Transboundary effects of flooding and flood reducing measures along the Rhine in North Rhine-Westfalia (Germany) and Gelderland (the Netherlands)

A project initiative of

- Provincie Gelderland (NL),
- Ministerie van Verkeer en Waterstaat (NL)
- Ministerium für Umwelt, Naturschutz, Landwirtschaft und Verbraucherschutz (North Rhine-Westphalia, Germany)

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1. aim of the project
2. methods
3. results
4. outlook
   a. statistical value of design discharges ?
   b. rules for and effects of retention areas ?

Background

- floods 1993, 1995
- Declaration of cooperation in flood control between NRW, Province of Gelderland, Rijkswaterstaat 1997
- Fondation of the German-Dutch workgroup for floodmanagement
- Project "Transboundary effects of extreme floods along the Lower Rhine "; 2001-2004

Transboundary effects of flooding and flood reducing measures along the Lower Rhine

aim: answers to the questions

➔ Question 1

How much discharge can result in the catchment of the river rhine?

➔ Question 2

What happend at extreme discharge along the Lower Rhine?

➔ Question 3

Which impacts have flood reducing measures?

➔ Question 4

Effects of climate change?

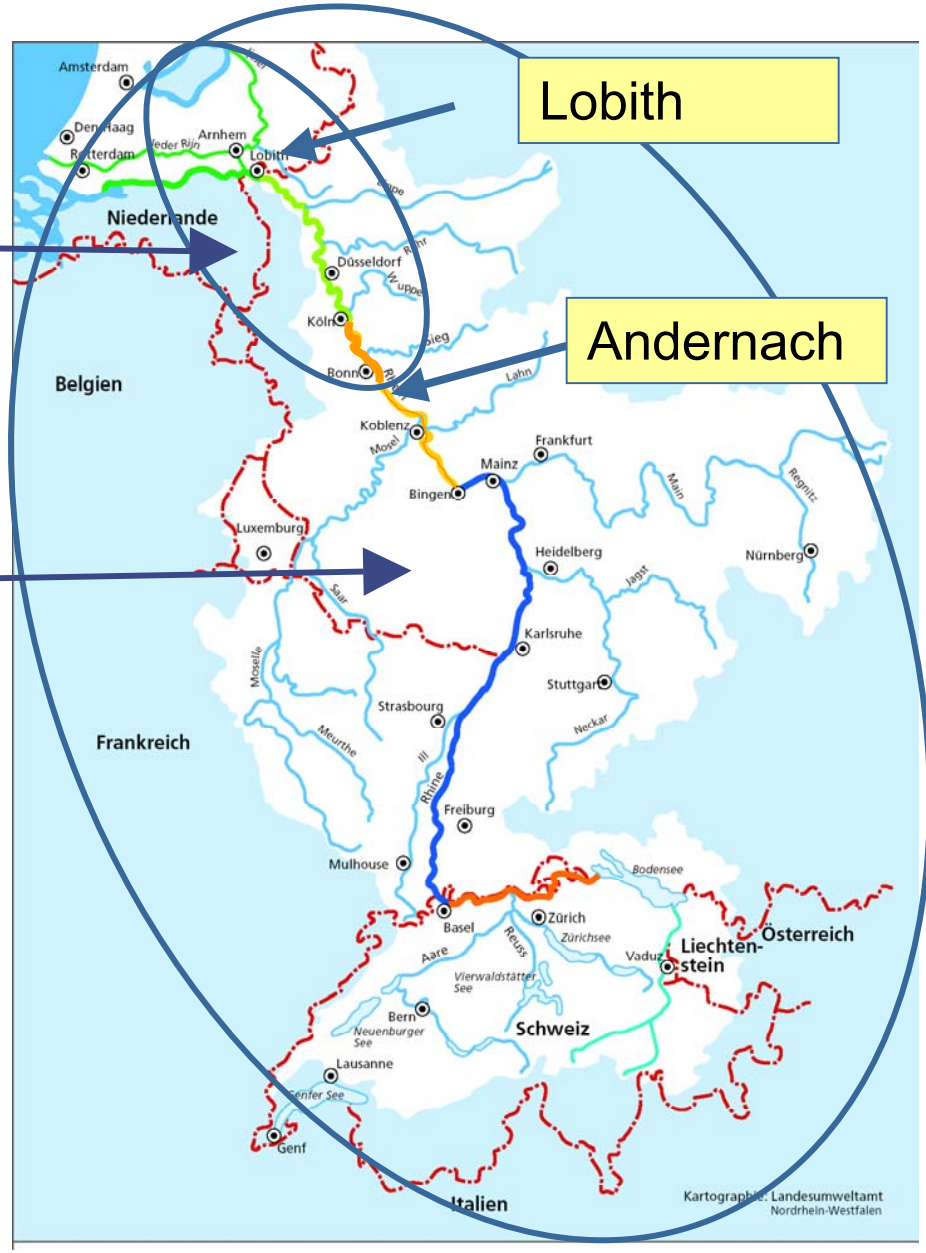
conditions

Detail research
Lower Rhine and Rhine branches downstream of Gauge Andernach

Hydrologic Calculation of the **whole catchment area** of the River Rhine

Scenarios 2002 and 2020
- reinforcement of dikes
- flood reducing measures

Dike damage only when dikes overflow



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Calculations for the catchment area of the River Rhine

Stochastic Rainfall generator (KNMI)

Time series ~1000 year P and T

↓

Rainfall-runoff model (HBV)

Trans-formation to discharge

↓

1000 year synthetic discharge waves

Selection of 16 highest discharge waves

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Flood routing (SOBEK, SYNHP)

Flood routing with retention and floodings along the Upper Rhine

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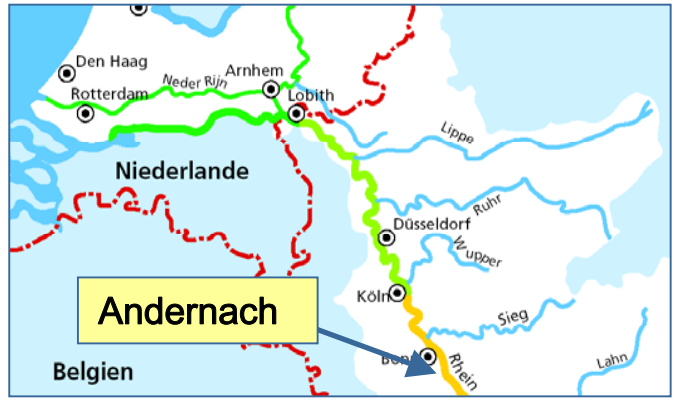
16 discharge waves at Andernach

Calculations beginning at Gauge Andernach



Extreme discharges from Rhine catchment

↓

Selected discharge waves at Andernach

↓ 2

Flooding at Lower Rhine and Gelderland (Delft-FLS)

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flooding protected area

Knowledge on inflow to protected area / loss of discharge in river

→

↓ 8

Discharge Lower Rhine – Rhine Branches (SOBEK)

↓

Effects of flooding on discharge waves

Effect of flood reduction measures

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Answers to Question 1:
How much discharge can result in the catchment of the river rhine?

Very large floods are possible !

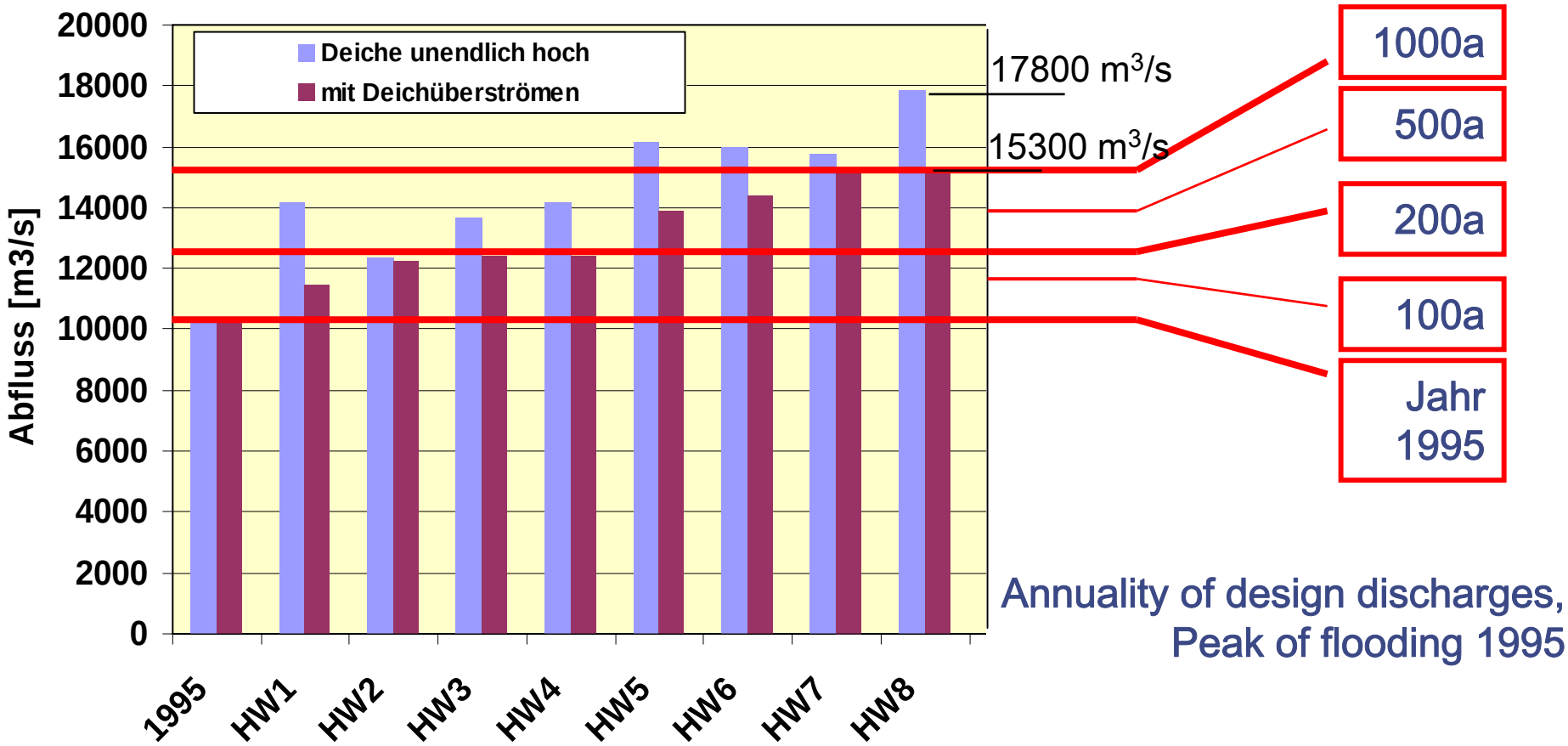
Highest calculated peak discharges at Gauge Andernach:

- With infinitly high dikes at the upper rhine : 17 800 m^3/s
- With dike overflowing at the upper rhine: 15 300 m^3/s

Discharge peaks at gauge Andernach

with and without considering dike overflowing at the Upper Rhine

-> how extreme are the peak discharges ?



Annuality of design discharges,
Peak of flooding 1995

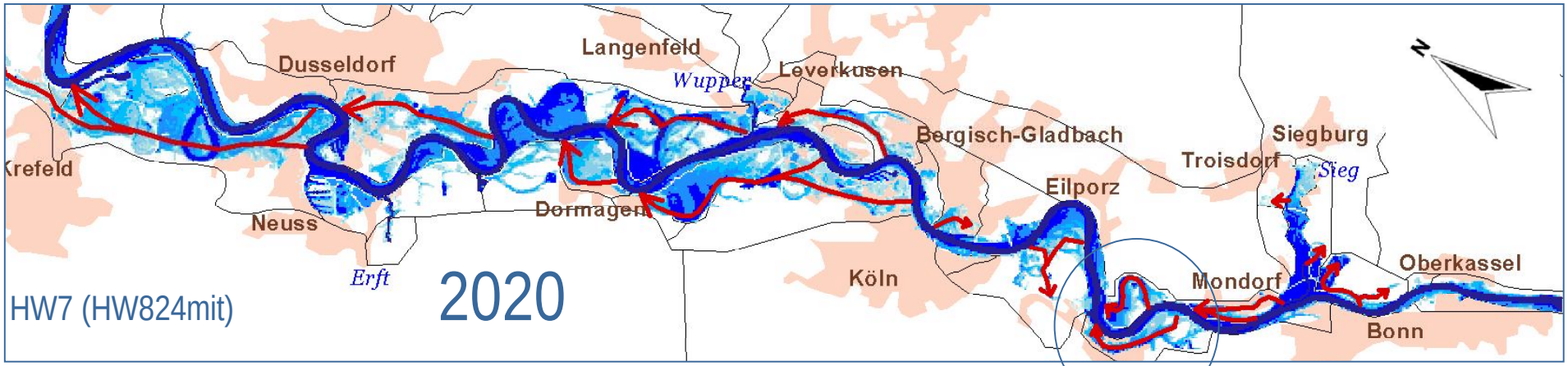
Question 2
What happend at extreme discharge along the Lower Rhine?

different design flood levels

Extreme discharges
of the project
will lead to overflowing
of dikes or high banks!

Flooding at the southern part of the lower rhein

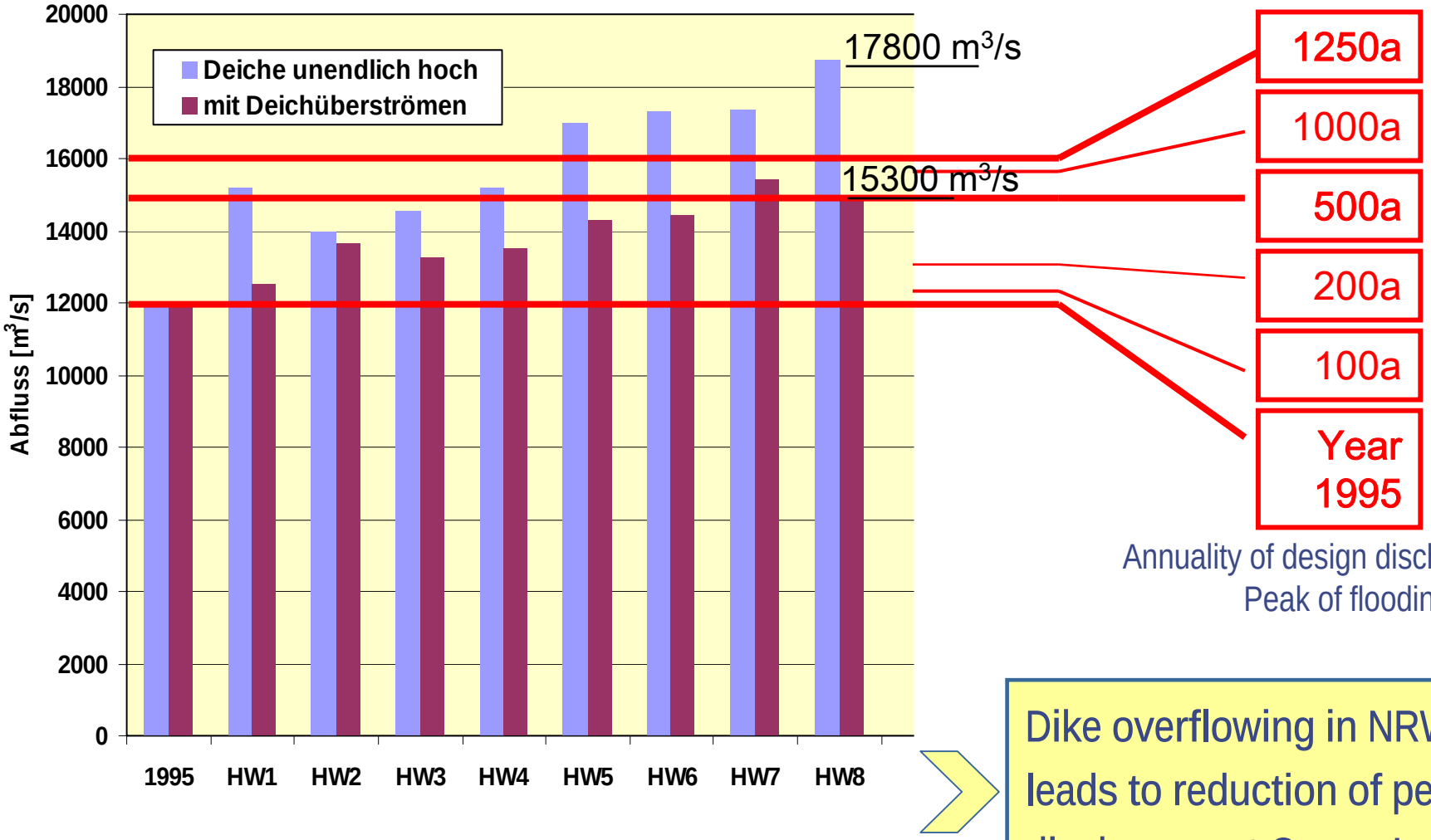
Example: project flood HW 824



Peak Discharge at Gauge Lobith

with and without considering dike overflowing

at the Upper and Lower Rhine



Annuality of design discharges,
Peak of flooding 1995

Dike overflowing in NRW leads to reduction of peak discharges at Gauge Lobith.

Answers to question 3:
Effects of flood reducing measures ?

- Dike overflowing and flood reduction measures together reduce peak discarges

- Retention areas have different effects in condition to shape and peak of the calculated discharge waves – these wave are influenced by dike overflowing

➔ in an area with changing flood design levels along the river the effects of flood reduction measures must be seen in combination with the effects of dike overflow upon the discharge and water level

➔ It is not allowed to say: „ Measure A reduces floods at B centimeters “

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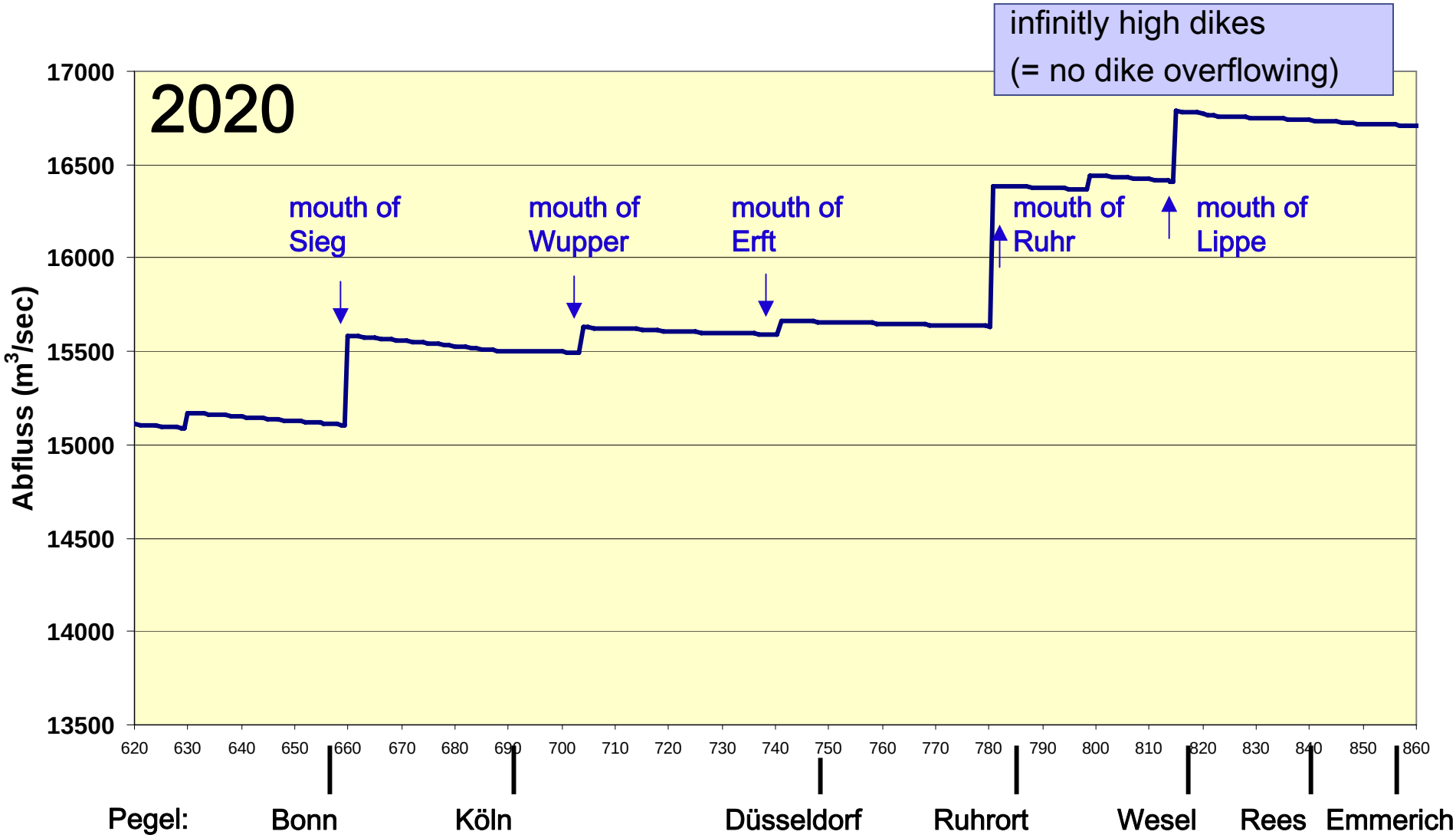
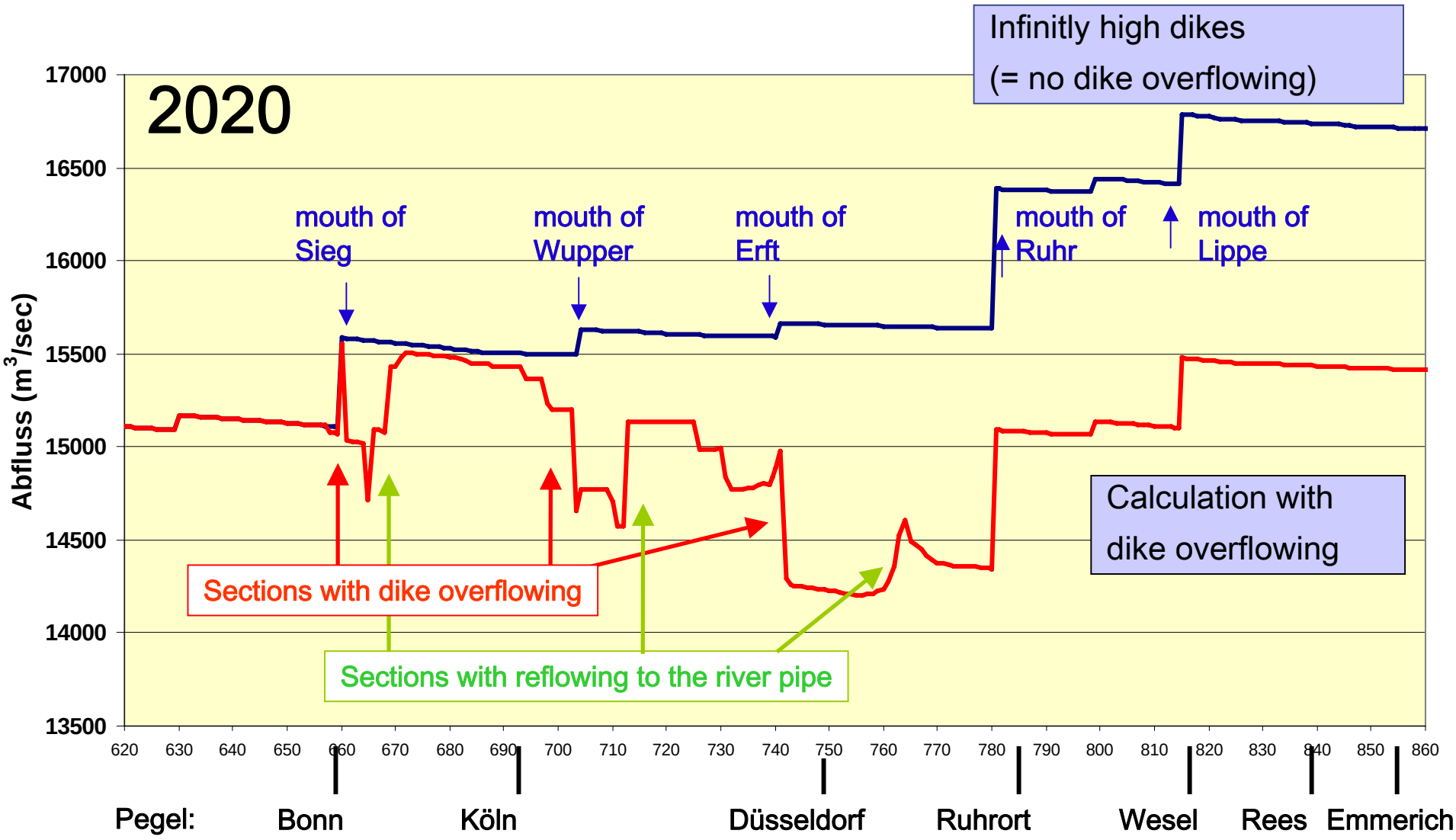
Influence of dike overflowing to peak discharges

➔ Peak discharges in longitudinal profile with infinite high dikes



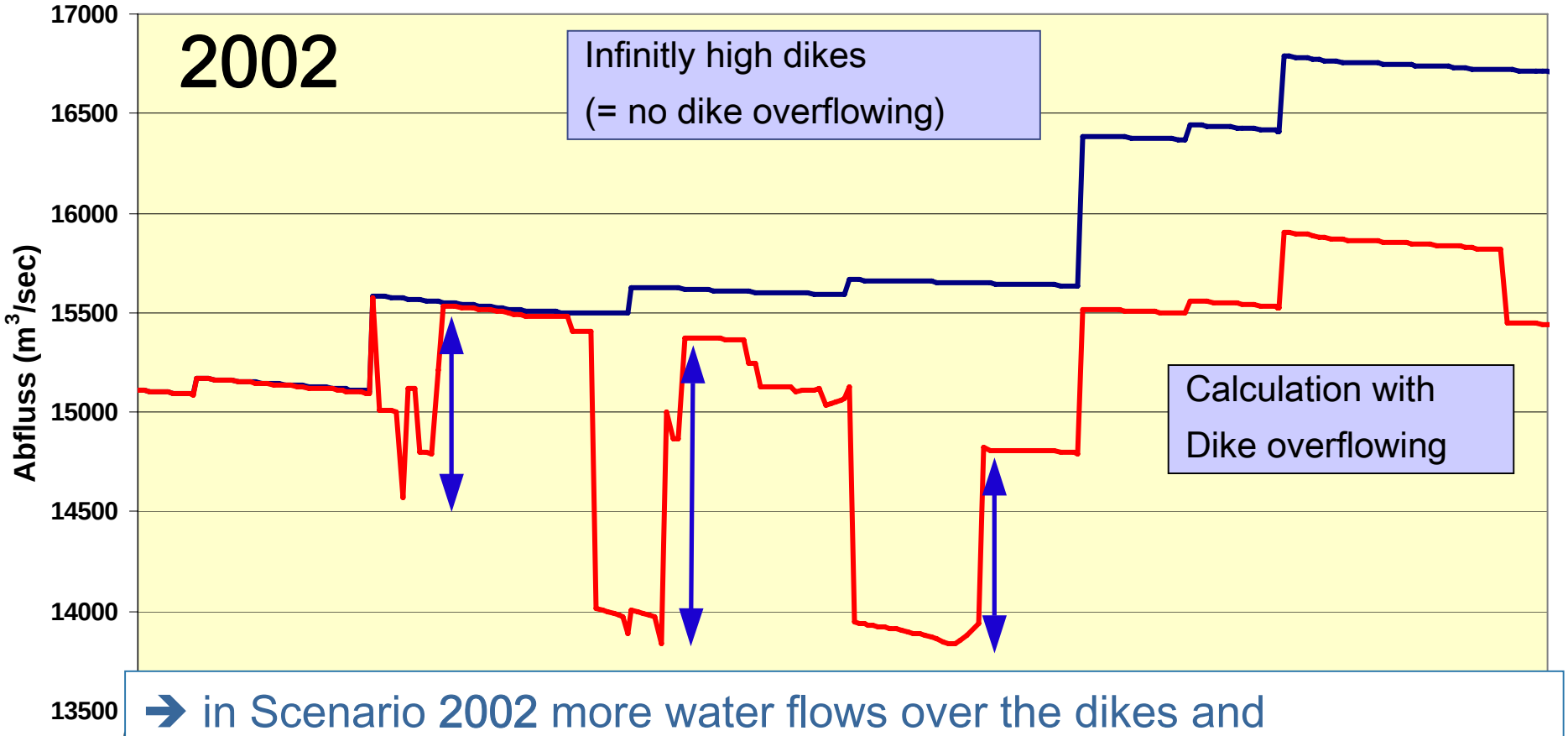
Influence of dike overflowing to peak discharges

➔ Reduction of peak discharges in the river pipe



Influence of dike overflowing to peak discharges

➔ Comparison: Year 2002 (without dike reinforcement)



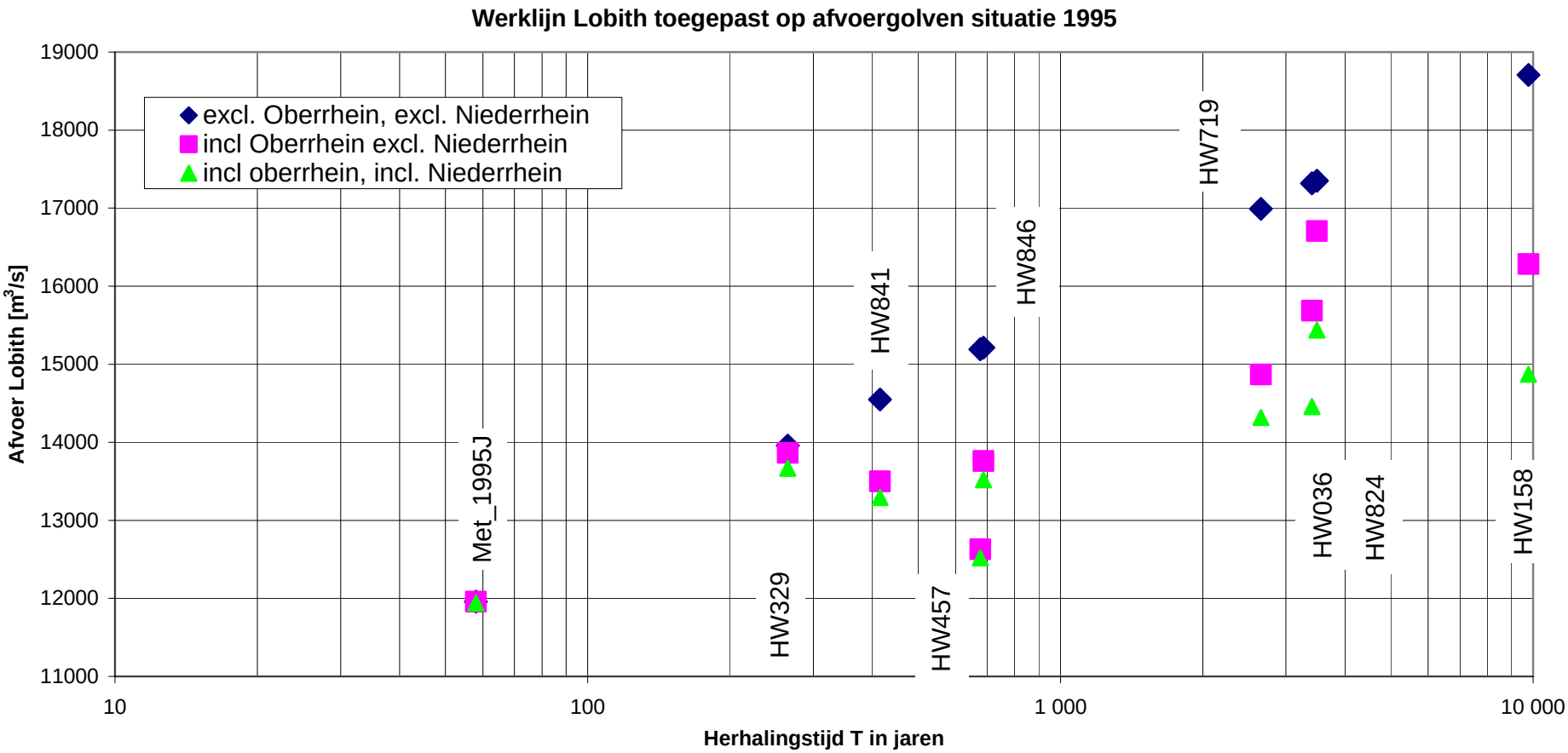
➔ in Scenario 2002 more water flows over the dikes and the streams behind the dikes are larger.

➔ In 2020 the reinforced dikes will reduce the overflows

Outlook

Impact of flooding and flood reduction measures upon extreme floods is very big

➔ This should be taken into account in flood statistics.



German – Dutch – Working Group „Floodings“

Grenzüberschreitende Auswirkungen von extremem Hochwasser am Niederrhein

Grensoverschrijdende effecten van extreem hoogwater op de Niederrhein

Questions to discuss:

What about statistical value of design discharges?

What about rules for and effects of retention areas, when dike overflowing happens upstream?

Main message: Understand the hydraulic processes !

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Quelle: „Jeder Zentimeter zählt“, DVD, StUA Krefeld

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