University of Natural Resources and Applied Life Sciences, Vienna
Institute of Hydrobiology and Aquatic Ecosystem Management

Ecology of Large Rivers, Anthropogenic Pressures and Impacts

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Content

Traits and features of large river systems (LRS)

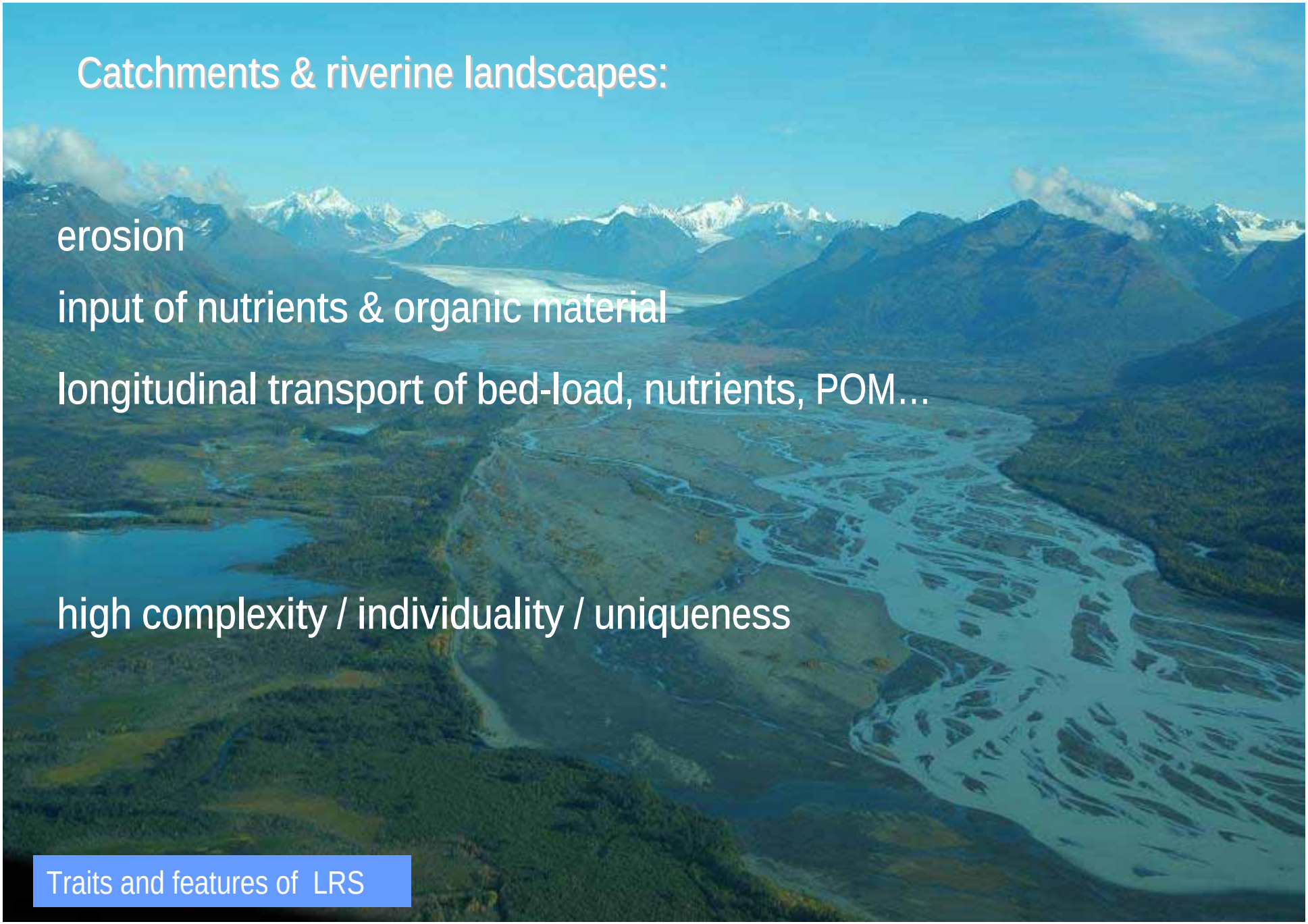
The multi-dimensional nature of riverine landscapes

Anthropogenic pressures and impacts

River/ floodplain landscapes along the Danube

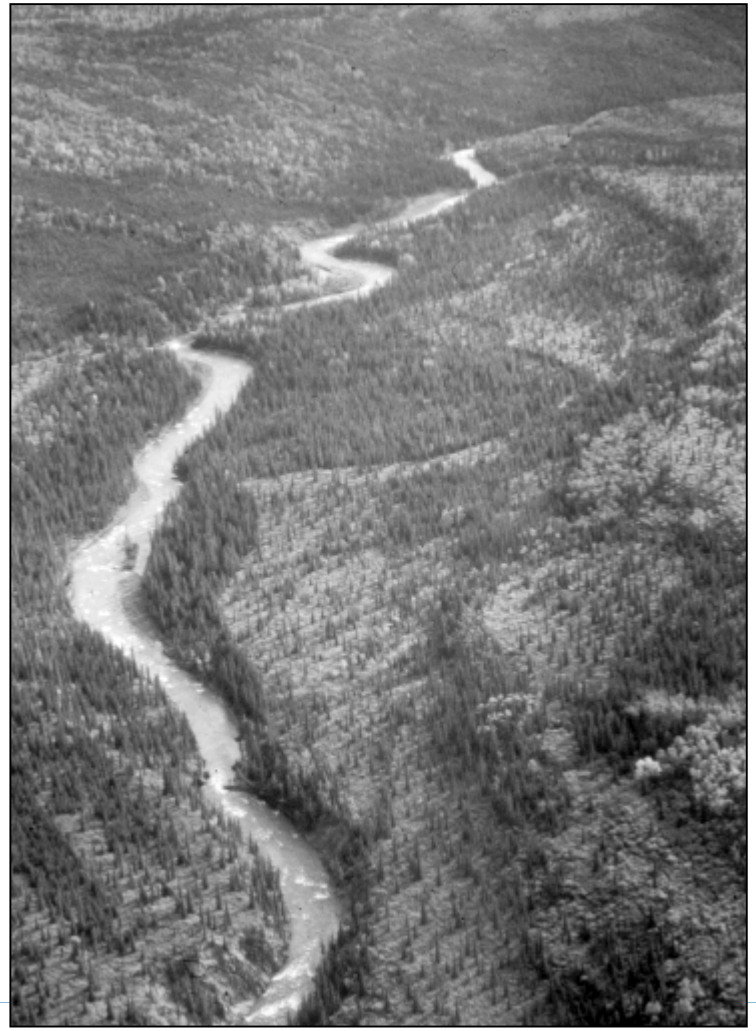
The need for protection and restoration

Reference conditions / “Leitbild-approach”


Catchments & riverine landscapes:
erosion
input of nutrients & organic material
longitudinal transport of bed-load, nutrients, POM…
high complexity / individuality / uniqueness
Traits and features of LRS

Constrained rivers

Traits and features of LRS



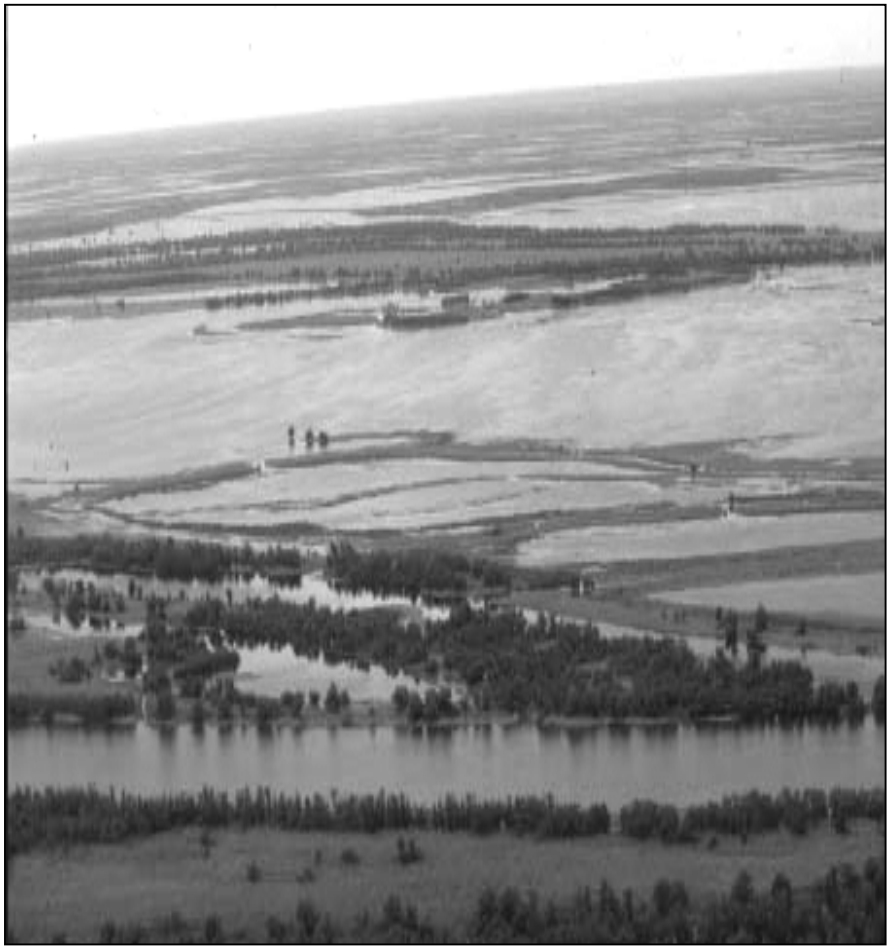
Braiding rivers

Traits and features of LRS

Meandering rivers

Traits and features of LRS

Delta landscapes

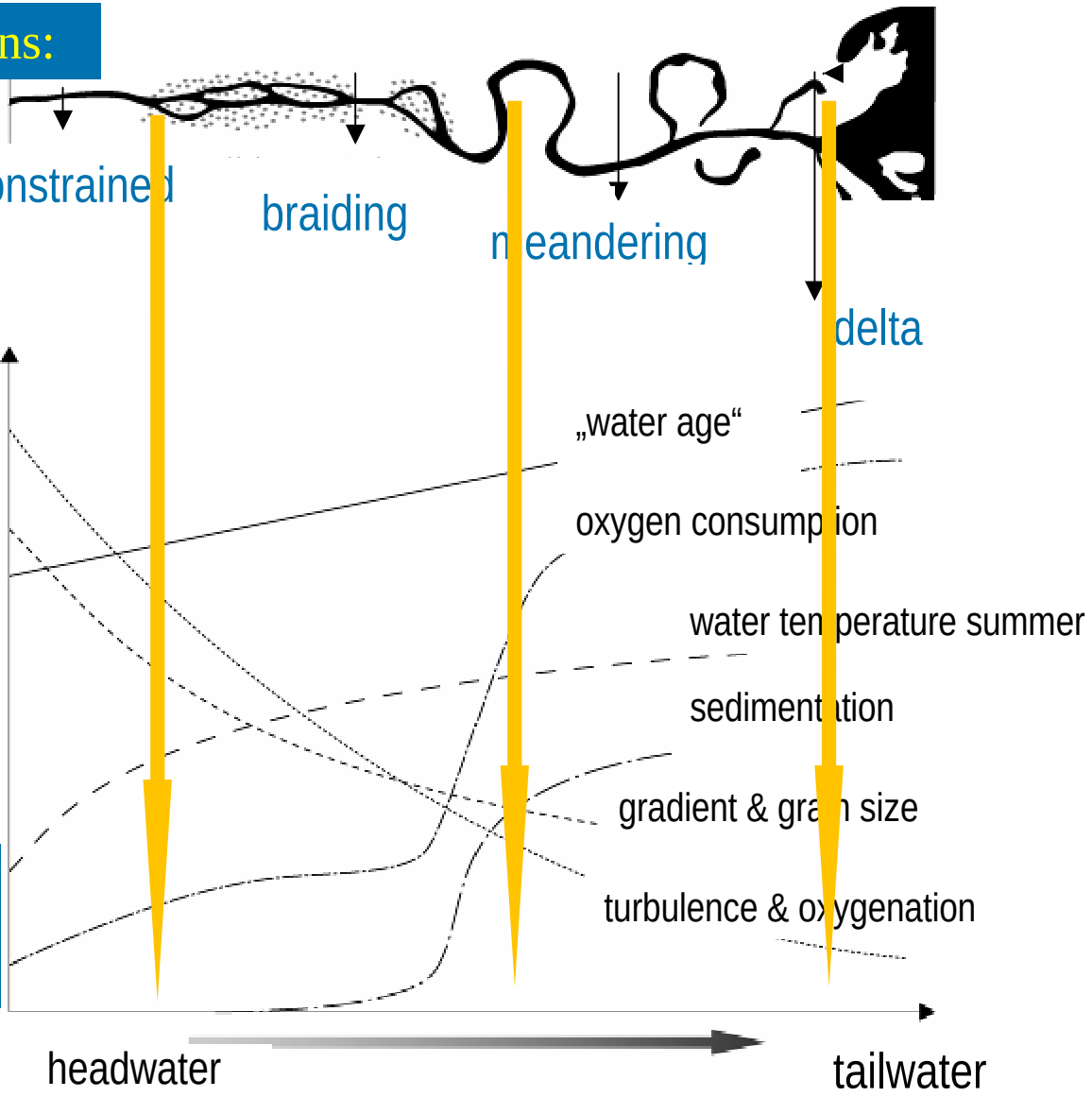


Traits and features of LRS

Scheme of longitudinal zonation

Connectivity conditions:

River morphology:



Important factors in the longitudinal zonation of running waters

multi-dimensional nature

Current Concepts of RW Ecology

- **River Continuum Concept** – Vannote et al. 1980
- **Shifting mosaic - steady state** – Bormann & Likens 1979
- **Intermediate Disturbance Theory** – Huston 1979
- **Serial Discontinuity Concept** – Ward & Stanford 1983
- **Ecological Connectivity** – Amoros & Roux 1988
- **Flood Pulse Concept** – Junk et al. 1989
- **Ecotone Concept** – Naiman & Decamps 1990
- **Extended Serial Discontinuity Concept** – Ward & Stanford 1995
- **Ecotones of riverine systems** – Ward & Wiens 2001

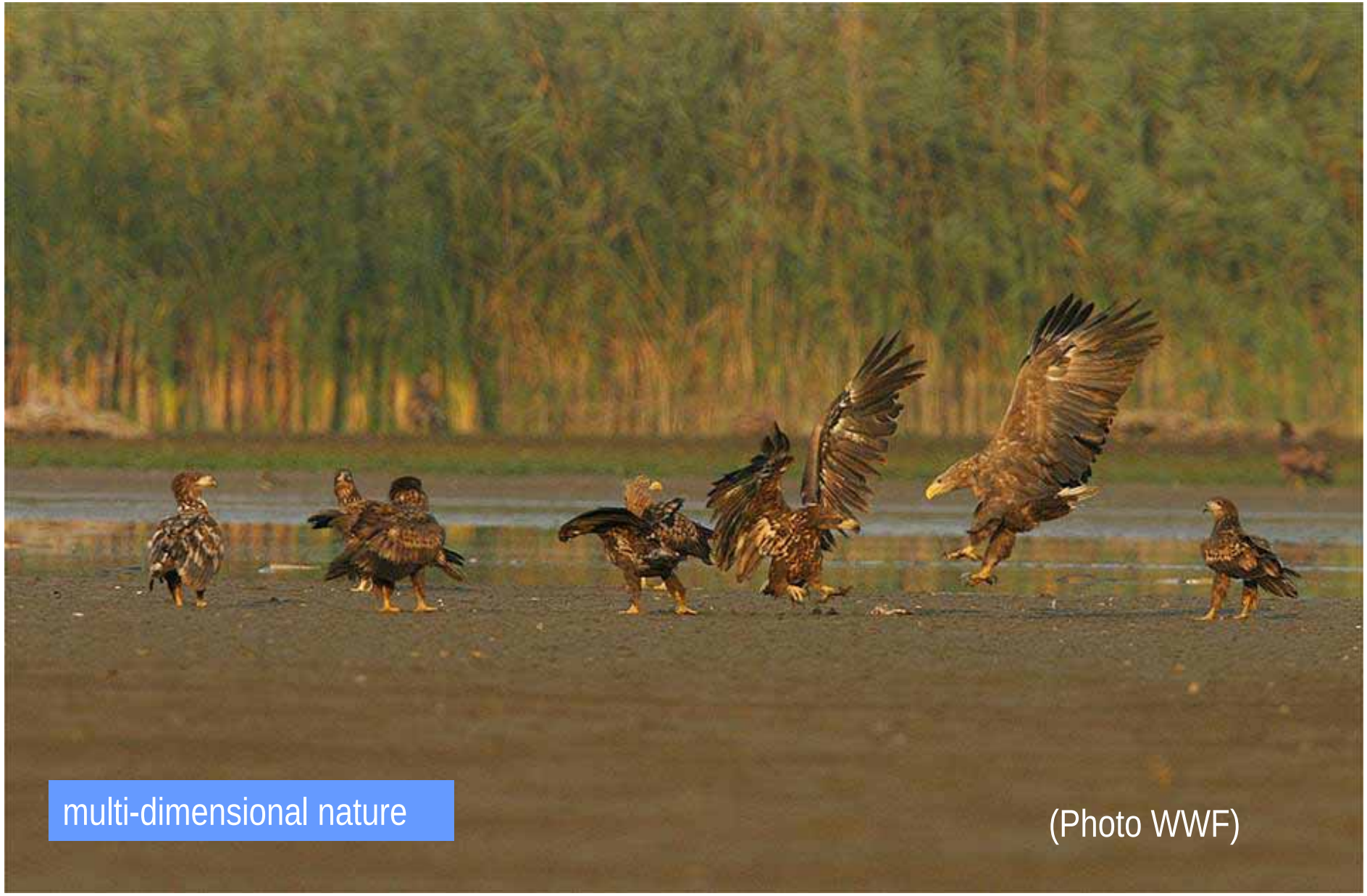
multi-dimensional nature

Current Concepts of RW Ecology

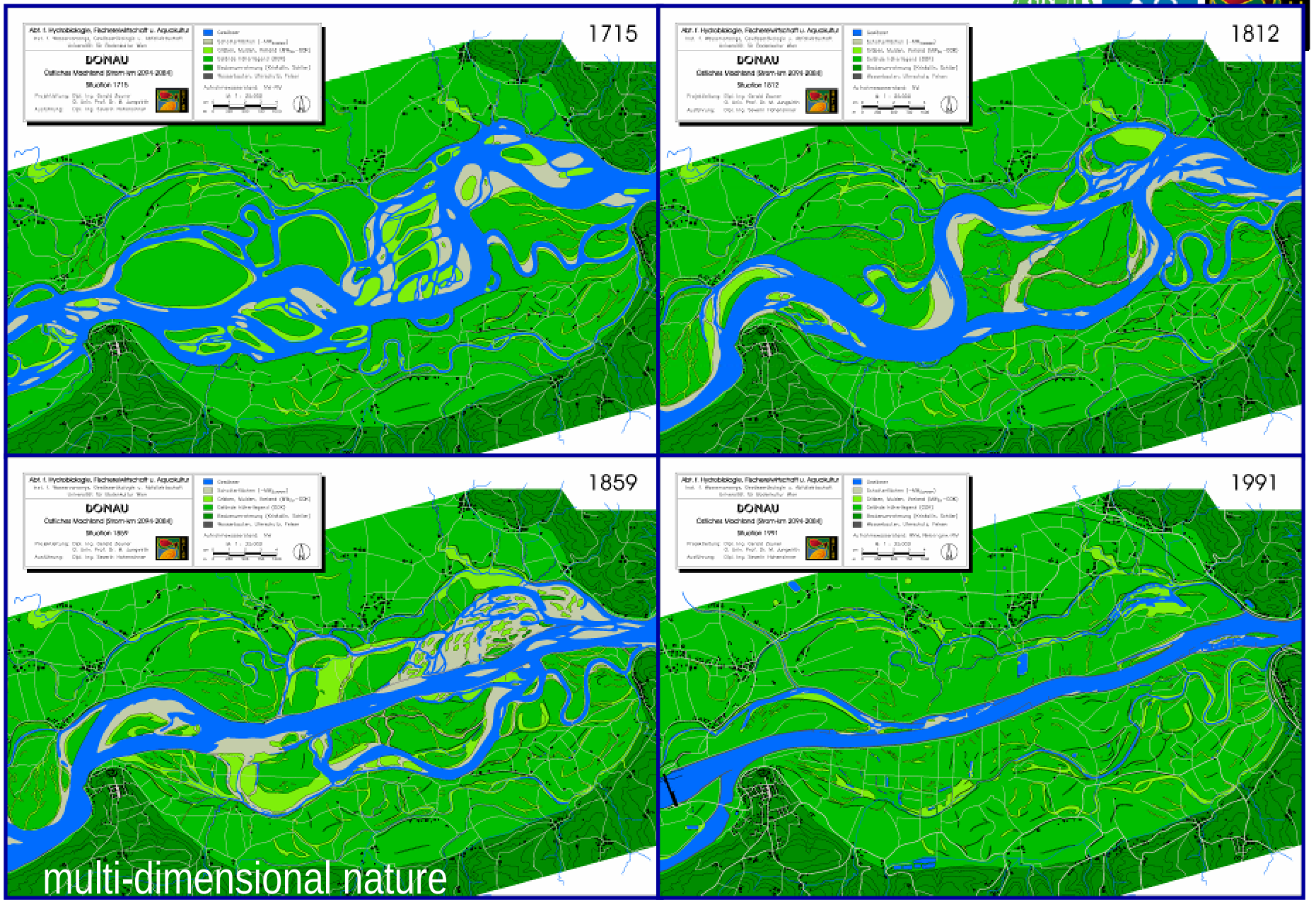
- multidimensional river/landscape - systems
- highly dynamic nature
- disturbances key element
- complex connectivity conditions
- heterogeneous habitat complex
- shifting mosaic, steady state
- outstanding high biodiversity

multi-dimensional nature

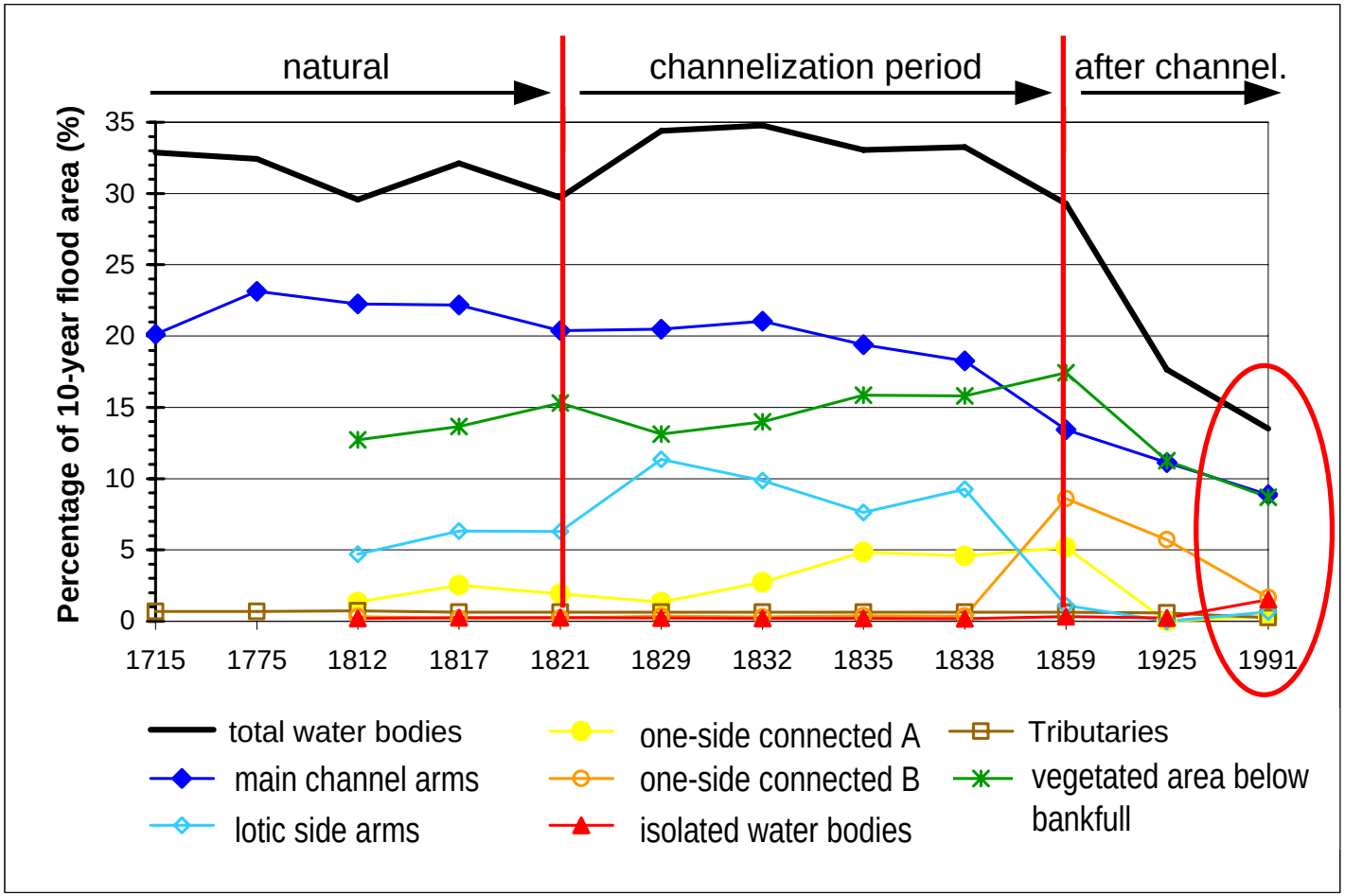
Biodiversity: White Tailed Eagle



Connectivity / dynamics



Consequences of channelization

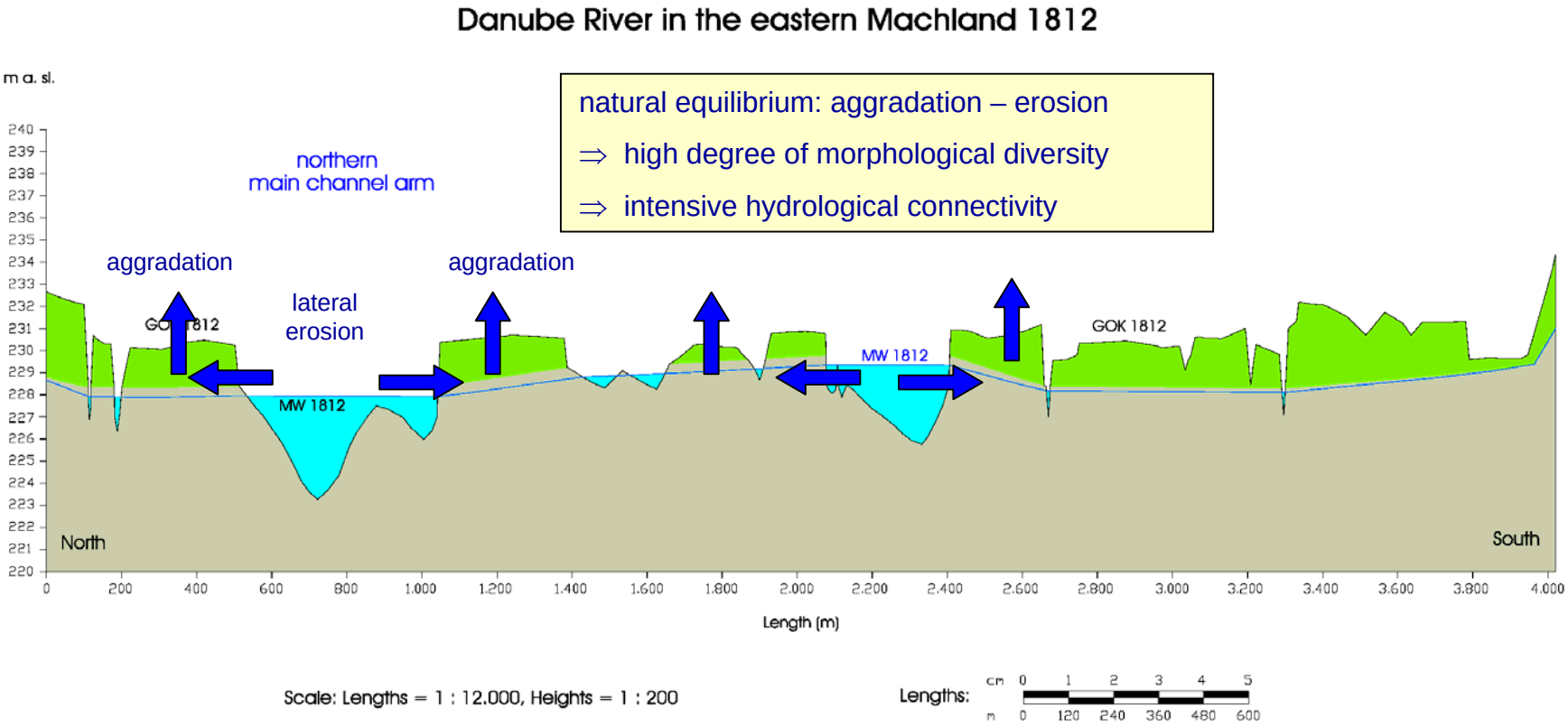


naturally:
rather stable composition of habitats
„shifting mosaic -steady state“
(*sensu* Bormann & Likens 1979)

today:
„static state“
artificial habitat composition, no dynamics

- naturally: > 90 % eupotamal water bodies (main channel, lotic side arms)
- channelization: area share of backwaters/lentic water bodies significantly increased
- after channelization: strong reduction of main channel and floodplain water bodies

Natural dynamic equilibrium



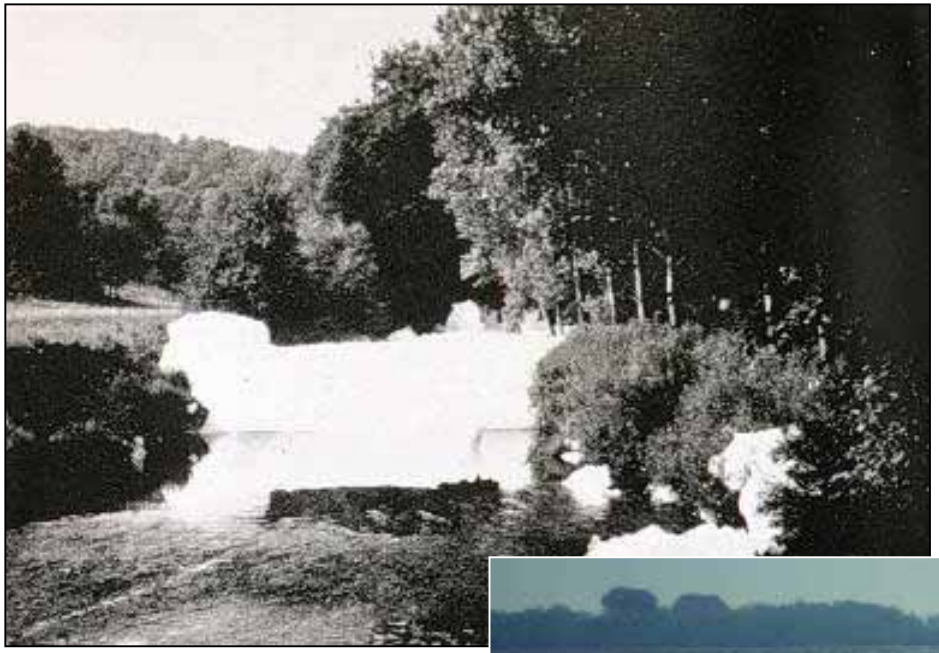
natural equilibrium: aggradation – erosion

⇒ high degree of morphological diversity

⇒ intensive hydrological connectivity

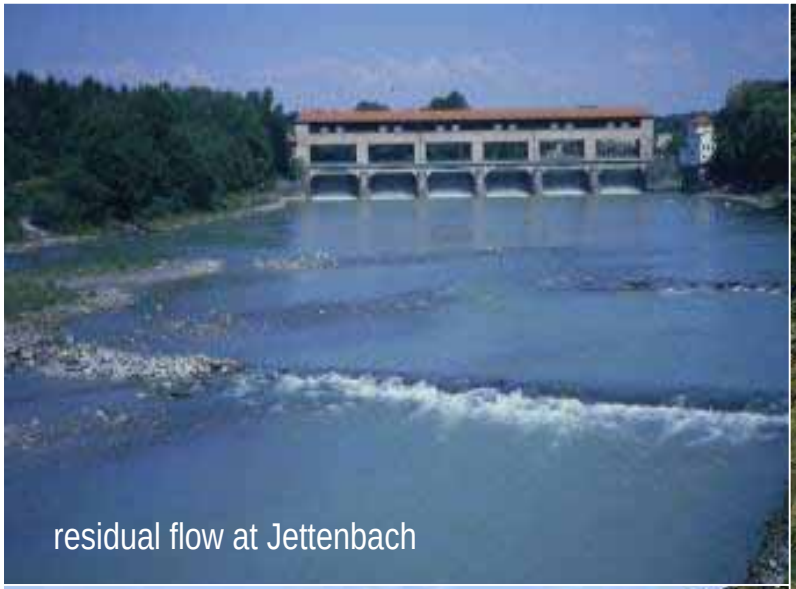
multi-dimensional nature

Pollution

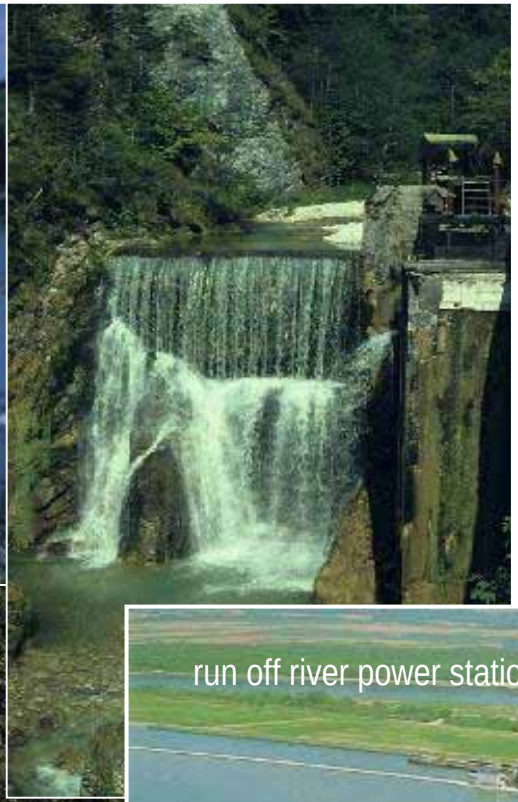


Anthropogenic pressures and impacts

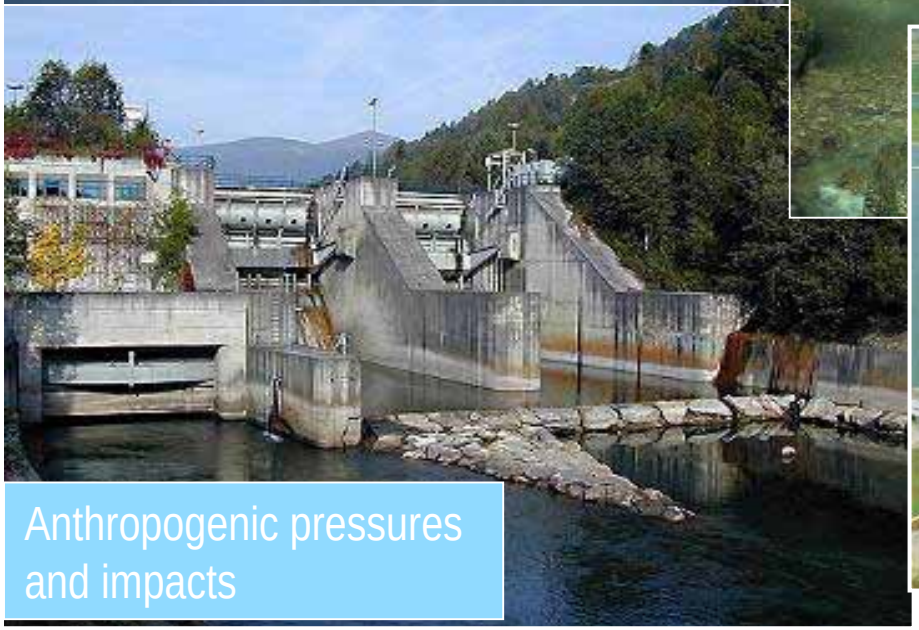
Hydro-electric power plants



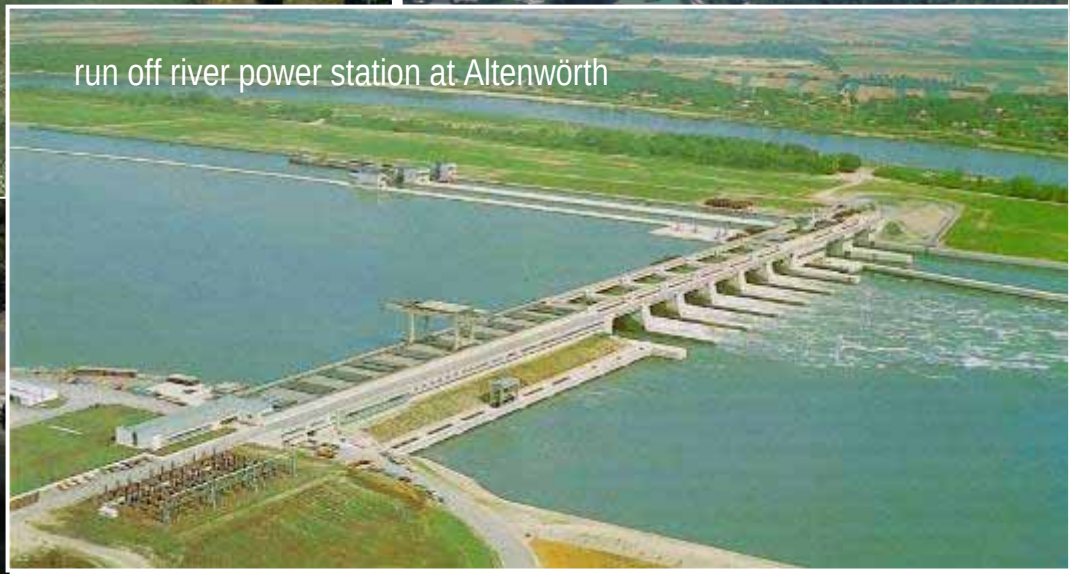
residual flow at Jettenbach



reservoir Waagspeicher



Anthropogenic pressures and impacts



run off river power station at Altenwörth

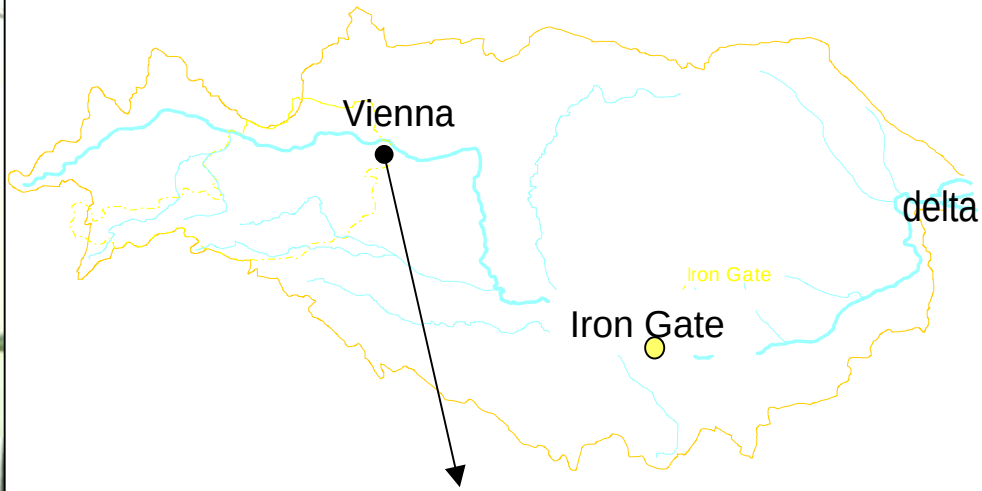
Hydro-electric power plants: spatially far reaching effects

- Hydro-peaking
- Water diversion / Residual flow
- Flushing of reservoirs & impoundments (run off river power stations)
- Bed-load retention
- Fragmentation of the longitudinal river corridor

Fragmentation of the river continuum: Effects on fish migration

- Hausen
  great sturgeon
  (*Huso huso*)
- Waxdick
  Russian sturgeon
  (*Acipenser güldenstädti*)
- Sternhausen
  stellate sturgeon
  (*Acipenser stellatus)*)

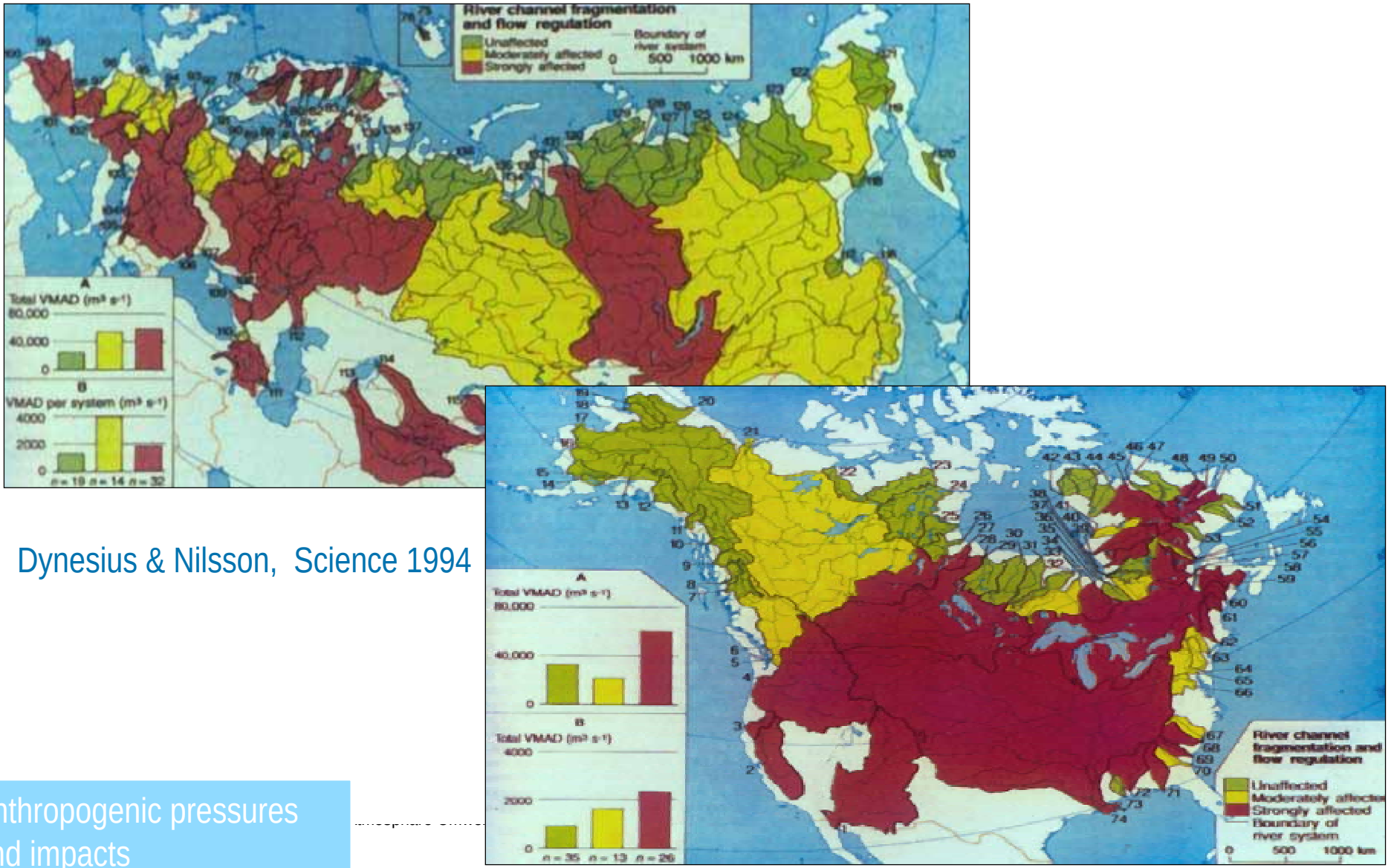
Danube catchment



former spawning sites around Vienna

Anthropogenic pressures and impacts

The worlwide situation of large river systems - River channel fragmentation & flow regulation



Dynesius & Nilsson, Science 1994

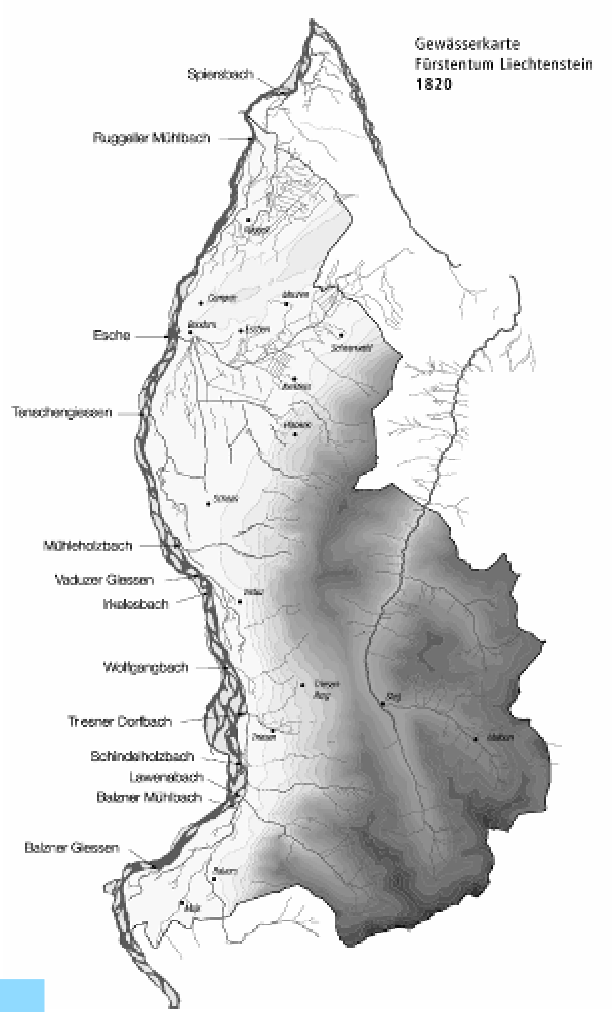
Anthropogenic pressures and impacts

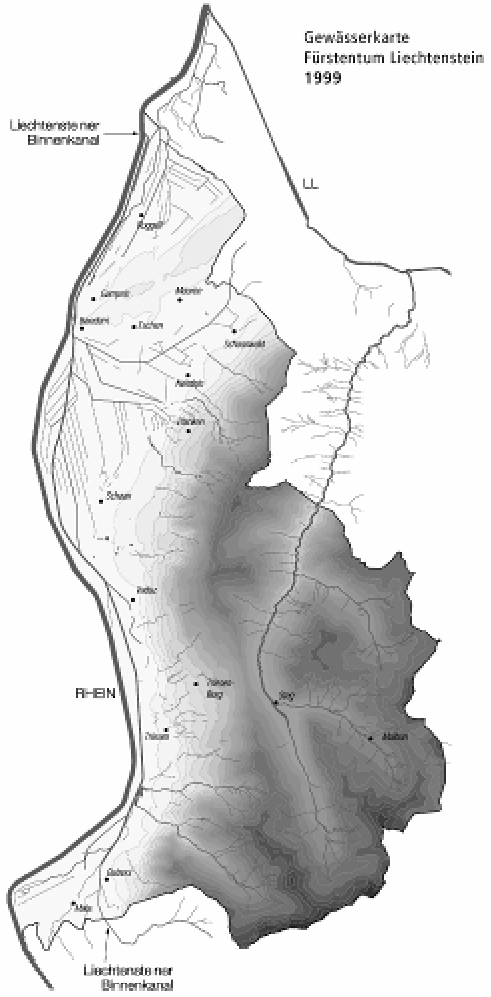
Flood protection measures

Anthropogenic pressures and impacts

River channelization

Comparison of the river-system in Liechtenstein 1820 and 1999 (Haidvogl & Kindle 2001)

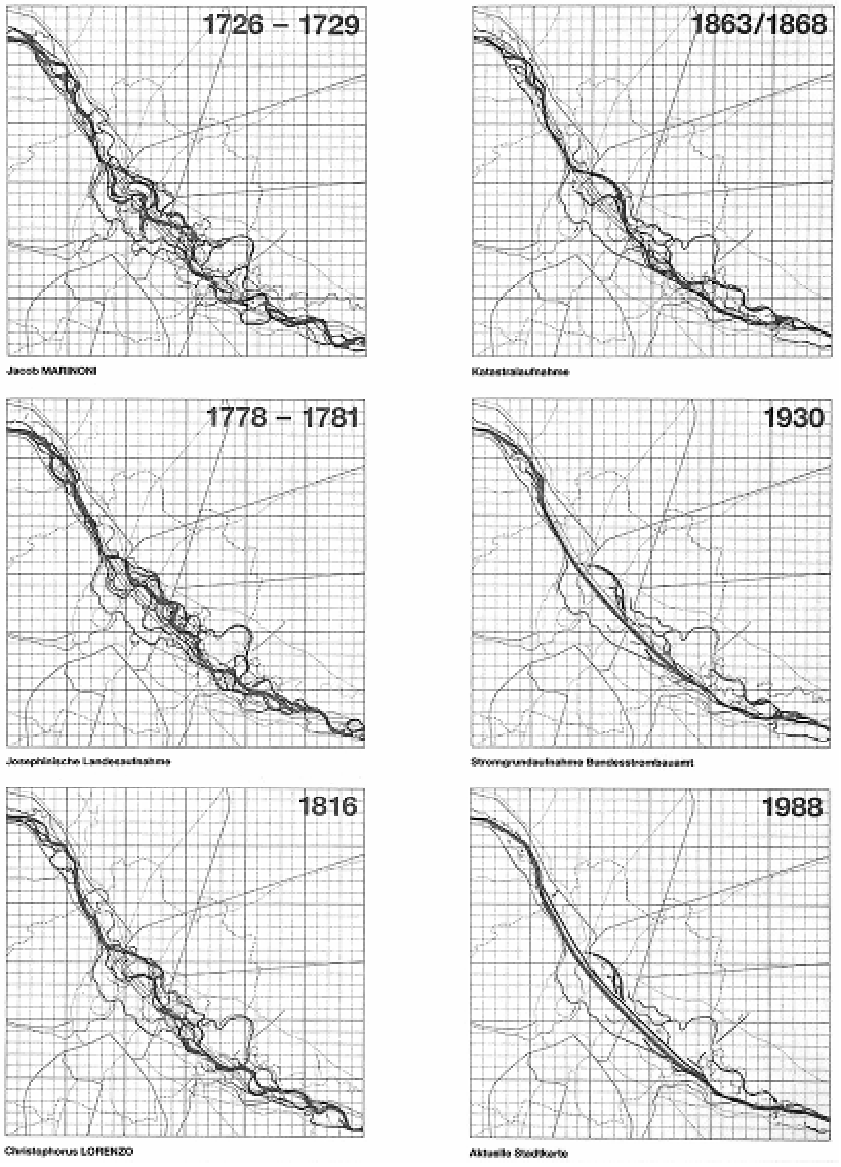




Anthropogenic pressures and impacts

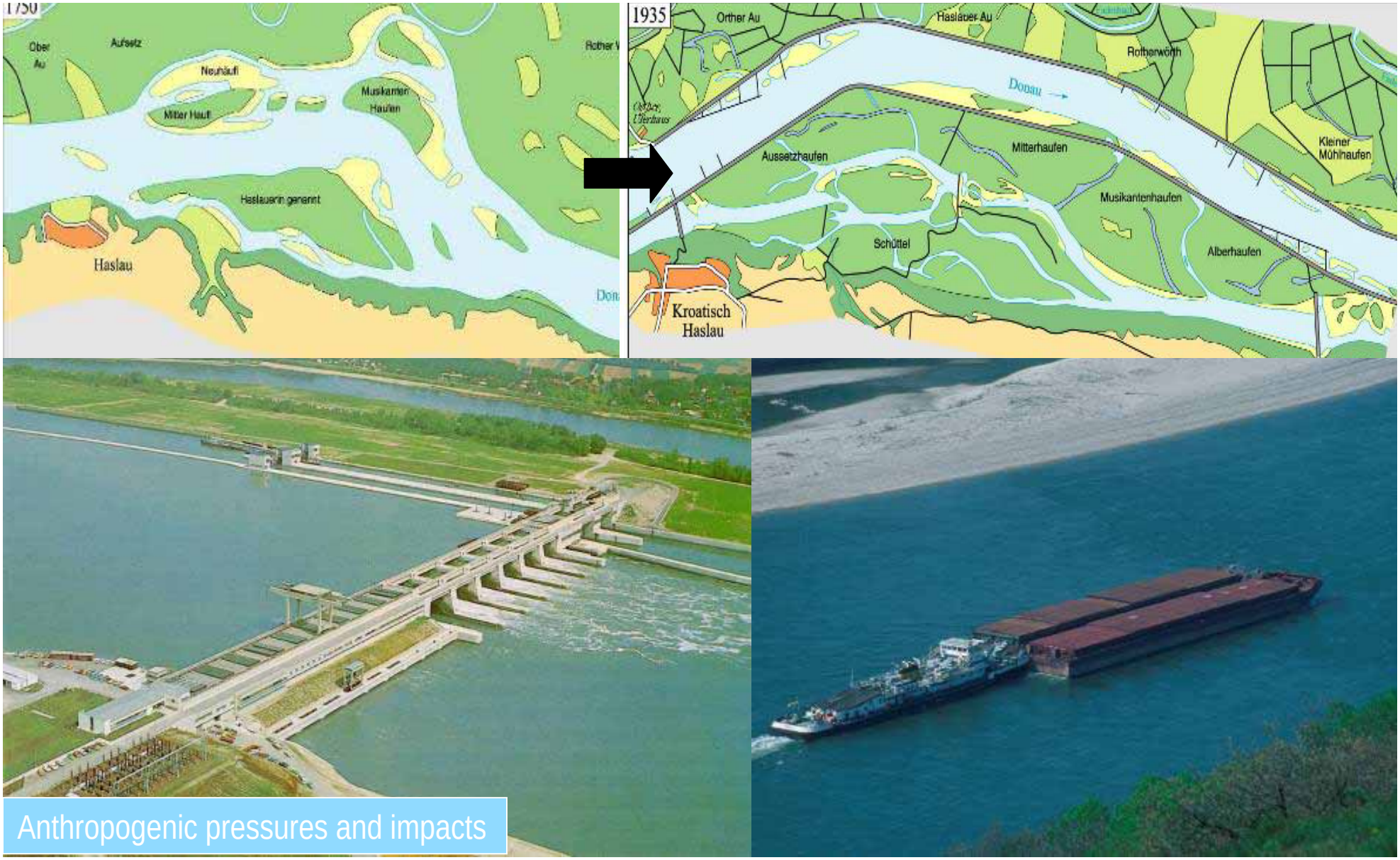
River channelization

Danube River in Vienna 1726-1988 (based on Mohilla & Michlmayr 1996)



Anthropogenic pressures and impacts

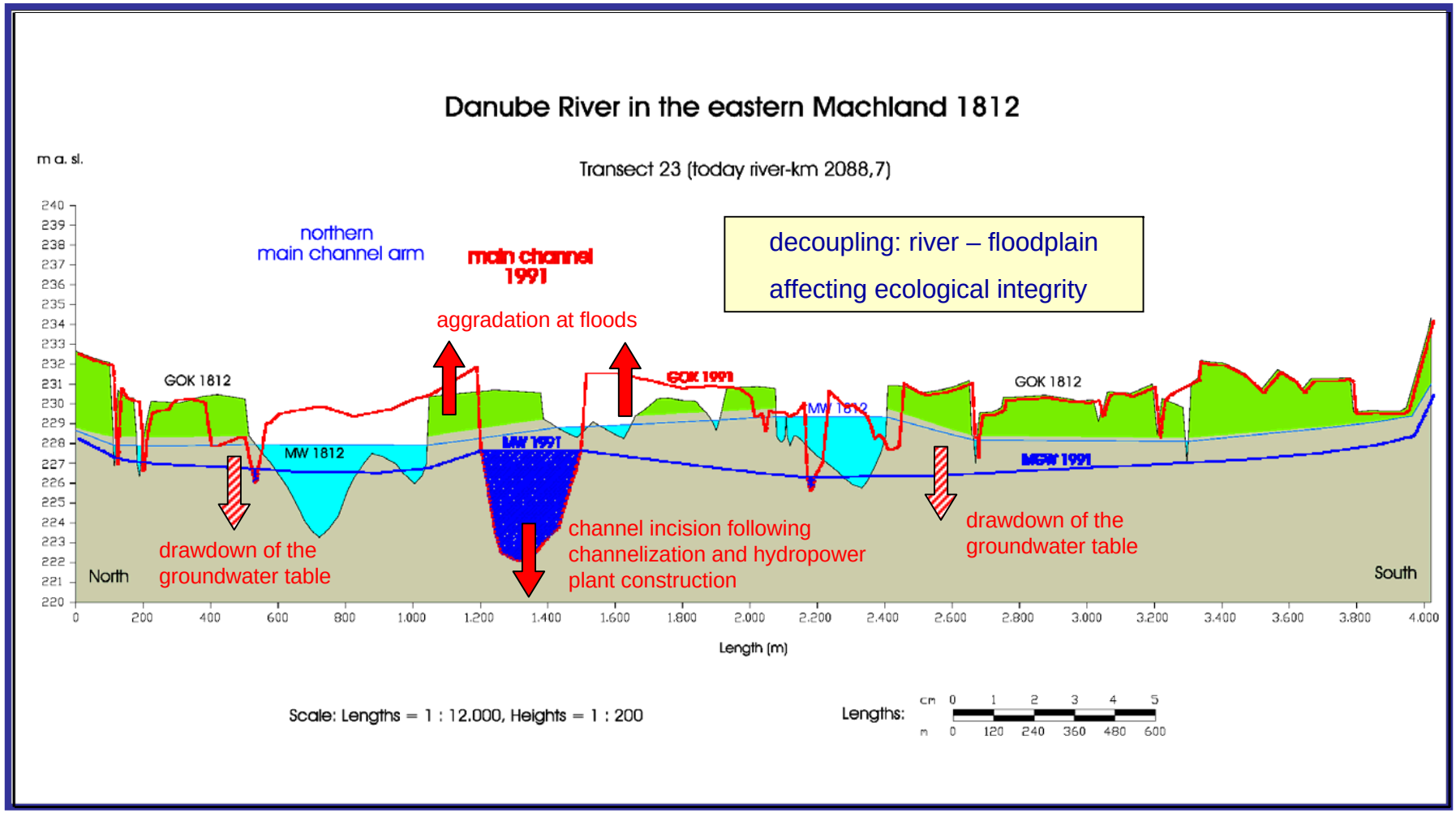
Problems created by flood control, navigation & hydroelectric power plants



Problems created by flood control, navigation & hydroelectric power plants

- Deep going alteration of the riverine landscape
- Impairment of the multidimensional nature / natural processes
- River bed degradation
- decoupling of alluvial floodplains from the river
- Reduction of exchange processes & lateral connectivity
- Suppression of hydro-morphological dynamics
- Reduced habitat variability
- Decreased biodiversity
- Loss of functions for recreation .....

The decoupling process: river bed degradation and floodplain aggradation



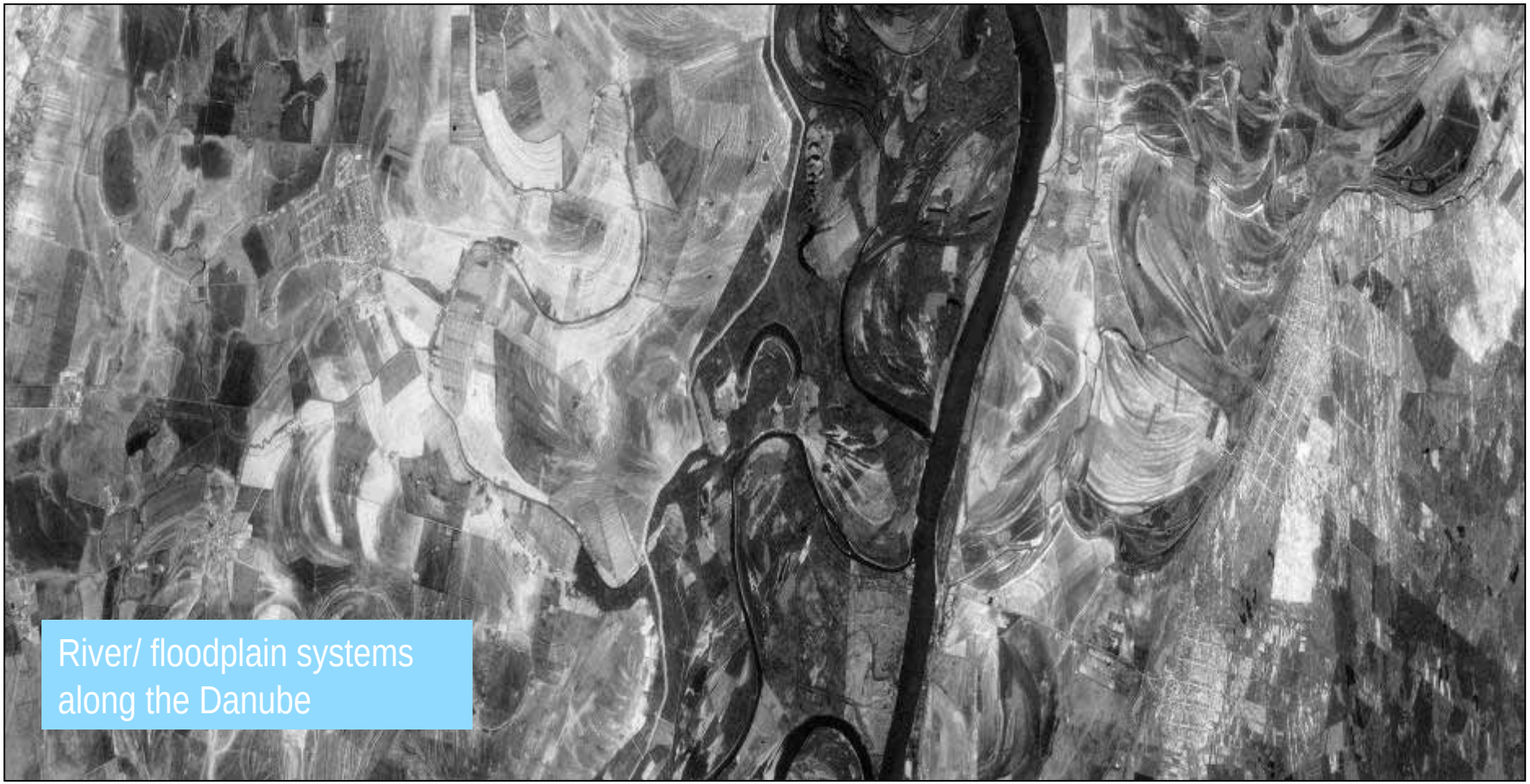
Anthropogenic pressures and impacts

Intact tributary-systems

River/ floodplain systems along the Danube

Middle reach of the Danube at Gemenc, Danube-Drava-National Park

(photos U. Schwarz, FLUVIUS)

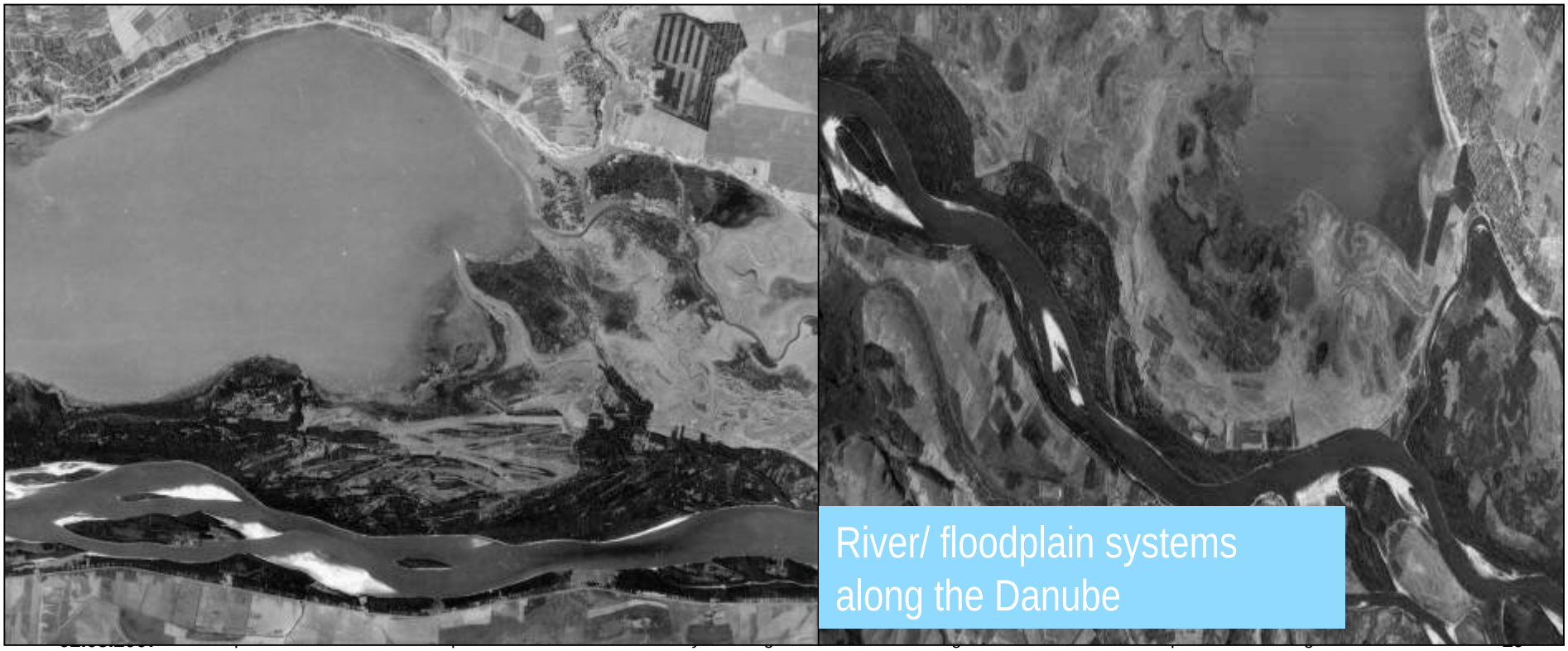


National park Kopacki Rit

River/ floodplain systems
along the Danube

„Island Danube“ along the border between Romania and Bulgaria downstream of the Iron Gate

(photos U. Schwarz, FLUVIUS)



Lower Danube II (Small Braila Island)

(photos U. Schwarz, FLUVIUS)

Danube – Delta

The need for protection and restoration

- Challenge to protect and restore sustainable river floodplain systems
- Protection of biodiversity commonly accepted goal
- Focus: Multi-usable systems instead of one-sided uses
- EU- Water Framework Direktive:

  - sustainable systems
  - integrative river basin management
  - good ecological status
  - „Leitbild“ approach

New planning philosophy / “Leitbild-approach”

Goal: good ecological status

Intact reference: undisturbed status of the respective river-type („vision“)

Deficit analysis: comparing current status vs. undisturbed reference

Interdisziplinary development of an operational „Leitbild“

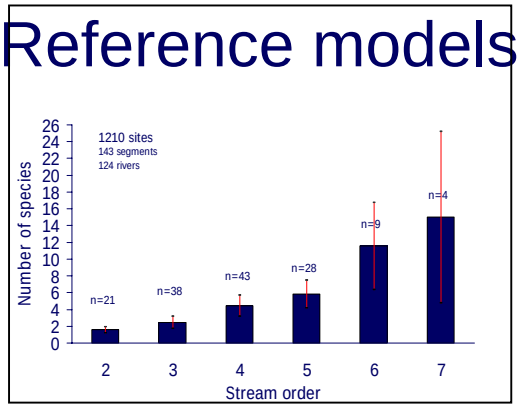
Detailed planning process

Monitoring / evaluation

Reference conditions

Reference site

Reference models



High ecological status

Historical fish data

Historical morphological data

Best references: intact systems