Valuing wastewater

Challenges and opportunities of agricultural water reuse

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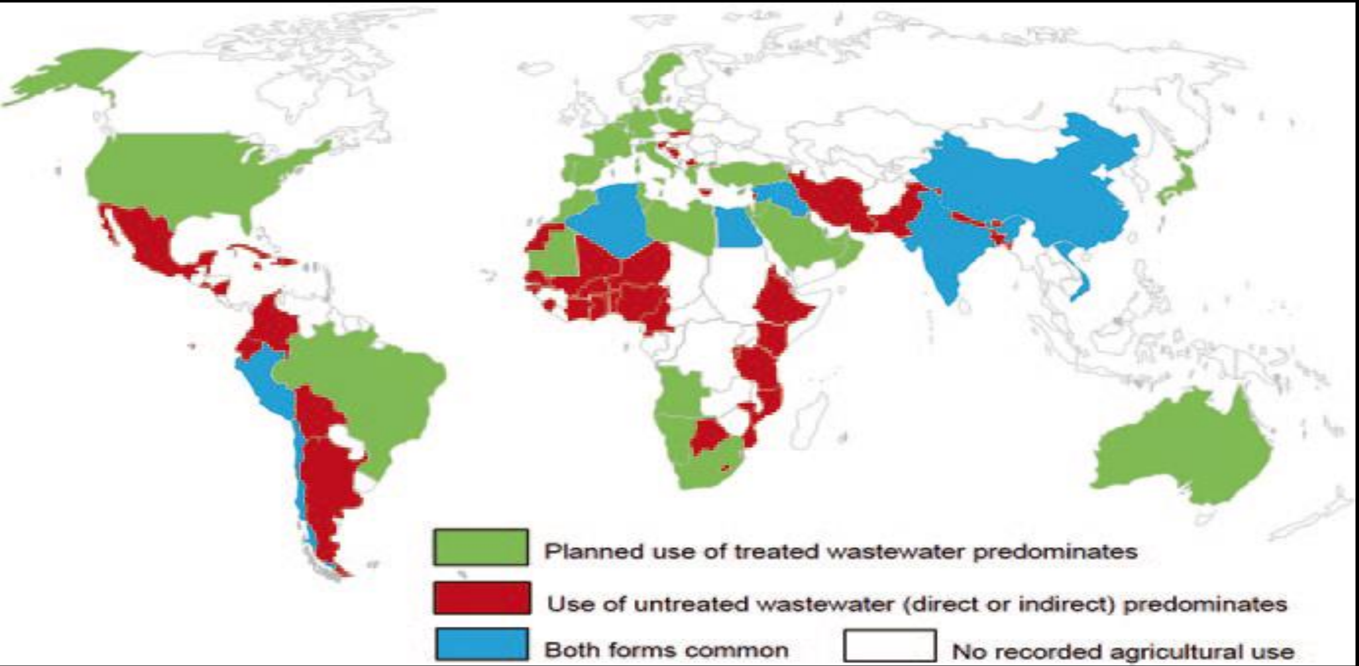
Harnessing opportunities for the safe reuse of wastewater in agriculture
Stockholm, 29 August 2017

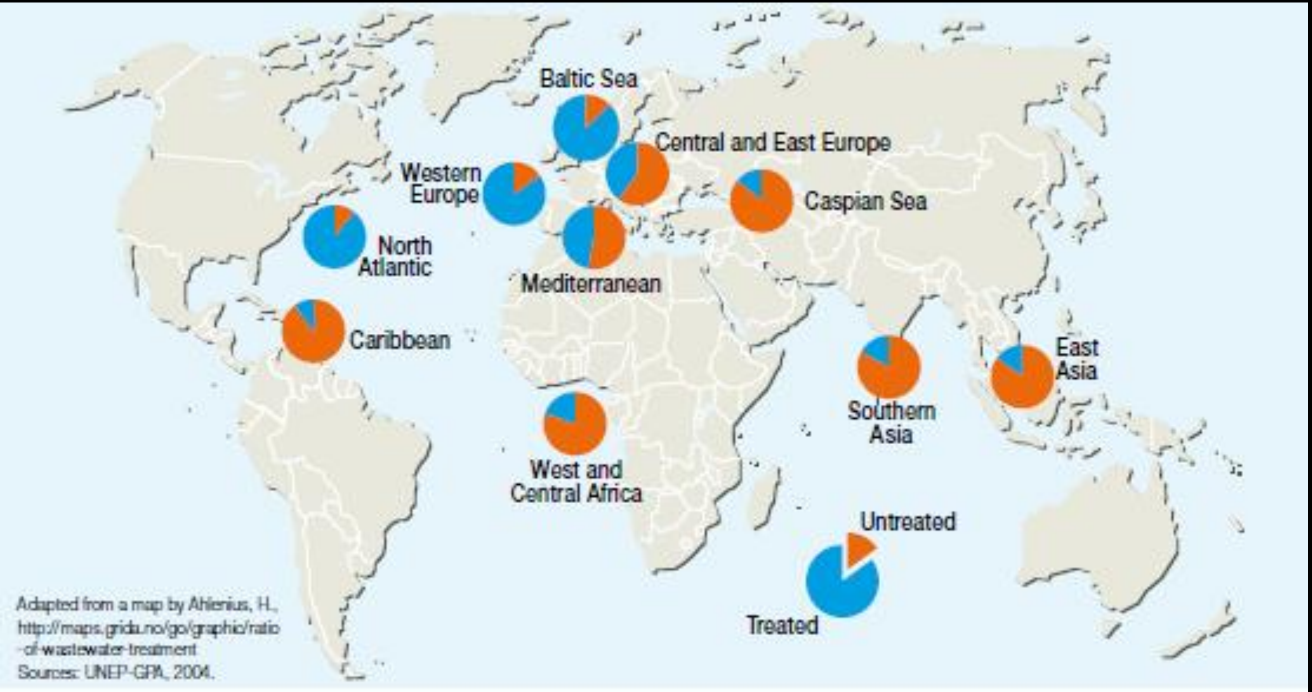
Countries with recorded water reuse for irrigation



Source: www.fao.org/nr/water/aquastat/wastewater/index.stm; and IWMI, unpublished

- **≈ 50 million m³/d (18 km³/yr)** of WW are **reused** (5-7% of the amount) - 58% is used untreated for irrigation (Jiménez and Asano, 2008)
- **≈ 29.3 million ha (≈ 9% of the global irrigated area)** irrigated with mostly raw wastewater (Thebo et al., 2017)
- Crops produced from irrigation with raw wastewater **≈ 10% of global agricultural production from irrigation** (Scheierling et al., 2010; Drechsel et al., 2010)

Ratio of wastewater treatment (treated to untreated wastewater)



- **330 km^3/year** of domestic WW generated in the world (Flörke et al., 2013)
- Over **80% of wastewater worldwide** not collected or treated (WWAP, 2012)
- Current **capacity to treat WW** to advanced levels is **only 7% of the total volume** of generated WW (GWI, 2009)

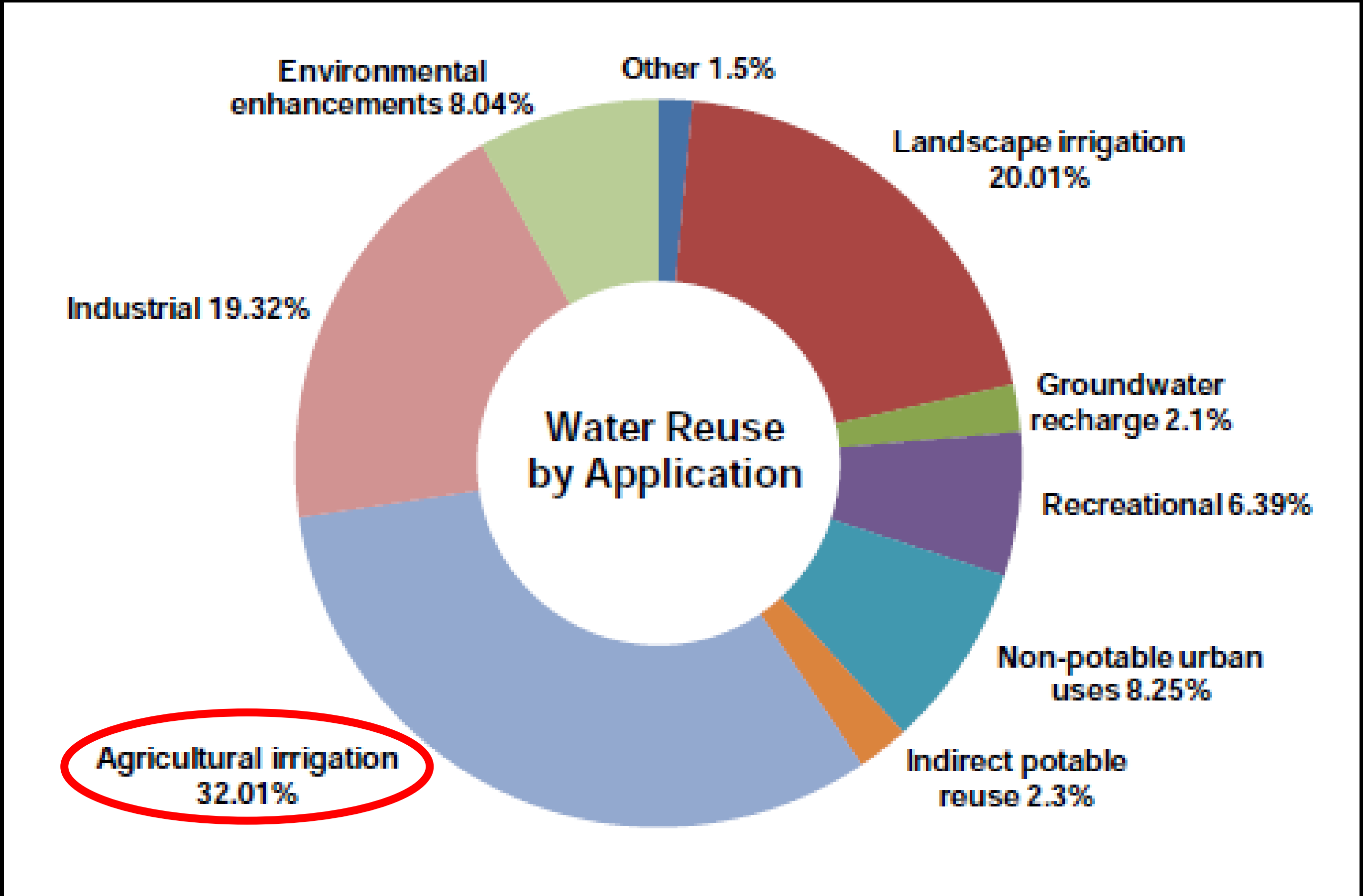
Untapped potential for resource recovery and reuse from wastewater

330 km^3 of municipal wastewater could theoretically:

- Irrigate more **than 40 million hectares (**8000 m^3/ha/yr) (FAO 2012)
- Provide ‘free’ fertilizer application in the order of **322 kg N/ha/yr and 64 kg P/ha/yr**
- Provide **electricity for about 130 million households** (3500 kWh/HH) (World Energy Council 2013)

Source: (Wilchens et al., 2015)

Water reuse options

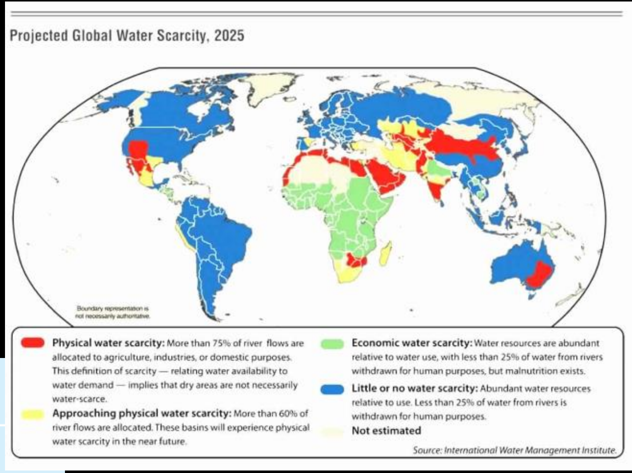


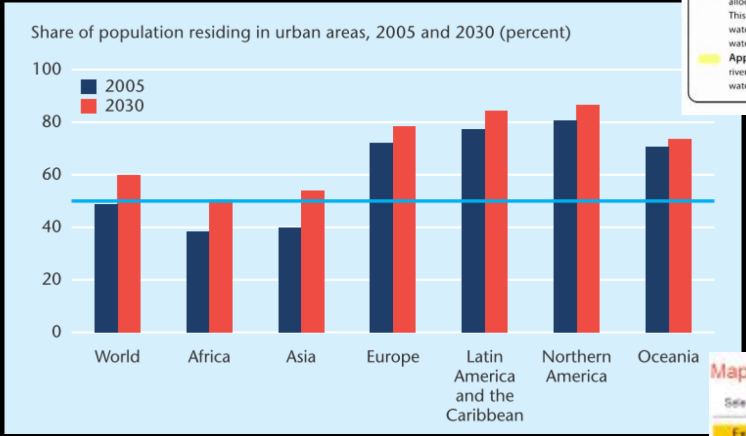
Most prominent and most rapidly expanding use of wastewater

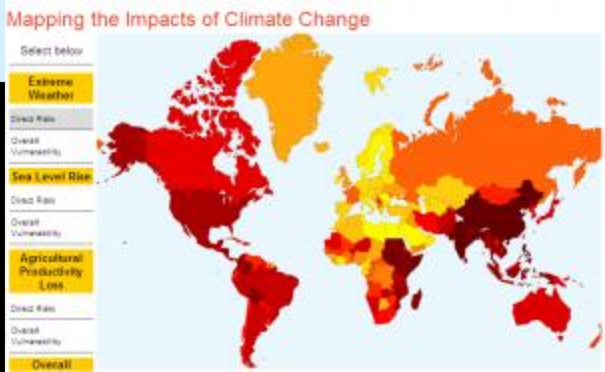
Source: GWI, 2009

Global drivers – Water quantity issues

- Water scarcity
- Population growth
- Urbanization
- Climate change
- Food production
- Water efficiency
- Energy efficiency
- Circular economy
- Environmental regulations

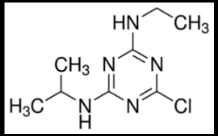
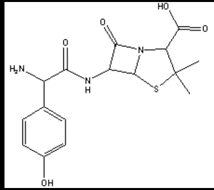


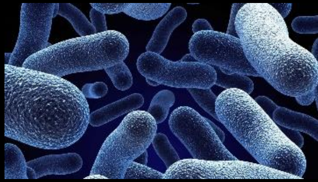




Water quality issues

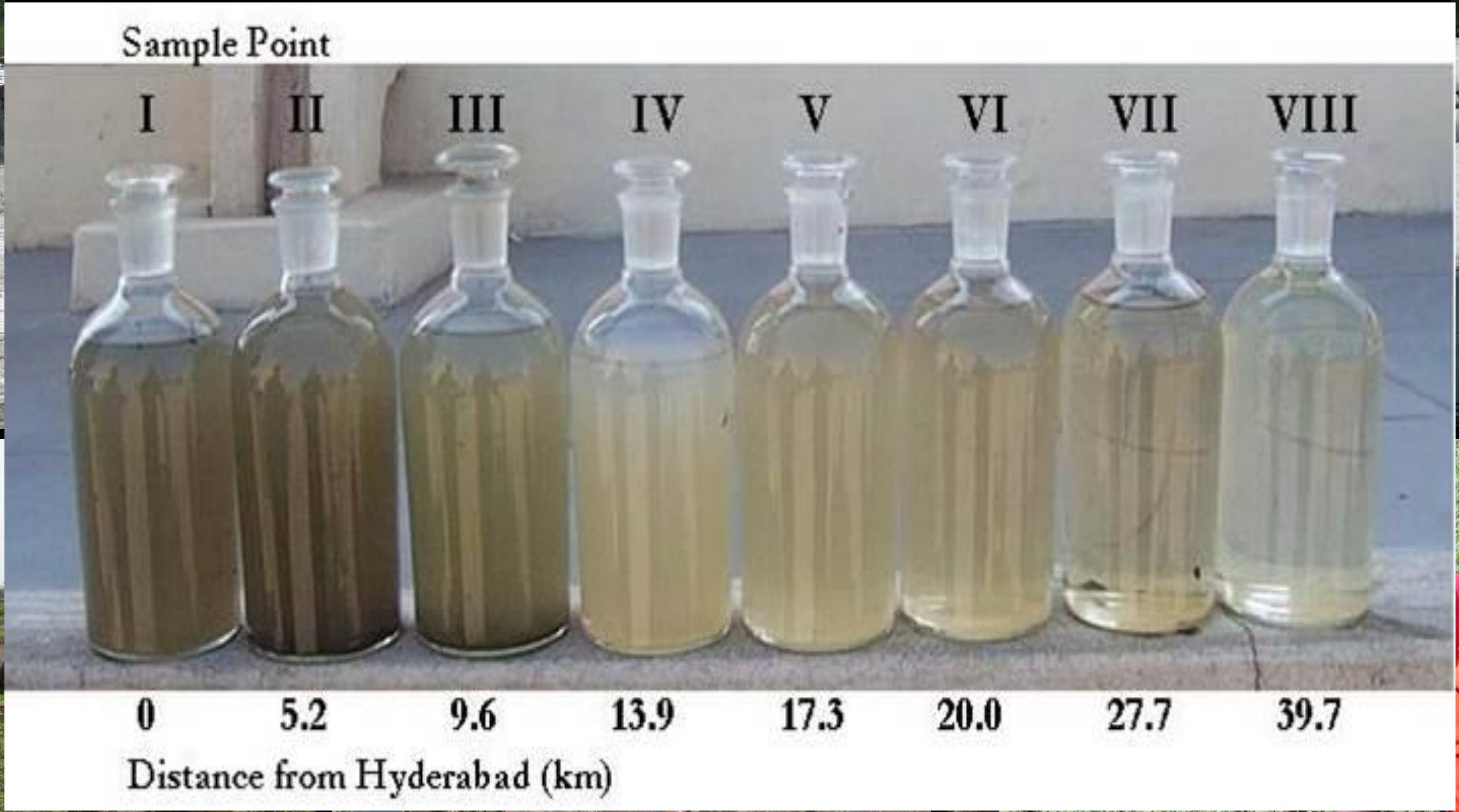
- *Microbial risks*:
  - Pathogens: Parasites, Bacteria, Viruses, Protozoa
- *Chemical risks*:
  - Trace elements: Cd, Pb, Hg, Ni
  - Organic compounds: pesticides
  - Trace organic chemicals: pharmaceuticals, hormones and endocrine disruptors, antibiotics, personal care products and household chemicals
- *Agronomic risks*:
  - Salinity, sodicity, B, trace elements and toxic ions management
- *Environmental risks: receiving bodies, soils, groundwater*
  - Salinity, Na, NO_3, B

	Benefits of agricultural water reuse
Social benefits	▪ Reliable and less costly irrigation water supply ▪ Protection of human health and ecosystems ▪ Improved nutrition and food security ▪ Increased income and employment generation ▪ Build climate resilient communities
Economic benefits	▪ Conservation and expansion of available water supplies ▪ Contribution toward a more IUWM ▪ Reliable and drought-proof alternative resource ▪ Save costs: new supply, disposal ▪ Recovery of water, energy, nutrients, sludge, C ▪ Increased crop production
Environmental benefits	▪ Avoidance of surface water pollution ▪ Conservation of freshwater resources ▪ Recycling of water, OM and nutrients and reduced use of artificial fertilizers ▪ Desertification control and desert reclamation ▪ Reduced energy costs and GHGs ▪ Improved water quality and flows

Wastewater use in Hyderabad, India



WASTEWATER RECLAMATION AND REUSE IN TUNISIA

Irrigation of food and non-food crops in Kuwait

$41 Million, 70% of USA’s Crop, 2150 ha

$16 Million, 6.0% of USA’s Crop, 950 ha

Sprinkler & Buried Drip Tape Irrigation

$44 Million, 1.6% of USA’s Crop, 2900 ha

Sprinkler Irrigation

MONTEREY COUNTY WATER RECYCLING PROJECT CALIFORNIA (USA)

Capacity: 114,000 m^3/d

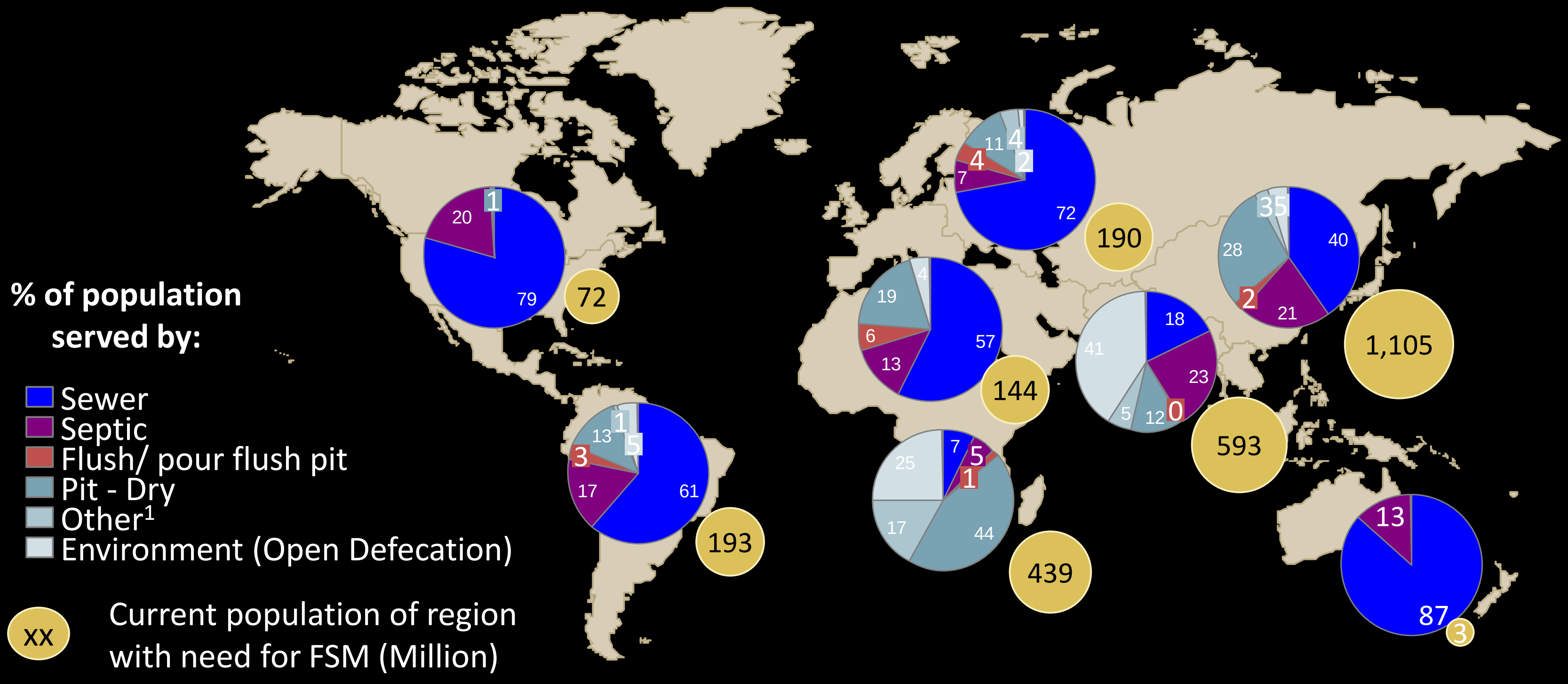
Disinfected Tertiary Recycled Water

6,000 hectares of which 5,000 ha of raw-eaten vegetables: Celery, Lettuce, Artichokes, Strawberries, Broccoli, Fennel, Cauliflower

Major challenges of water reuse

- Technical challenges
- Institutional obstacles
- Food safety and public perception
- Public education, participation and support
- Acceptance
- Economic viability
- Government support, politics and public policy

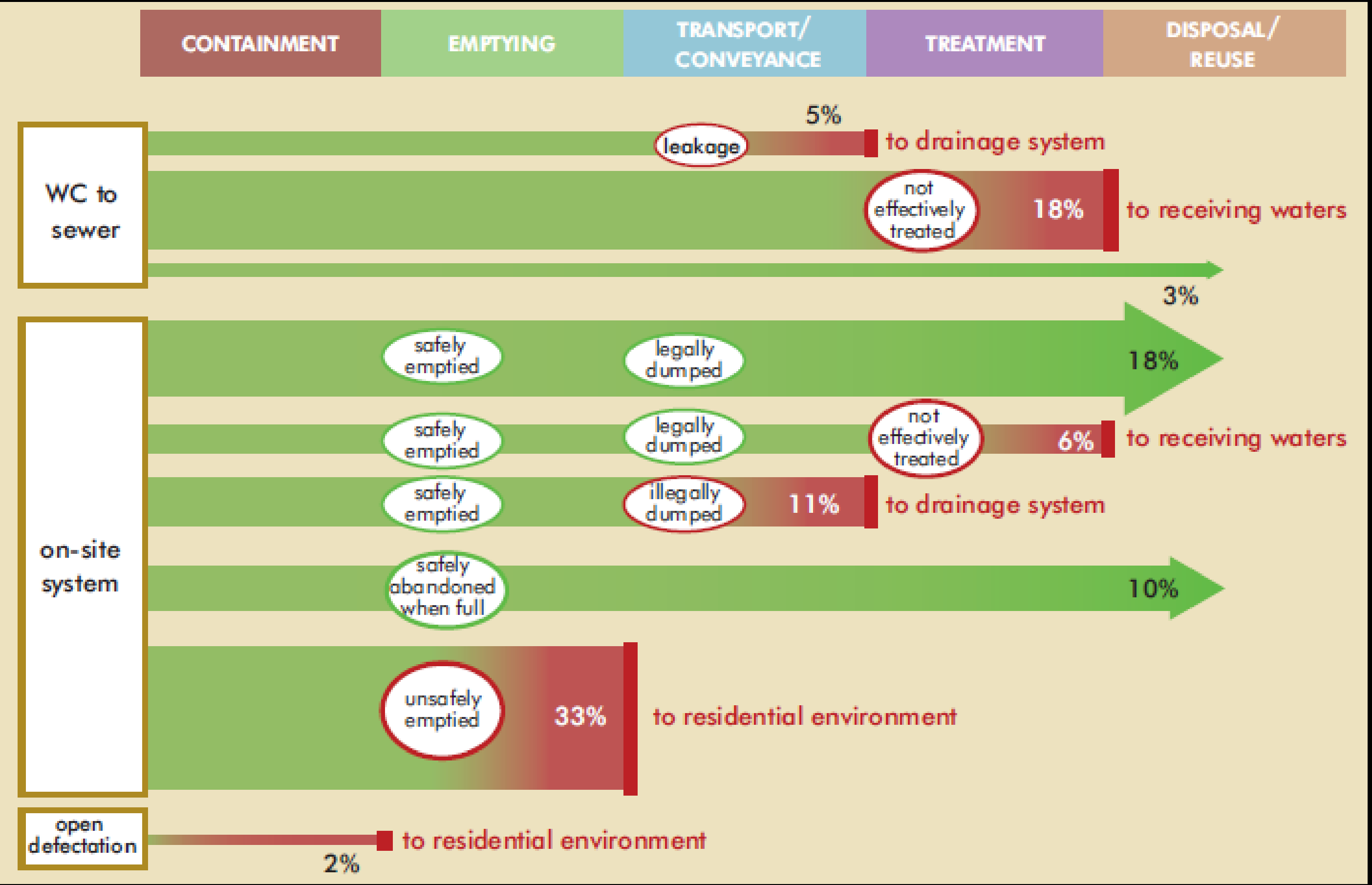
~2.7 BILLION PEOPLE WORLDWIDE NEED FECAL SLUDGE MANAGEMENT TODAY
~5 BILLION BY 2030



1. Open pits, pits without slabs and composting toilets included in "Other" as these do not need FSM (open pits/ pits without slabs covered up when full)

Source: UN JMP sanitation data, BCG analysis

Wastewater and Fecal Sludge Management in Dakar (Senegal)



31% safely managed

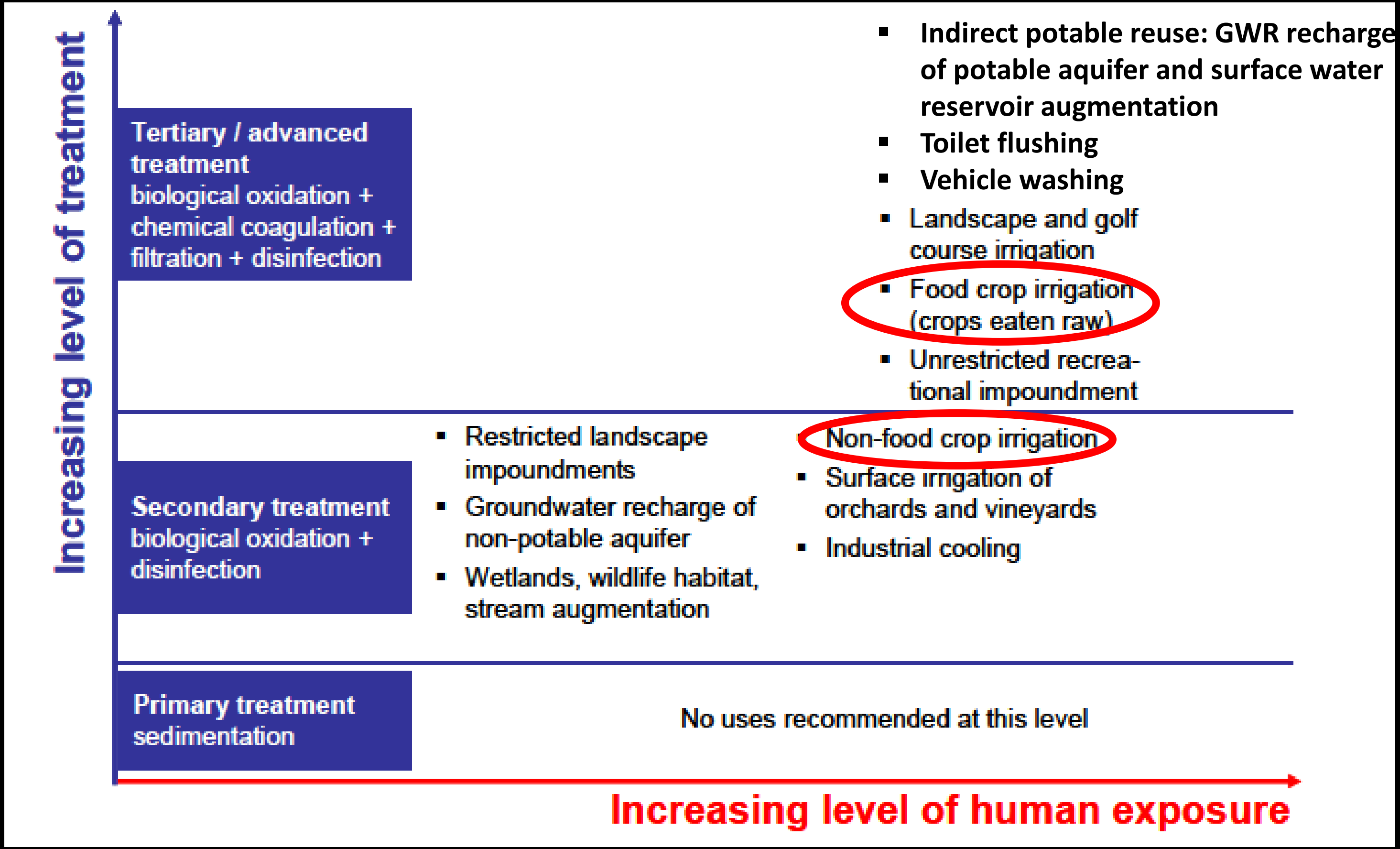
69% unsafely managed

Source: SEI based on WSP, 2014

Informal Urban and Peri-Urban Agriculture

Contamination of irrigated vegetables sold in the markets with FC and HE:
> 10^3 FC/g fresh weight and up to 3 HE/g of vegetables

Water recycling technologies and water quality requirements



Source: Wintgens and Hochstrat, 2006 (Aquarec), USEPA, 2012

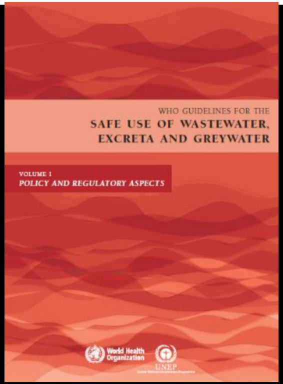
Major challenges of water reuse

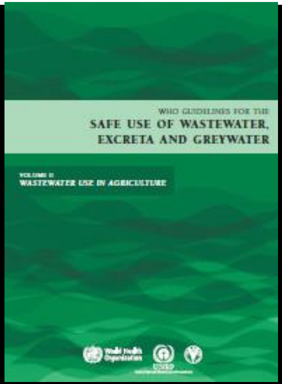
Converge regulatory frameworks

- Regulatory framework must support water reuse
- A health-based approach is necessary for all water reuse applications (WHO 2006, Australia 2006-2009)
- Regulation enforcement *e.g.* water quality monitoring should be realistic and economically affordable

WHO Guidelines for the safe use of wastewater in agriculture (2006)
A multi-barrier approach

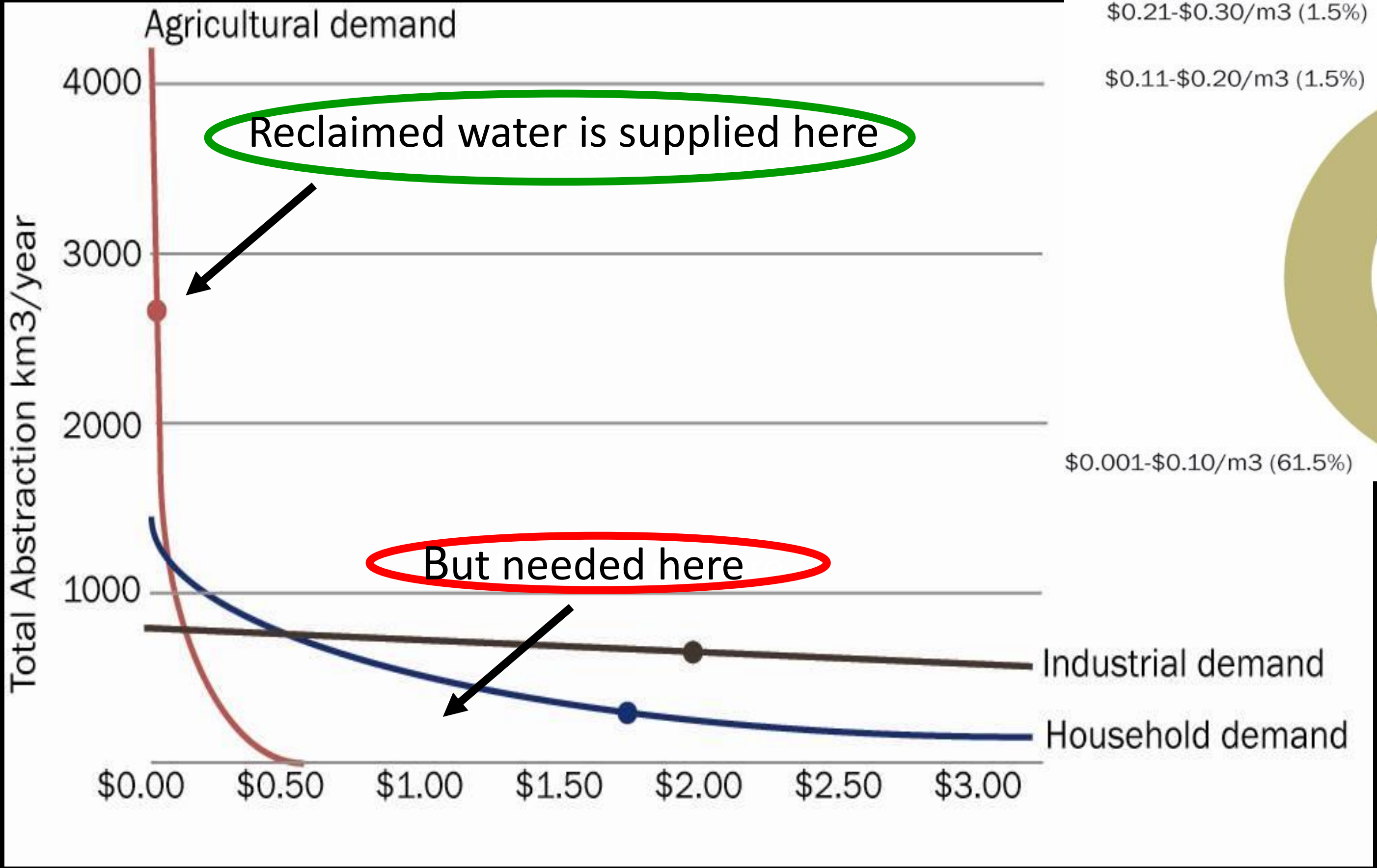
California Code of Regulations
Title 22, Division 4, Chapter 3
Water Recycling Criteria (2000)

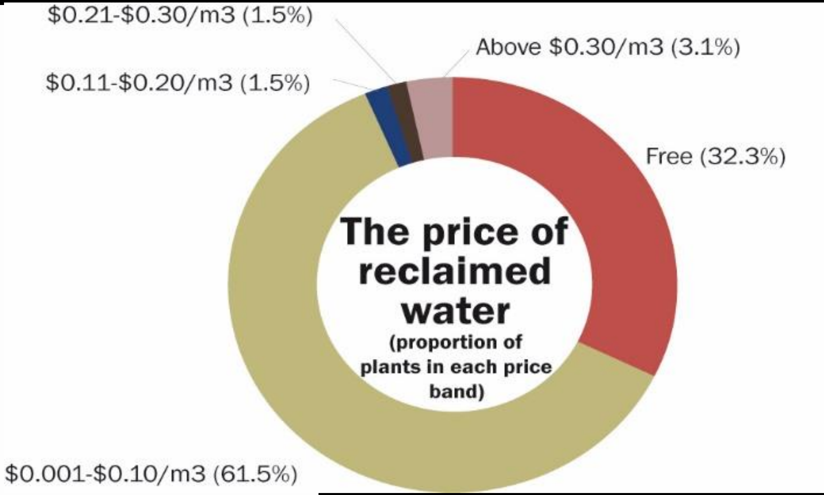




Australian National
Water Reuse Regulations
(2006-2009)

Reuse and the water economy





Source: GWI, 2009

Progressing from unplanned to planned agricultural reuse

This process requires decades

Low-income countries

*Low-cost treatment options

*Policy reforms and non-structural interventions

*Multi-barrier options for post-treatment health-protection control

Middle-income countries

*Water reuse policies, institutions, and regulations, and some WWT

* Need for improved financial management for mobilizing needed investments to maintain and improve overall operations

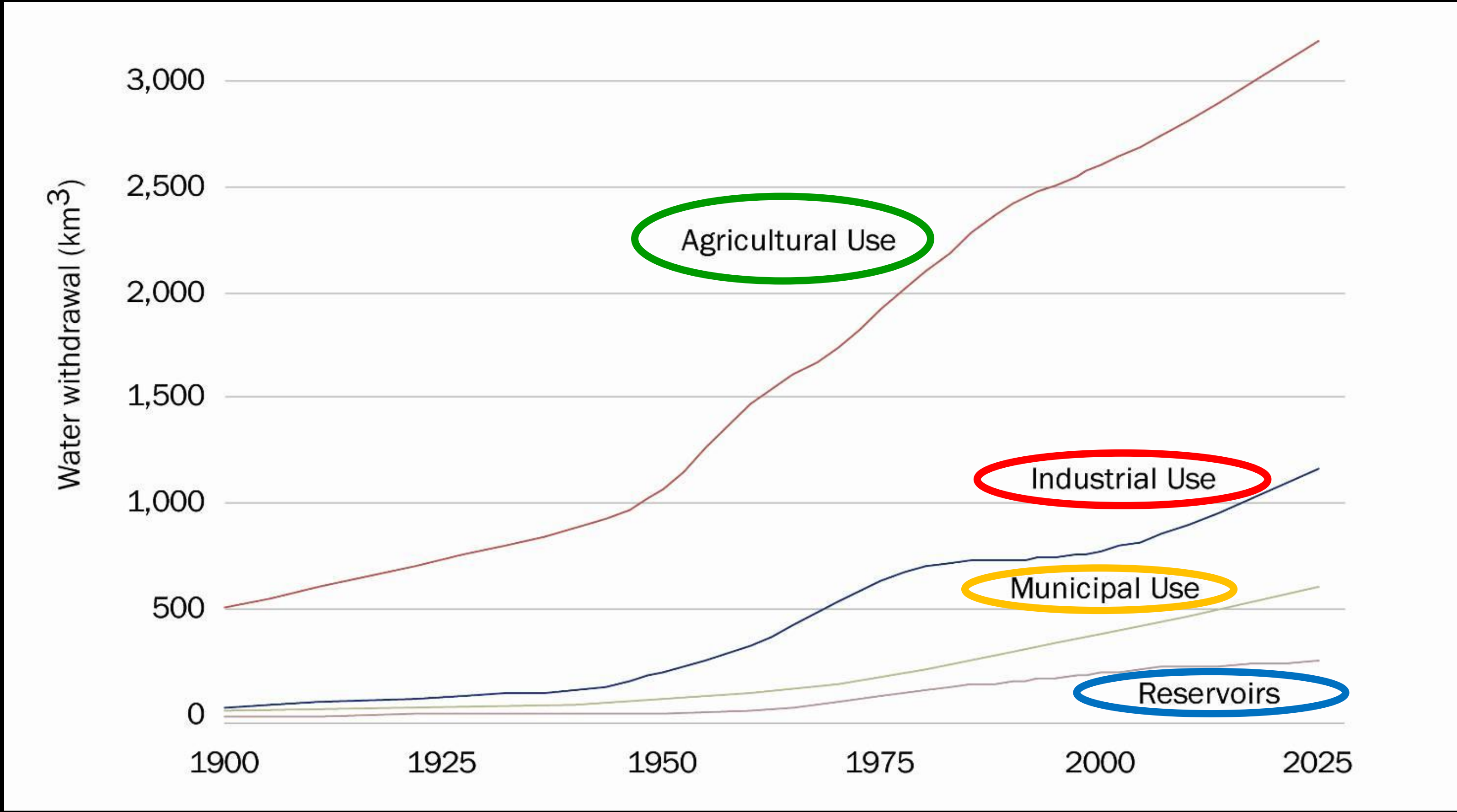
High-income countries

* Stepwise implementation of policies and regulations

*Progressively more stringent standards for water and wastewater quality and use for irrigation

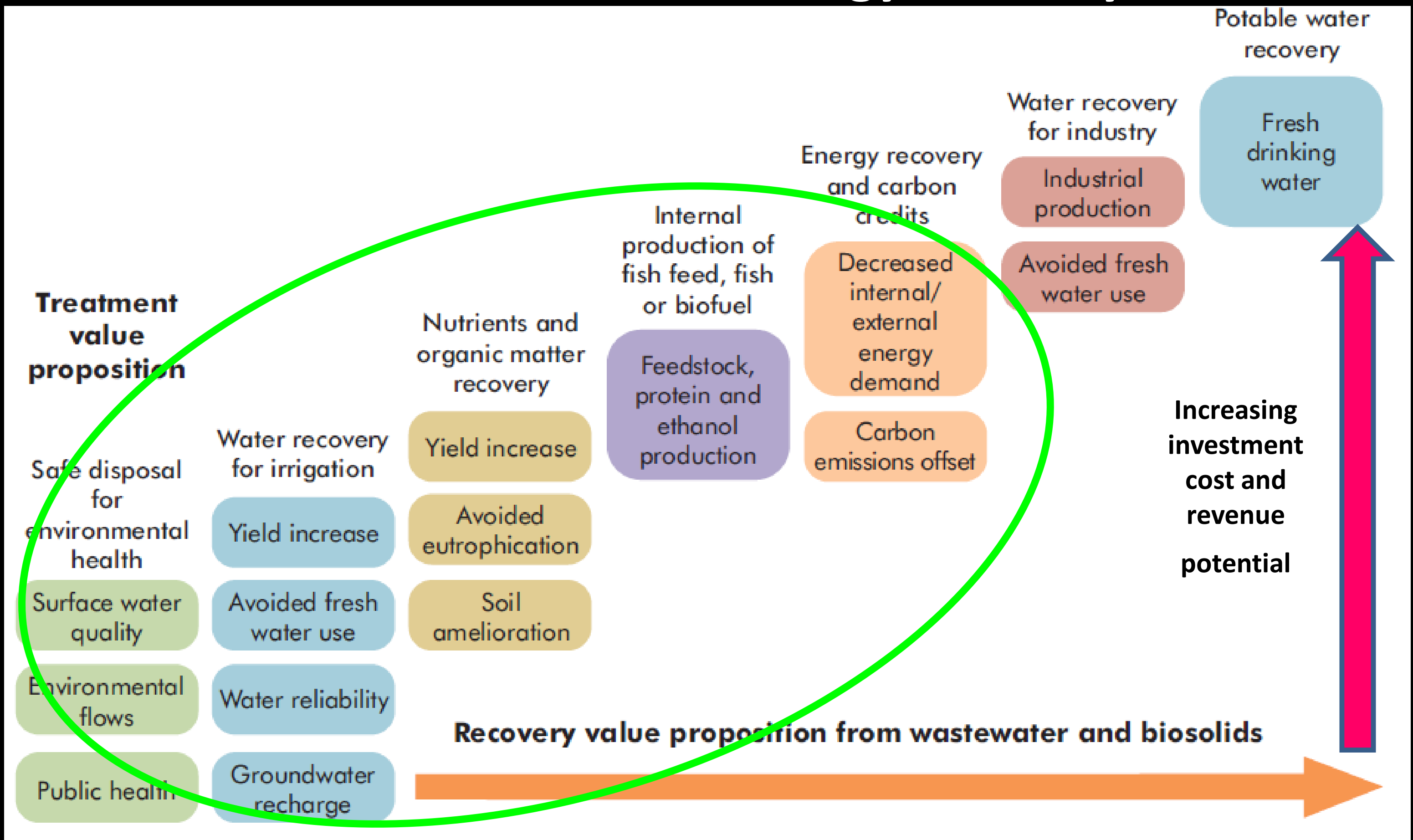
Source: Adapted from World Bank, 2010

Agricultural users vs others users

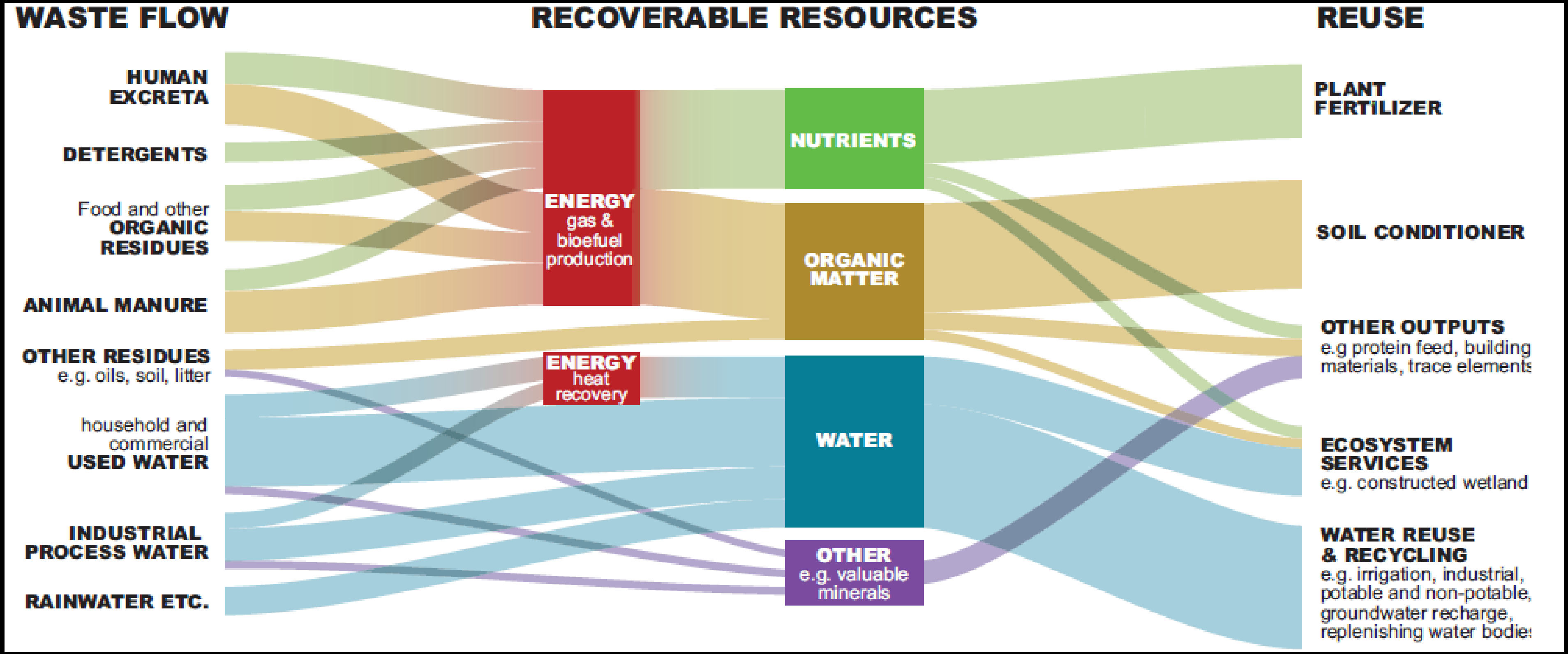


Source: GWI, 2009

Ladder of increasing value propositions related to wastewater treatment and water, nutrient and energy recovery (Source: IWMI, 2015)



Waste resources and potentials for improved management and recovery



Source: SEI based on WSP, 2014

Testing Fecal Sludge recycling under a PPP in Ghana

Municipality → Private company ← Research / development organizations

Private truck operators → (Waste) → FS treatment / Compost production plant → (Compost) → Farmers, Landscapers, Agroforestry

IN

- 15,000 m³/yr FS
- 700 tons/yr SW

Dewatering, co-composting with organic municipal waste, enrichment and pelletization

OUT

- Compost for 100 ha/yr
- Yield increase by 20-50%
- Aquaculture

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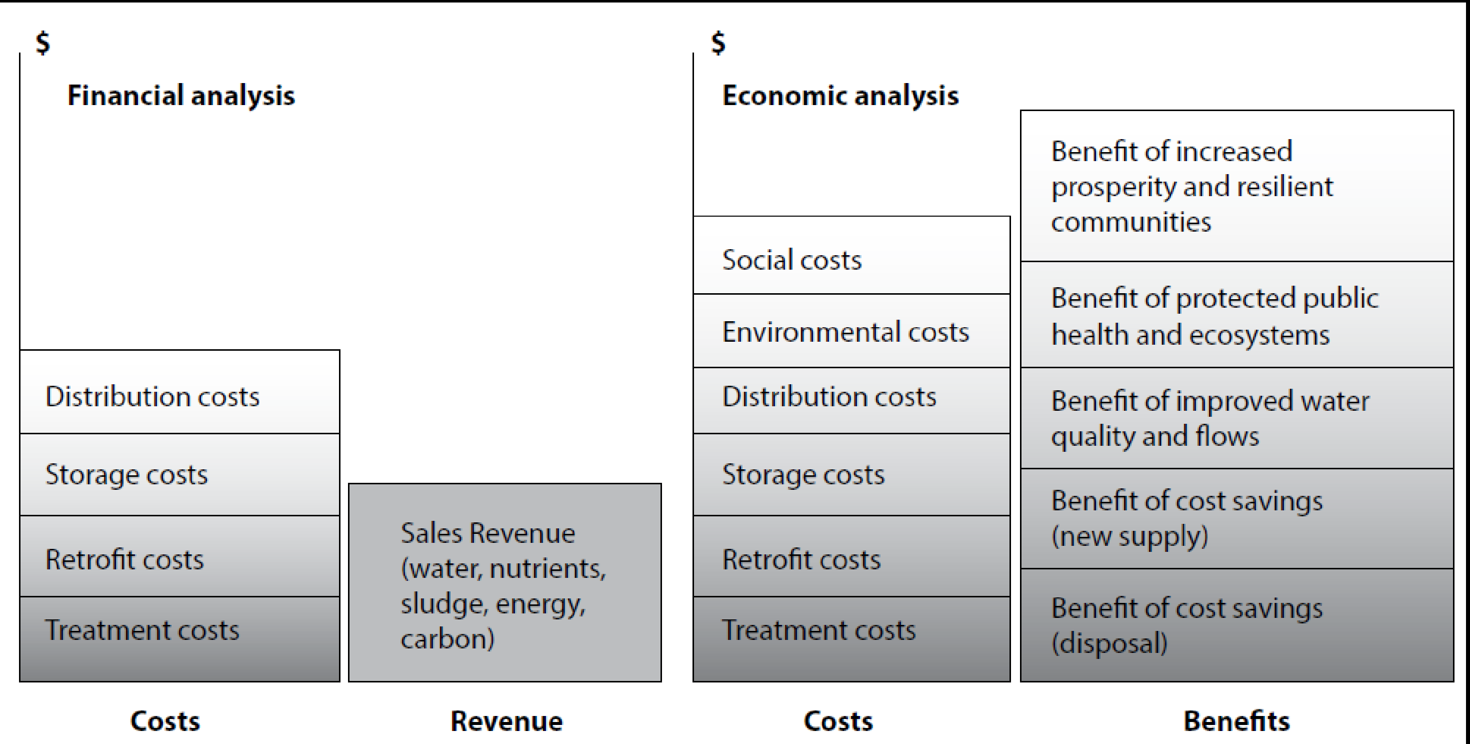
Financial versus economic analysis to evaluate the costs and benefits of water reuse



As an essential component of a circular economy, wastewater use and by-product recovery can generate new business opportunities while helping finance improved sanitation services

Source: WaterReuse Foundation, 2006, adapted by Hanjra et al., 2014

Conclusion

- The potential to generate valuable input and income from waste and wastewater still largely untapped. High risks associated with the reuse of untreated or improperly treated wastewater and excreta. Several innovations offer new business models and market opportunities
- Improved WW & FS management generates social, environmental and economic benefits, and is essential to achieving the 2030 SDGs (WWDR, 2017)
- WW & FS are cost-effective and sustainable sources of water, energy, nutrients and other recoverable by-products, with direct benefits to food and energy security
- Agriculture needs to be integrated into urban sanitation concepts as a major way of closing the water and nutrients loops
- A tailored ag. water reuse strategy with the planning approaches, policies, and investments adapted to the local conditions and with incremental solutions to move from an informal practice to a formal one
- Contributions from all stakeholders: governments, NGOs, and private sector

Thank you