

# Emerging solutions to the water challenges of an urbanizing world

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**Håkan Jönsson Farewell Symposium**

# Håkan Jönsson: A pioneer of urine source separation

## **Where we first met:**

Jönsson et al. (1997) Source separated urine-nutrient and heavy metal content, water saving and faecal contamination. Water Sci.Tech. 35 (9), 145-152.

**20 years later, urine source separation still has not taken off. Does this mean that we have failed?**

# Urine source separation in a historical perspective

[Journal of Hygiene](#), Volume , Issue 5, November 19 , Pages 609-653

**On the rôle of bacteria in the biological methods of sewage purification, with special reference to the process of denitrification**

[Mair, W.](#)

University of Manchester, United Kingdom

The investigations ... were carried out in connection with the **experimental plant** laid down by the Corporation of Belfast with a view to **discover the most suitable method** of dealing with the sewage of that city. ...

# Urine source separation in a historical perspective

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**On the rôle of bacteria in the biological methods of sewage purification, with special reference to the process of denitrification**

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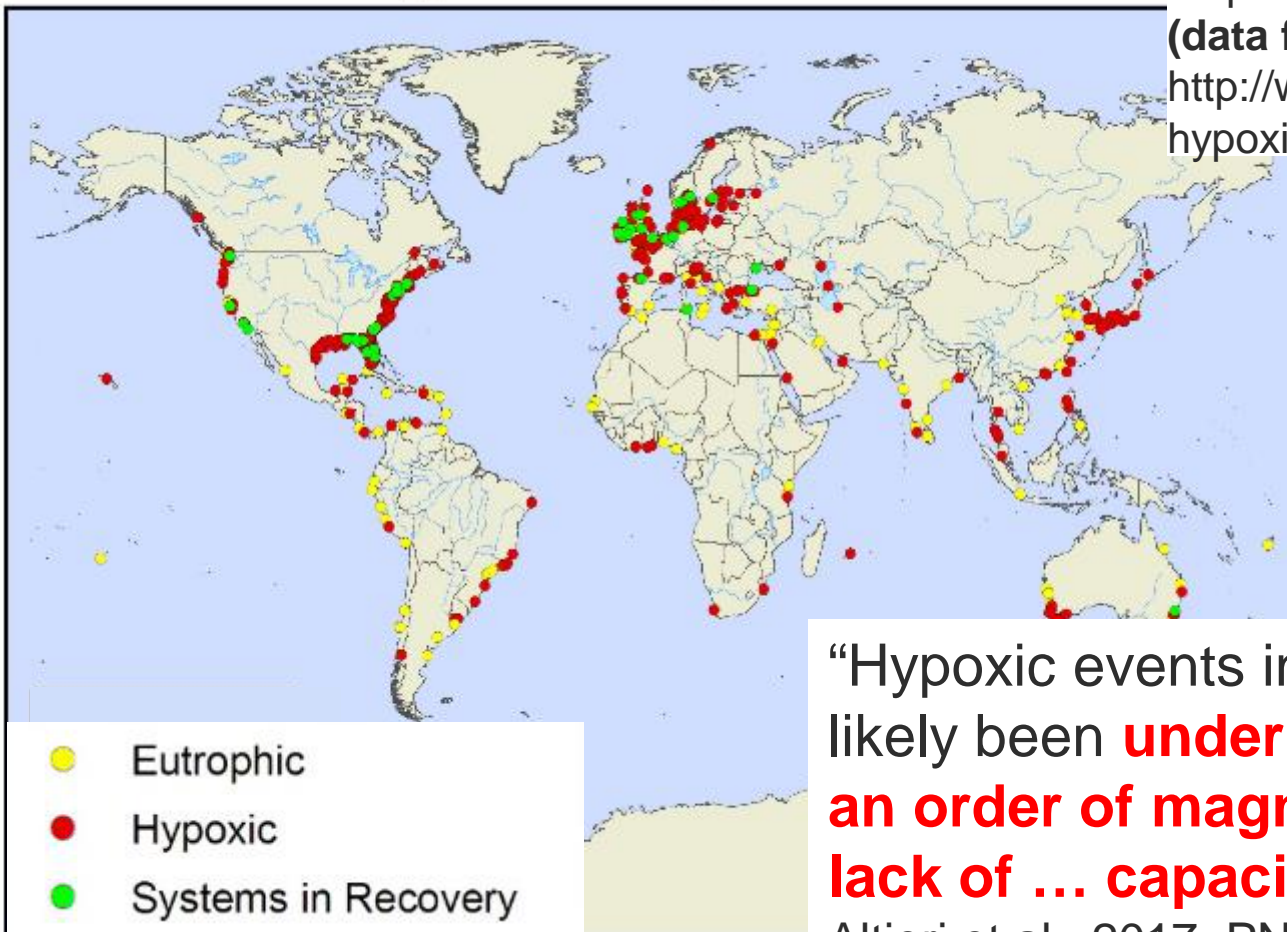
University of Manchester, United Kingdom

**In the area of wastewater treatment,  
new technologies are only advanced  
when there is a clear problem to solve**

# What is the problem of nutrients on a global level: Hypoxia ('Dead Zones')

World Hypoxic and Eutrophic Coastal Areas

Map from World Resources Institute  
(data from 2010)  
<http://www.wri.org/resource/world-hypoxic-and-eutrophic-coastal-areas>



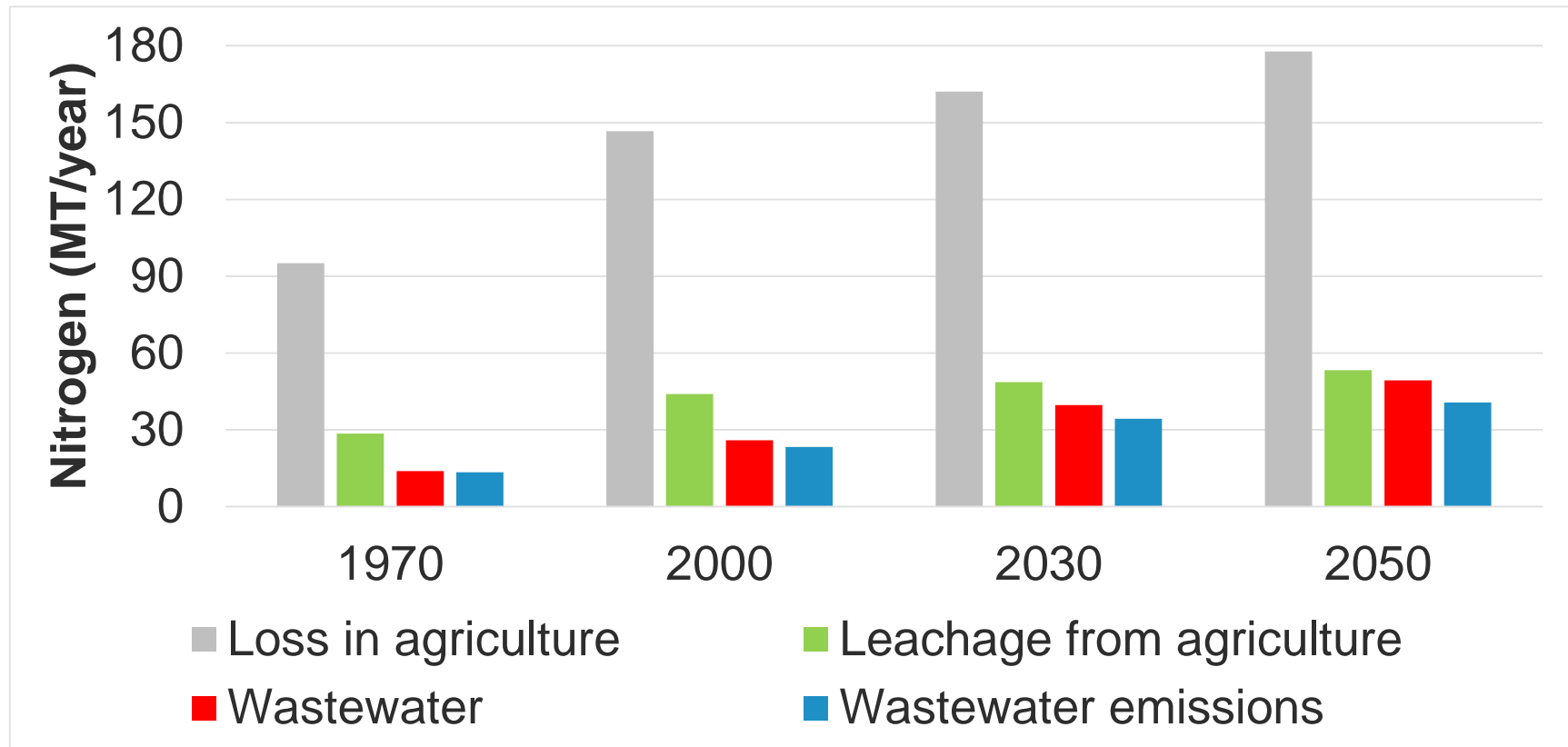
“Hypoxic events in the tropics ... have likely been **underreported**, perhaps by **an order of magnitude**, because of the **lack of ... capacity** for their detection.

Altieri et al., 2017, PNAS 114(14), 3660–3665

# Global N-emissions from agriculture and wastewater

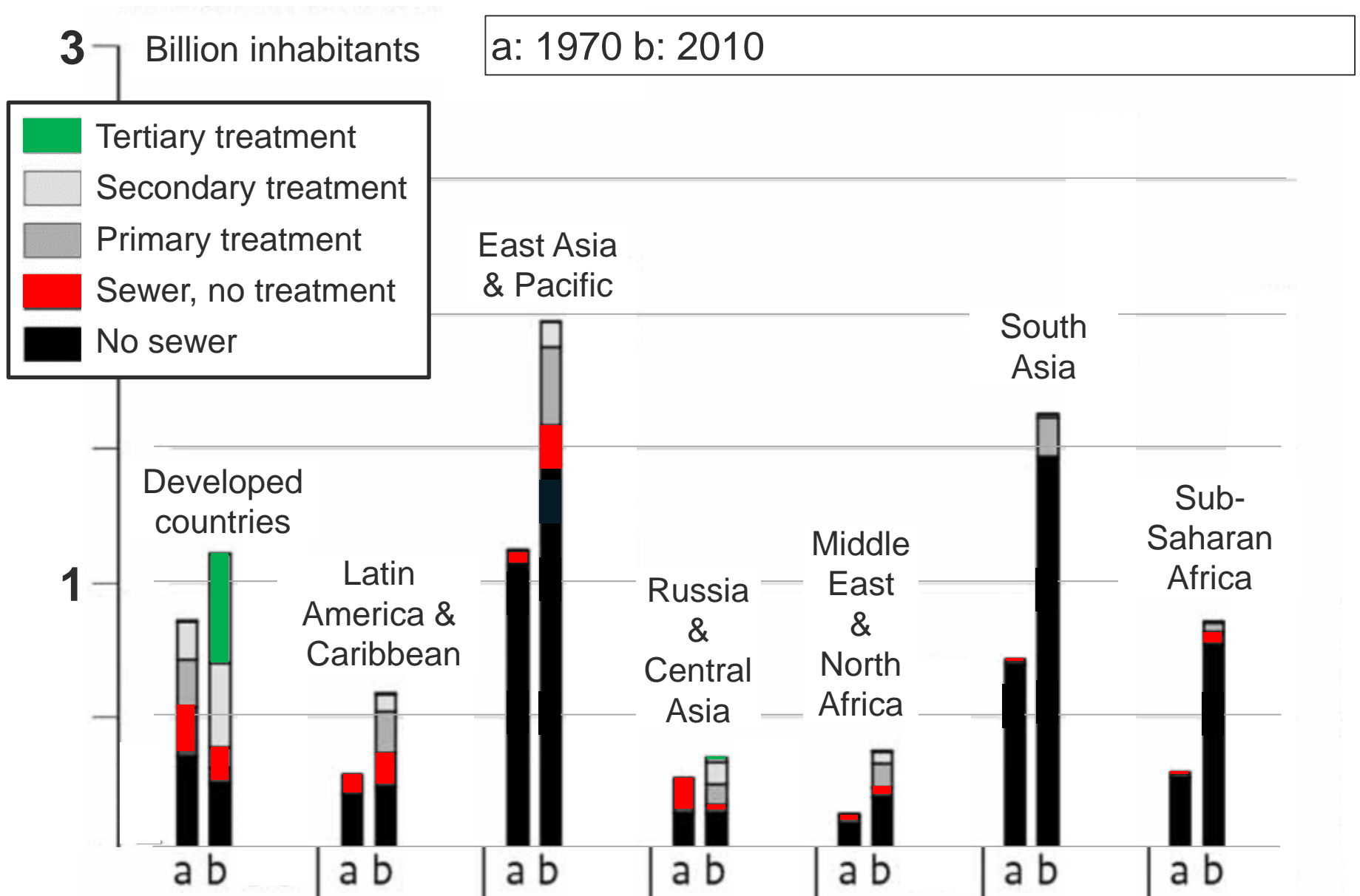
Bouwman et al. (2009), Van Drecht et al. (2009).

Model predictions are average values from 4 different scenarios



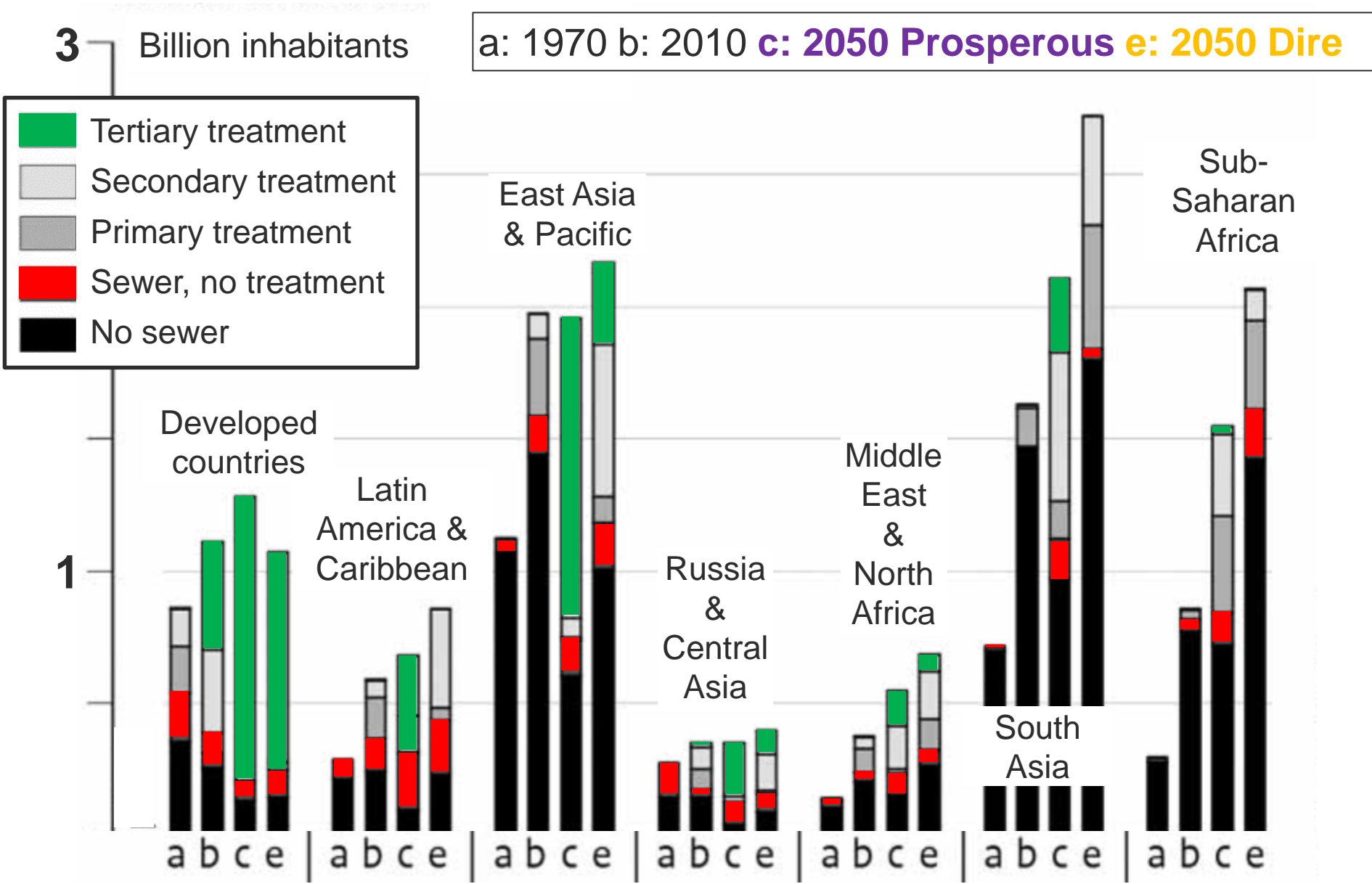
# The global strategy for wastewater

From Puijenbroek et al., 2015, Water Science and Technology 71(2), 227-232



# Prognoses for global wastewater treatment

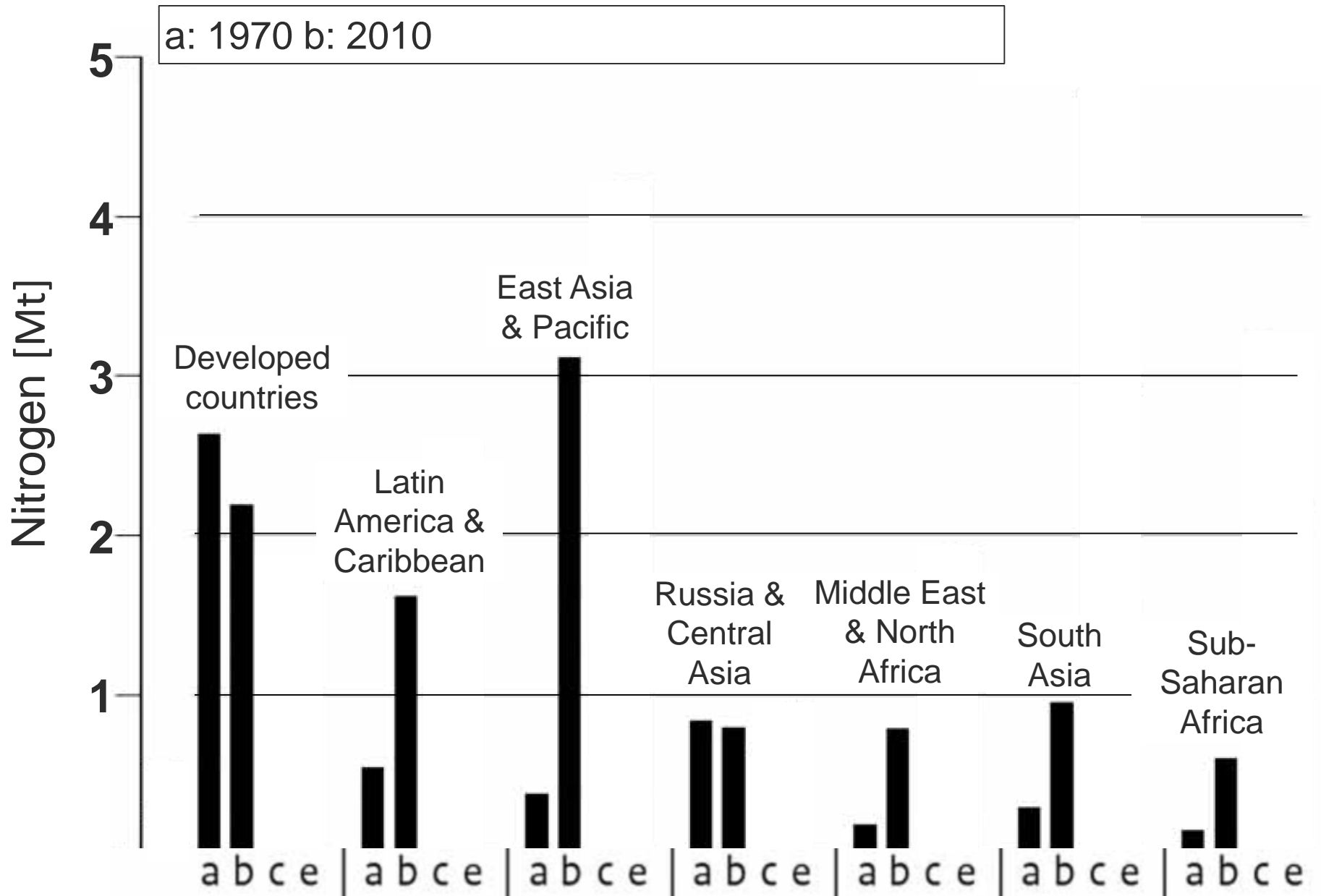
From Puijenbroek et al., 2015, Water Science and Technology 71(2), 227-232





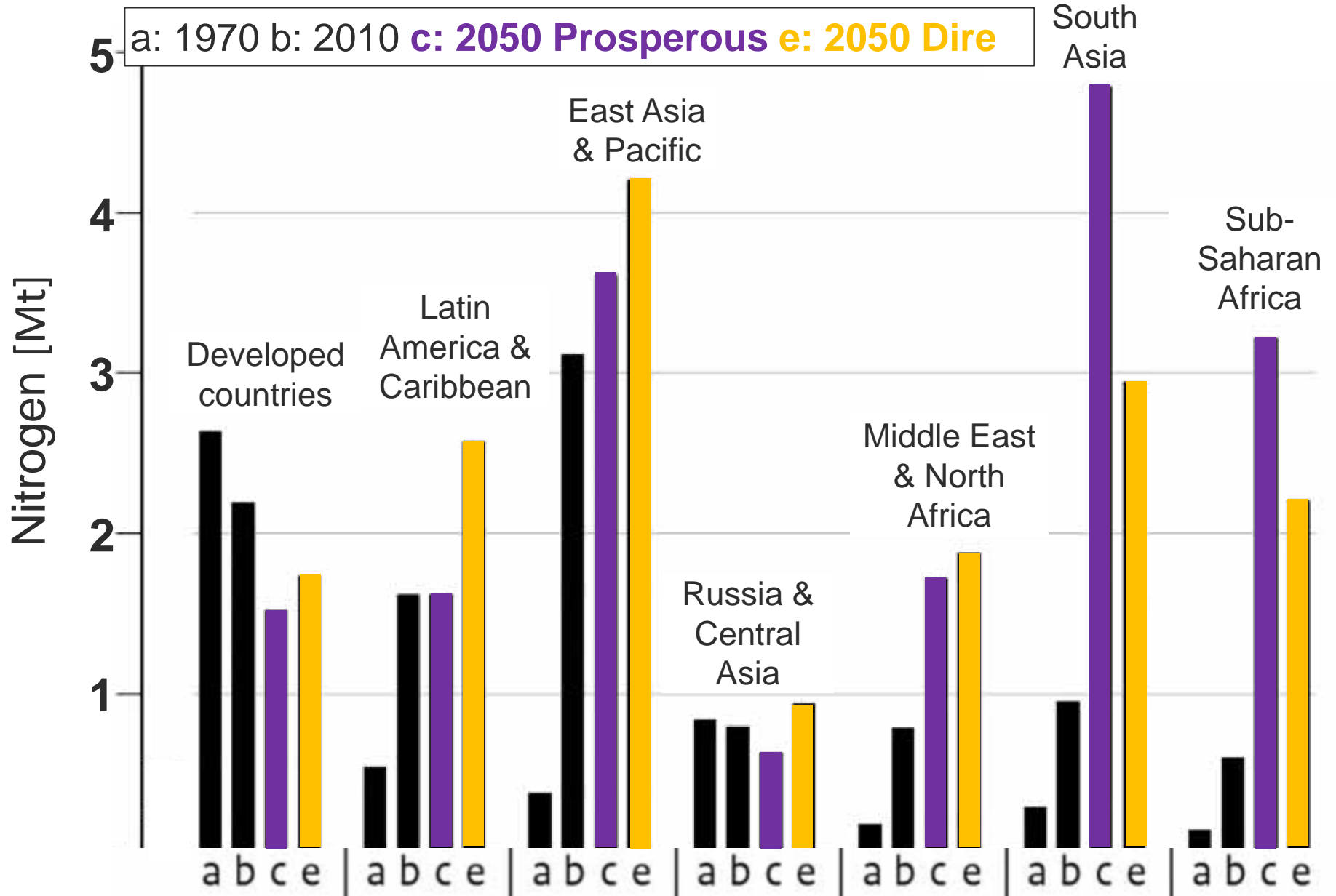
# Nitrogen from wastewater (ww) to surface water

From Puijenbroek et al., 2015, Water Science and Technology, 71(2), 227-232



# Prognoses on nitrogen from ww to surface water

From Puijenbroek et al., 2015, Water Science and Technology, 71(2), 227-232



**Can urine source separation be part of the solution to the unprecedented increase in global nutrient emissions?**

**One billion people live in slums today and as part of the rapid population growth and urbanization this number may increase to two billion**

In 2011, the Bill & Melinda Gates Foundation invited 21 research units to develop a zero emission slum toilet

- Western comfort (no smell, flies, etc.)
- Availability of water –  
for hand washing, anal and menstrual hygiene
- Must function without ‘grids’  
(pipes, sewer, electricity)
- Full resource recovery & zero emission
- Costs below 5 cents/person/day
- No transport of excreta

# Blue Diversion System Design **(with some transport)**

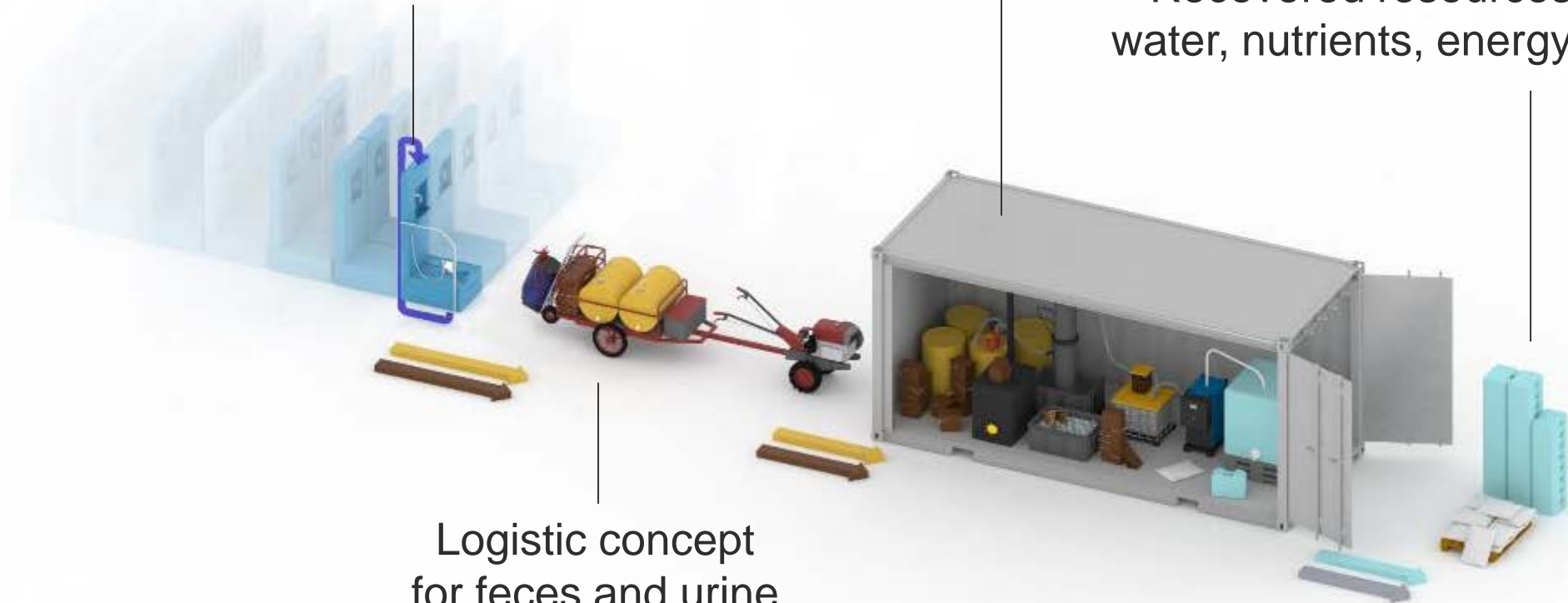
Larsen et al., 2015, Water, Sanitation, Hyg. Dev. 5(1), 64-71

Shared toilet for 2 families (~ 10 people)  
with a separate water cycle  
and on-site water re-use

Resource Recovery Plant (RRP)  
for ~100 toilets (~1000 people)

Recovered resources  
water, nutrients, energy

Logistic concept  
for feces and urine



# The Principle of the Blue Diversion toilet

Larsen et al., 2015, *Water, Sanitation, Hyg. Dev.* **5**(1), 64-71

- Urine and feces are collected twice a week (on demand)

Schmitt et al., 2017, *Water Res.* **110**, 297-312

- Self-sealing feces container (only conceptual)

- Urine removed by pumping

- Water is treated in a self-cleaning, gravity-driven ultrafiltration

## Membrane Bio Reactor

Künzle et al., 2015, *Water, Sanitation, Hyg. Dev.* **5**(3), 448-455

Randall et al., 2015, *Water, Sanitation, Hyg. Dev.* **5**(4), 544-552

Chomiak et al., 2015, *Water Res.* **85**, 512-520



# NEST – a test bed for sustainable buildings, including the Eawag Water Hub





# The backbone of the Eawag Water Hub: Separate wastewater pipes in the NEST building





# The Eawag Water Hub is a production site

- Fertilizer **production** from urine

Fumasoli et al., 2016, Water Science and Technology **73**(1), 215-222

- Water **production** from greywater

Derlon et al., 2016, Water Research, **102**, 63-72

Ding et al., 2016, Journal of Membrane Science, **510**, 382-390

- Pellet **production** from feces

Gold et al., 2016, Journal of Water Sanitation and Hygiene for Development, **7**(2), 243-251



The Water Hub is open for national and international cooperation ([www.empa.ch/web/NEST](http://www.empa.ch/web/NEST))

