Institute of Meteorology and Water Management
National Research Institute

Water quality estimation regarding to climate change

Marta Bedryj
Institute of Meteorology and Water Management NRI, Poland

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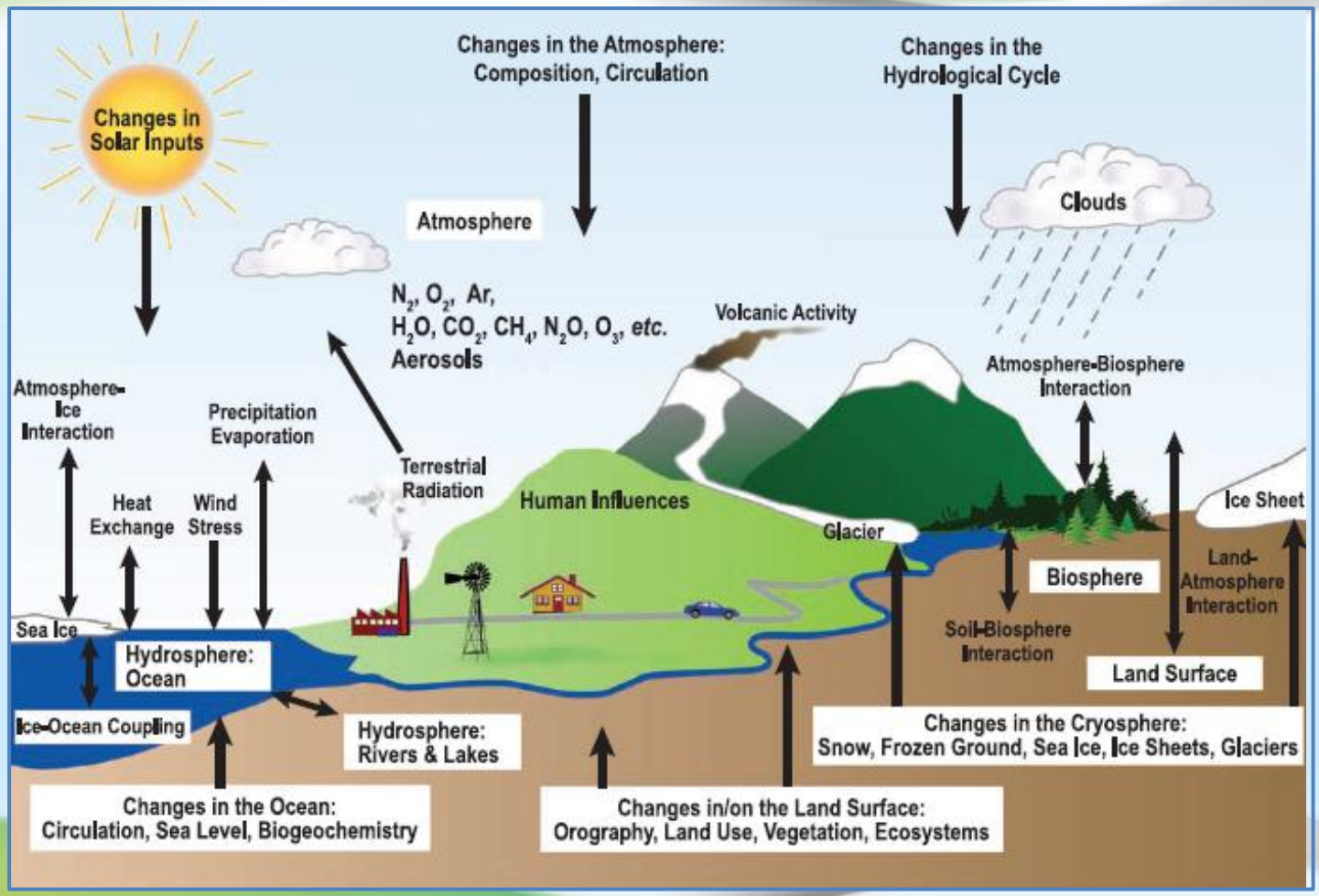
CLIMATE SYSTEM

Schematic view of the components of the climate system (processes & interactions)



IPCC Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change

POGODYNKA PL

WATER STATUS

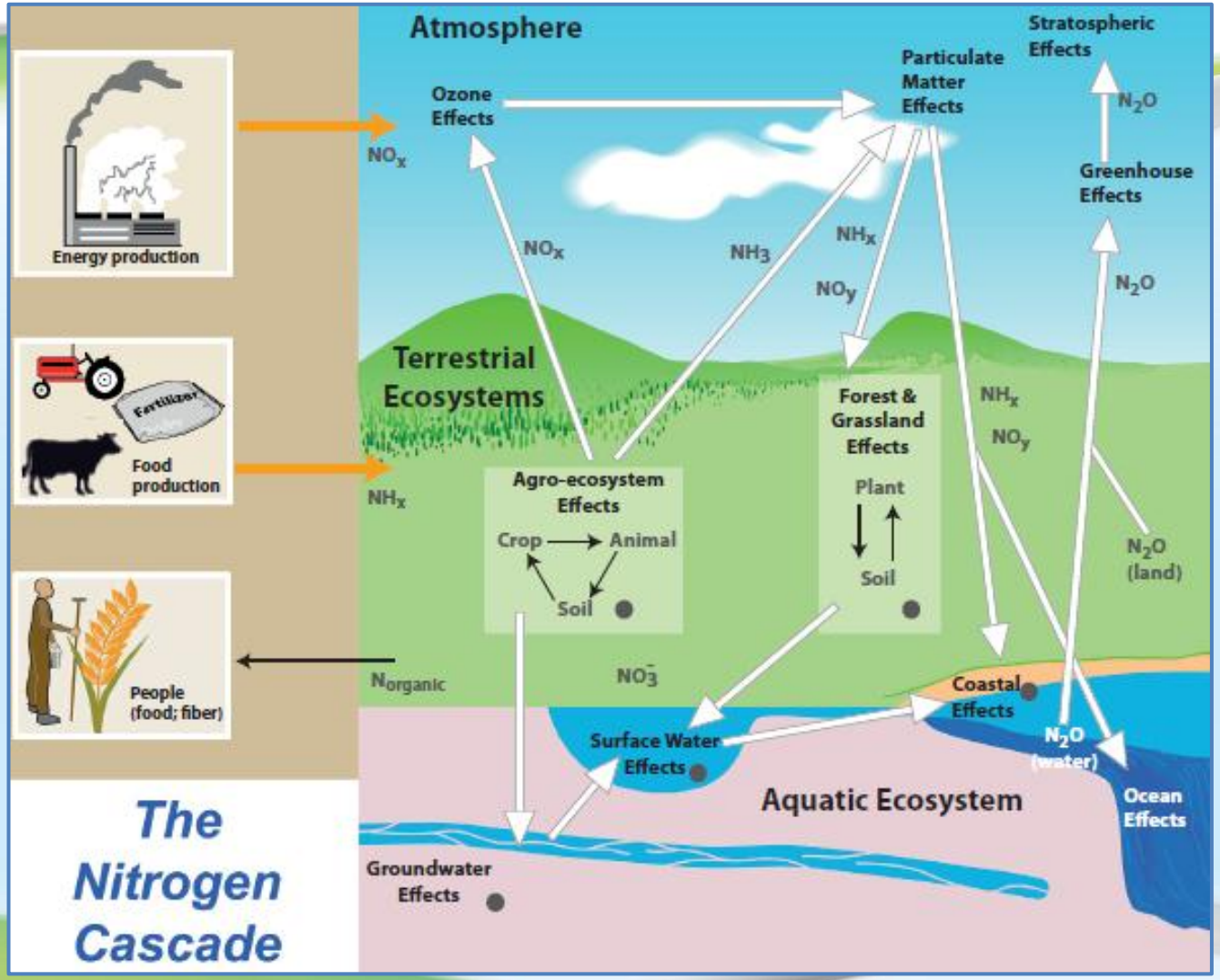
Ecological status for rivers (Directive 2000/60/EC)

Biological elements	**Hydromorphological elements** supporting the biological elements	**Chemical and physicochemical** elements supporting the biological elements
✓ **composition and abundance of aquatic flora,** ✓ **composition and abundance of benthic invertebrate fauna,** ✓ **composition, abundance and age structure of fish fauna.**	✓ **hydrological regime:** – quantity and dynamics of water flow, – connection to ground water bodies, ✓ **river continuity,** ✓ **morphological conditions:** – river depth and width variation, – structure and substrate of the river bed, – structure of the riparian zone.	✓ **general:** – thermal conditions, – oxygenation conditions, – salinity, – acidification status, – nutrient conditions, ✓ **specific pollutants:** – pollution by priority substances identified as being discharged into the body of water, – pollution by other substances identified as being discharged in significant quantities into the body of water.

WATER STATUS – ISSUES

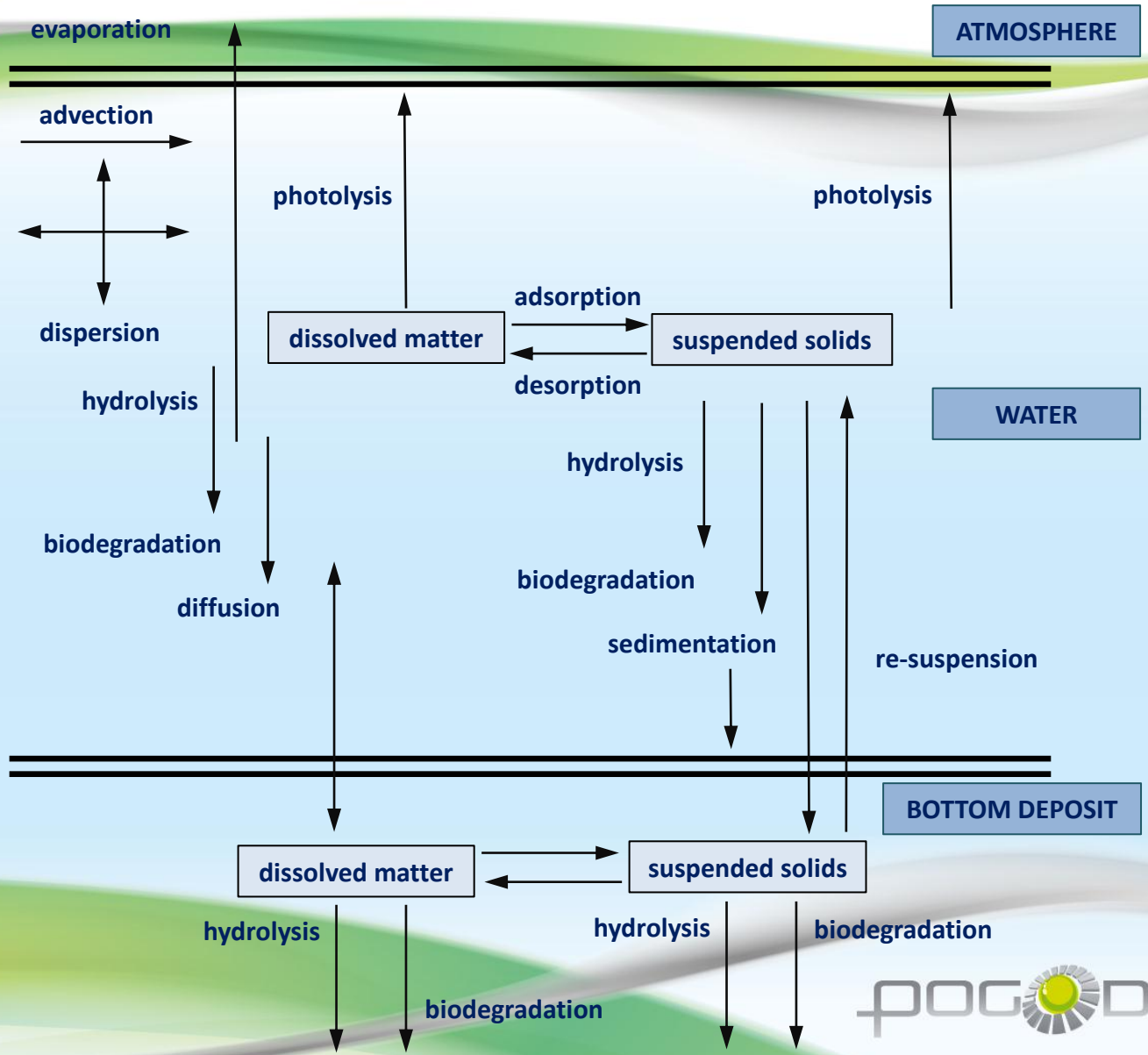
1. Many different water status elements are obliged to take into account.
2. The estimation of all water status elements should be performed to total water status level obtain.
3. The estimation of water quality in future is performed mainly for basic chemical and physicochemical pollution indexes (N_{TOT}, P_{TOT}, BOD etc.) because of long measurement time series for them.
4. Other specific indexes are required for the estimation of hydromorphological elements.
5. The estimation of biological elements seems to be the most difficult because of unpredictable nature/environment.

WATER QUALITY PROCESSES



IPCC Climate Change 2013: The Physical Science Basis. Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change

WATER QUALITY PROCESSES



WATER QUALITY PROCESSES – ISSUES

1. Processes of different Earth's spheres are required to take into account.
2. Physical, chemical and biological processes/reactions are required to take into account.
3. Sophisticated nature of pollution migration in water.
4. Many different factors/elements influencing on water quality are required to be identified and quantified (for example point and non-point pollution sources of natural and anthropogenic origin).
5. The problems with the estimation of factors/elements changes over time (historical data, programme of measures effects).

CLIMATE CHANGE

Parameters influencing on water status

Air temperature

Precipitation

Snow cover

Water resources change (runoff)

Water acidification (CO_2)

Water temperature

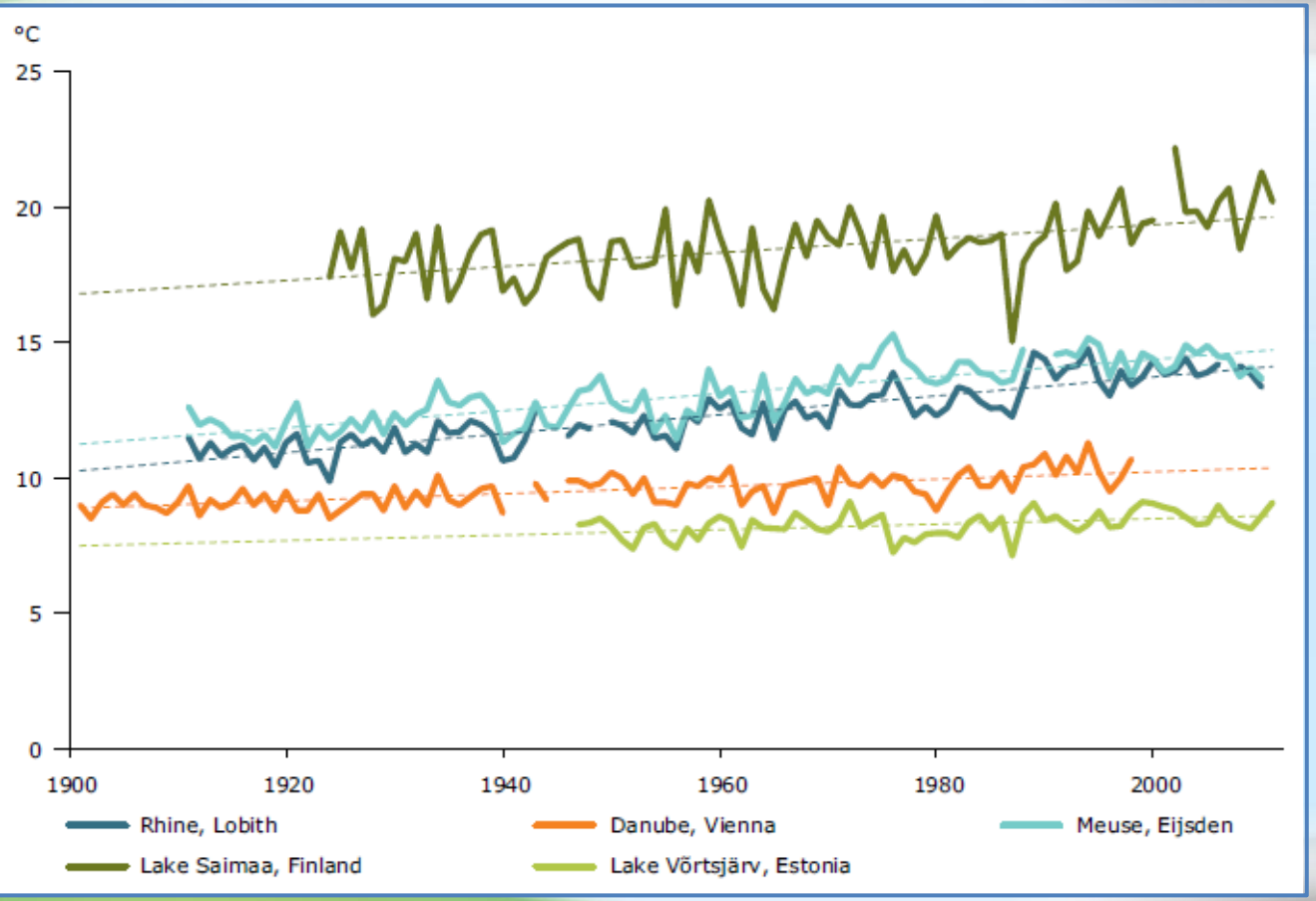
Lake and river ice

Extreme events (flood, drought, heavy rain)

All other factors/elements which influence on nature and biodiversity

CLIMATE CHANGE

Trends in water temperature of large European rivers and lakes in 20th century



Annual average water temperature:

RIVERS:

Rhine: 1911-2010

Meuse: 1911-2010

Danube: 1901-1998

LAKES:

Võrtsjärv: 1947-2011

Saimaa: 1924-2011 (data for August)

Climate change, impacts and vulnerability in Europe 2012, EEA Report, No. 12/2012

CLIMATE CHANGE IMPACTS ON WATER STATUS

Biological-ecological parameters	Hydrological-hydromorphological parameters	Physicochemical parameters
✓ changing metabolic rates of organisms, ✓ changing ecosystem productivity and biodiversity, ✓ climate space of plant and animal distributions, ✓ fish migration patterns and dispersal corridors, ✓ increased eutrophication and occurrence of algal blooms, ✓ changes in aquatic fauna and flora including those at reference sites, ✓ changes in species assemblages in designated areas, ✓ more rapid decline in faecal indicator organisms and pathogen populations, ✓ increased microbiological activity, ✓ decreasing groundwater levels may have adverse effects on depending terrestrial ecosystems.	✓ changing river flows, lake levels and retention times, and sea levels lead to coastal erosion, ✓ hydrological connectivity of slopes, channels, and coastal zones, ✓ long-term bed-load and channel change, ✓ geomorphological processes creating dynamic/diverse habitats, ✓ sediment transport changes associated with climate change, ✓ changes in groundwater demand and recharge system induced or enhanced by climate change.	✓ changes in water temperature and dissolved oxygen, ✓ decreased dilution capacity of receiving waters, ✓ increased erosion and diffuse pollution, ✓ more frequent flushing of combined sewer outflows, ✓ potential remobilisation of sediment- and soil-associated historic contamination, ✓ photoactivation of toxicants, ✓ exceedance of water quality standards, ✓ salt water intrusion (both into groundwater and upstream into estuaries and tidal river systems).

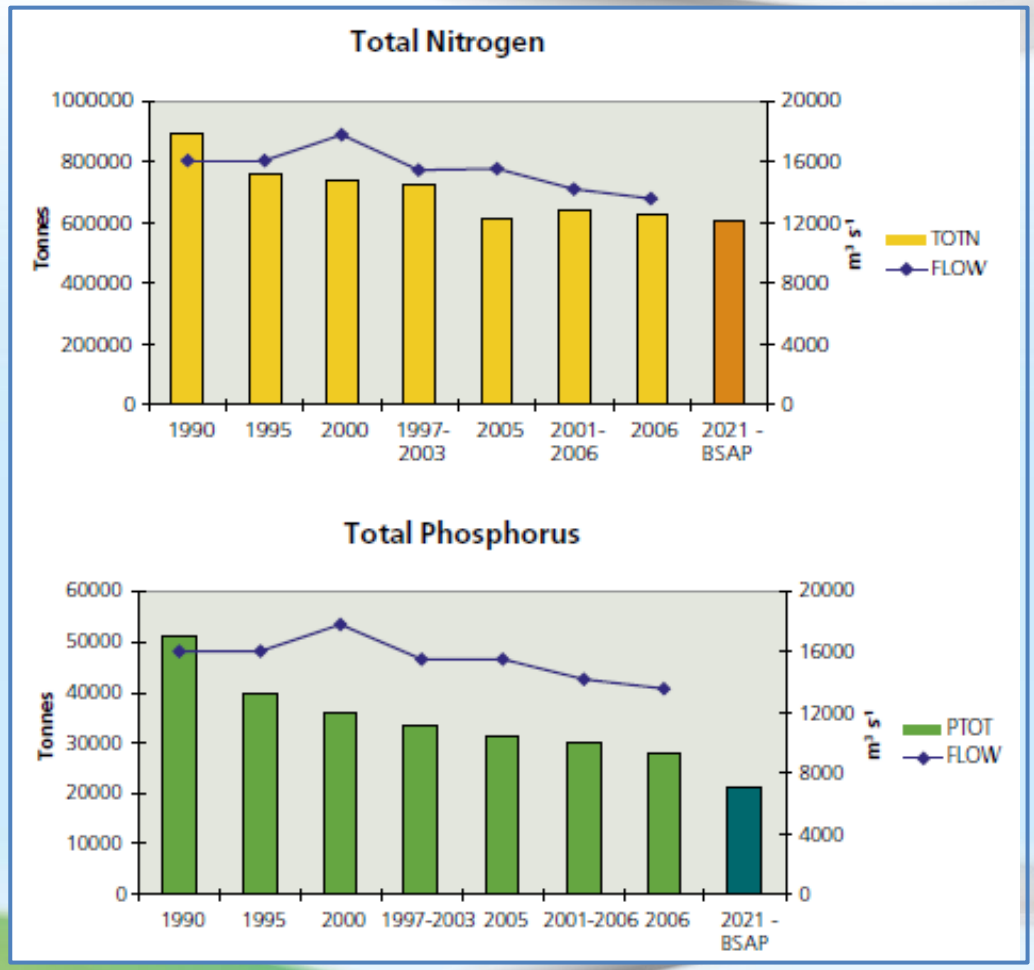
CIS for WFD, Guidance document No. 24, River basin management in a changing climate

CLIMATE CHANGE – ISSUES

1. Many climate change factors influencing on water quality are required to be identified and quantified.
2. The relationships/interactions of the factors (and their changes) and their total influence on water quality are required to be determined.
3. The influence of many socio-economical factors related to climate change projections on water quality is required to be determined.
4. The influence of programmes of measures related to climate change projections on water quality is required to total estimation of water status in future.

EXAMPLE – THE BALTIC SEA

Direct riverine and point-source loads of nitrogen and phosphorus to the Baltic Sea



HELCOM 2009: Eutrophication in the Baltic Sea, Baltic Sea Environment Proceedings No. 115A

EXAMPLE – THE WEŁNA RIVER

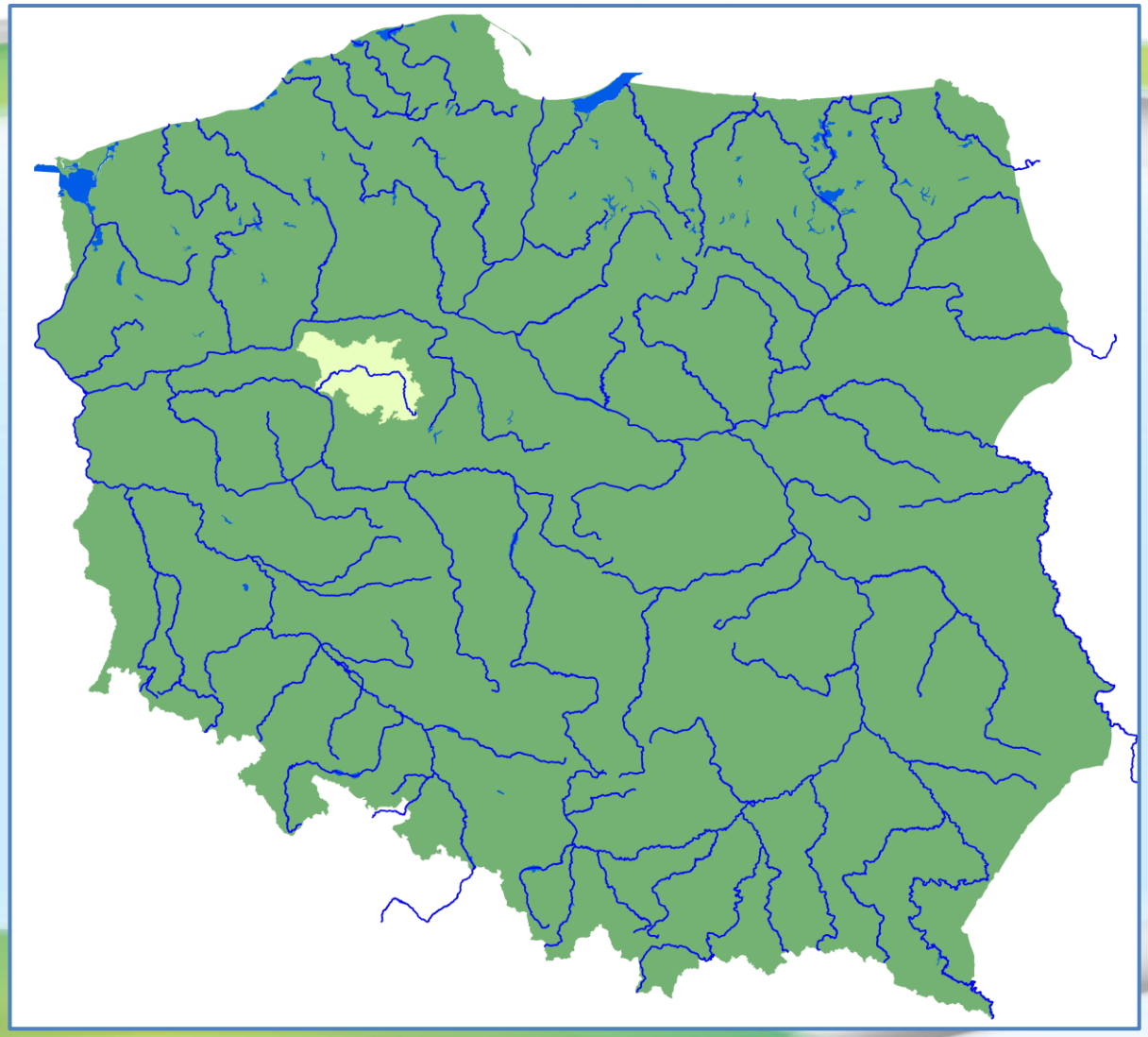


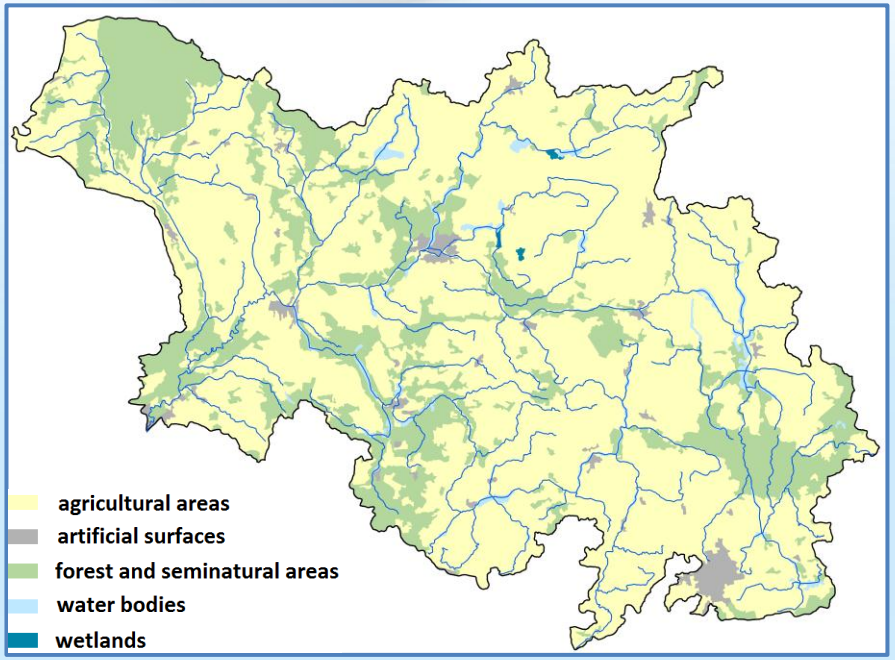
Photo: Paweł Terlecki

catchment area: 2605 km^2

the Wełna river length: 118,2 km

EXAMPLE – THE WEŁNA RIVER

The emissions scenario		N_{TOT}
A1	very rapid economic growth, global population that peaks in mid-century and declines thereafter, and the rapid introduction of new and more efficient technologies	+3,5%
A1B	the A1 scenario balance across all energy sources (fossil and non-fossil sources)	-0,8%
B1	a convergent world with the same global population, that peaks in mid-century and declines thereafter, as in the A1 storyline, but with rapid change in economic structures toward a service and information economy, with reductions in material intensity and the introduction of clean and resource-efficient technologies	+9,5%



arable area: 1946 km² (74%)

N_{TOT} = ~3,5 mg/l

SUMMARY

1. The comprehensive water quality estimation, related to all water status elements according to Water Framework Directive and climate changes, is sophisticated and requires individual approach in the case of all particular elements.
2. Many interlinked processes are required to be taken into account in the estimation of the only one element.
3. The mathematical modelling of water quality can be useful tool for the estimation of water quality changes. The requirement of many input data to model is the most serious restriction of the tool.
4. The water quality estimation related to climate change has serious uncertainty (uncertainty related to climate change and uncertainty related to analyses of water quality).

THANK YOU FOR YOUR ATTENTION

Marta Bedryj
National Flood and Drought Modelling Centre
Institute of Meteorology and Water Management
National Research Institute
174/176 Dąbrowskiego St., 60-594 Poznań, POLAND
marta.bedryj@imgw.pl