A Strategic Research and Innovation Agenda for the Water in the EU

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EU and the Water Framework Directive

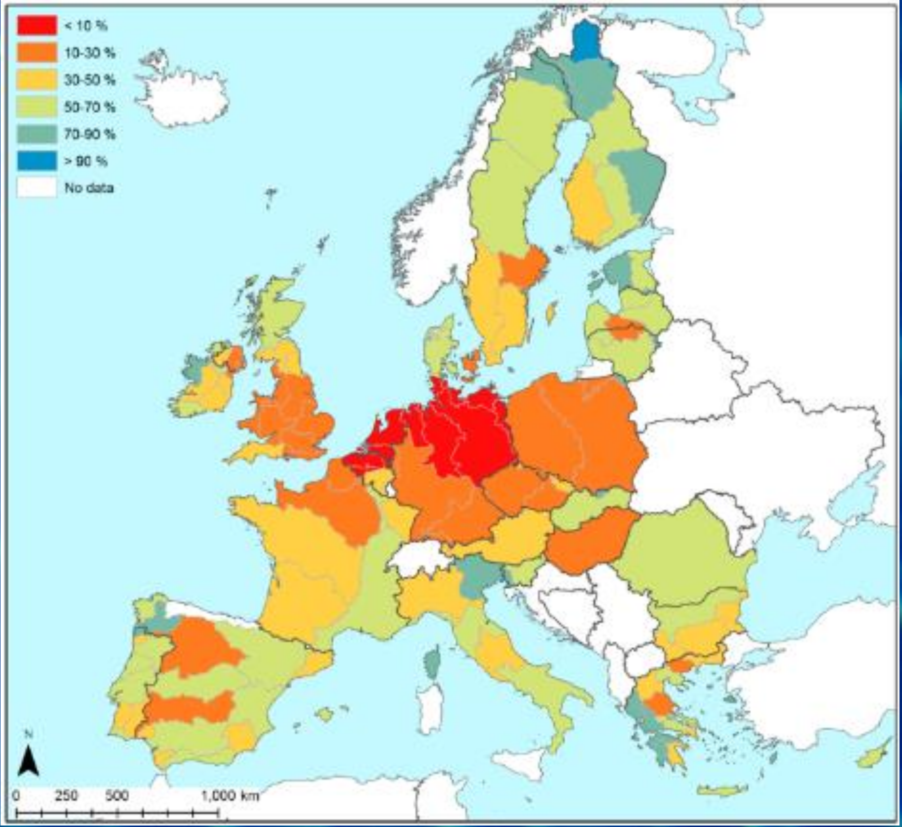
- In the E.U., the Water Framework Directive (WFD, 2000), mandates that all surface waters (except those subject to specific derogations) must achieve "Good Ecological Status" (GES) by 2015.
- Good Ecological Status is defined as deviating only slightly from "undisturbed" reference conditions, based on an integrated assessment of water-body ecological condition, including biological, hydromorphological and physicochemical quality elements.

Only 1 river basin achieved 90% of its reaches at GES (in Finland…)

Reason for failure attributed to
- 31% agricultural management,
- 32% WWTPs,
- 14% other urban sources.

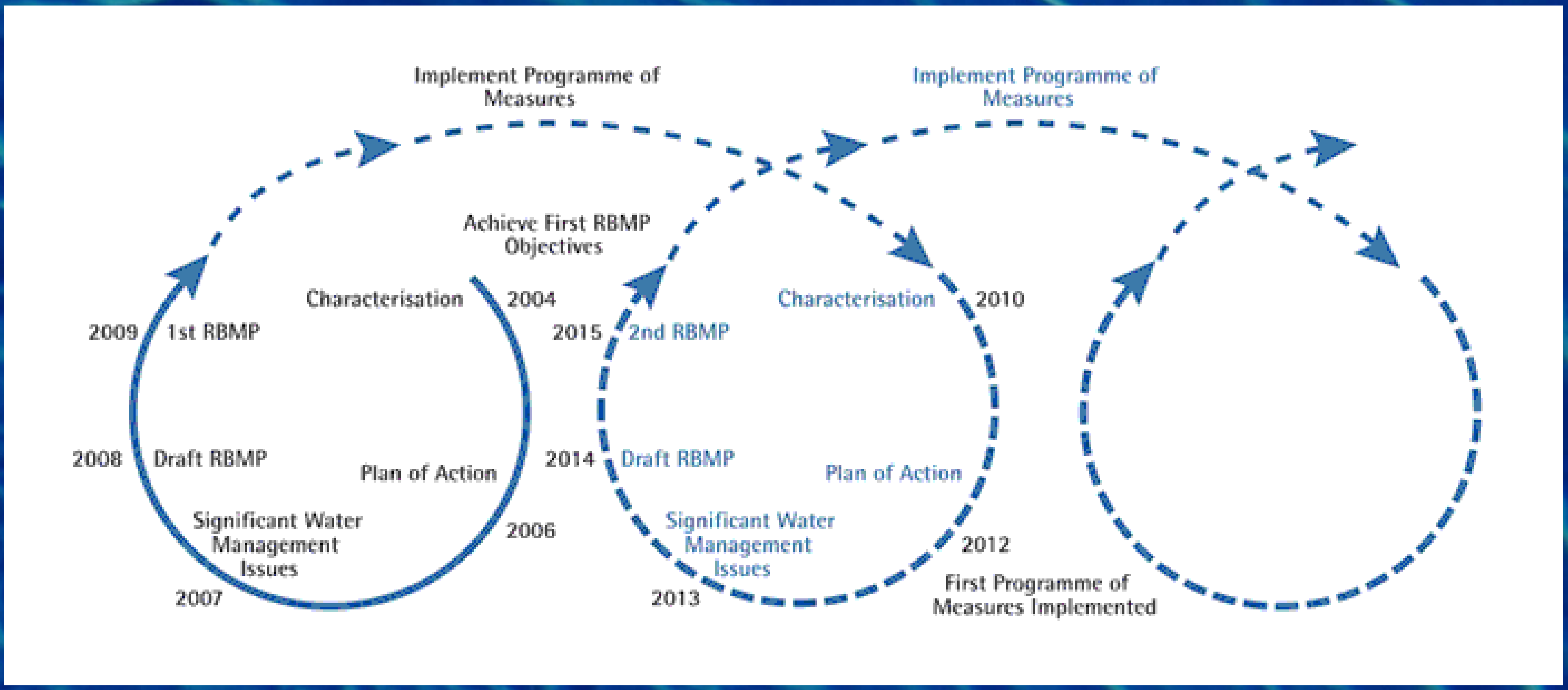
P responsible for 60%

(UK, Jarvie and Jenkins, 2014)



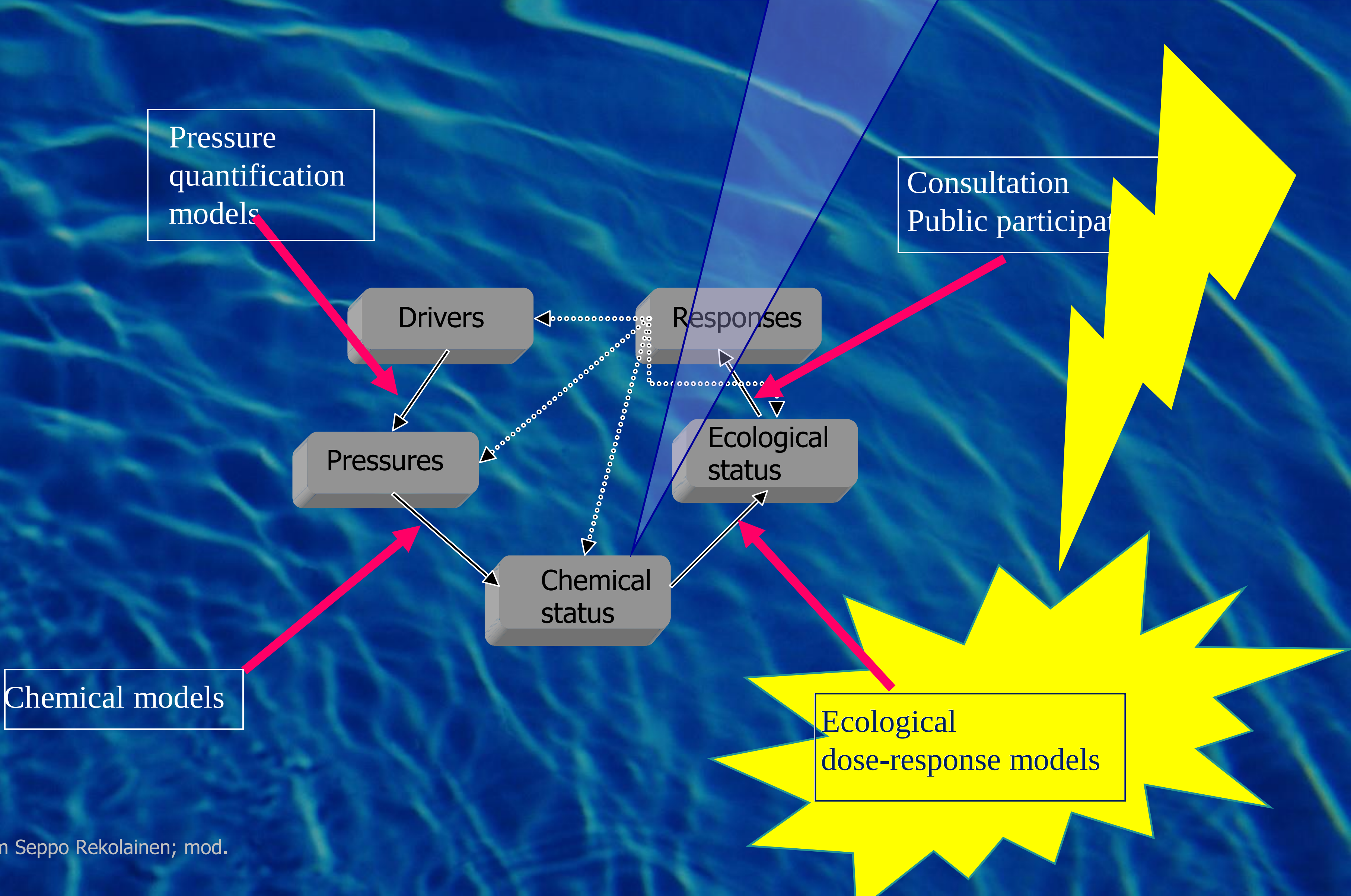
Percentage of surface water bodies in EU River Basin Districts achieving Good Ecological Status or Potential in 2012

WFD implementation cycle



River Basin Management Plan implementation

Environmental quality standards have been established for 53 chemical pollutants of high concern across the EU



From Seppo Rekolainen; mod.

Some difficulties and obstacles in implementing the WFD

- How to go from "a good chemical status" to a "good ecological status"?
- Programs of measures usually include BMPs designed to improve the chemical status (rather indirect link to the ecological status)
- Enforcement and monitoring (mostly for not-structural measures)

The proposal

- Limit the WFD chain of actions to the obtainment of a good /hydrological chemical status (experimental)
- Introduce the TMDL approach
- Create a "water quality trade" policy

TMDL pros and cons

- Actual implementation easily monitored and assessed
- Well-known and validated models exist
- Gives sense to ecosystem services payment
- Complex administrative machine needed
- Resistance in changing the WFD process

Research needs / Policy gaps (1)

a. Research is still needed regarding ***sensoring technologies***, decision support systems, irrigation techniques and communication instruments to help a rationale use of water resources of different origin in smart irrigation

b. Despite sensors and technologies already available, still innovation struggles to become real part of everyday life of EU farmers. There is a need for ***advisory systems and networks*** to be developed and adapted to different socio-economical realties in the EU regions.

c. In the implementation of the EU Water Framework Directive (WFD), still the ***efficiency*** of several ***management practices*** required in the Programs of Measures remain rather unclear under different climates and environmental situations. The WFD implementation thus requires a further research effort also including ***linkages between hydrological, chemical and ecological status targets*** and source allotment of allowed nutrient and pollutant discharge.

Research needs / Policy gaps (2)

d. ***Water reuse in agriculture*** can play a paramount role in EU agriculture, mostly but not only in water stressed areas. EU legislation still lacks on this issue and is really needed.

e. A clear ***linkage*** is needed between the relevant ***EU legislations*** in the field of water resources management and use, i.e. the Water Framework, the Marine Strategy, the Nitrate, the Drinking Water, the Groundwater, the Soil, the Bathing Water Directives and the CAP to clarify respective field of applicability, avoid unnecessary overlaps, rationalize implementation.

f. Various ***measures to enhance water quality and to adapt and mitigate for extreme hydrological events exist***. In particular in major river basins, a common framework to discuss and decide on local to basin-wide measures (kind of measure, place and timing) is lacking. How can governance help or obstruct best practices.

g. The *use of **new technology (e.g. real-time soil moisture monitoring)*** to better match irrigation with plant needs, *improved irrigation practice*, further development of *promising soil management practices* to increase irrigation efficiency and water conservation as well as improved crop management practices (e.g. the *use of more drought resistant varieties*, *nutrition programmes that favor efficient growth*) should be promoted.

Five major Research Development and Innovation needs (JPI-Water, SRIA)

1. Maintaining ecosystem sustainability;
2. Developing safe water systems for the citizens;
3. Implementing a water-wise bio-based economy;
4. Closing the water cycle gap;
5. Promoting competitiveness in the water industry.

1 - Maintaining Ecosystem Sustainability (1/2)

Developing Approaches for Assessing and Optimising Ecosystems Services

- Understanding and quantifying the ecological functioning of ecosystems
- Developing mechanistic models for the forecast and evaluation of changes in ecosystems in response to water management measures

Managing the Effects of Hydro-climatic Extreme Events and Multiple Pressures on Ecosystems

- Setting the causes of drought/scarcity; predicting drought events and water scarcity
- Improving water management to mitigate the harmful impacts of extreme events (extreme weather events, impaired water quality)
- Developing innovative (or improved) tools for the protection and prevention of hydro-climatic extreme events

1 - Maintaining Ecosystem Sustainability (2/2)

Integrated Approaches: Developing and applying ecological engineering and ecohydrology

- Developing a better understanding of the effects of hydromorphological pressures (damming, embankment, channelisation, non-natural water-level fluctuations) on the structure and functioning of aquatic and riparian ecosystems
- Quantifying the effects of pollution on biological communities. Analyse the links between ecotoxicological tools and biological assessment tools based upon the structure of biological communities
- Analysing the linkage between upstream and downstream areas, the role and functional importance of floodplain/lateral connectivity and channel dynamics, and the interaction between groundwater and the hyporheic zone
- Understanding the processes and dynamics of sediment transport, hydraulic connectivity, flow regimes and fish migration within river systems.
- New green infrastructure, nature-based solutions and ecological engineering methods for the clean-up of lakes, streams, inner waters, etc.
- Understanding the techniques and approaches, including modelling tools, that can be efficiently used to maintain and improve the ecological potential of Heavily Modified Water Bodies.

2 - Developing Safe Water Systems for the Citizens

Emerging Pollutants: Assessing their effects on nature and humans and their behaviour and treatment opportunities

- Developing analytical techniques for groups of substances
- Understanding and predicting the environmental behaviour and effects of by-products, emerging pollutants and pathogens, including their environmental effects
- Pollutants remediation: Developing strategies to reduce pollutants, including at source

Minimising Risks Associated with Water Infrastructures and Natural Hazards

- Exploiting ageing urban water systems for dependable and cost-effective service
- Producing integrated systems for the prediction and risk management of urban floods (overflows in advanced wastewater treatment facilities, urban hydrology, surrounding river flow, hydrodynamics, internet of things, drainage design, social sciences and climate change analysis)

3 - Implementing a Water-Wise Bio-Based Economy

Developing integrated water-conserving farming practices and varieties

- Designing water-efficient, cost-effective farming/forestry techniques and technologies supporting water conservation and efficiency
- Technologies and management tools for higher agricultural productivity while minimizing land-surface and water used
- Progressing towards future-proof agricultural water use
- Developing, testing and evaluating innovative and efficient irrigation systems and practices combining crop water requirements, crop physiology, ground-based sensors, imagery satellite, ICT, and expert systems

Reducing Soil and Water Pollution

- Reducing diffuse and point source pollution caused by agrochemicals, mineral fertilisers and manure. Development of cost-effective, easy-to-access and adaptive technologies, including manure separation and treatment, energy recovery technology, irrigation, precision farming, regulated drainage and an adapted management of buffer strips
- Developing new, integrative simulation models for soil, water and crop management providing agrochemicals dynamics in soil and water to build effective tools for decision-making on natural resources and policy support
- Designing measures underpinning water and land-use policies
- Developing methodologies to define appropriate monitoring scales and locations for policy development/assessment

4 - Closing the Water Cycle Gap

Enabling Sustainable Management of Water Resources	• Promoting adaptive water management for global change • Downscaling of climate change scenarios to appropriate levels for management plans • Implementing Managed Aquifer Recharge (MAR)
Promoting new governance and knowledge management approaches for water management	• Developing new approaches and tools for water management aimed at setting up innovative alternatives suitable for decision-making. These approaches should be ideally based on: • the broad participation of stakeholders; • multidisciplinary research; and, • the development of scenarios to support decision-making in the short and long term
Supporting the establishment of a European research infrastructure	• Integrated hydrological models • sensors for precipitation, surface and subsurface water stores • Establishing comprehensive, easy to access and interoperable databases • Improving monitoring and data capture