NUTRIENTS IN DANUBE RIVER BASIN

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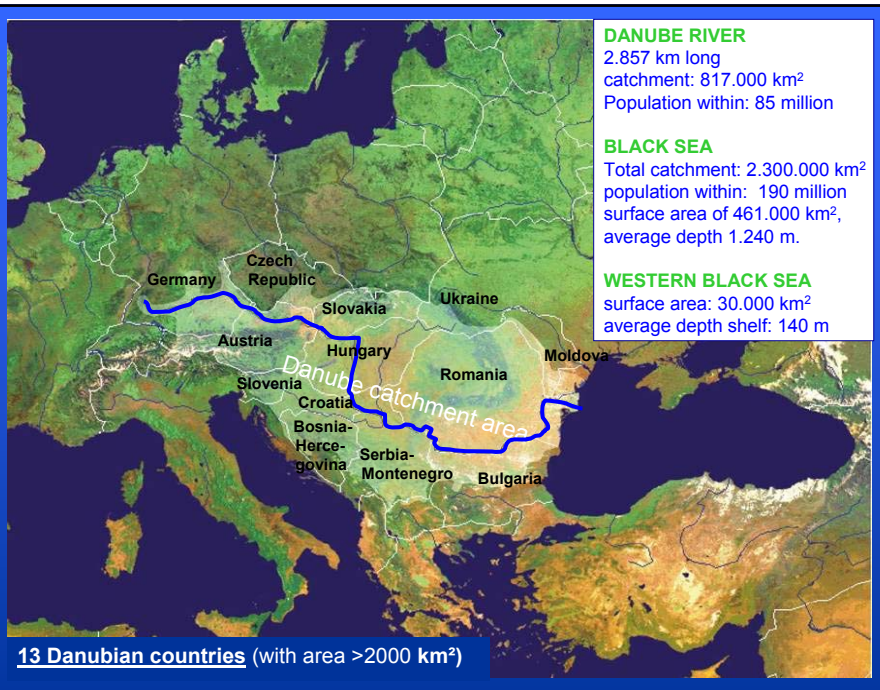
many results from the project "Nutrient management in the Danube Basin and its impact on the Black Sea ("daNUbs")

EU-5th Framework Programme

Duration 1.2.2001 – 31.1.2005

Coordination: Institute for Water Quality and Waste Management, Vienna University of Technology.



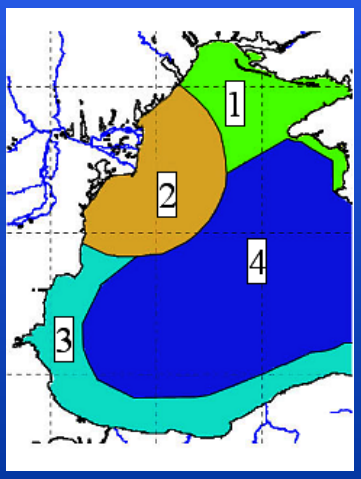
DANUBE RIVER
2.857 km long
catchment: 817.000 km²
Population within: 85 million

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
average depth shelf: 140 m

13 Danubian countries (with area >2000 **km²**)

Areas impacted by the Danube river



1 - North-western Shelf
2 - Area of direct Danube river-water influence
3 - Western and southern Shelf
4 - Central Western Black Sea

more-or less closed Sea

=> vulnerable to Eutrophication

Results from Danubs research project

The **situation** in WBSC **has improved significantly** since the late eighties and early nineties.

- reduced eutrophication (algae production),
- Bottom hypoxia has disappeared since 1997
- regeneration of zoo-benthos and
- regeneration of phytoplankton.

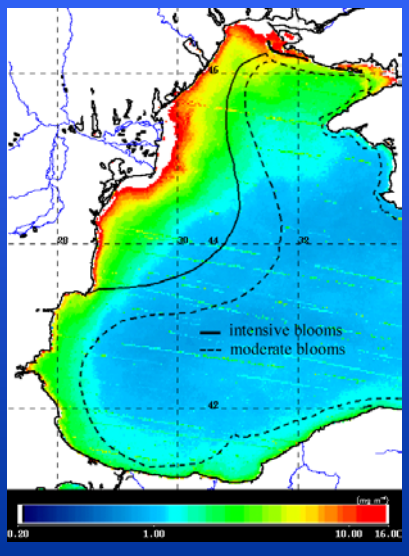
P-loads in 2000: about 24 kt P – as in the 1960ies

P is the limiting nutrient now in the Western Black Sea.

Main reasons for the decrease of nutrient discharges

- Economic Crises
  - ❖ Reduced fertilizer production
  - ❖ Closure of large animal farms
  - ❖ Reduced fertilizer application
- Introduction P-free detergents esp. in A and D
- P and N removal at treatment plants (A, D,CZ)
- favourable weather conditions (e.g. wind directions)?

Chlorophyll a in the WBS



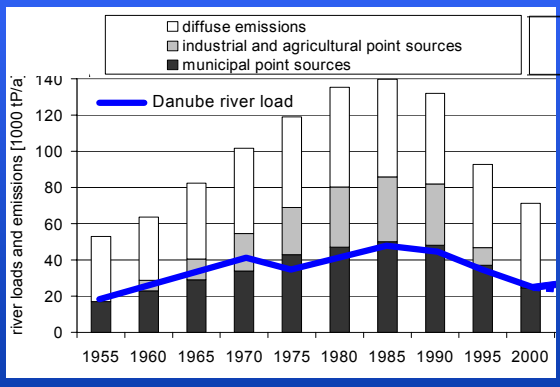
Satellite (SeaWiFS = Sea-viewing Wide Field-of-view Sensor) obtained, 5 years summarised (1998-2002), chlorophyll *a* data and zones of moderate and intense summer phytoplankton blooms in the 1980ies in the western Black Sea (after Zaitsev and Mamaev, 1997)

Diappeareance of anoxic conditions

September 2002: *Mytilus galloprovincialis*, in front of the Danube Delta (Horstmann, 2002)

September 2004: Red algea *Philophora* in front of the Ukrainian coast (Horstmann, 2004)

P-emissions in the Danube catchment and discharge to the Black Sea



(adopted from *Behrendt et al.*, 2004)

Decrease since 1990: N: minus 25%, P: minus 50% (mainly dissolved forms).

Main risks for **not** reaching good ecological status in respect to Western Black Sea eutrophication:

- Development of sewerage systems without nutrient removal at treatment plants (fulfilling EU Urban Waste Water Directive!)
- Recovery of the economic situation in the Eastern Danubian Countries (EDC) in the future (of agriculture and industry)

A **"stand-still" scenario** can **only** be related to the **nutrient load to the Black Sea** but not to the economic development.

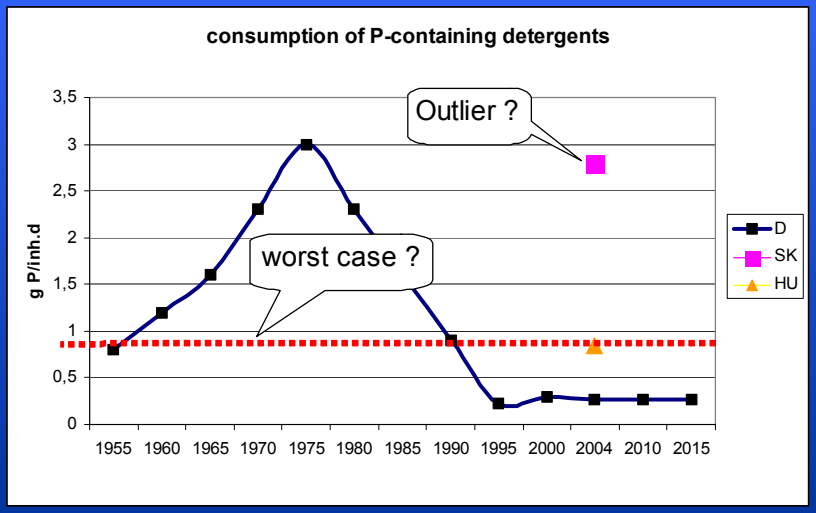
Economic development in these countries is desired even it leads to an **increase** of **nutrient emissions** e.g. from agriculture in some regions (mainly N).

Management of nutrient emissions in the whole catchment of Danube is required even the quality of the Western Black Sea has improved!

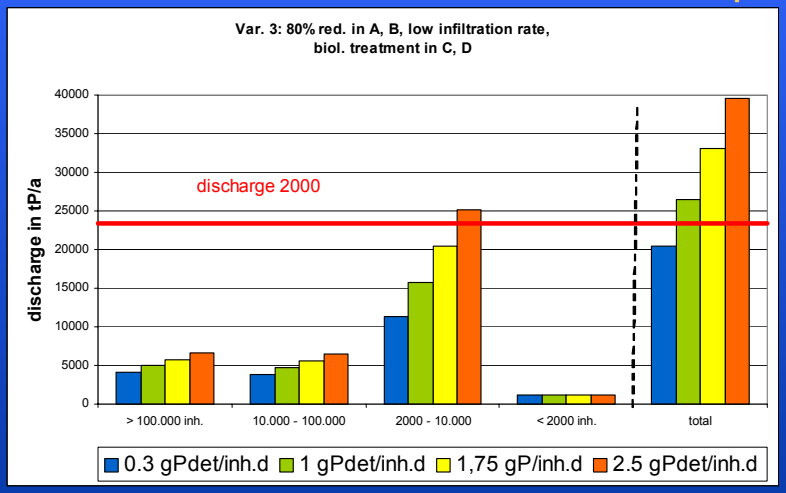
Main assumptions for scenarios

- emission per inhabitant: 1,65 g P/d
- 4 detergent-consumption scenarios
  - **0.3 / 1.0 / 1.75 / 2.5 g P_{det}.inh.d**
- Implementation of the UWWD: all agglomerations > 2000 inhabitants are sewered (about 16% resp. 12 Mio. not connected to sewer system)
- all areas are considered as **sensitive** areas
- > 10.000 inhabitants: P-precipitation
- emissions of industry: as in 2000

Development of the worst case scenario

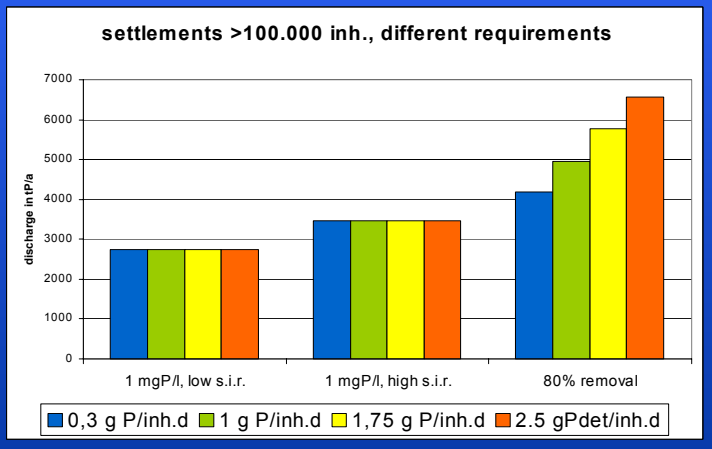


Emissions to surface waters via wwtps



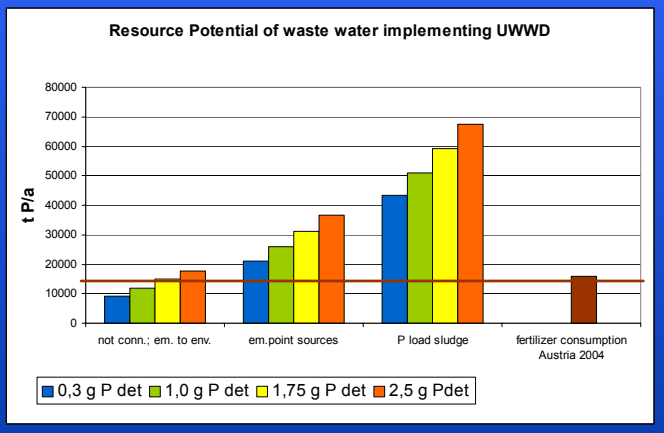
Variante Urban Waste Water Directive (UWWD)
(A,B,C: 100% connected, D not connected (ca. 12 Mio inh. not connected)

Emissions to surface waters via large wwtps



UWWD: „One or both parameters may be applied depending on the local situation. The values for concentration or for the percentage of reduction shall apply“

Resource Potential

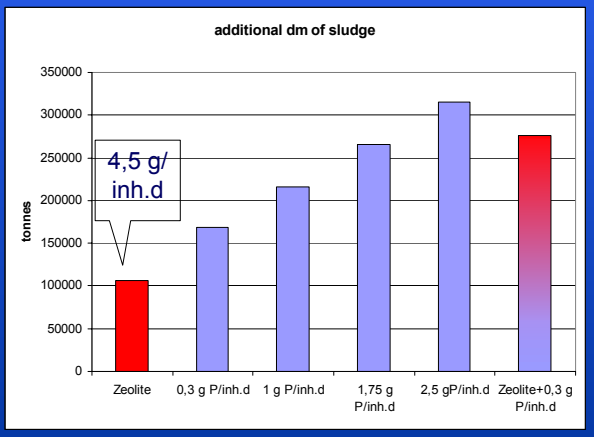


15.000 - 48.000 tP consumption of laundry detergents

P-fertilizer use in Austria 2004: 15.800 t P

sludge has a considerable resource potential – question of quality

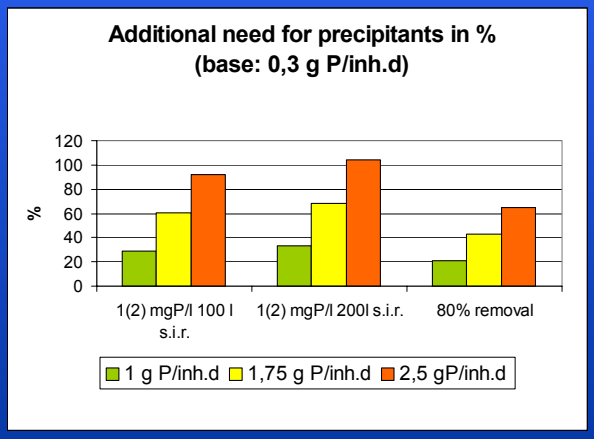
Additional sludge dry matter production due to Zeolite and P-precipitation



Sludge produced without P-removal: 1.6 mio t dry matter annually

The amounts increase due to the use of detergents up to 20%.
The costs of sludge management are similar.

Consumption of precipitants



A switch from P-containing detergents to alternative detergents reduce the amount of precipitants up to 100%.

Costs of P-precipitation

The additional costs of precipitation due to the use of P-containing laundry detergents amount

- in the scenario 1,0 g P/inh.d to 1 – 3% (7 – 14 Mio €/year) of the operation costs,
- in the scenario 2.5 g P/inh.d to 4 – 8% (21 – 43 Mio €) of the operation costs.

Costs in Austria: 1,5 – 3 €/kg P removed (excluding sludge disposal)

operation costs: about 40% of annual costs of wwtp

Summary

- The ecological situation in the Western Black Sea has improved considerably – **to a minor part due to environmental policy.**
- The improvement is due to the reduction of nutrient emissions via the Danube esp. of dissolved P
- The Western Black Sea is P-limited.

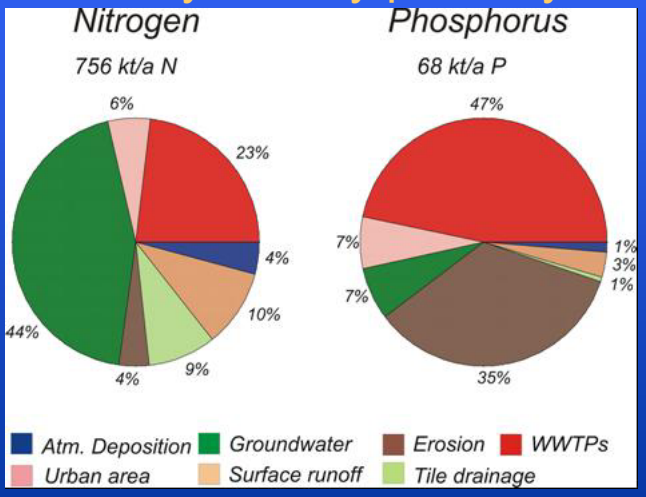
The improvement is endangered by:

- Recovery of the economic situation in the Eastern Danubian Countries (EDC) in the future (of agriculture and industry)
- Development of sewerage systems without nutrient removal at all treatment plants (fulfilling EU UWWD)

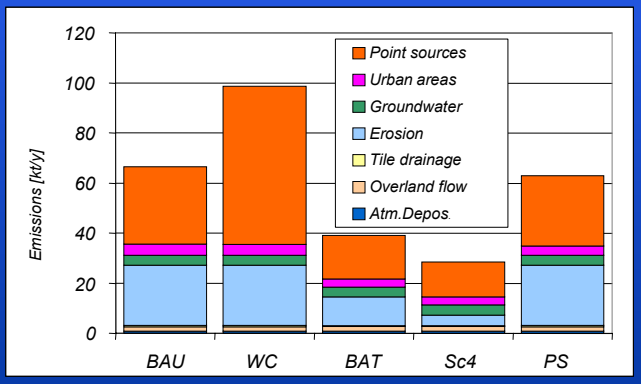
Summary

- Main contributors to P-emissions will be settlements between 2000 and 10000 inhabitants (ca. 50% of the emissions).
- wwtp-emissions can be kept on the level of 2000 if:
  - all areas in the catchment are “sensitive areas”
  - in areas 2000 -10000 inhabitants P-removal is applied or a ban (limitation?) of P-containing laundry detergents
- Sewage sludge represents a considerable P-resource.
- The costs of P-precipitation compared to the operation costs are small.

N- and P-emissions into the Danube river system by pathways



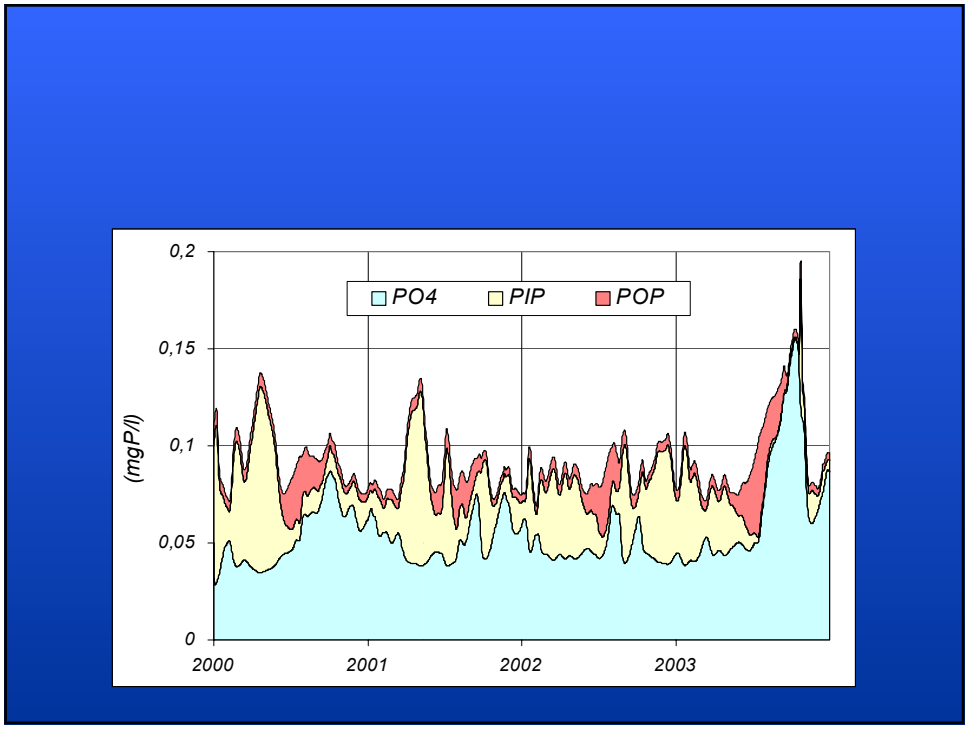
Emission of P in scenarios in 2015



	pe in mio		nu.plants	annual costs
A	36,6	200000	183	448
B	32,0	75000	426	863
C	38,7	7500	5155	3609
D	2,7	1500	1802	541
				5460

addit. costs due to detergents (base 0,3) in mio €		
1,0 g P det	7	14
2,5 g Pdet	23	45

addit. costs due to detergents (base 0,3) in %		
1,0 g P det	1,3	2,6
2,5 g Pdet	4,1	8,1


0,2
0,15
0,1
0,05
0
(mgP/l)
PO4
PIP
POP
2000
2001
2002
2003