VIENNA UNIVERSITY OF TECHNOLOGY
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Institute for Water Quality
Resources and Waste Management

Nutrient management in large international river basins with special regard to the Danube

"Future of European Waters - How should be policies adapted?"
Hungarian Academy of Sciences (HAS),
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Rhine, Danube, Elbe, Maas, Oder..,
North-, Baltic-, Black- Mediterranean- Sea…

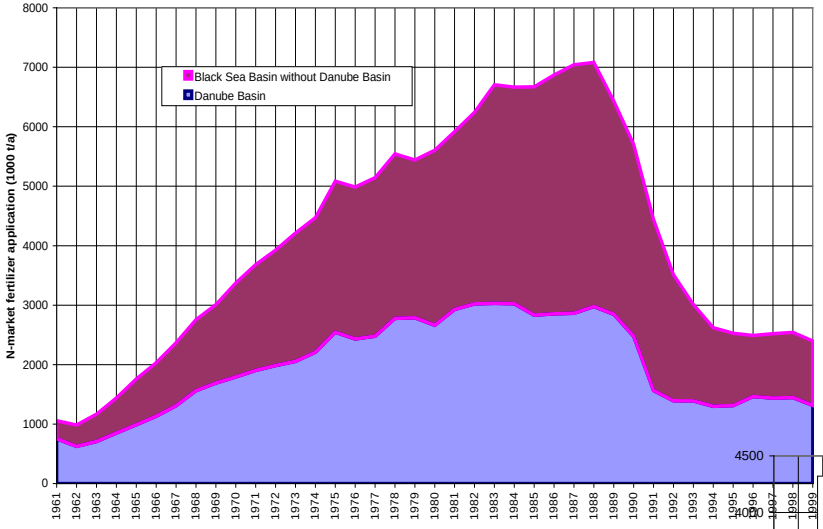
Table of Contents

- Introduction
- Sources and relevance of nutrients for water quality management
- Nutrient management in international catchments
- Danube catchment and ICPDR
- Conclusions

Which role play nutrients?

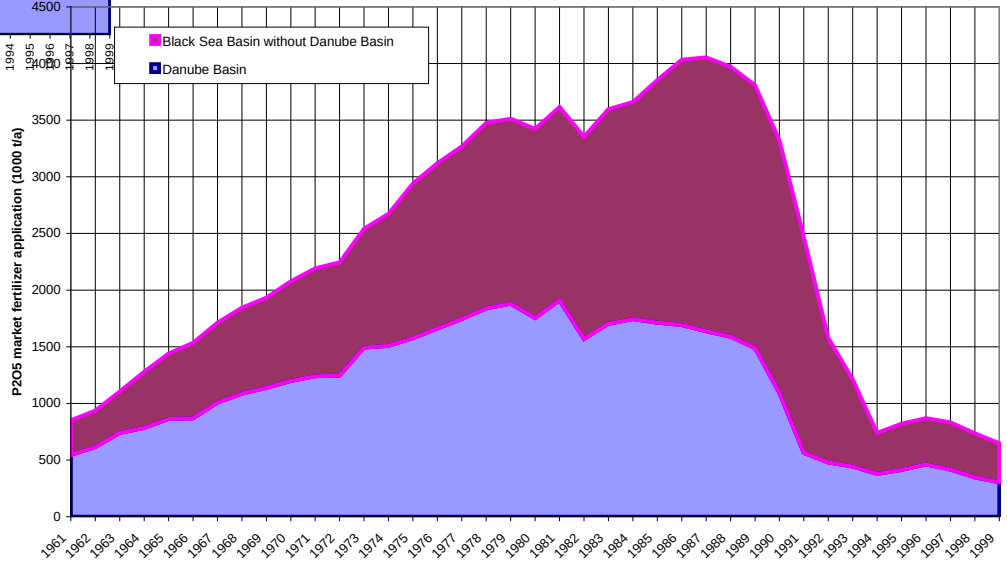
- Most relevant elements for all living systems as important as water
- Sufficient food for the global population can only be produced by applying (market) fertilsers (N, P, K) in order to avoid a dramatic extension of agriculture on the expense of biodiversity
- Increased area specific crop yield and econo-mically viable agriculture is bound to elevated nutrient concentrations in the soil, which necessarily results in increased losses of nutrients to the environment

N and P market fertiliser application in the Black Sea Catchment (Mt N, P2O5)



N

P



Which role play nutrients?

- Growth of all living organisms is controlled by:
  - Genetic code
  - The interaction between the environment and the genetic code
  - The concentration (availability) of a limiting „nutrient“
- Most of the natural (aquatic) ecosystems with high biodiversity are characterised by limited availability low concentrations of „nutrients“
- Nutrient management has to find a solution for a basic conflict between nature and human needs.

Which role play nutrients?

- Nutrients therefore play a global role, and link agriculture and water quality management
- If nutrient concentrations in the waters increase by anthropgenic influence the competition between the natural species is changed,
  beyond certain threshould concentrations the ecosystems completely change and will not „recover“ without changing the nutrient flows.
- Nature can adapt even to severe changes of nutrient flows but we loose a valuable „resource“

Sources of nutrients

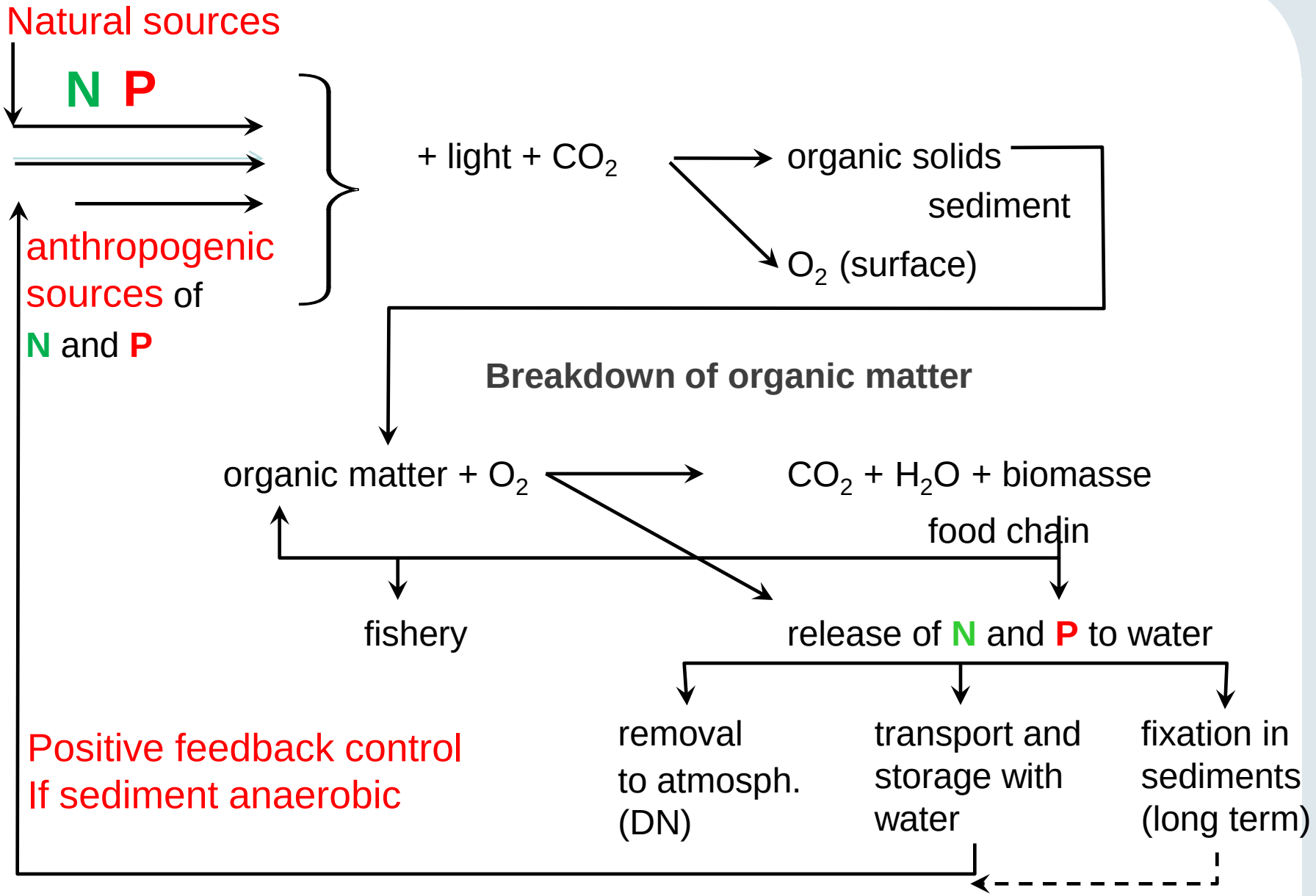
Sources for nutrient loads:

- All Point sources (sewers, CSO, WWTP's).
- Diffused sources in the catchment
  - Agricultural activities:
    - fertilizer application (N,P) transported by
    - Ground water and surface runoff, soil erosion.
  - Air pollution, in and beyond the catchment !!:
    - nitrogenous compounds from agriculture (ammonia from manure),
    - combustion processes (nitrous gases from traffic and industry).

Water Quality Control:

- Water quality control:
  - Nutrient flows (mass/time) need to be controlled in order to find a “sustainable” compromise between agricultural activity, human water use and environmental protection.
  - Direct problem: nitrate concentration in the ground water for drinking water
  - Indirect problem: Excessive growth of algae in rivers, lakes or coastal waters and its consequences. Limiting nutrient for algae growth in most cases phosphorus, in seas also nitrogen can be limiting.

Eutrophication



Water Quality Control:

- We have to consider the dilution of nutrient loads (M/T) by the water flow (hydrology), or the water depth of a lake, the temperature regime, the solar energy.
- We have to consider the great variability of the climatic conditions over the year and from year to year and from region to region.
- This is a complex problem and needs the co-operation of many disciplines and stakeholders, scientific research, monitoring and experience as we have to control adapteable living systems.

Nutrient management in international catchments

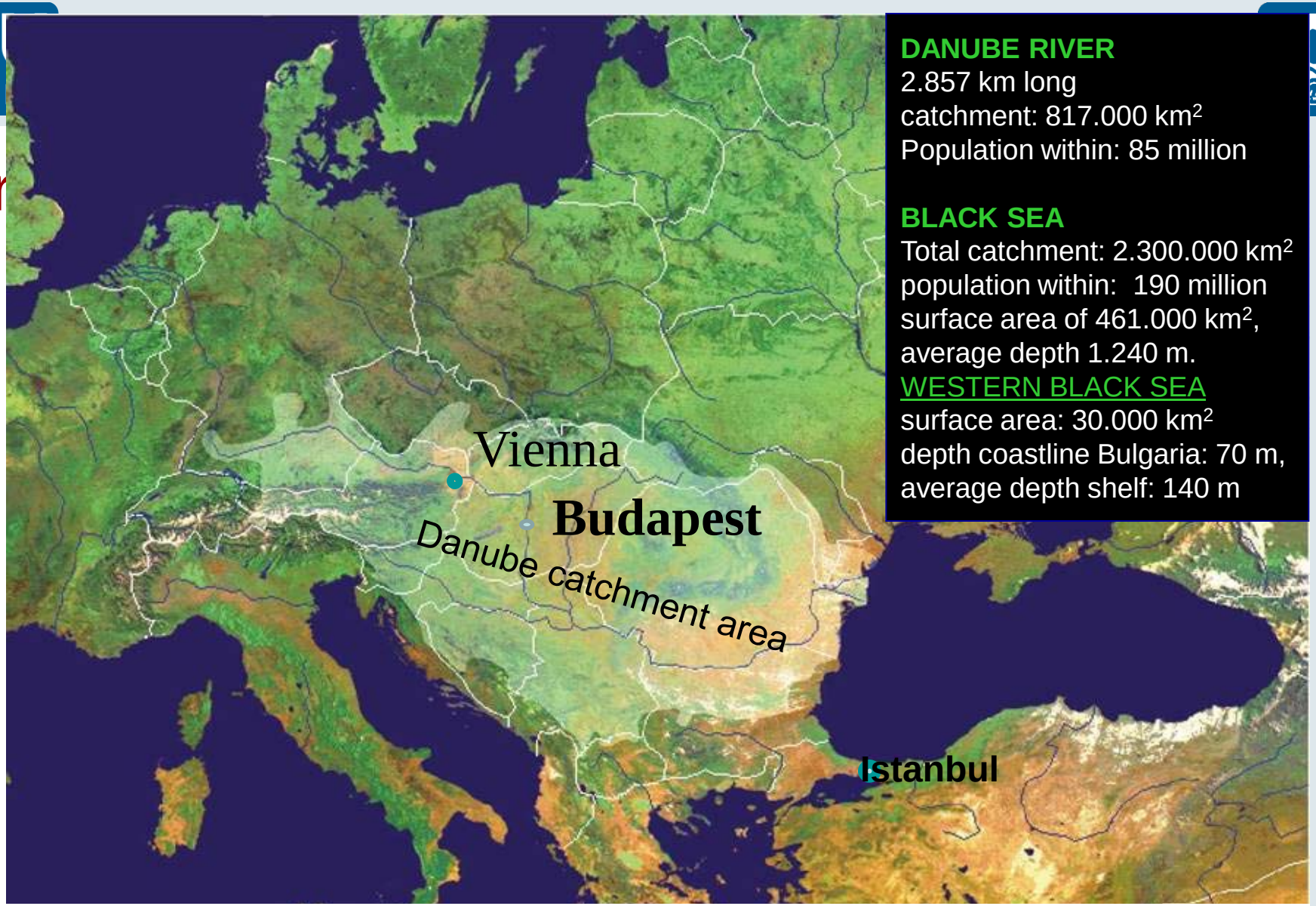
- Nutrient management in international catchments
  - has to comprise all the countries and administrations contributing (substantially) to the pollution by nutrients:
    - Point sources from sewer systems or waste water treatment plants.
    - Diffused sources from all agricultural areas.
    - Surface and underground runoff containing erosion products, soil leachates and the
    - transnational air pollution transport beyond the catchment area! (agriculture, traffic and industry).

Nutrient management in international catchments

- Organizational solution for nutrient management
  - Cooperation needs a transnational political basis (in case of air pollution even beyond the catchment boundary)
  - Can be based on legal framework (Danube) or on voluntary agreements between the partners (Rhine)
  - Has to comprise the whole catchment not only the rivers or seas and their water quality (Black Sea)
  - Example: ICPDR (International Commission for the Protection of the Danube River).

Danube

The most international river basin worldwide

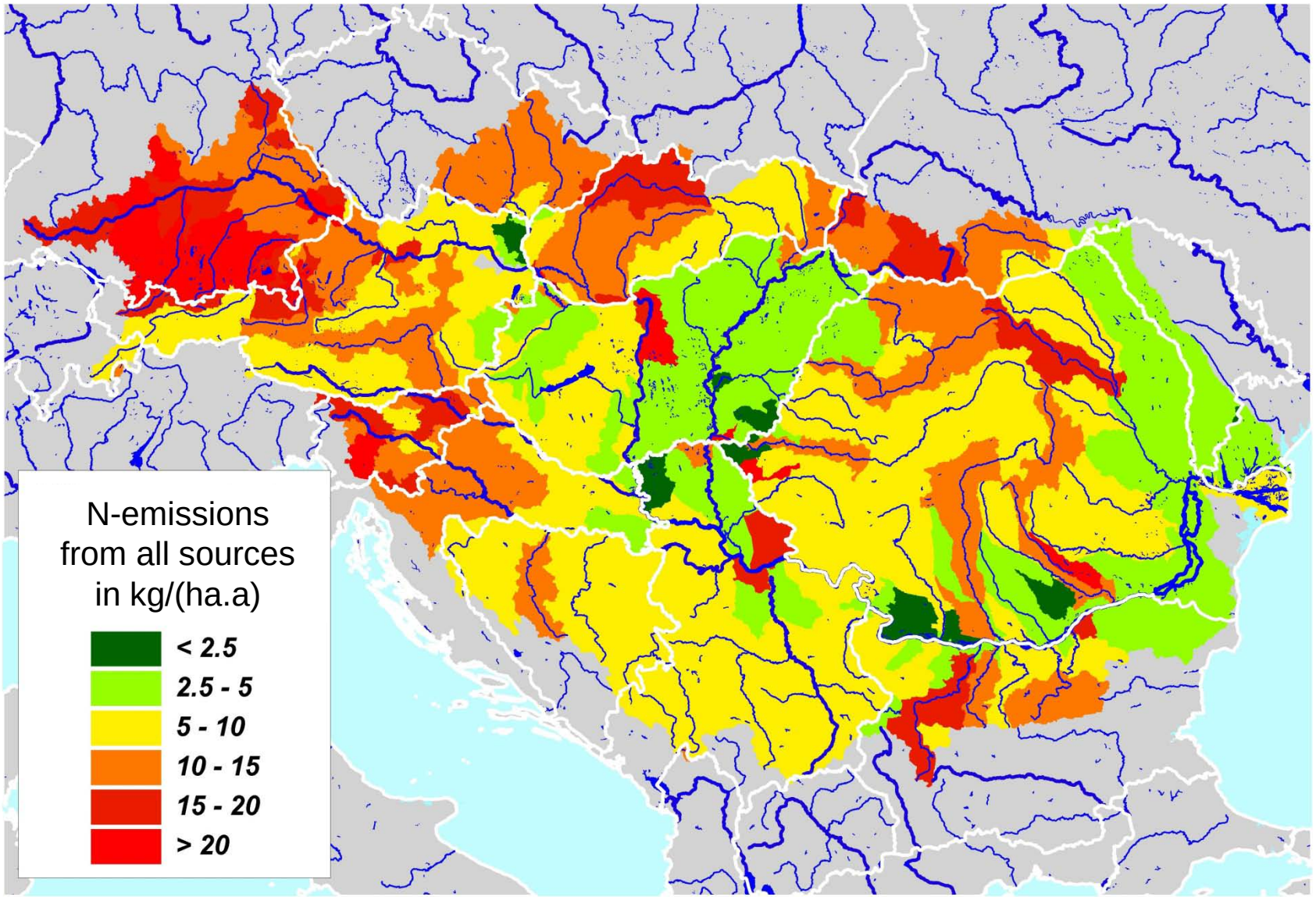


DANUBE RIVER
2.857 km long
catchment: 817.000 km²
Population within: 85 million

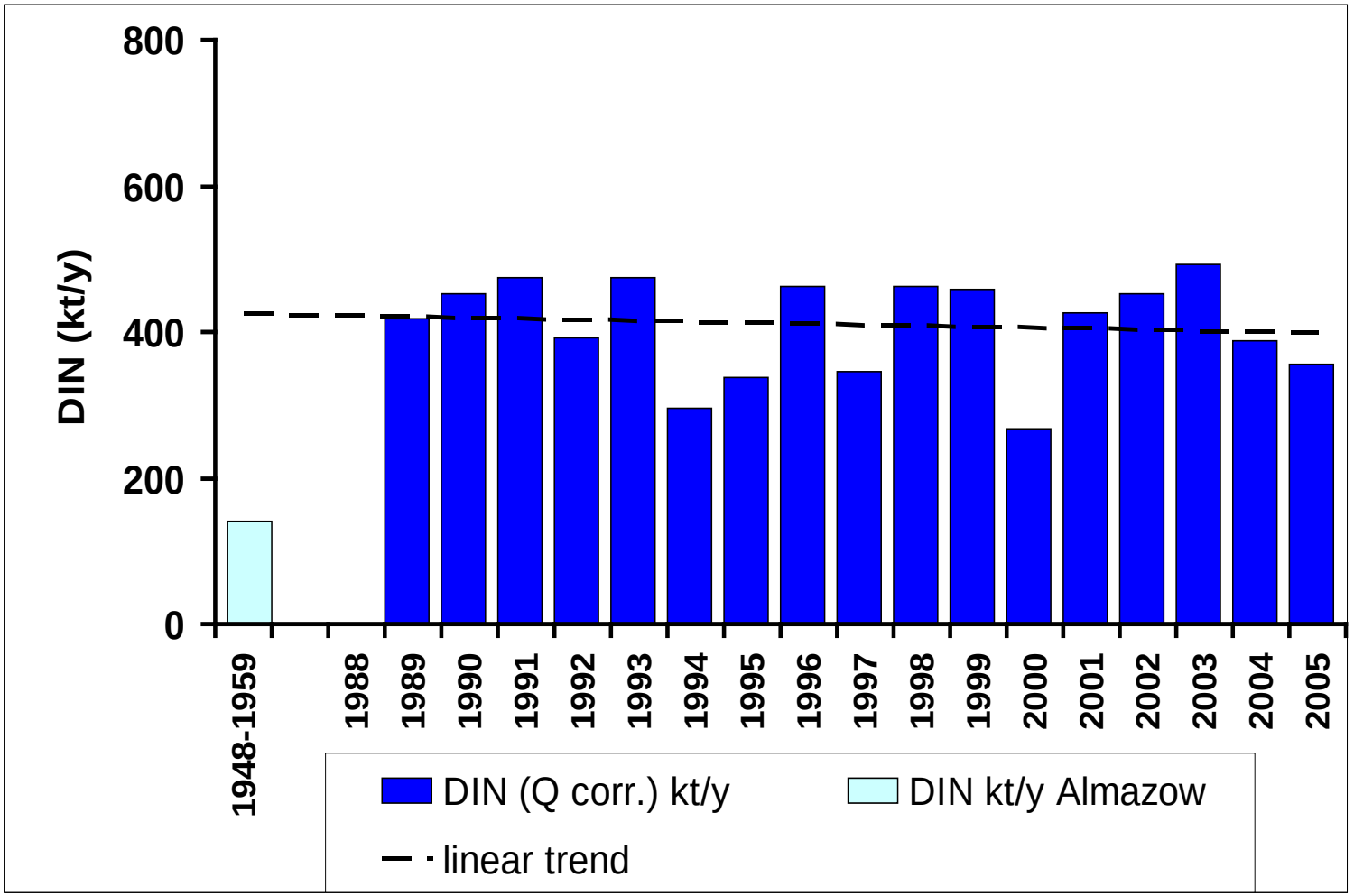
BLACK SEA
Total catchment: 2.300.000 km²
population within: 190 million
surface area of 461.000 km²,
average depth 1.240 m.
WESTERN BLACK SEA
surface area: 30.000 km²
depth coastline Bulgaria: 70 m,
average depth shelf: 140 m

Danubian countries (with area >2000 **km²),**
Austria **(A);** Bosnia-Hercegowina **(BIH);** Bulgaria **(BG);** Croatia **(HR);** Czech Republic **(CZ);** Germany **(D);** Hungary **(H);** Moldova **(MD);** Romania **(RO);** Serbia (YU); Slovakia **(SK);** Slovenia **(SLO);** Ukraine **(UA);**

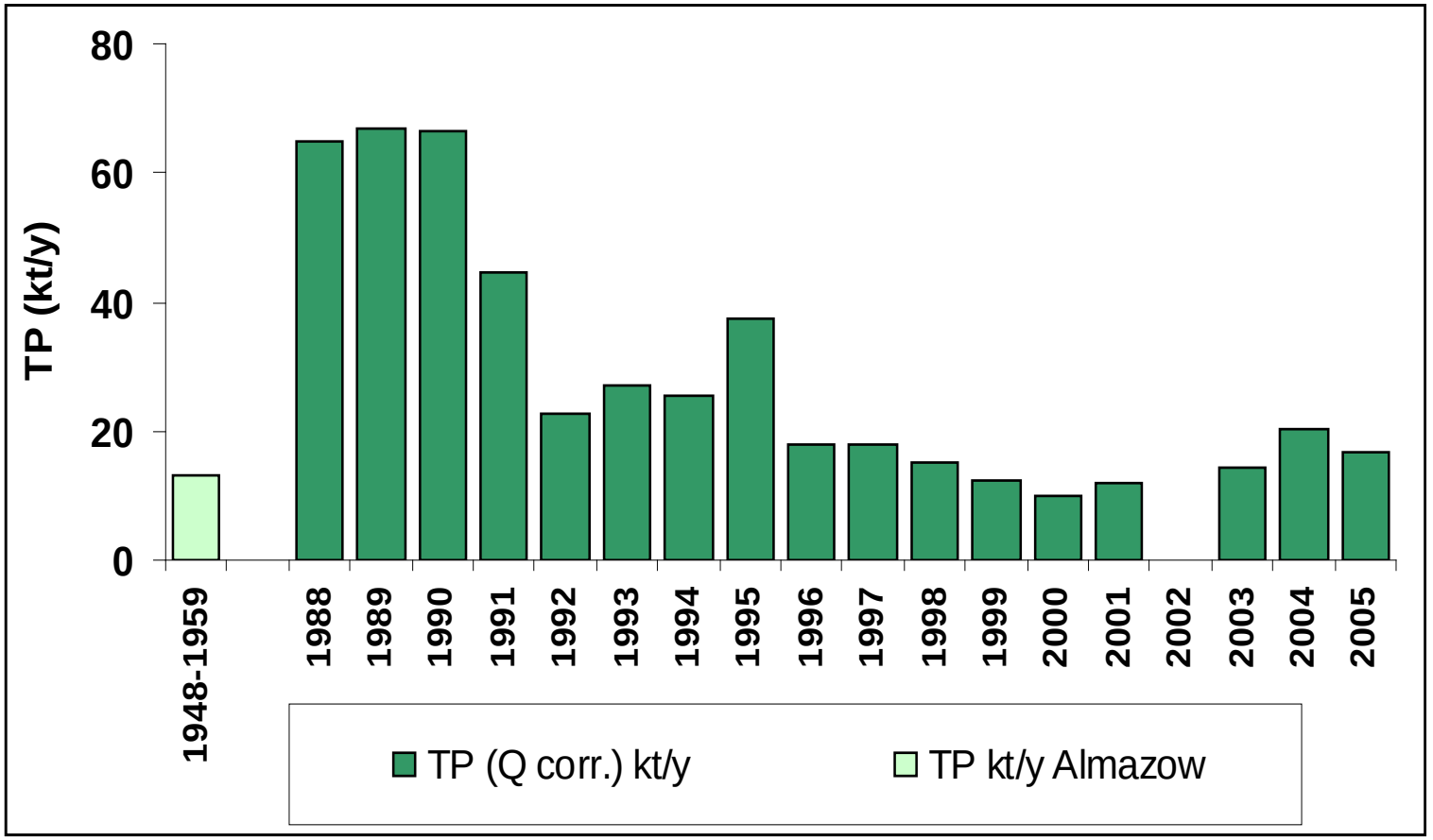
Danube catchment, N-emissions



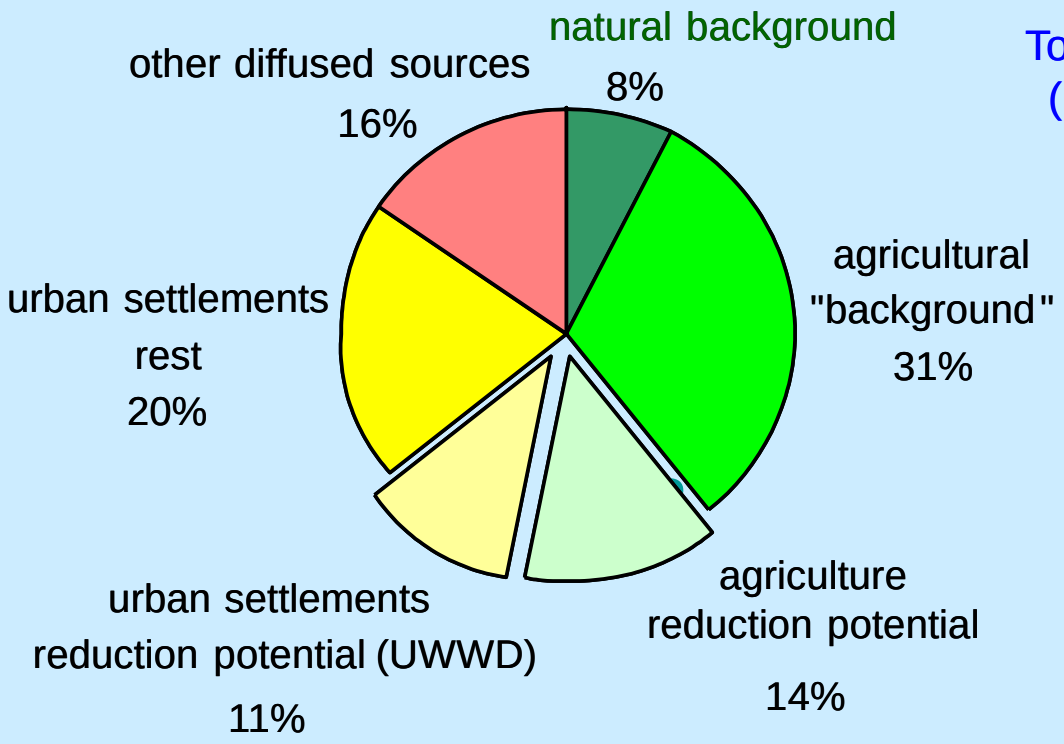
River Danube annual inorganic nitrogen loads (corrected for annual discharge) to the Black Sea



River Danube annual total phosphorus loads (corrected for annual discharge) to the Black Sea



Nitrogen emissions to Danube and Black Sea



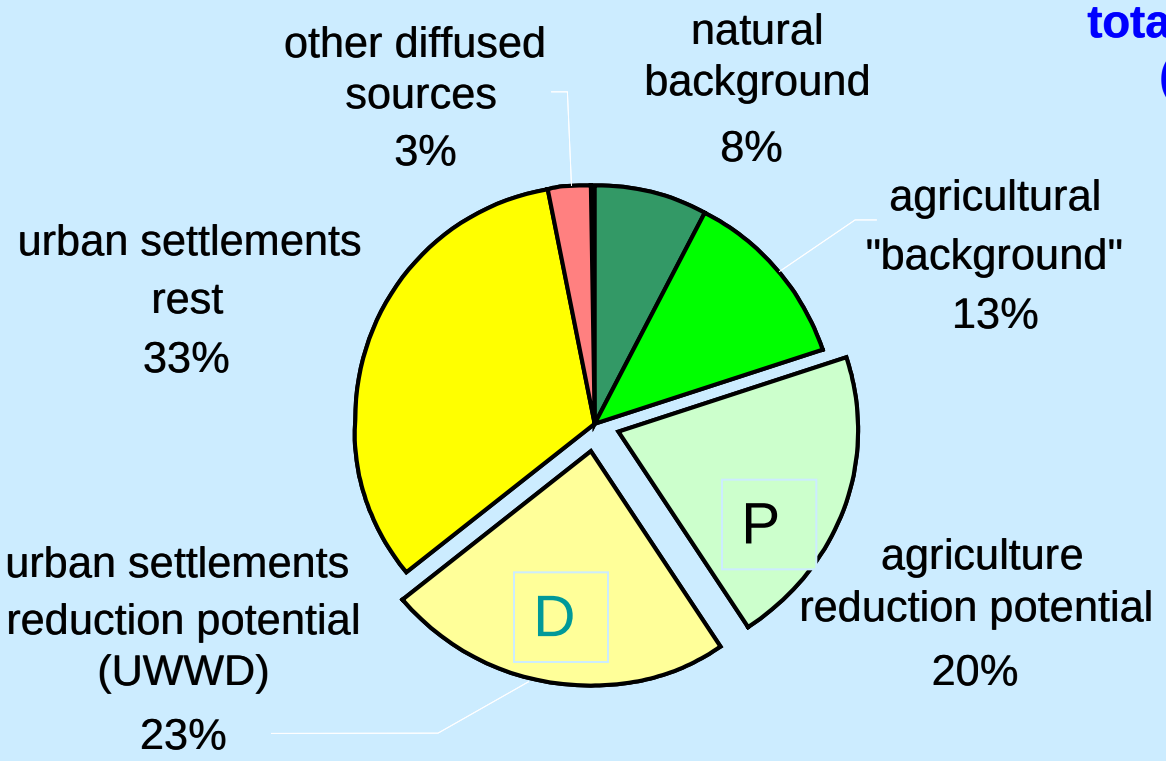
Total N-emissions about 700 kt/a
(N to Black Sea 420 kt/a (60%))

can hardly be reduced

can be reduced during next 10 years

can be reduced and increased with a delay of ≥ 10 years between implementation and response

Phosphorus emissions total and to Black Sea



total P-emissions about 70 kt/a (P to Black Sea 20 kt/a + P in Iron Gate 8 kt/a)

- hardly to be reduced
- can be reduced during next 10 years
- can be reduced

P particulate
D dissolved

ICPDR

- ICPDR
  - Danube river basin comprises actually 19 different countries (most international river world wide).
  - Is based on Danube River Protection Convention:
    - signed in June 29 1994 in Sofia (Bulgaria),
    - came into force in 1998
    - has made subtantial progress regarding nutrient management on catchment scale

- Achievements of ICPDR:
  - Agreement of all countries to apply the EU Water Framework Directive.
  - Enforcement of the Danube roof reports required by WFD:
    - protection of the coastal waters in the Black Sea North Western Shelf area (Rumania, Bulgaria),
    - ground water protection in the whole Danube basin (Nitrate Directive).
  - Implementation of a quality controlled transboundary monitoring system.
  - Implementation of a management plan for nutrient control for Danube Catchment (not finished yet)
    - P as a limited and valuable resource

Conclusions

- Effective nutrient management for water protection has to be developed and implemented **on catchment scale** and has to include all point and diffused sources and all stakeholders.
- The dominating partners within the catchment are waste water management (municipal, industrial) and agriculture
- Management needs basis:
  - correct monitoring data
  - scientific understanding of the complex anthropogenic and natural processes enabling
  - mathematical modeling
  - Political, legal, economic and, technical tools

Conclusions

- **The International Commission for the Protection of Danube River**,
  - responsible for water management in the most international river basin in the world
  - It can serve as a model for an effective political, legal, economic and organizational solution
  - Is able to implement the necessary co-operation beyond national borderlines
  - Is based on the acceptance of EU Water Framework Directive by all Danubian countries
  - EU is a member of ICPDR able to strongly support implementation of agreed policy into practice despite the great variety of languages, cultures and religions.

Conclusions

- Nutrient management has the following goals:
  - ground water protection for drinking water supply (Nitrates Directive)
  - Eutrophication control in surface waters (rivers, lakes, coastal waters) (UWWD for sensitive areas)
  - **sustainable resource management** especially for **phosphorus**, as it is an essential and limited resource for all living organisms (No legal basis!)

Conclusions

- Nutrient management uses the following tools:
  - Use of P-free detergents in the whole catchment
  - stopping continuous direct discharge of municipal and industrial waste water to receiving waters
  - Efficient removal (and recovery) of phosphorus, nitrification and nitrogen removal at all WWTP
  - Basin wide implementation and optimisation of „Good Agricultural Practice“ (fertilisation, erosion abatement, soil management, cattle breeding, biogas production)
  - Reducing erosion from non cultured land
  - Reduction of Nox air emissions from traffic and industry

Conclusions

- Nutrient management can be supported by:
  - River restoration especially for the small rivers
  - Protection and restoration of wetlands
  - Economic incentives for emission reduction
  - Education and media causing a change of conscousness and nutrition habits (meat consumption)
  - Efficient monitoring and control systems

Conclusions

- Nutrient management can be supported by:
  - River restoration especially for the small rivers
  - Protection and restoration of wetlands
  - Economic incentives for emission reduction
  - Education and media causing a change of consciousness and nutrition habits (meat consumption)
  - Long term efficient monitoring and control systems
  - By a wise and flexible combination of the precautionary and environmental standard principle

Conclusions

What do we get from nutrient management in international catchments:

- mutual recognition of a joint responsibility, creating co-operation not only in the field of water
- Safer and cheaper drinking water supply
- Increased recognition of the value of water quality
- Touristic development of coastal regions
- Healthier population (water, nutrition)
- Increased biodiversity
- Improved resource protection

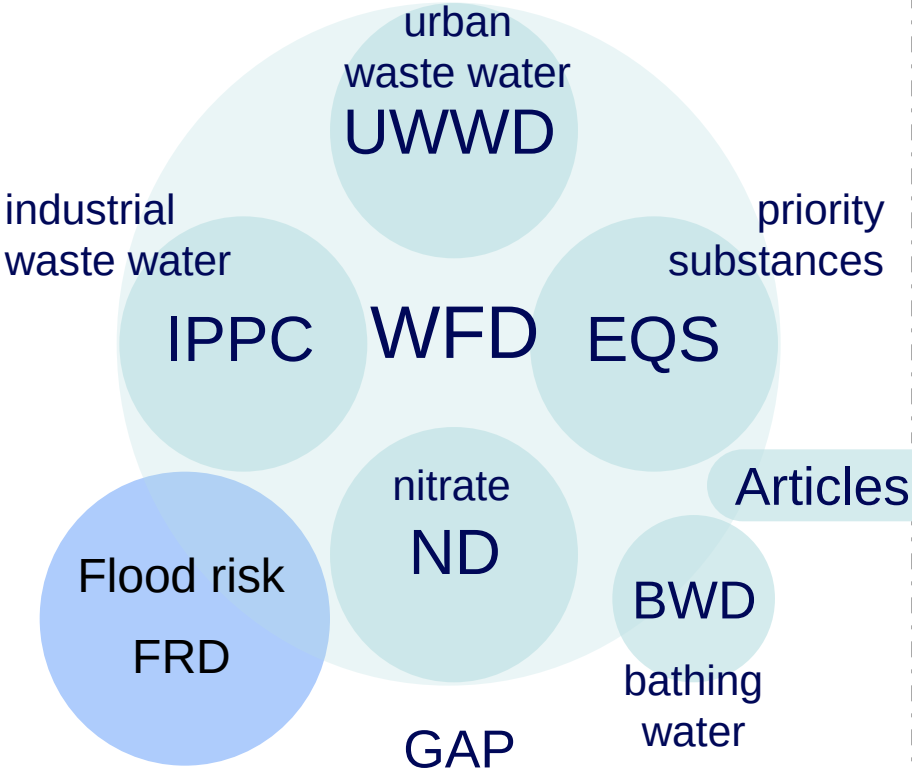
Final remarks

Nutrient management will remain a continuous challenge with increasing relevance on a global and a regional scale.

It has to be adapted to the specific regional situation in order to safeguard a sustainable development and suply of the population with enough food and water of an adequte quality for us and nature.

EU

Water Quality Management



EU-DWD

Drinking Water Directive

Amendment

risks by life long consumption:
micro-pollutants

acute risks from pathogens:
"new" pathogens
giardia, cryptosporidium,
legionella,entero viruses

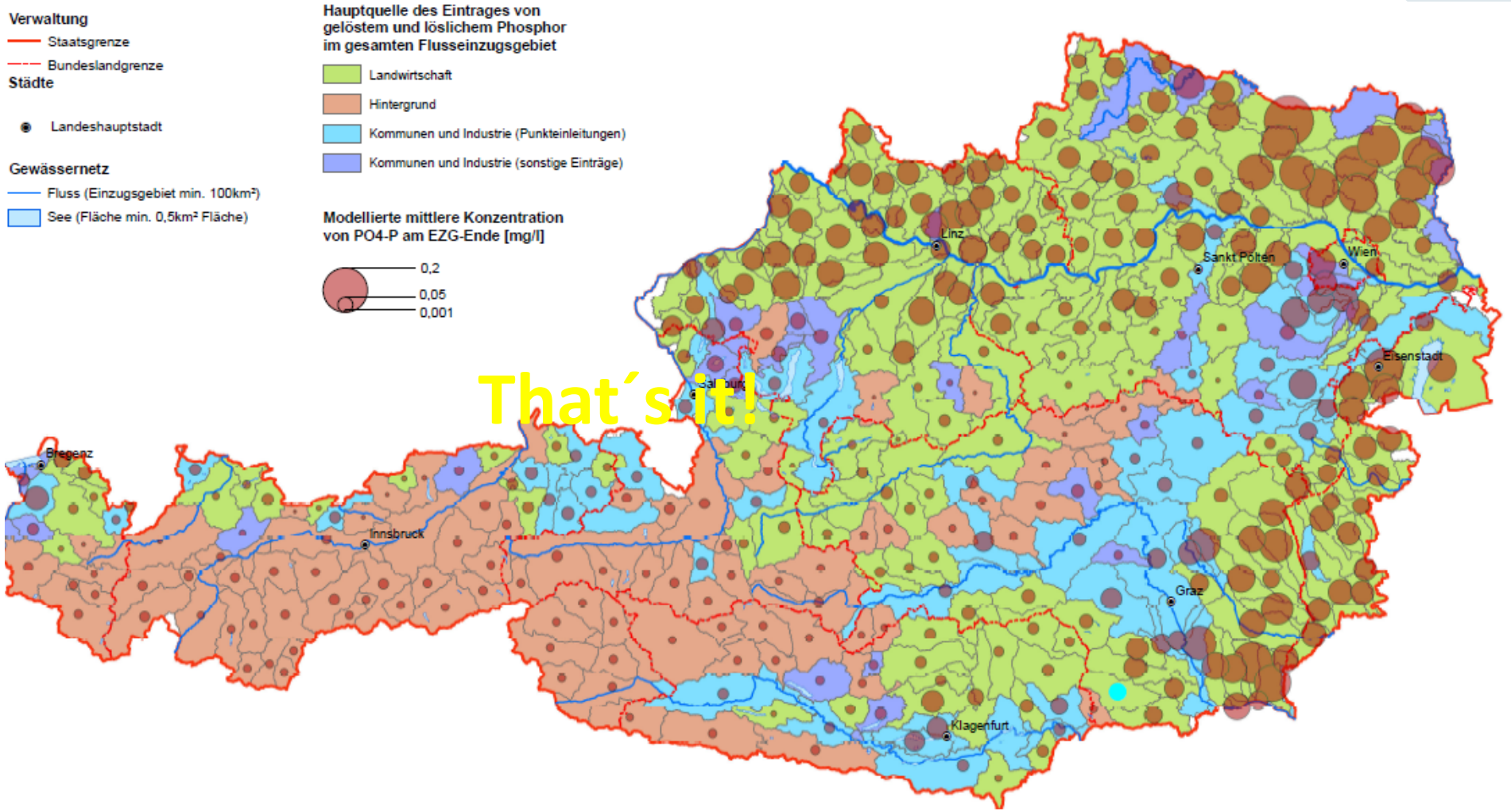
Articles 7, 16 WFD

UV desinfection, chlorine?,
activated carbon

WHO Water Safety Plans

REACH, HACCP

WHO Drinking water guidelines



Detailed model results for regional decision making

Final remarks

International co-operation is a key element as we have only one air and one sea, which has also a high relevance for food supply and probably also for climate change abatement.

A rational combination of an affordable and cost effective precautionary principle for „everybody“ with a science based environmental standard principle has proven to be a successful joint water protection and agricultural policy if consequently implemented.

There is still room for better co-ordination in EU and implementation at the memberstates..

Invitation

IWA –LWWTP

Specialist Conference on

Design, operation and economics of Large Waste Water Treatment Plants

Budapest

September 4 to 9, 2011