

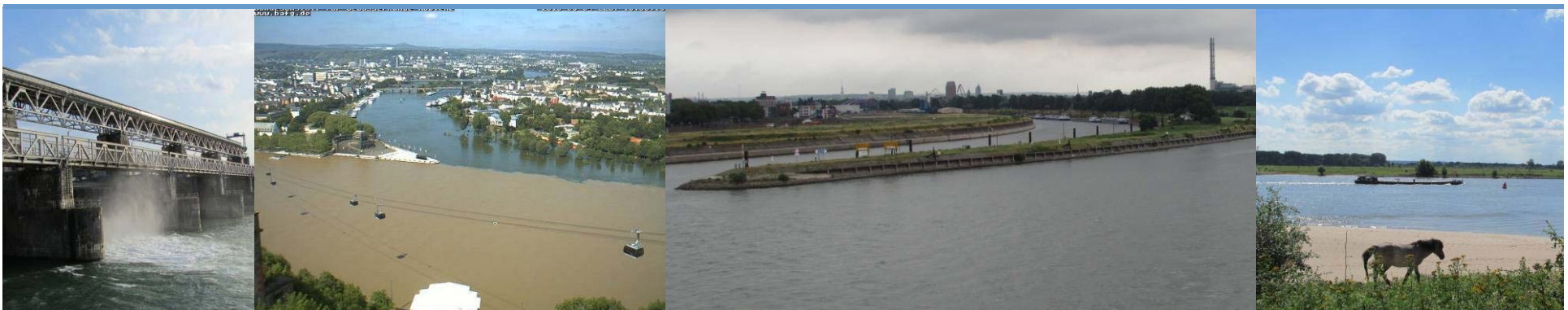


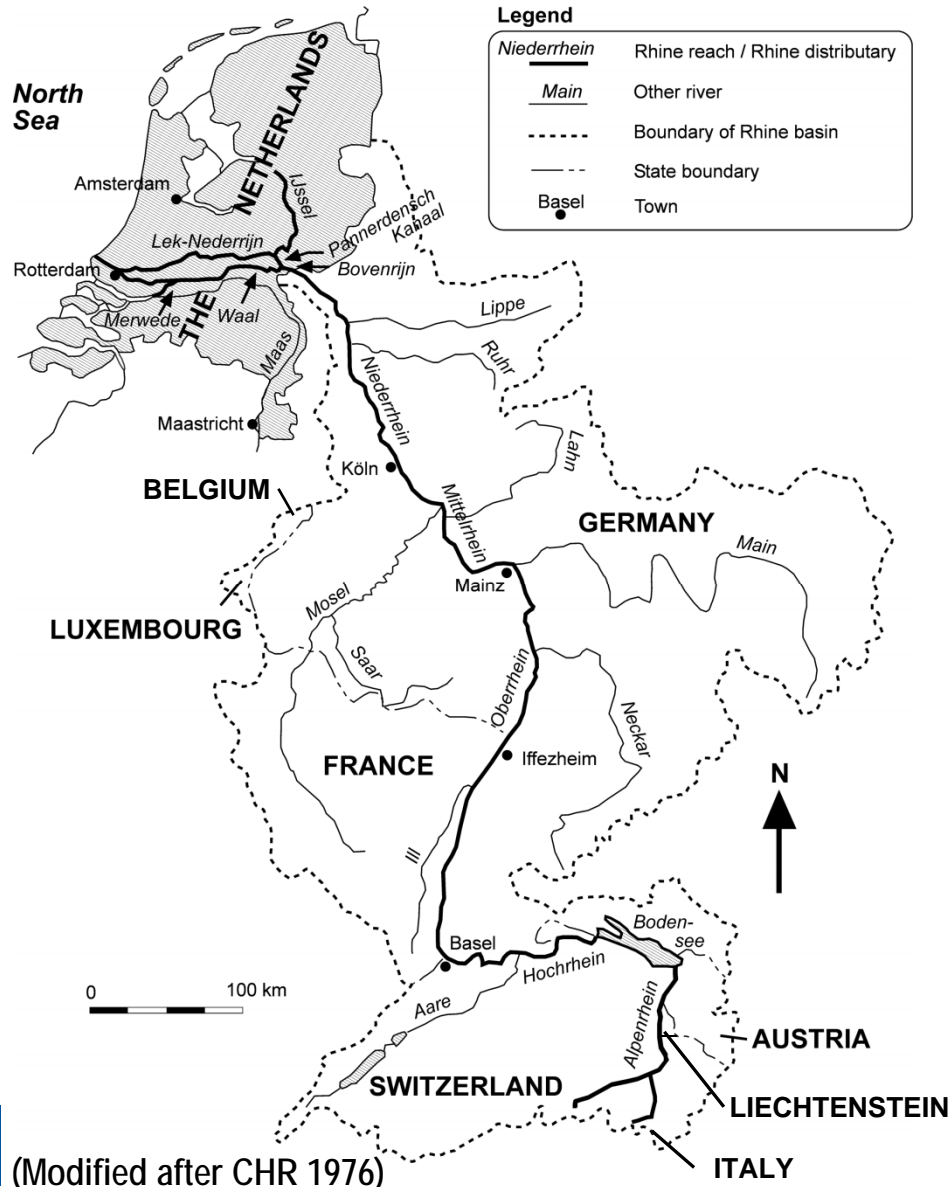
The Rhine Basin

Hydrography, hydrology, geology, sedimentology
human-impact history, channel geometry

Dr. Roy Frings

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The Rhine Basin

- Basin: 185,000 km²
- Length: 1232 km
- Inhabitants: 58 Million
- Countries: 9
- Discharge: 2300 m³/s

Societal functions

- Culture
- Ecology
- Food supply
- Recreation
- Shipping
- Waste disposal
- Water supply

Since Neolithic

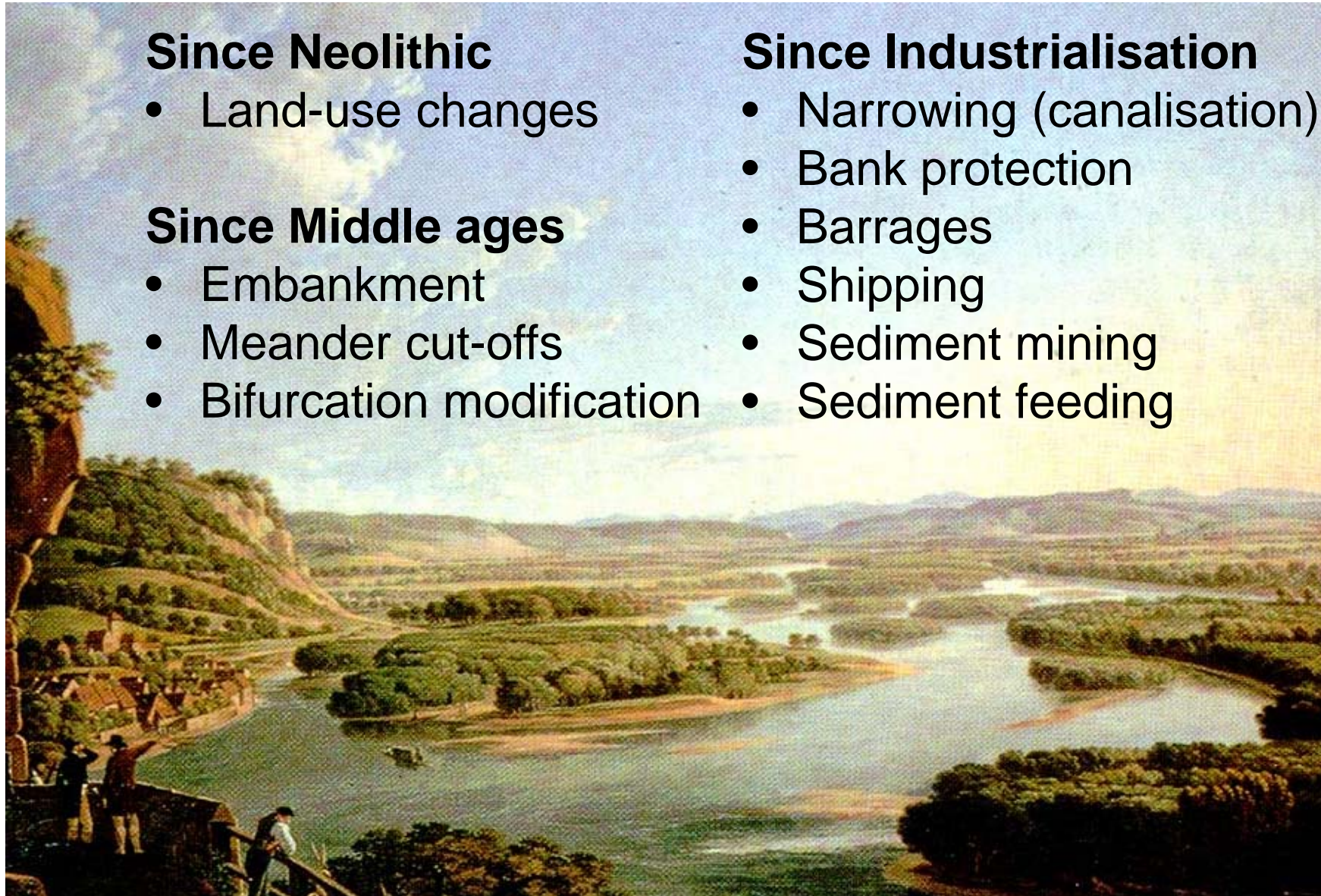
- Land-use changes

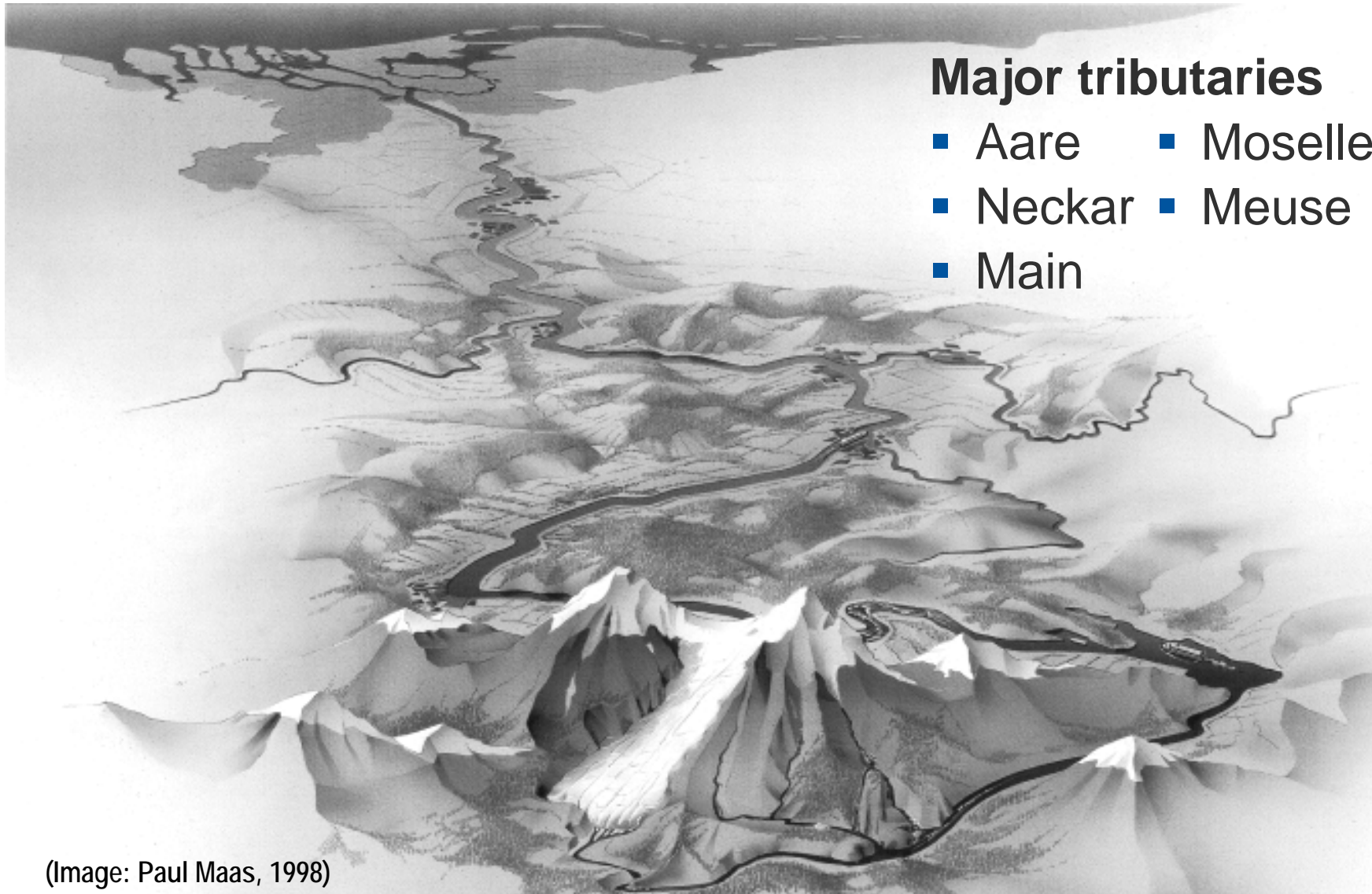
Since Middle ages

- Embankment
- Meander cut-offs
- Bifurcation modification

Since Industrialisation

- Narrowing (canalisation)
- Bank protection
- Barrages
- Shipping
- Sediment mining
- Sediment feeding

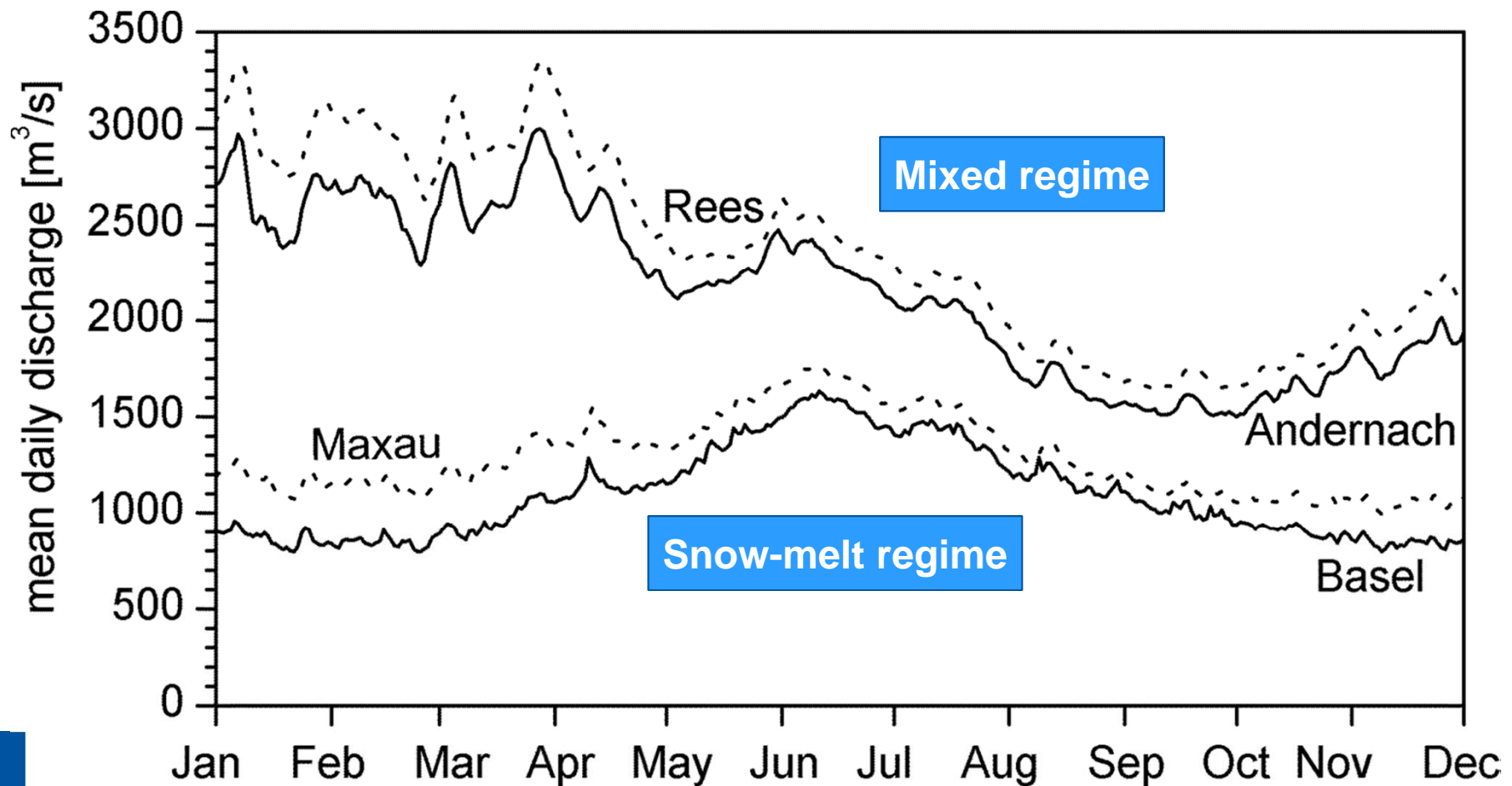




Major tributaries

- Aare
- Moselle
- Neckar
- Meuse
- Main

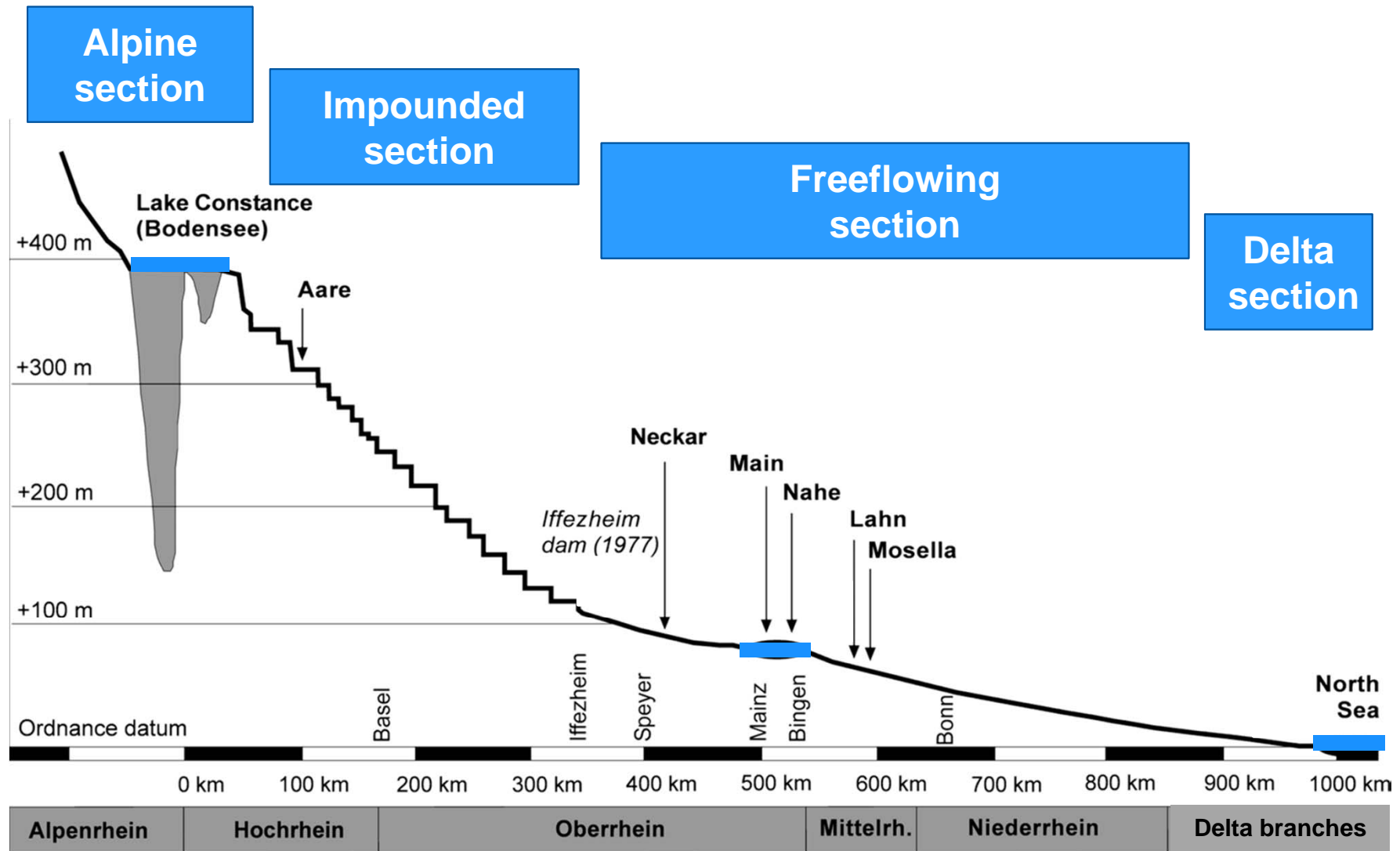
Max. discharge ever recorded: 12,200 m³/s (1926)



Geology and Relief

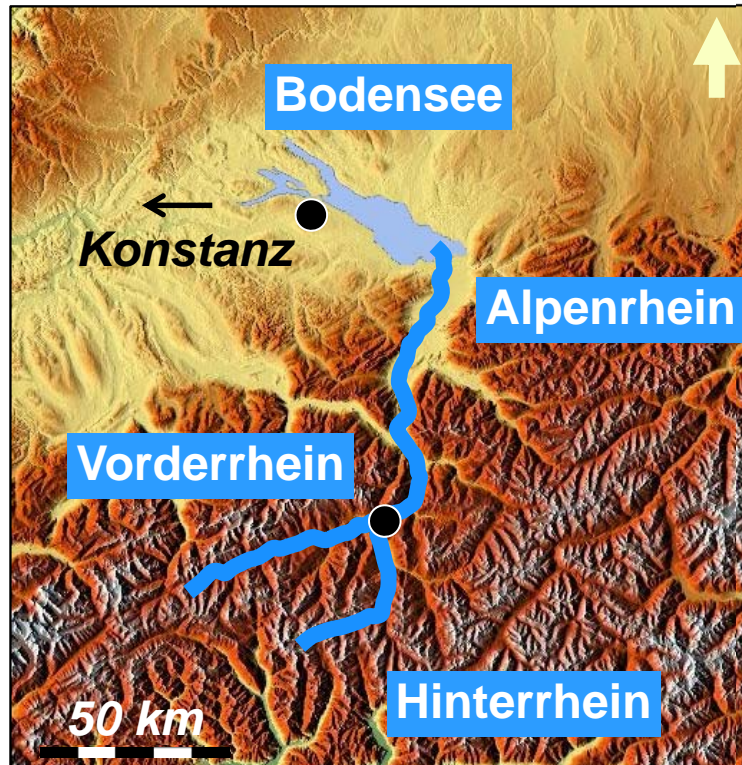


Longitudinal bed profile



(Frings et al, 2008)

The Alpine Section



Tectonic setting

- Uplift

Fact sheet: Alpenrhein

Hydrology

- Tributaries: Landquart, Plessur, Ill
- Q_{av} : 0 \rightarrow 230 m³/s

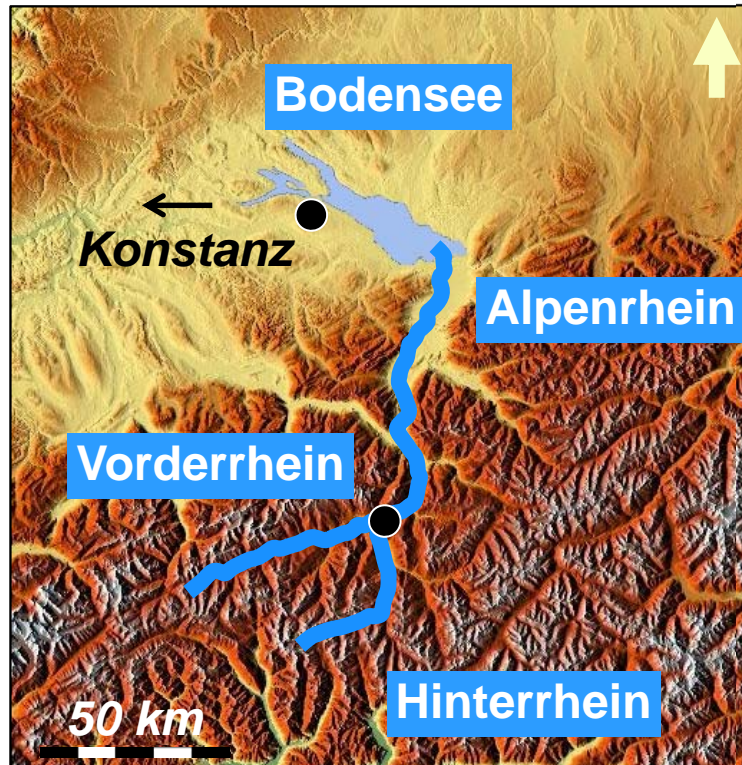
Geometry

- Gradient: 100 \rightarrow 0.3 m/km
- Width: 0 \rightarrow 300 \rightarrow 40 m

Sedimentology

- Partly alluvial
- Grain size: 20 \rightarrow

The Alpine Section



Tectonic setting

- Uplift

Fact sheet: Bodensee

Hydrology

- Tributaries: minor
- Q_{av} : 230 \rightarrow 350 m³/s

Geometry

- Gradient: 0 m/km
- Depth: up to 254 m

Sedimentology

- Lacustrine sediments
- Grain size: clay, silt, sand

The Impounded Section



Tectonic setting

- Uplift / Subsidence

Fact sheet

Hydrology

- Tributaries: a.o. Aare
- Q_{av} : 350 \rightarrow 1230 m³/s

Geometry

- Gradient: 1 m/km (dams!)
- Width: 50 \rightarrow 250 m
(max 750 m)

Sedimentology

- Alluvial, locally bed-rock
- Restrhein: 40 \rightarrow 20 mm

The free-flowing Section



Tectonic setting

- Subsidence

Fact sheet: Oberrhein

Hydrology

- Tributaries: Neckar, Main
- Q_{av} : 1230 \rightarrow 1670 m³/s

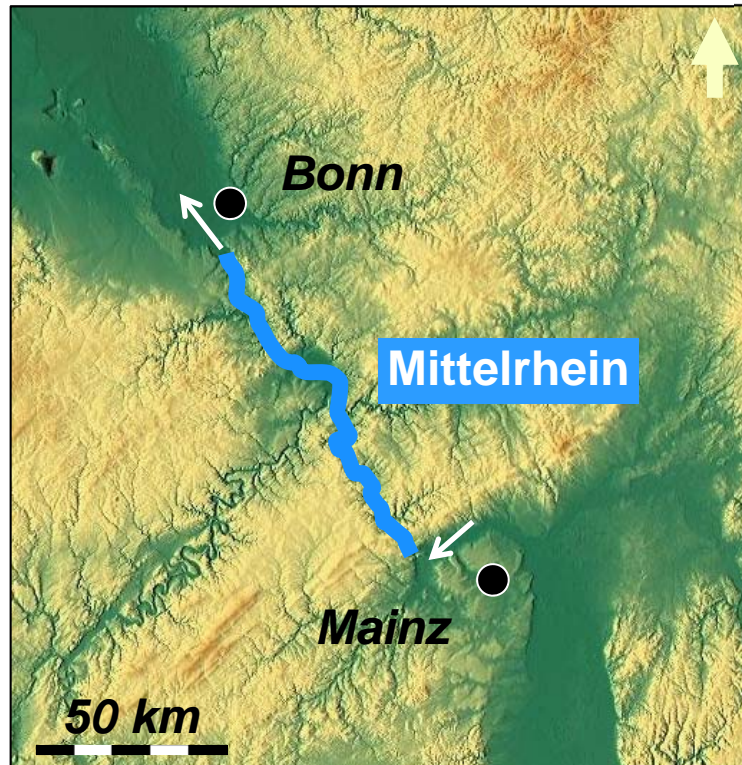
Geometry

- Gradient: 0.4 \rightarrow 0.1 m/km
- Width: 150 \rightarrow 450 m

Sedimentology

- Mostly alluvial
- Grain size: 17 \rightarrow 2 mm

The free-flowing Section



Tectonic setting

- Uplift

Fact sheet: Mittelrhein

Hydrology

- Tributaries: Moselle
- Q_{av} : 1670 \rightarrow 2090 m³/s

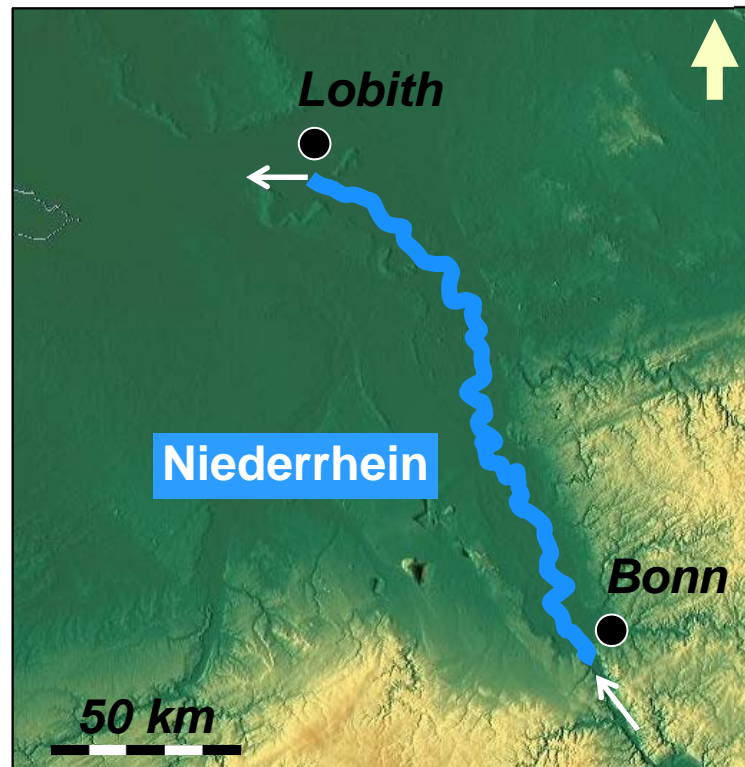
Geometry

- Gradient: 0.26 m/km
- Width:

Sedimentology

- Bed-rock, often alluvial
- Grain size: 17 mm

The free-flowing Section



Tectonic setting

- Slight uplift

Fact sheet: Niederrhein

Hydrology

- Tributaries: minor
- Q_{av} : 2090 \rightarrow 2310 m³/s

Geometry

- Gradient: 0.2 \rightarrow 0.1 cm/km
- Width: 230-300 m

Sedimentology

- Mostly alluvial
- Grain size: 16 \rightarrow 3 mm

The Delta Section



Tectonic setting

- Subsidence

Fact sheet:

Hydrology

- Tributaries: (Maas)
- Q_{av} : 2310 m³/s

Geometry

- Gradient: 0.1 → 0 cm/km
- Width: 60 – 3150 m

Sedimentology

- Mostly alluvial
- Grain size: 3 → 0.06 mm

The Alpine Section



Lai da Tuma

The Alpine Section



Rein da Tuma

The Alpine Section



(Foto: Frings, 2013)

Rein da Maighels

The Alpine Section



(Foto: Frings, 2013)

Vorderrhein

The Alpine Section



(Foto: Frings, 2013)

Rein da Somvitg

The Alpine Section



(Foto: Frings, 2013)

Vorderrhein (Tavanasa)

The Alpine Section



(Foto: Frings, 2013)

Vorderrhein (Rheinschlucht Flims)

The Alpine Section



(Foto: Frings, 2012)

Hinterrhein

The Alpine Section



(Foto: Frings, 2012)

Hinterrhein

The Alpine Section



(Foto: Frings, 2012)

Hinterrhein (Viamala)



(Foto: Frings, 2013)

Confluence Vorderrhein-Hinterrhein

The Alpine Section



(Foto: Frings, 2013)

Alpenrhein (Vaduz)

The Alpine Section



(Foto: Frings, 2013)

Alpenrhein (Vorstreckung)

The Alpine Section



(Foto: Frings, 2013)

Bodensee

The Alpine Section



(Foto: Rizzo, 2008)

Bodensee (Insel Mainau)

The Alpine Section



(Foto: Frings, 2013)

Seerhein

The Impounded Section



(Foto: Frings, 2013)

Hochrhein (Schaffhausen Dam)

The Impounded Section



(Foto: Frings, 2012)

Hochrhein (Rheinfall)

The Impounded Section



(Foto: Frings, 2013)

Hochrhein (Aare confluence)

The Impounded Section



(Foto: Frings, 2013)

Hochrhein (canal Albbruck-Dogern)

The Impounded Section



(Foto: Frings, 2013)

Oberrhein (Grand Canal d'Alsace)

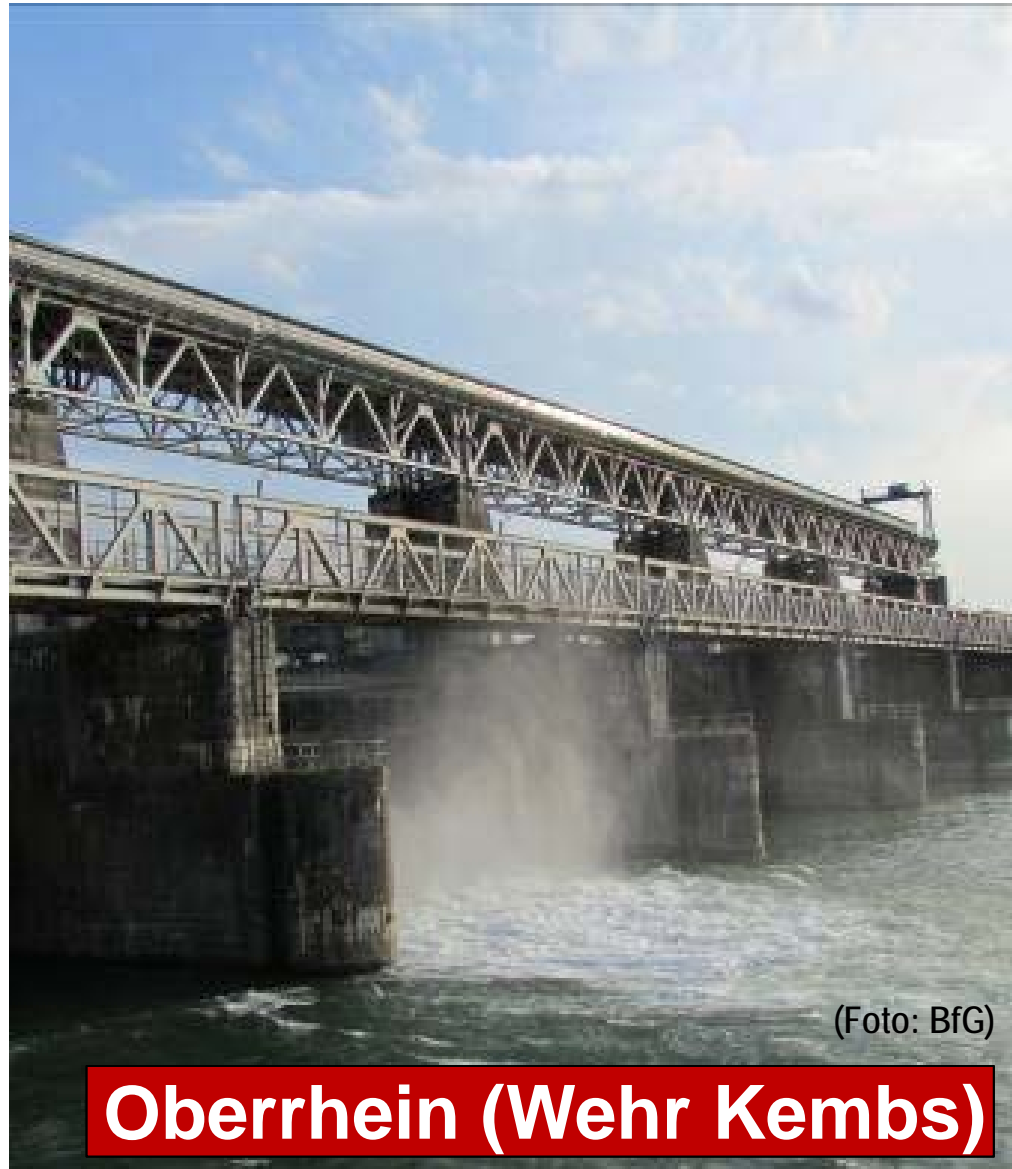
The Impounded Section



(Foto: Frings, 2013)

Oberrhein (Restrhein)

The Impounded Section



Oberrhein (Wehr Kembs)

The Impounded Section



(Foto: Frings, 2013)

Oberrhein (Weisweil)

The Impounded Section



(Foto: BfG)

Oberrhein (Iffezheim dam)

The free-flowing Section



(Foto: Gehres, 2010)

Mittelrhein

The free-flowing Section



(Foto: Frings, 2011)

Mittelrhein (bed rock outcrop)

The free-flowing Section



(Foto: Frings, 2013)

Moselle

The free-flowing Section



(Foto: BfG)

Confluence of Mittelrhein and Moselle

The free-flowing Section



(Foto: Frings, 2013)

Niederrhein (Emschermündung)

The free-flowing Section



(Foto: Bilderbuch Köln)

Niederrhein (Cologne)

The Delta Section



(Foto: Frings, 2013)

Waal

The Delta Section



(Foto: Frings, 2013)

Pannerdensch Kanaal

The Delta Section



(Foto: B. Boekhoven)

Pannerdensch Kanaal, Nederrijn, IJssel

The Delta Section



(Foto: Van der Voort, 2004)

Merwede

The Delta Section



(Foto: Frings, 2013)

Lek (Kinderdijk)

The Delta Section



(Foto: Frings, 2013)

Port of Rotterdam

The Delta Section



(Foto: Frings, 2013)

Port of Rotterdam



(Foto: Frings, 2013)

Nieuwe Waterweg (Mouth of the Rhine)

The Delta Section



(Foto: Frings, 2013)

Haringvliet (Mouth of the Rhine)



Thank you!



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