery of resources have to be addressed in an integrated manner, to obtain clean, sustainable water supplies supporting human and environmental health

- Pollutants may enter the agroecosystem through e.g. reclaimed wastewater irrigation (direct), soil amendment with biosolids, sludge, or animal manure or irrigation from freshwater bodies (indirect)
- Regulatory standards for wastewater/ process water reuse for industrial, groundwater recharge and agricultural irrigation are needed
- Urban (blue and green) infrastructures must be designed and improved to enable a sustainable urban water cycle that links treatment plants, natural resources, and a reliable provision

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