Morphology and Floods in the Alpine Region

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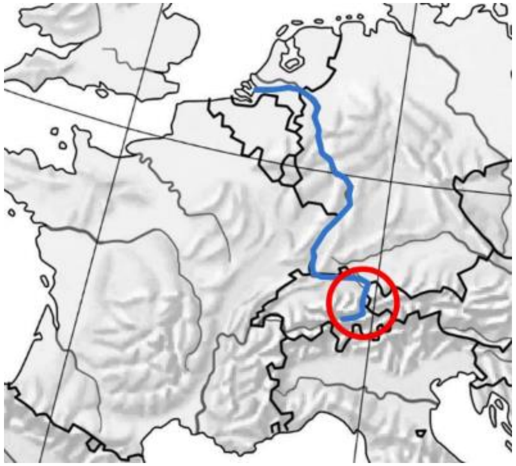
KHR, From the Source to mouth, a sediment budget of the Rhine River
25-26 March 2015, Lyon France

Content



1. Catchment
2. Hydrology
3. River Training - Morphology
4. Bed load transport

Alpenrhein

Hunziker, Zarn & Partner
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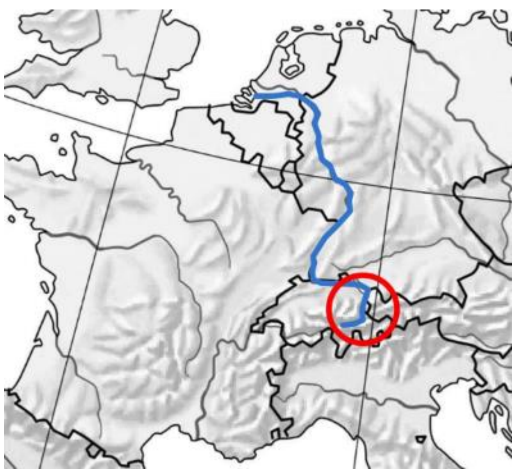
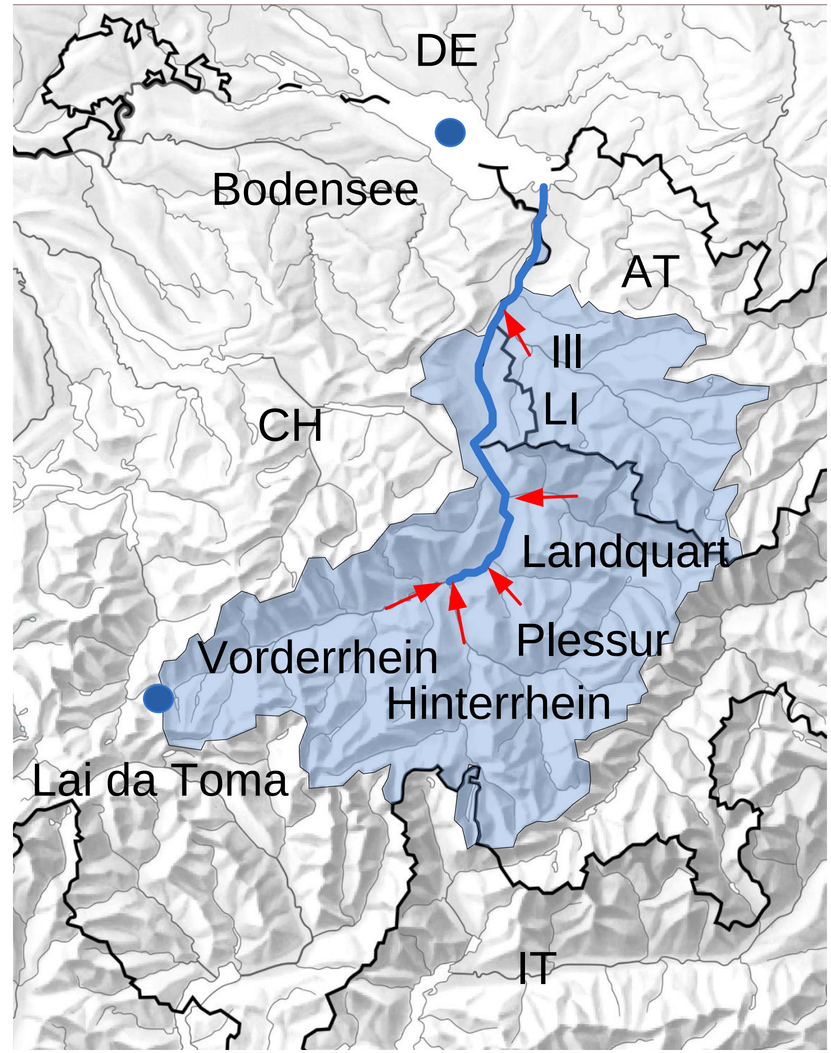
1. Catchment

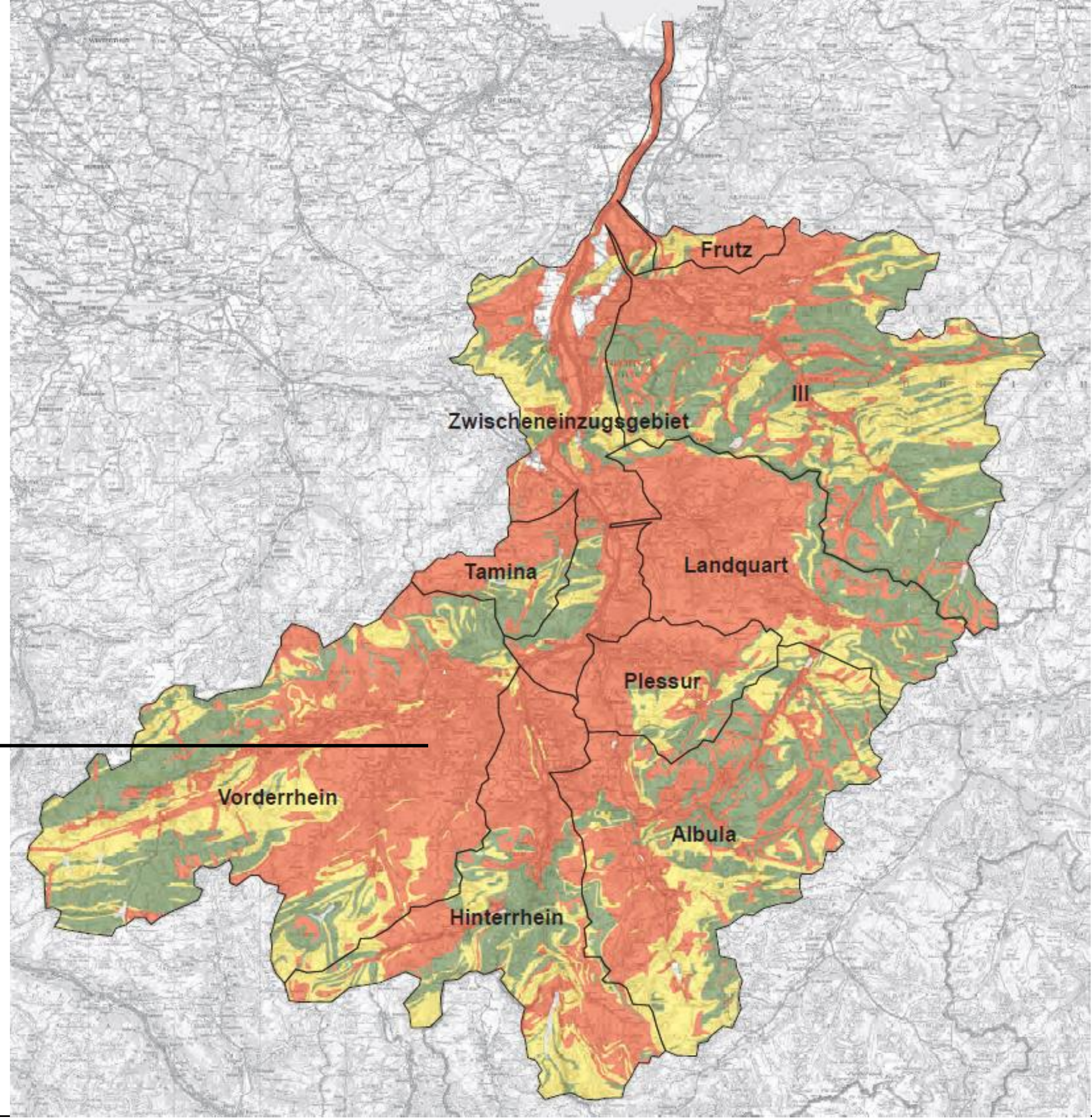
drainage area:	6’119 km^2
average altitude:	1’800 a.s.l.
glaciation:	< 1.4%
100-year flood:	3’100 m^3/s
bed load:	35’000 – 60’000 m^3/y
suspended load:	3 Mio. m^3/y





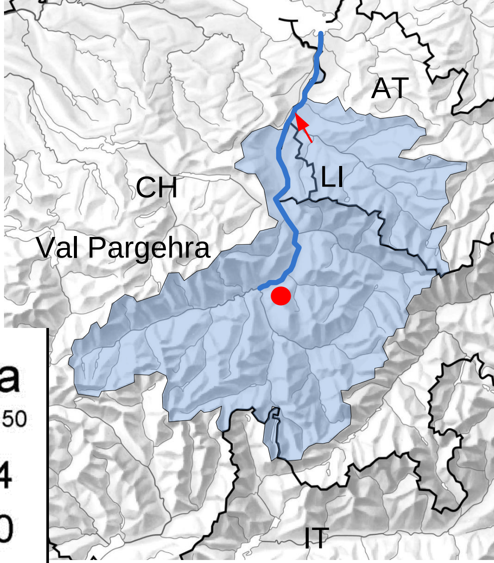
Geology

schist



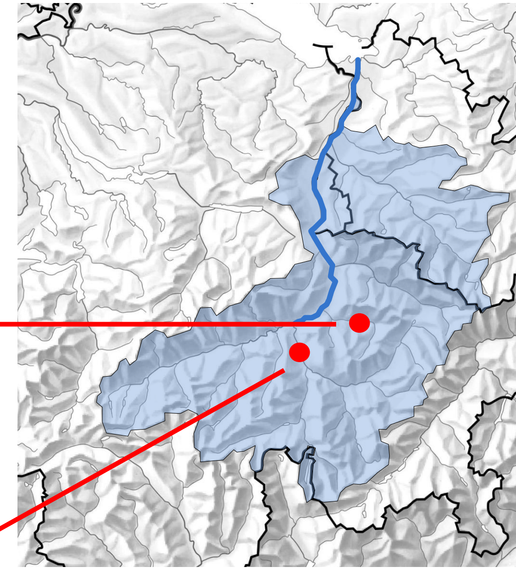
Alpenrhein

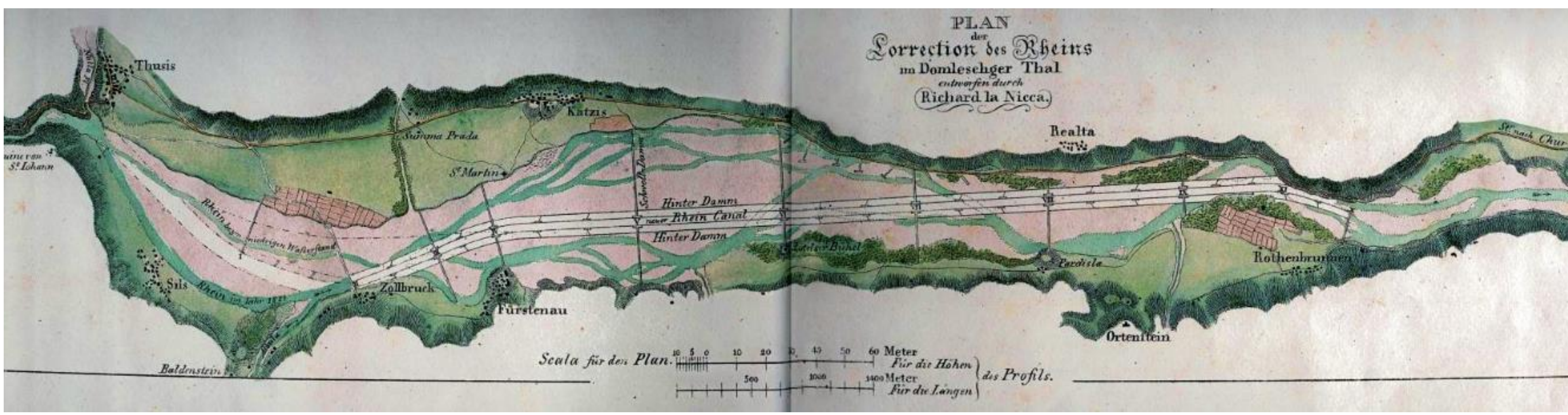
Val Parghera



tributaries

moraine, sediment source Plessur

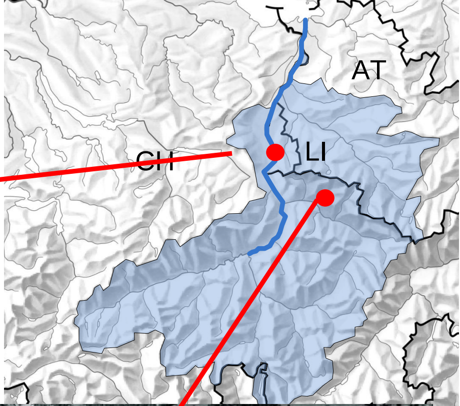




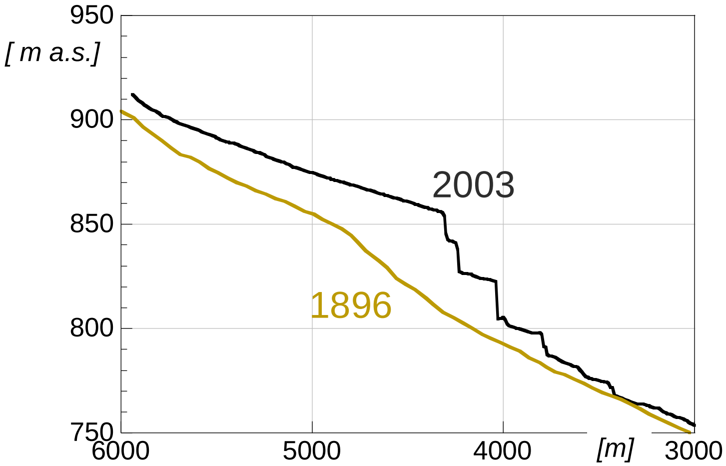
narrowing Hinterrhein (Domleschg) about 200 years ago

1927 flood – torrent control e.g. Schraubach

Dammbruch Buchs / Schaan 1927



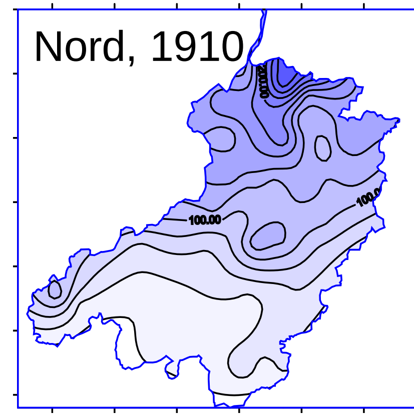
Rutschung Schuders um 1950, 15 – 20 Mio. m3

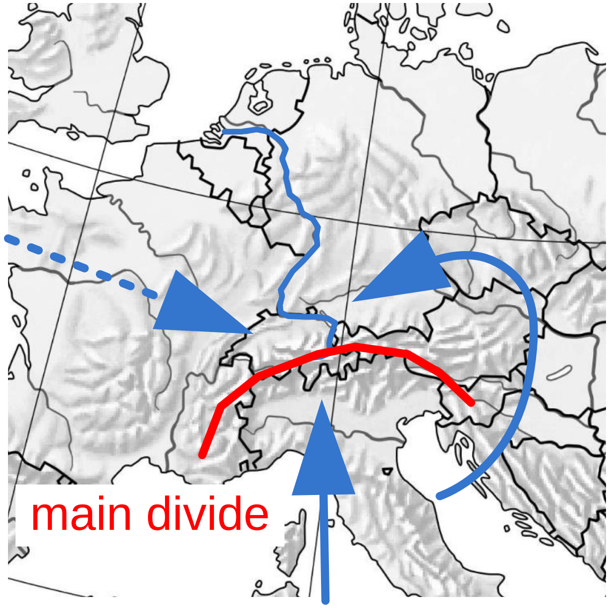


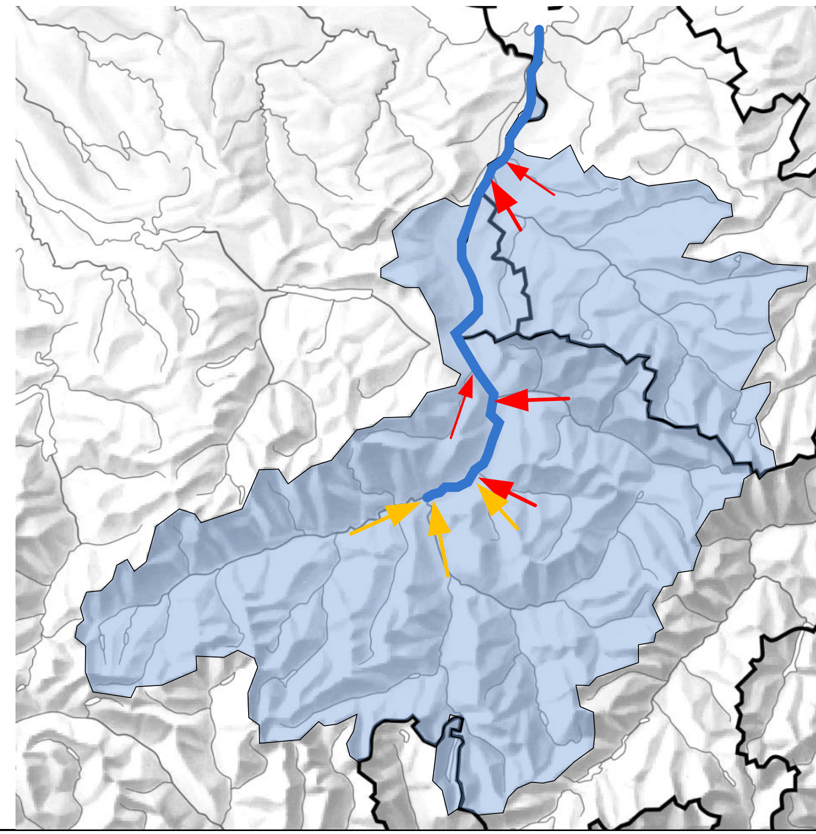
Schraubach

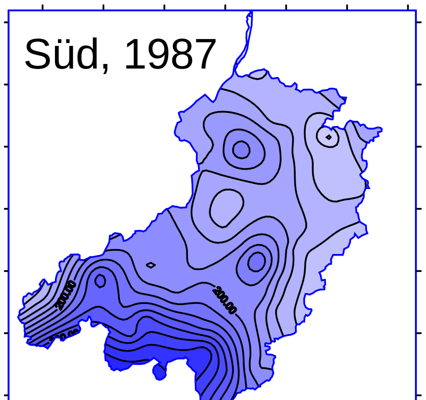
2. Hydrology

1999, 2005





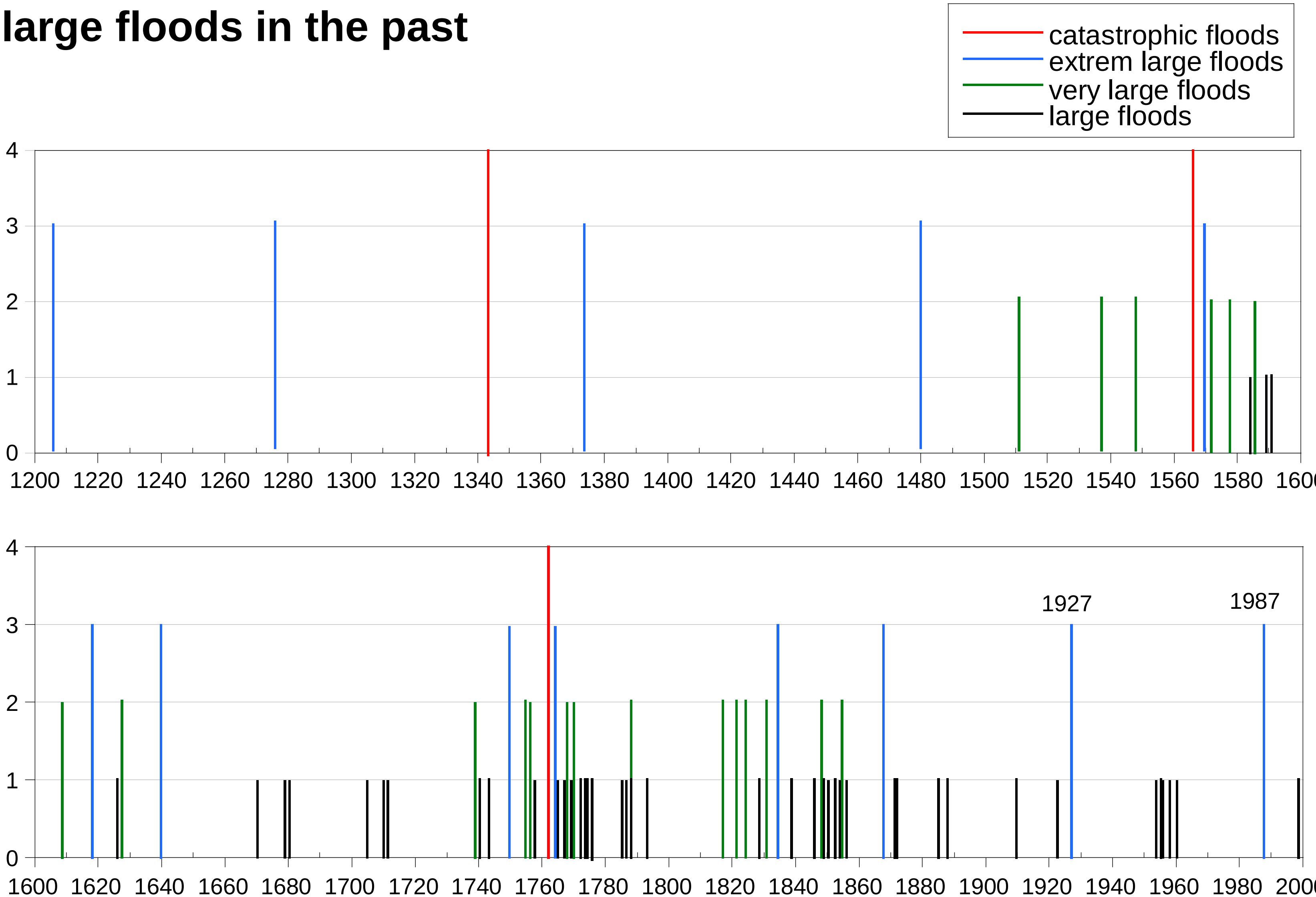




1834, 1868,
1927, 1954,
(2002)

Alpenrhein

large floods in the past

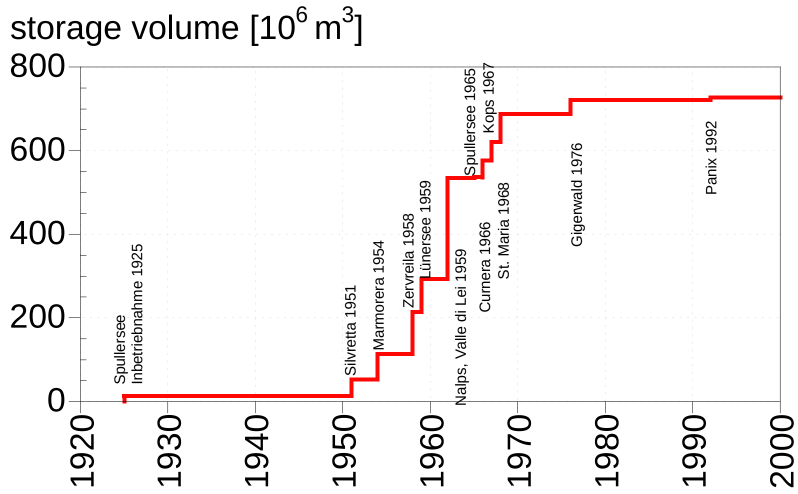


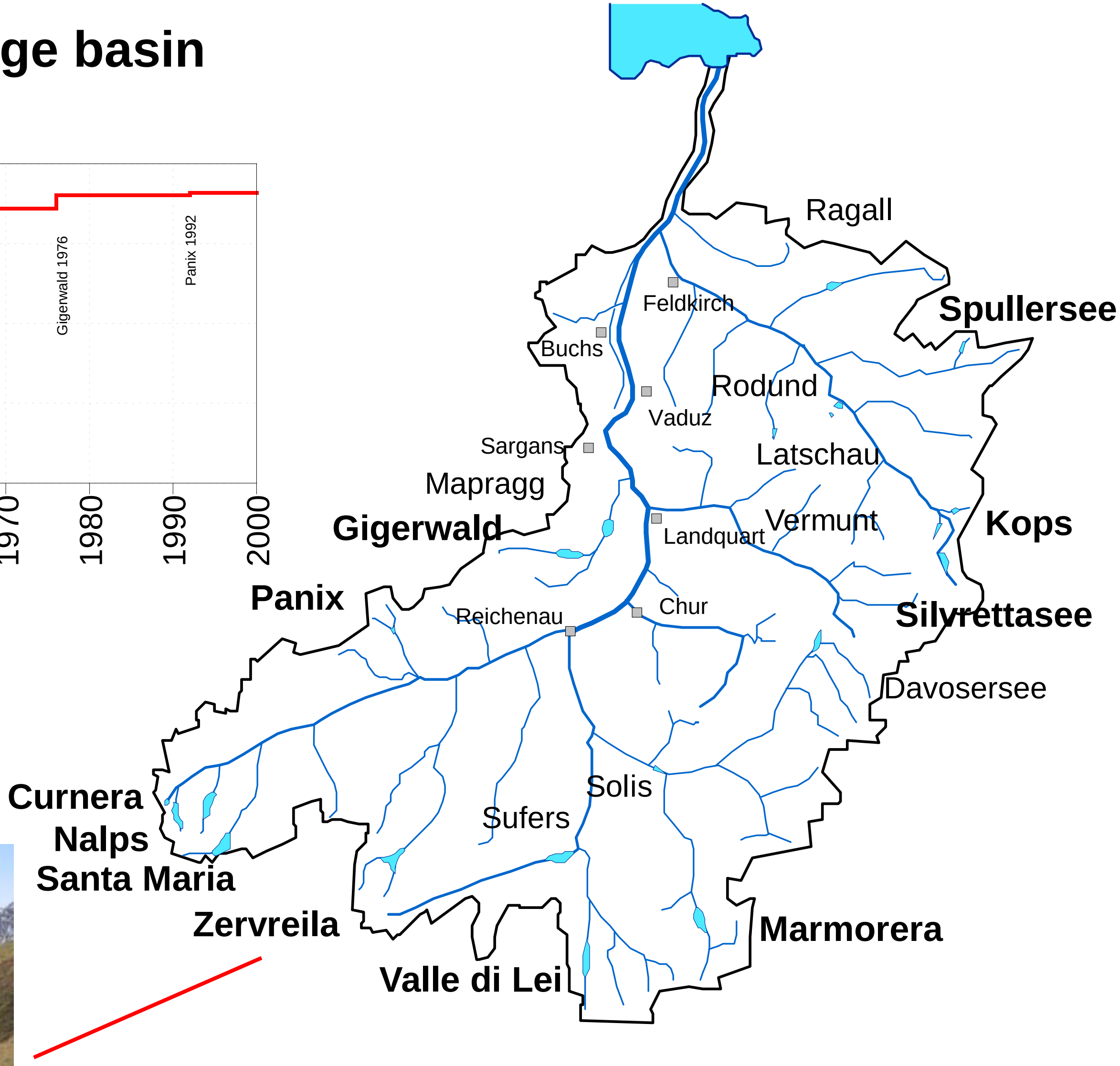
Alpenrhein

1927- and 1987 floods

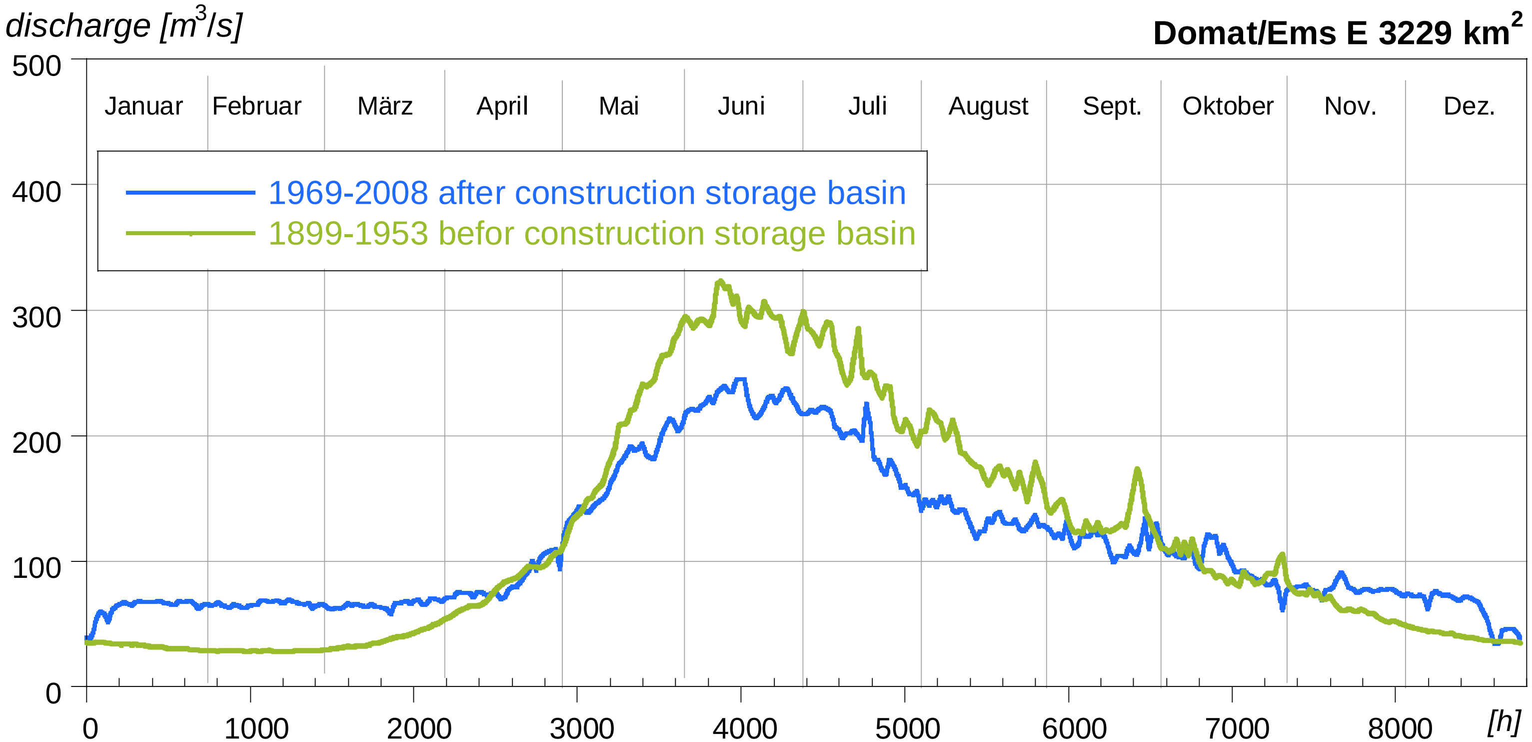
Rhine gorge – ruin aulta (Vorderrhein)

hydro power – storage basin





average hydrograph bevor/after storage construction



decrease snowmelt runoff about 80 - 100 m³/s

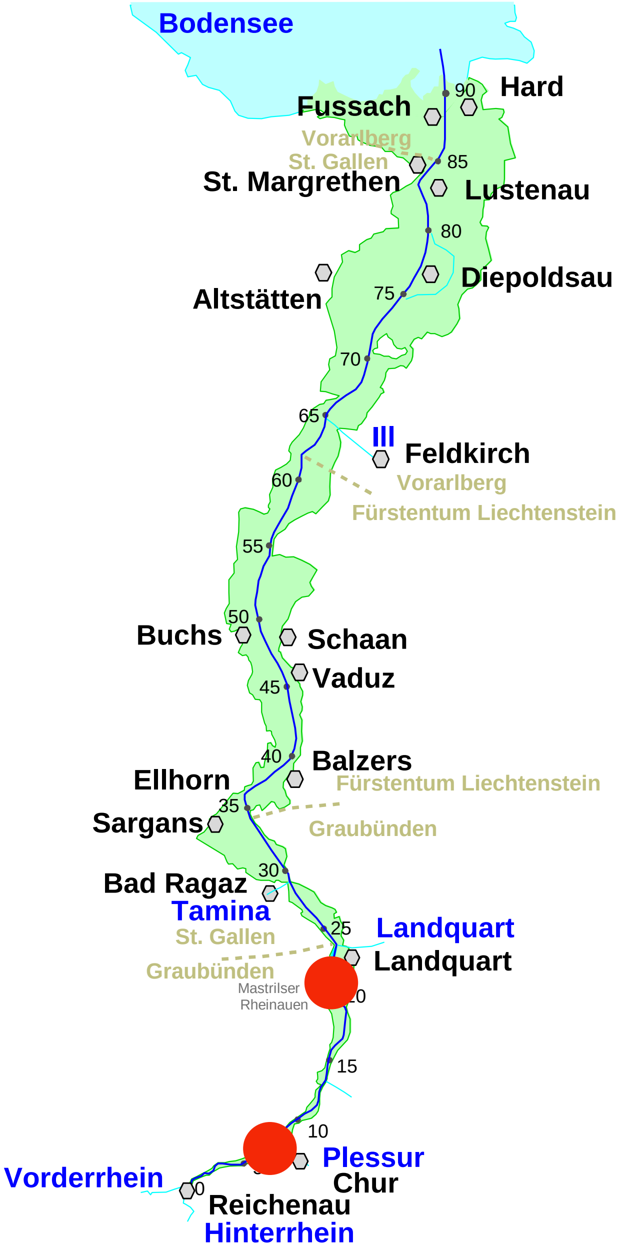
increase winter discharge (average 30 up to 60 m³/s, daily changes up to 180 m³/s)

reduction of the sediment transport capacity of about factor 1.6

3. River training - morphology

- systematically since ca. 1850
- narrowing to increase the bed load transport capacity
- example downstream mouth River Landquart

Dufourkarte, blau eingefärbt heutiger Flusslauf



river training - morphology

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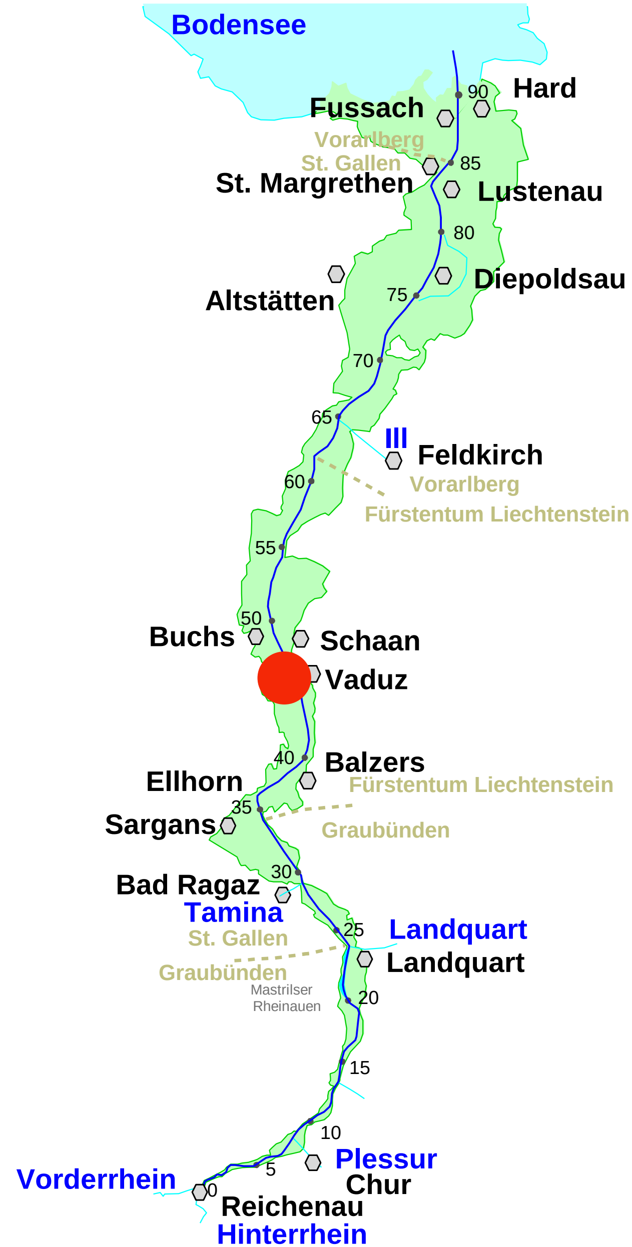
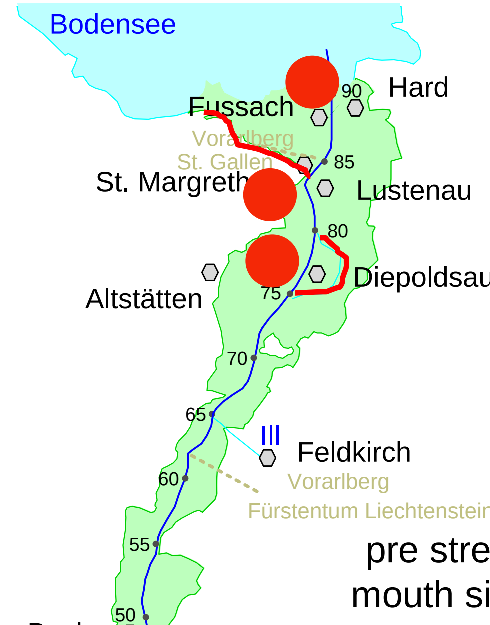


river training - morphology

cut at Fussach (1885 - 1900)

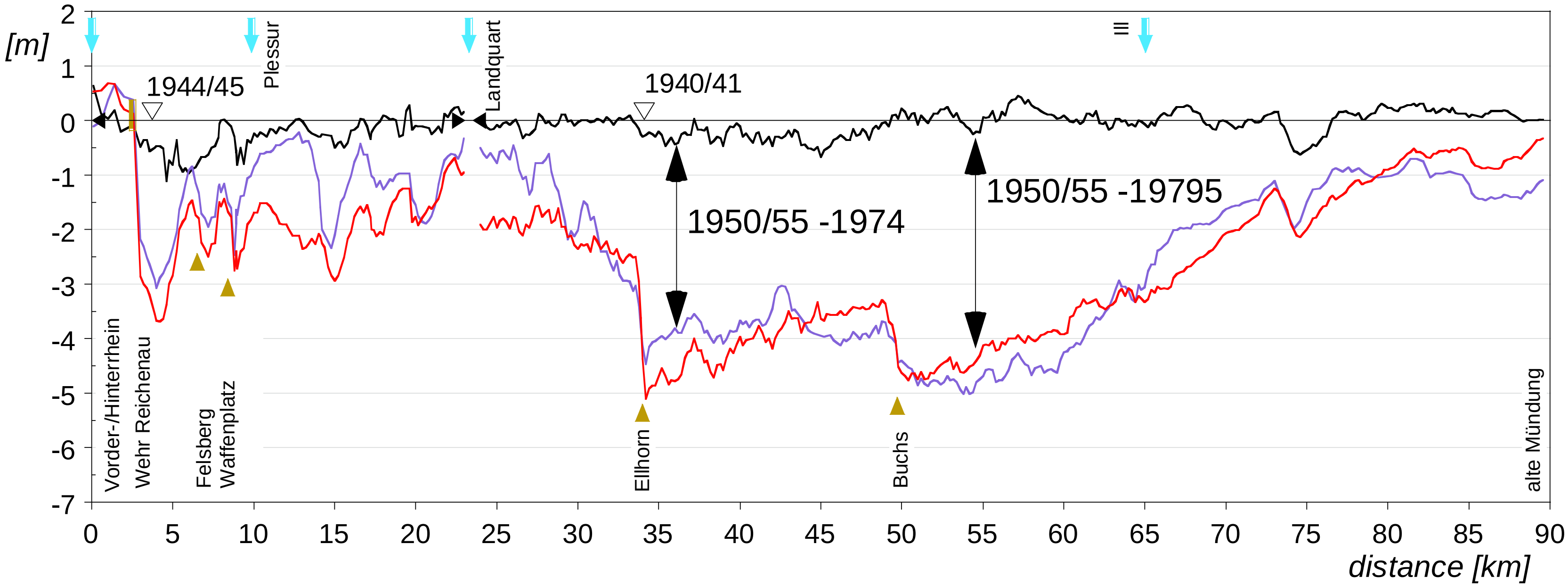


pre stretch at the mouth since 1972

meander cut at Diepoldsau (1909-1923)

Alpenrhein

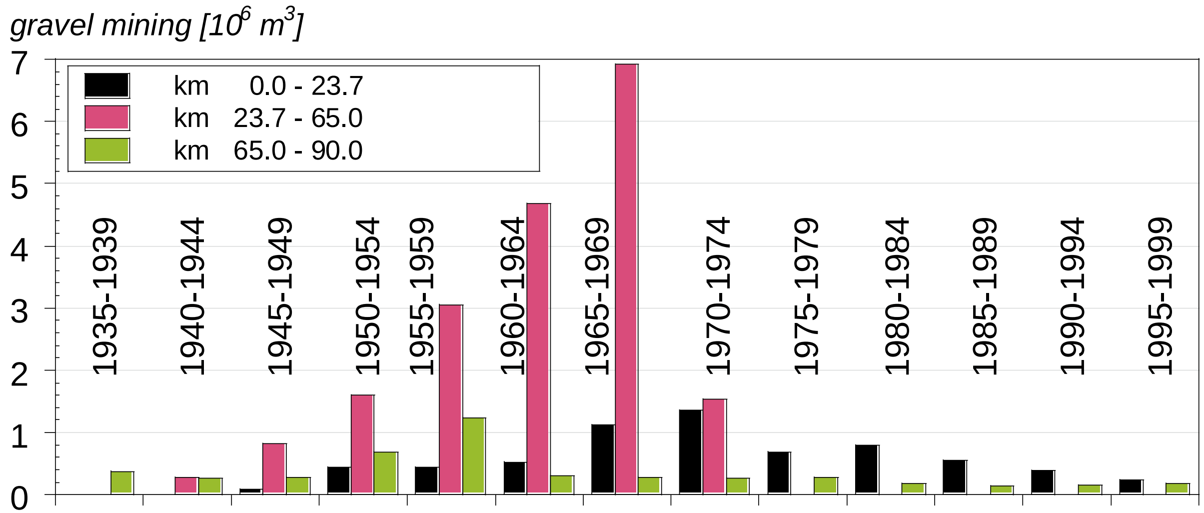
“erosion” between 1950 and 1974

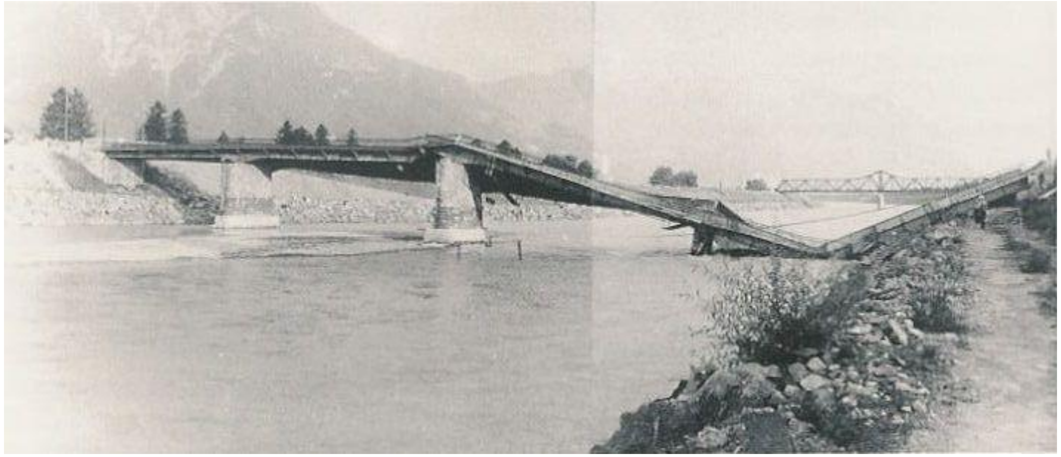


Alpenrhein

Alpenrhein

gravel mining





Brücke Buchs/Schaan über den Alpenrhein, Einsturz 1972, Werdenberger Jahrbuch

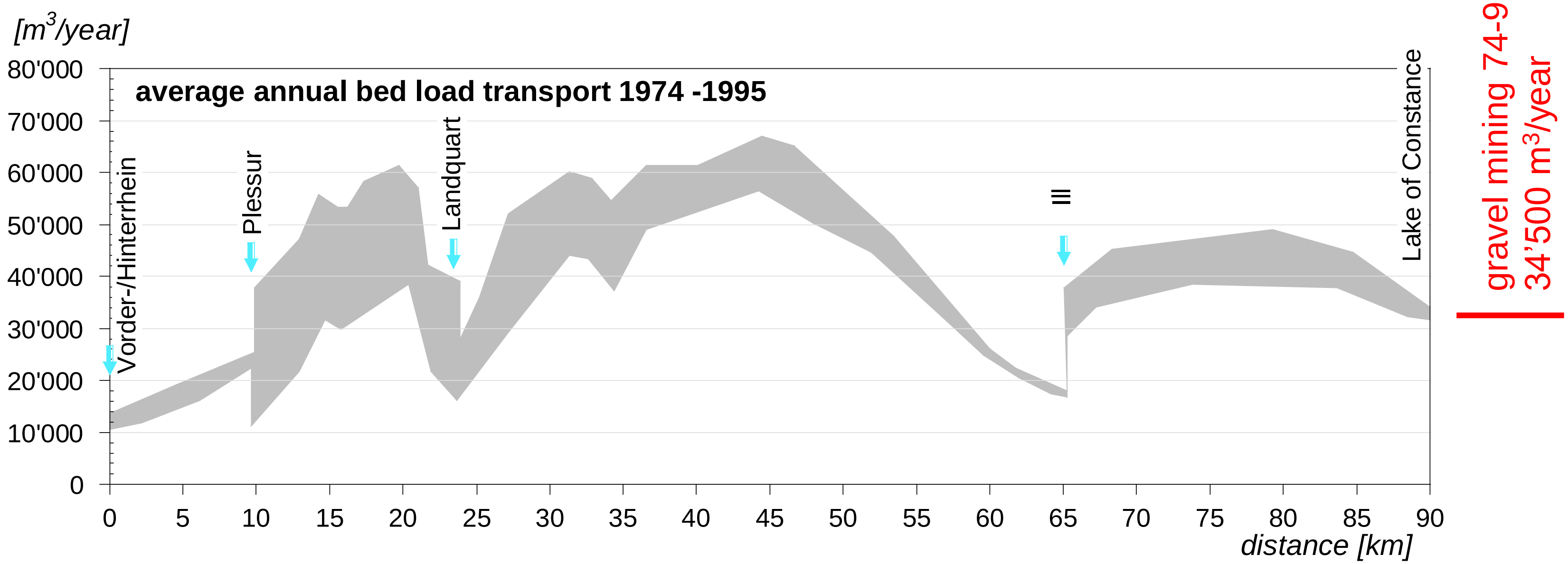
4. Bed load transport

bed load transport model 1974-95

calibration

parameter reference — - gravel mining Lake of Constance (observed)
- variation mean bed level (observed)

parameter changeable — - grain size (inside observation range)
- bed load input



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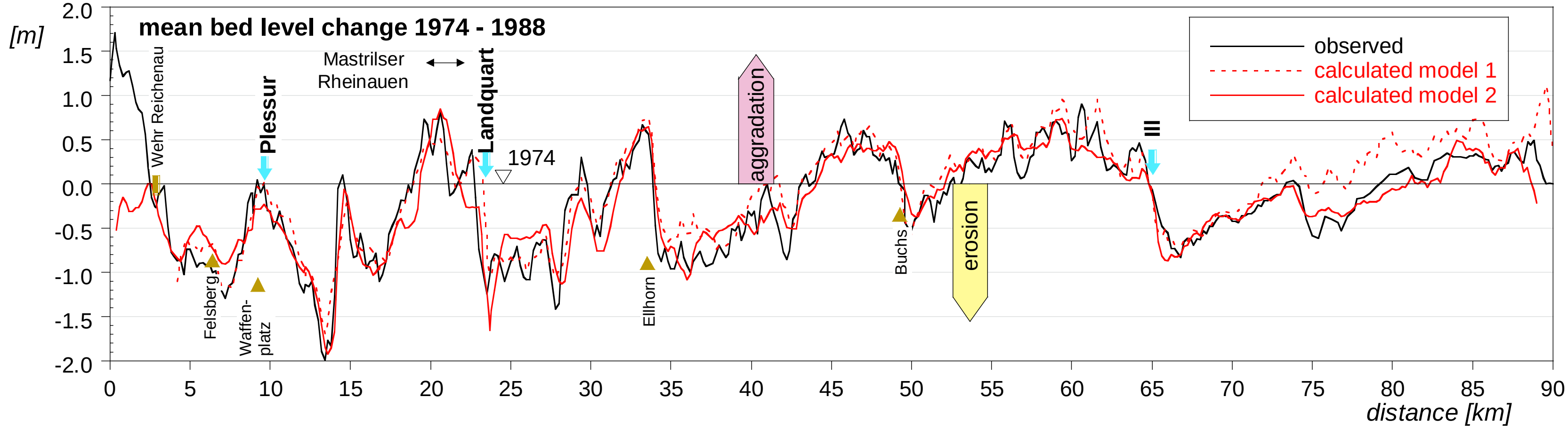
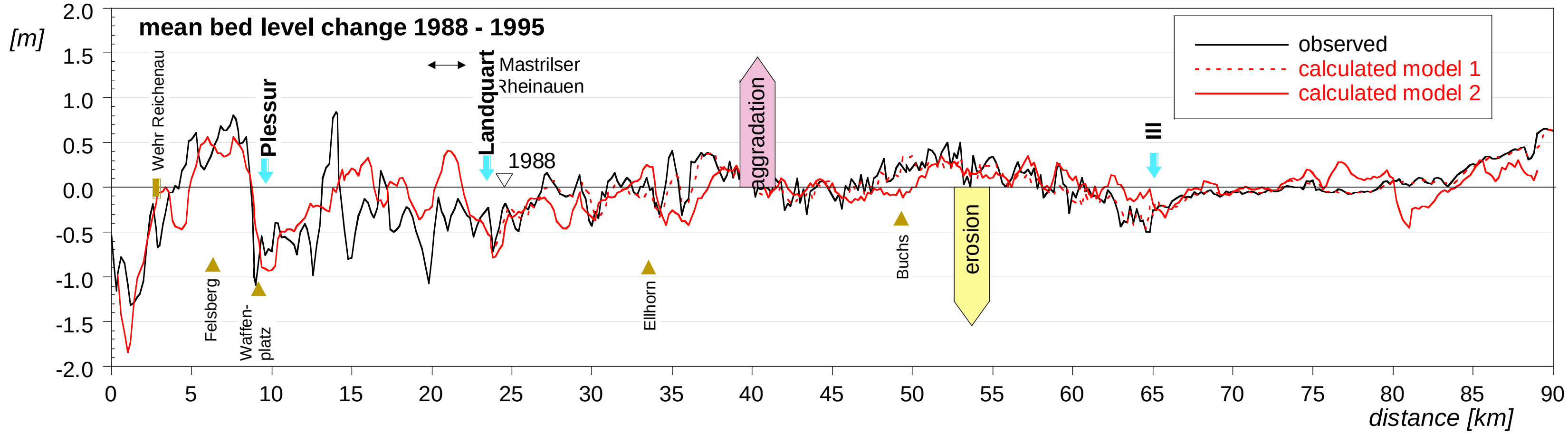


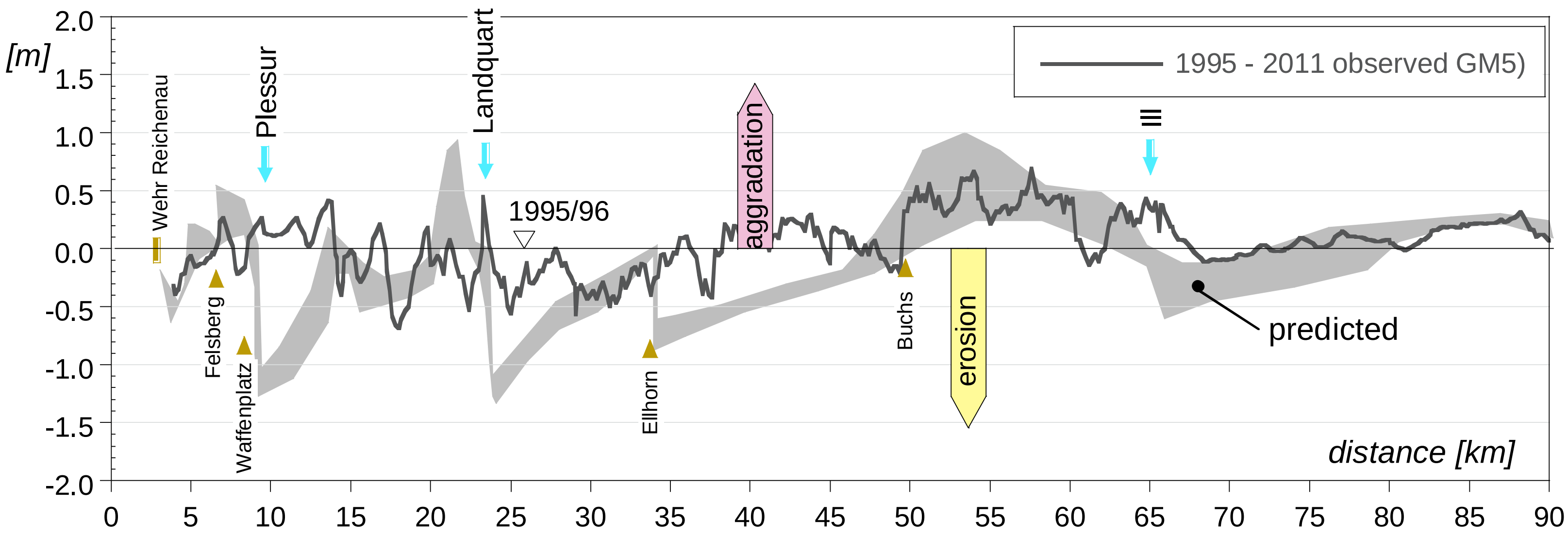


bed load transport

comparison mean bed level change:

- prediction 22 years (regime 1974 – 1995)

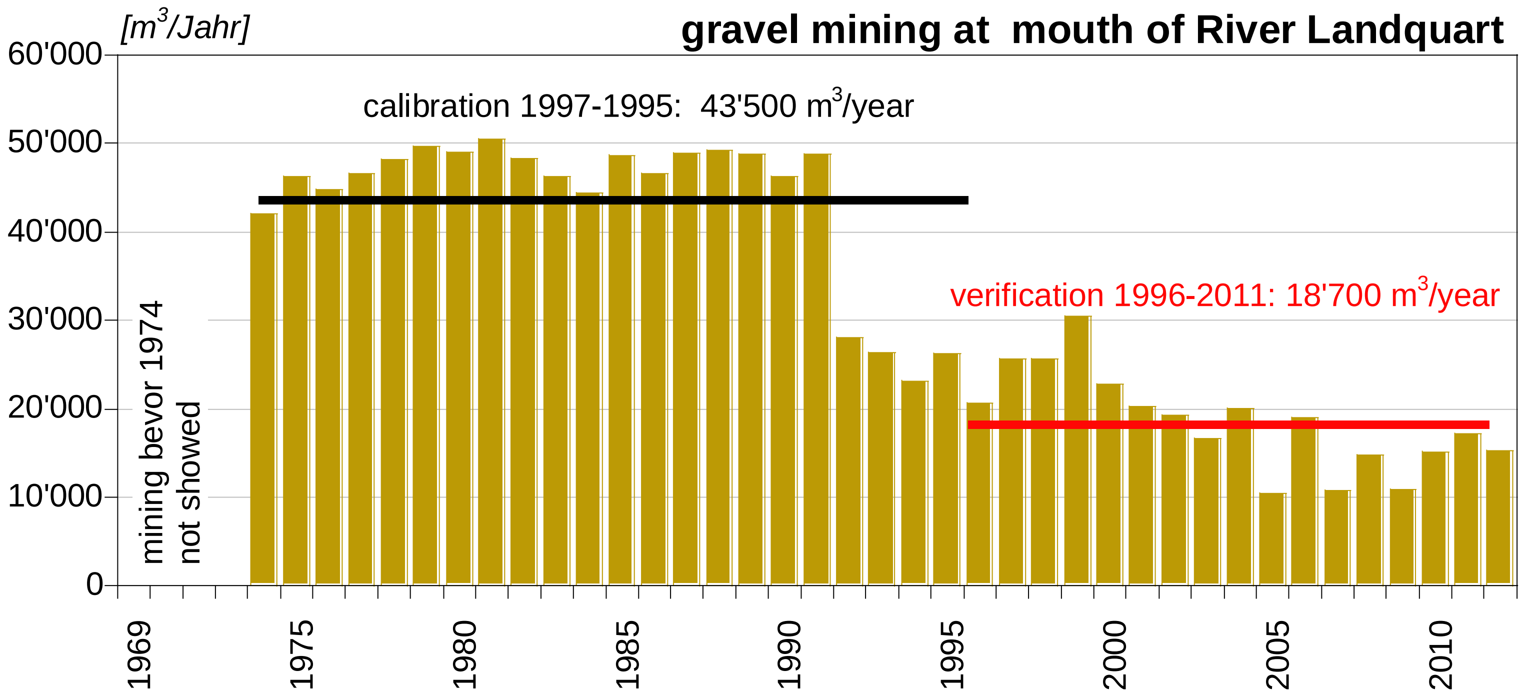
- observation 15 years (1996 – 2011)



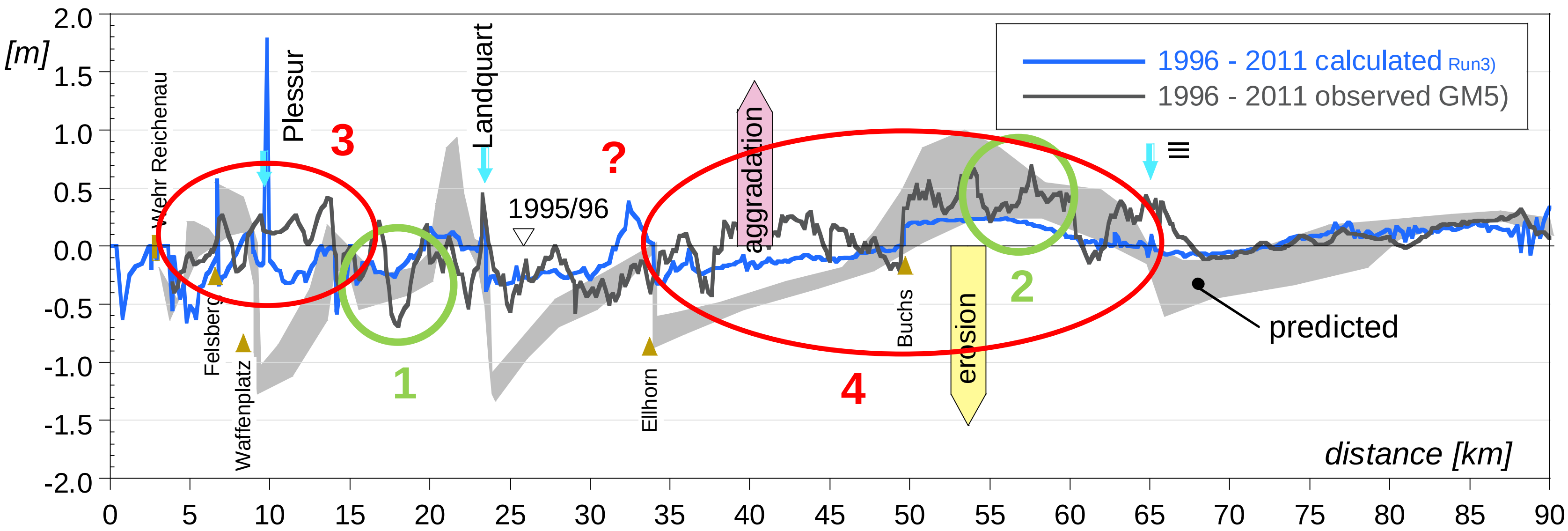
verification

model parameter as calibration 1974 – 1995 except

- discharge (bed load input by tributaries)
- gravel mining as observed 1996 – 2011
- bed load input by Maschänser Rüfi (debris flow)



Verification 1996 - 2011



Probable explanation for the differences

1 local effect

2 bed load transport as «waves» ?

3 underestimation bed load input Vorderrhein/ Plessur?

4 underestimation bed load input Landquart, Ill? / grain size ?

Alpenrhein

Conclusion

- understanding of the past is necessary for prediction
- bed load budgets are the first step
- second step: models
- third step: better understanding of the processes and alterations in the tributaries for adequate assumptions of the bed load input in the main river