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Global Megatrends and European Vision for Future in Water Supply and Sanitation

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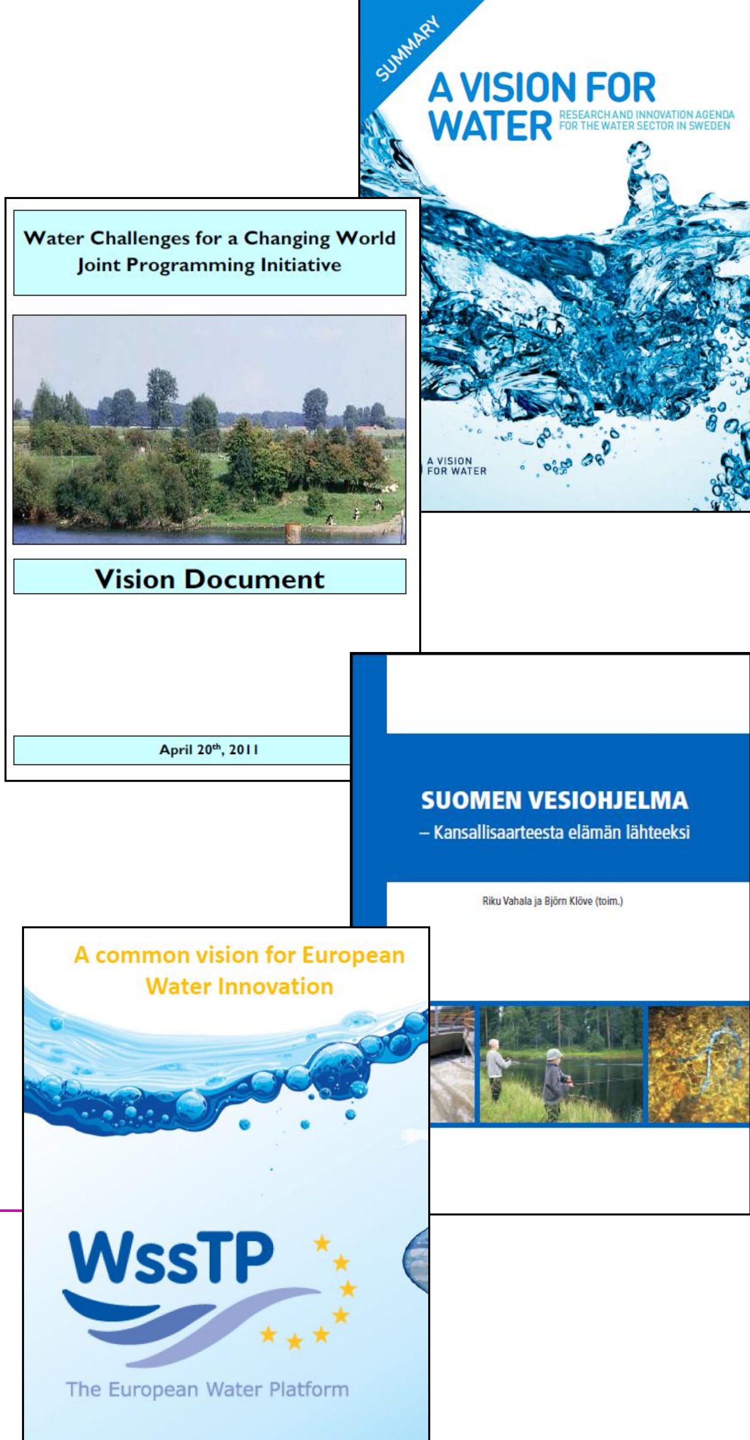
Content

Global megatrends

Vision for future – compilation of four European vision documents:

- **Water Supply and Sanitation Technology Platform (2005)**
- **Finnish Water Programme (2008)**
- **Joint Programming Initiative (2011)**
- **Swedish Water (2013)**

Five examples from the research of Aalto University's doctoral students



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Global megatrends

Adapted from: A. Klobut (2013): The impacts of megatrends on water supply and sanitation in selected large cities: Current state and future challenges

Population growth and urbanisation

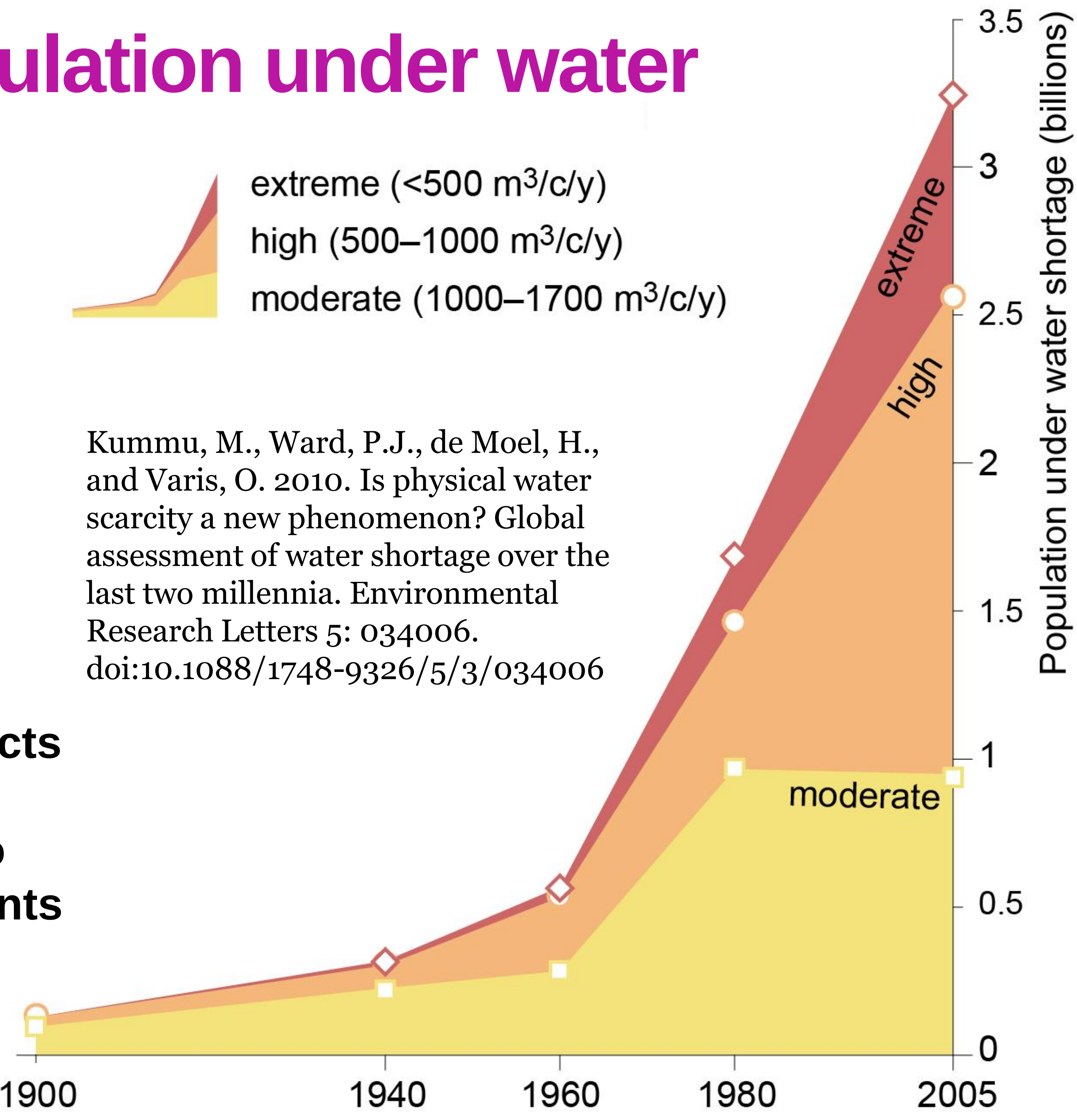
Up to 9.3 billion people by 2050 (UN, 2012), dramatic increase in urban and peri-urban areas

- Increased stress on the environment
- Health risk of inadequate sanitation and waste management
- Increase in paved areas
- Escalating need for food, water supply, sanitation and drainage; infrastructure
- Shifting dietary preferences, need to reduce food-to-waste

Climate change

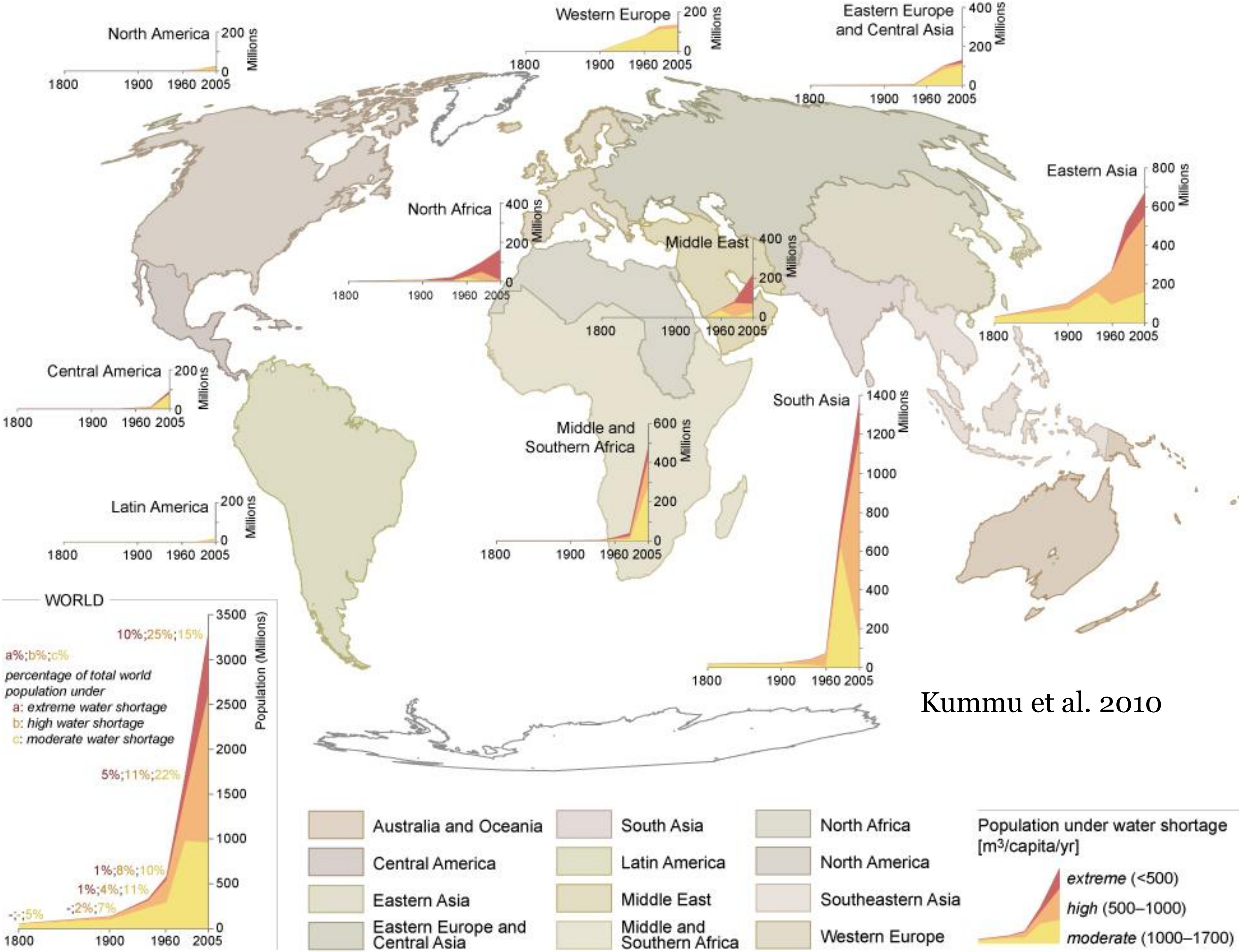
- Wet areas are getting wetter and dry areas even drier
- Extreme weather events, such as storms, floods and droughts, are more severe and intense
- Sea level rise poses a flood risk to coastal cities and may cause salt intrusion
- Erosion and desertification
- In the past 30 years (1976-2006), drought events had a cost of 100 billion € to the European economy
- The number of European river basins under water scarcity are expected to increase by up to 50% by 2030

Global population under water shortage



Kummu, M., Ward, P.J., de Moel, H., and Varis, O. 2010. Is physical water scarcity a new phenomenon? Global assessment of water shortage over the last two millennia. Environmental Research Letters 5: 034006. doi:10.1088/1748-9326/5/3/034006

Water shortage affects 30 % of Europe's population, equal to 130 million inhabitants (EC 2007)



Kummu et al. 2010

Economic growth

- **The world-wide turnover of water market amounts to ~250 billion €**
- **Currently, China has the fastest-growing economy in the world**
- **Improvement and implementation of modern technologies can be expected in water sector**
- **Changes in demography - aging population in developed countries**

- **<u>BUT</u> 783 million people are still without access to safe drinking water, and 2.5 billion people still lack improved sanitation (WHO & UNICEF 2012)**

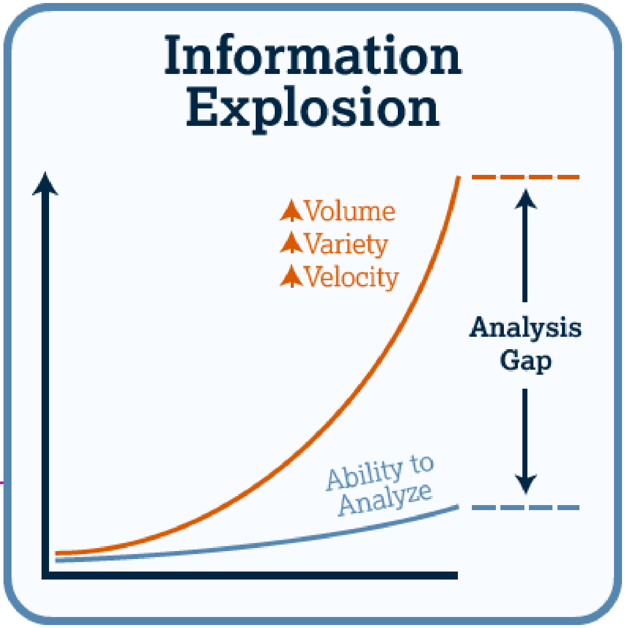
Increasing environmental awareness

- **More extensive and strict legislation can be expected to prevent pollution and control the use of natural resources**
- **Reduction of greenhouse gases are expected**
  - water-energy nexus
- **The role of renewable energy sources increases**
  - shift from a fossil-fuel economy to a more bio-based economy
  - major effect on the water cycle

Technological innovations and data explosion

- Membrane technologies gain popularity in water treatment facilities
- Water reclamation and reuse technologies develop further and become cheaper and thus more widely adapted

- Amount of data from the system and the environment has dramatically increased – limited amount of it is analysed and thus utilised in our decision-making process



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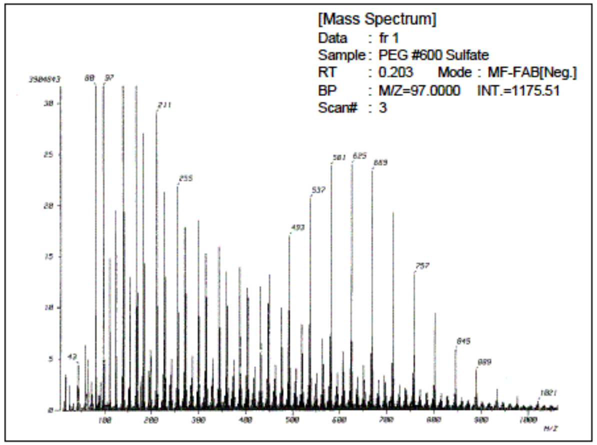
Vision for future

*Adapted from: WSSTP 2005, Finnish Water Programme,
Water JPI 2011, Svenskt Vatten 2013*

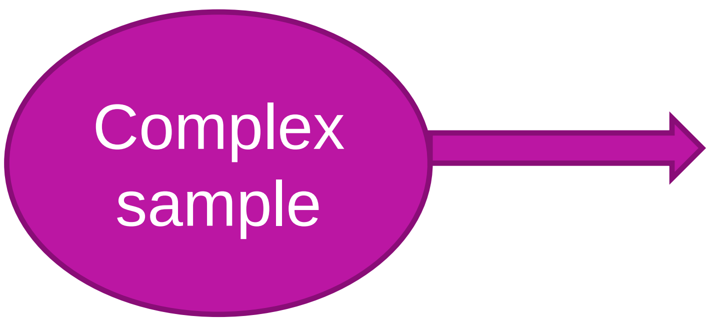
Quality and security are ensured by

- Continuous assessment of emerging pollutants and pathogens as well as their environmental behaviour and removal (incl. combined effects)
- Assessing and managing risks at all levels of the water cycle
- Removing the targeted compounds and micro-organisms from all types of water (drinking water, irrigation water etc.)
- Monitoring water quality comprehensively using rapid and on-line analytical methods



Negative FABMS spectrum of P1185 PEG #600 Sulfate

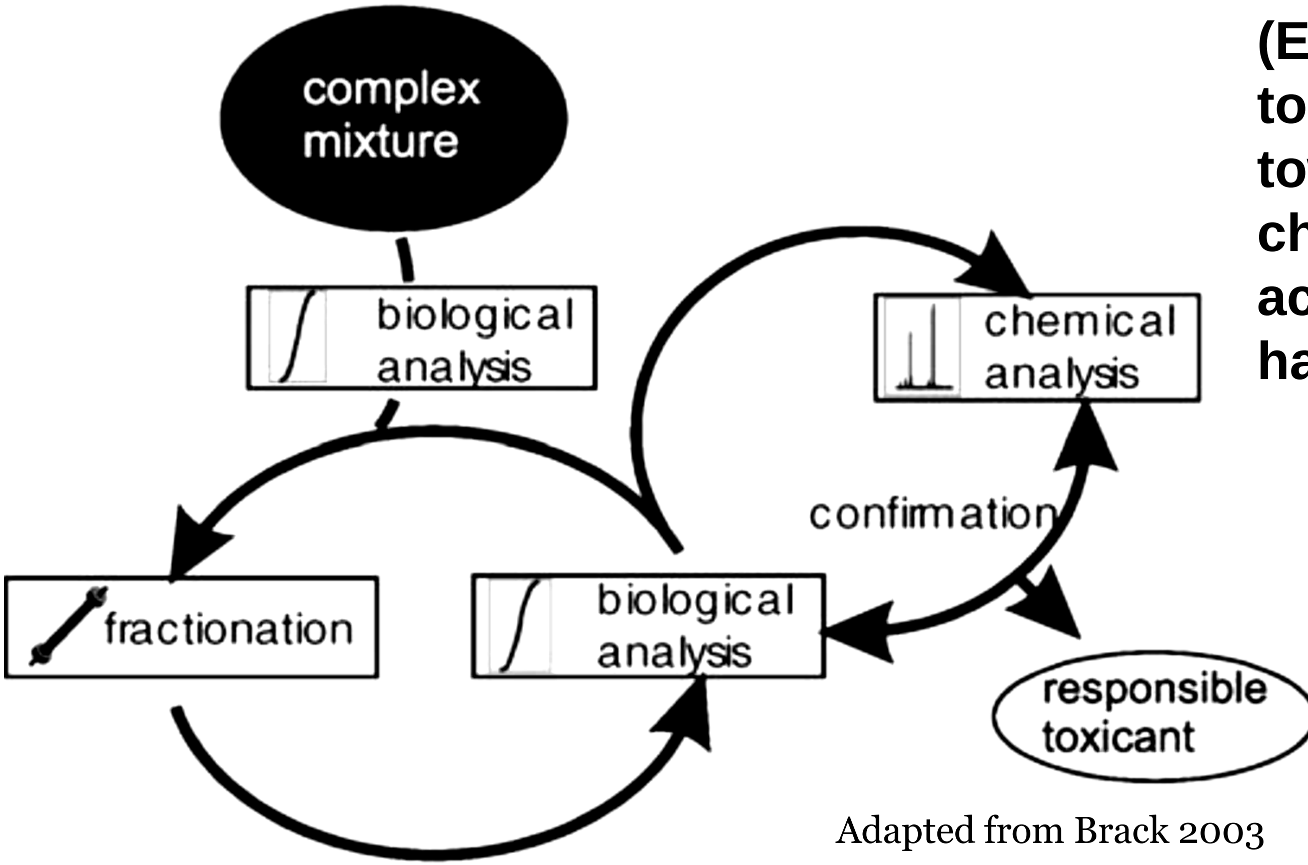
Example 1: Evaluating the toxicity is challenging…..



- What compounds are causing the observed effects?
- New compounds? Transformation products? Combined effects?
- Bioavailability of chemicals
- Low concentrations → expensive and sophisticated analytical devices
- Limitations in detection

Traditional monitoring is based on measuring concentrations → Does not tell anything about the EFFECTS on aquatic ecosystems or human health!

… is the Effect-Directed Analyses (EDA) a solution?



Adapted from Brack 2003

(EDA) is designed to direct analysis toward those chemicals that actually CAUSE harmful effects.

Water cycle is managed in an integrated way by:

- Better understanding of the impacts and interactions of all water-related activities
- Decision support systems
- On-line monitoring
- Early warning systems
- Emergency response plans
- Better communication and community involvement
- Adaptive management for climate change
- More extensive use of aquifer recharge
- Water-wise bio-based economy
- Being integral part of sustainable urban planning

Demand and supply are balanced by

Closing water cycles and re-using water

Alternative water resources

- **Rainwater harvesting**
- **Stormwater collection**
- **Desalination**
- **Wastewater reclamation**

Demand management *e.g.*

- **Saving water in agriculture, industry and households**
- **Detecting, controlling and repairing leakages**
- **Effective incentives**

Environmental impact is reduced by

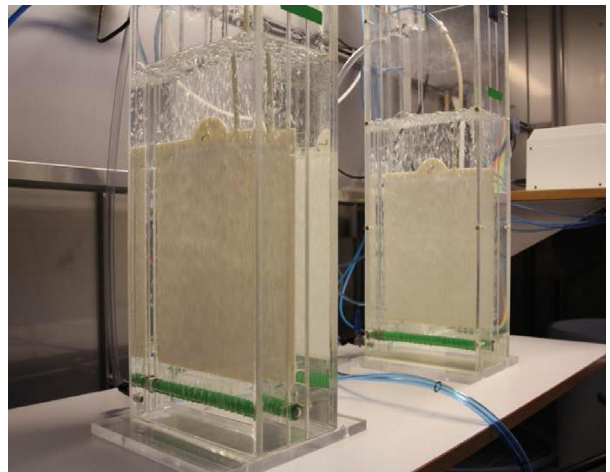
Resource-efficient water management

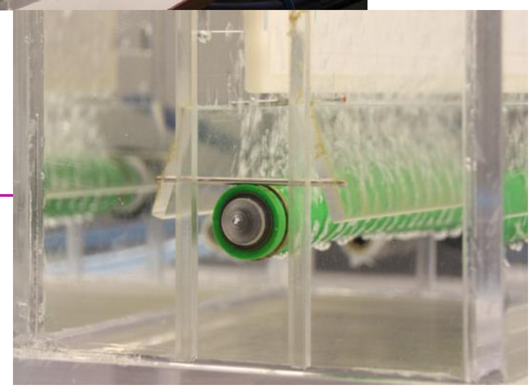
- **Effective use of energy and chemicals (advanced control systems etc.)**
- **Energy recovery (heat, biogas, etc.)**
- **Nutrient recovery from biosolids or incineration ash**
- **Leakage control**
- **Innovative process concepts**
- **Energy-efficient devices (pumps etc.)**

Control of pollutants at source

Producing less waste

Reducing the water-based emissions





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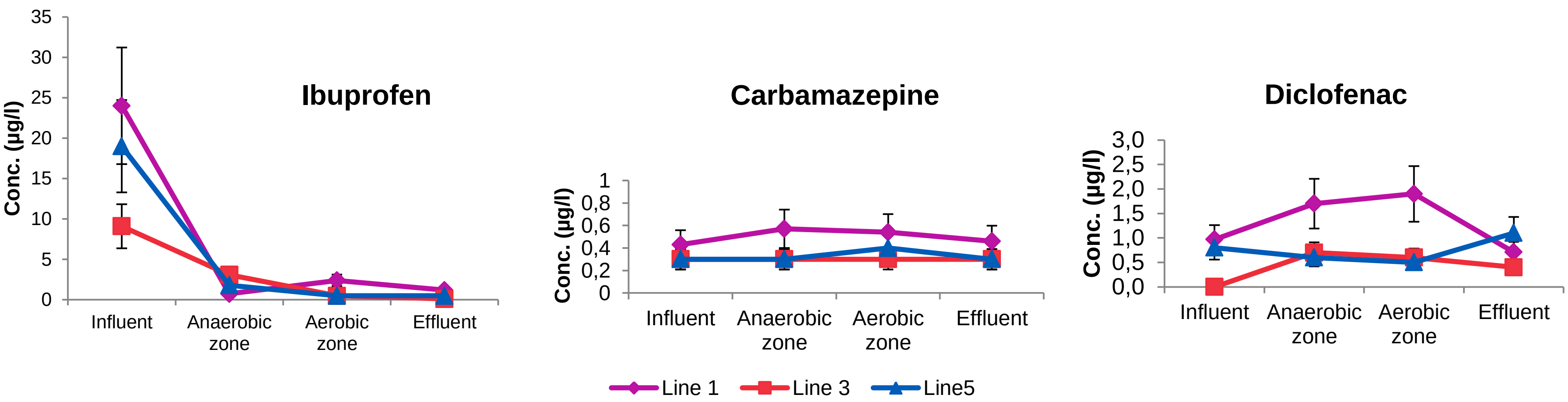
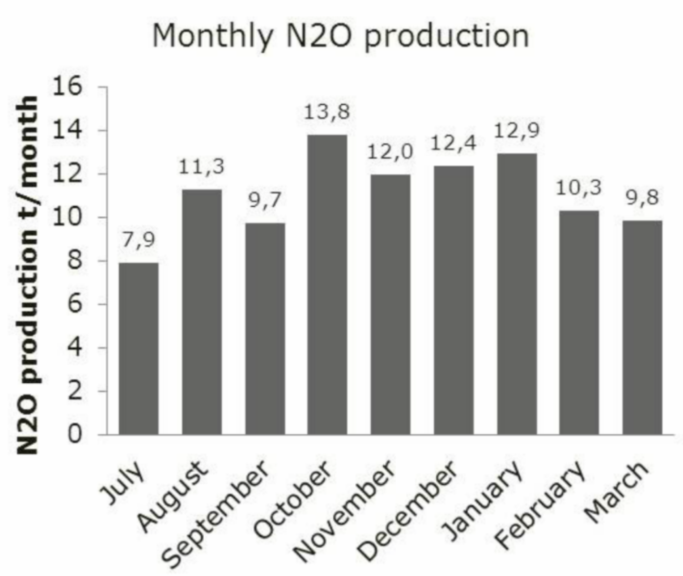
Example 2: Removal of pharmaceuticals from wastewater



Kbiol	Ibuprofen	Carbamazepine	Diclofenac
Line1	4.6	0.2	0.5
Line2	5.9	0.2	0.7
Line3	5.4	0.2	0.5
average	5.3	0.2	0.6

Example 3: Release of N_2O from WWTP

Emissions of nitrous oxide N_2O may constitute a major part of the carbon footprint of the WWTP, being responsible for 35 – 65 % of the global warming index of the wastewater treatment (Johnson and Hiatt, 2009)



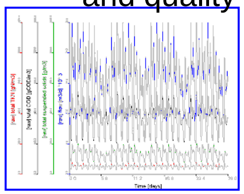
Kosonen H. 2013

Annual emissions

Continuous on-line measurement	E-PRTR emission model	Short-term measurements in 2011	IPCC emission factor
134,0 t/a	136,0 t/a	26,3 t/a	1,7 t/a
2,7% (Influent N)	2,8% (Influent N)	0,7% (Influent N)	0,035% (Influent N)

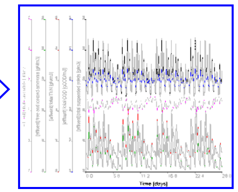
Example 4. Advanced process control in WWTP

Wastewater flow and quality



Deterministic models

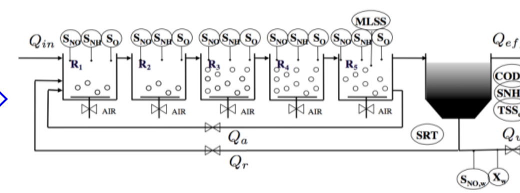
Simulated result



OFF-LINE

Easily measured data

Data-derived models



Hard to measure data

ON-LINE

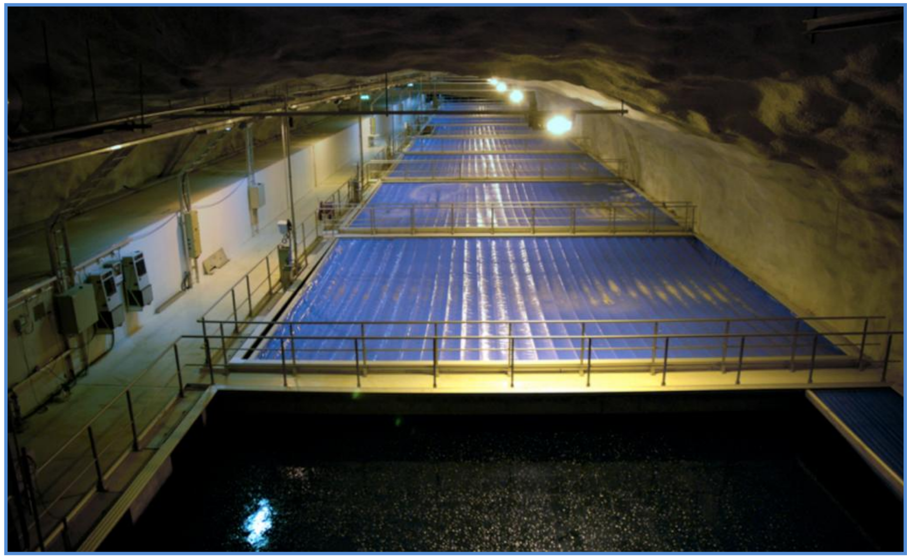
DIAMOND

SEVENTH FRAMEWORK PROGRAMME

Optimize the operation of wastewater systems by adequately managing and using all the information available in the plant.

…monitoring nitrate concentration

- **Focus on the nitrate sensors in the denitrifying post-filtration unit of the WWTP**
- **Methanol is dosed with a feedback loop policy according to the NO_3-N concentration in an array of ten filters measured on-line with analytical instruments.**



Picture retrieved from:
www.flickr.com/photos/sameli/sets/72157607704932823/

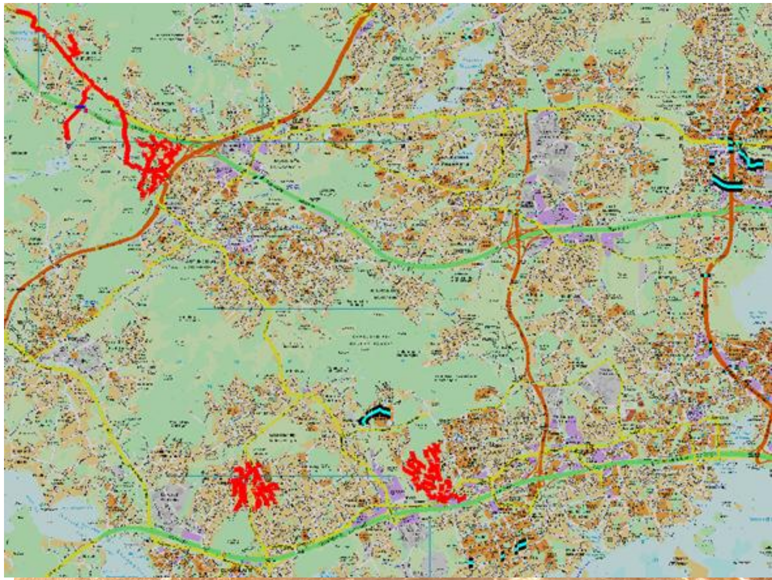
- **Development of an array of software sensors that estimates in real-time the nitrate concentration in the ten filters:**
  - **Back-up system to conventional analytical equipment for replacing out-of-order components.**
  - **Validation tools for existing field measurements.**

Assets are managed cost-efficiently by

- Maintaining and replacing the 5.7 M km long network asset at the right moment and at the right place with minimum disturbances to third parties
- Optimal operation of all the 70 000 WWTPs
- Better construction materials and replacement technologies
- Low maintenance and long-lived pipes, pumps and robust processes
- Climate-adaptive solutions
- Integrative operation of sewer and WWTPs (incl. capasity)
- Control of excessive inflows to the separate sewer system

Example 5: Targeting of sewer network inspections and renovations

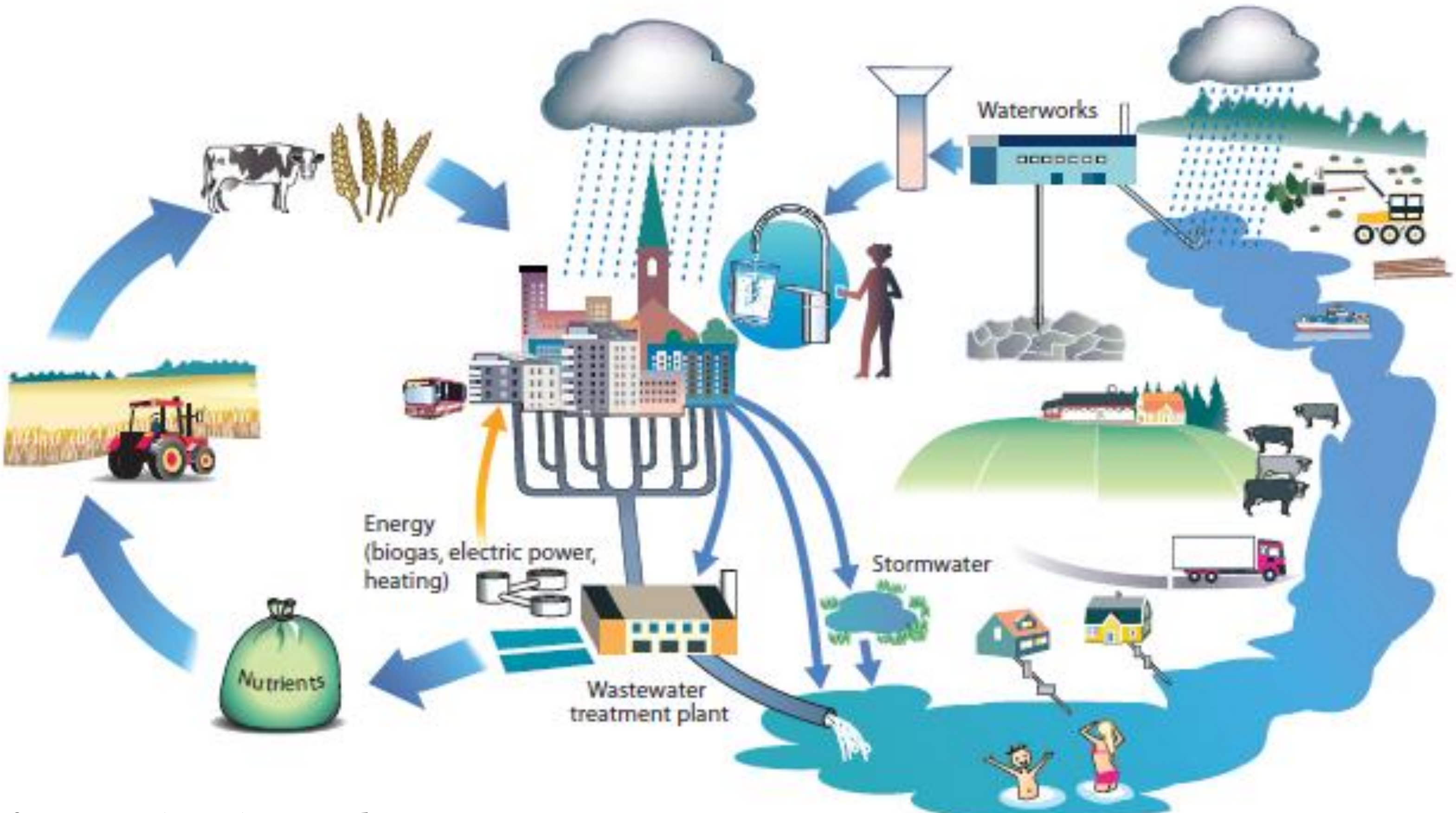
- **Development of a systematic and comprehensive computer-aided procedure for deciding which network assets to renovate or inspect and when**
- **Risk based approach: All the pipes are categorized according to their condition (probability of failure) and the consequence of failure**
- **The approach combines the open-source GIS data with the utility's historic and operational data**



Competitive advance of European water sector is maintained

- **Continuous development of robust and cost-effective technological solutions**
- **Time from innovation to market is reduced**
- **Smart water technologies are in use**
- **Solutions are tested for transferability to other sectors and areas of Europe and the world**
- **Barriers for innovation are removed**
- **Effective policy and management framework**
- **Water Stewardship**
- **Shifting from a conventional view of waste to a view of resource that can be processed for the raw material or for the recovery of energy**

Water and food cycles



A Vision for water (2013), Svenskt Vatten

To enable this happen we also need...

- To understand the value of water, water-energy nexus, social perceptions, costs and all the bottlenecks
- Better investment climate to water infrastructure
- More training, communication and knowledge dissemination
- European standardisation (e.g. water reuse)
- Participatory approaches between the stakeholders
- and much more...

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- Where *Science* and
Art meet **Technology**
and *Business*