

# Floods in Germany (June 2013)

Post-flood field investigation, July 2& 3, 2013

Preliminary Findings

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in collaboration  
with:



# Objectives and scope

- Post-flood field investigation July 2 & 3
- Focus on dike breaches and flood fighting
- Team:
  - Torsten Heyer (TU Dresden)
  - Bas Jonkman (TU Delft, Rijkswaterstaat, ENW)
  - Timo Schweckendiek (TU Delft, Deltares, ENW)
  - Joop de Bijl (STOWA, Waterschap Aa en Maas)
  - Guy Dupuits (TU Delft)
  - Astrid Labrujere (Rijkswaterstaat)
  - July 2, Reinhard Pohl (TU Dresden)
  - July 3, Koos Wieriks (Dutch Embassy in Berlin)

# Deichbruch

**Achtung allgemeine Gefahrenstelle !**

**Das Betreten des Deiches durch Unbefugte ist  
untersagt !**

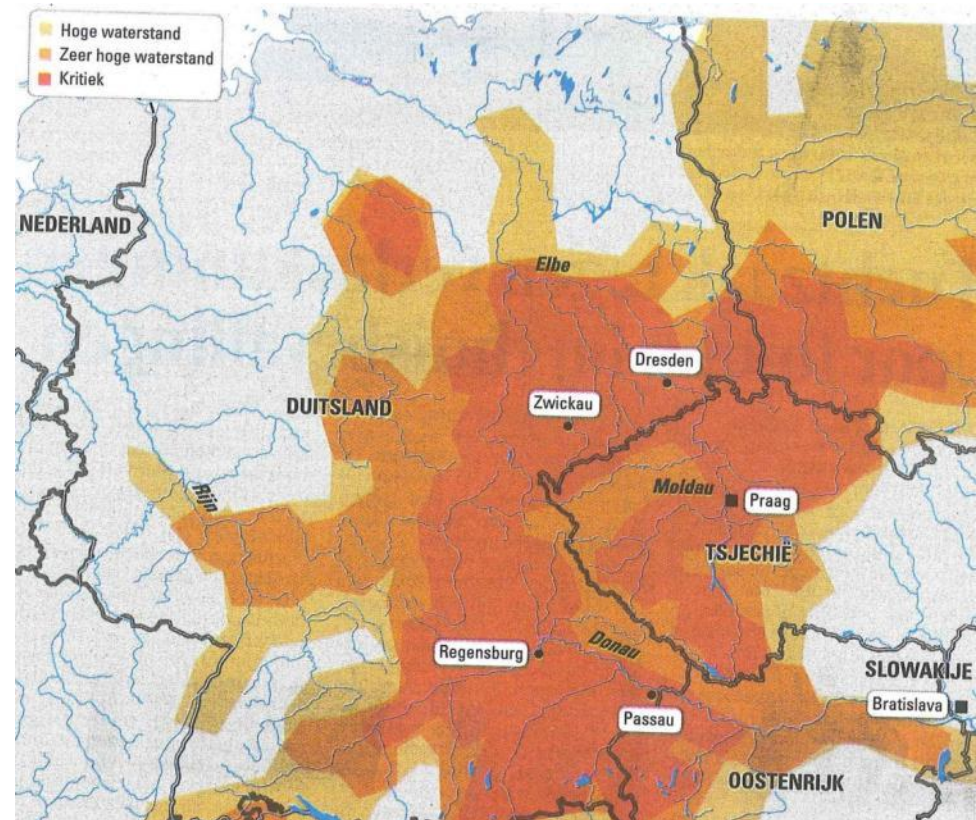
Landestalsperrenverwaltung des  
Freistaates Sachsen  
Betrieb Elbaue/Mulde/Untere Weiße Elster  
Flussmeisterei Bad Dübener  
Tel. 034243 / 333 00

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# Precipitation and Floods

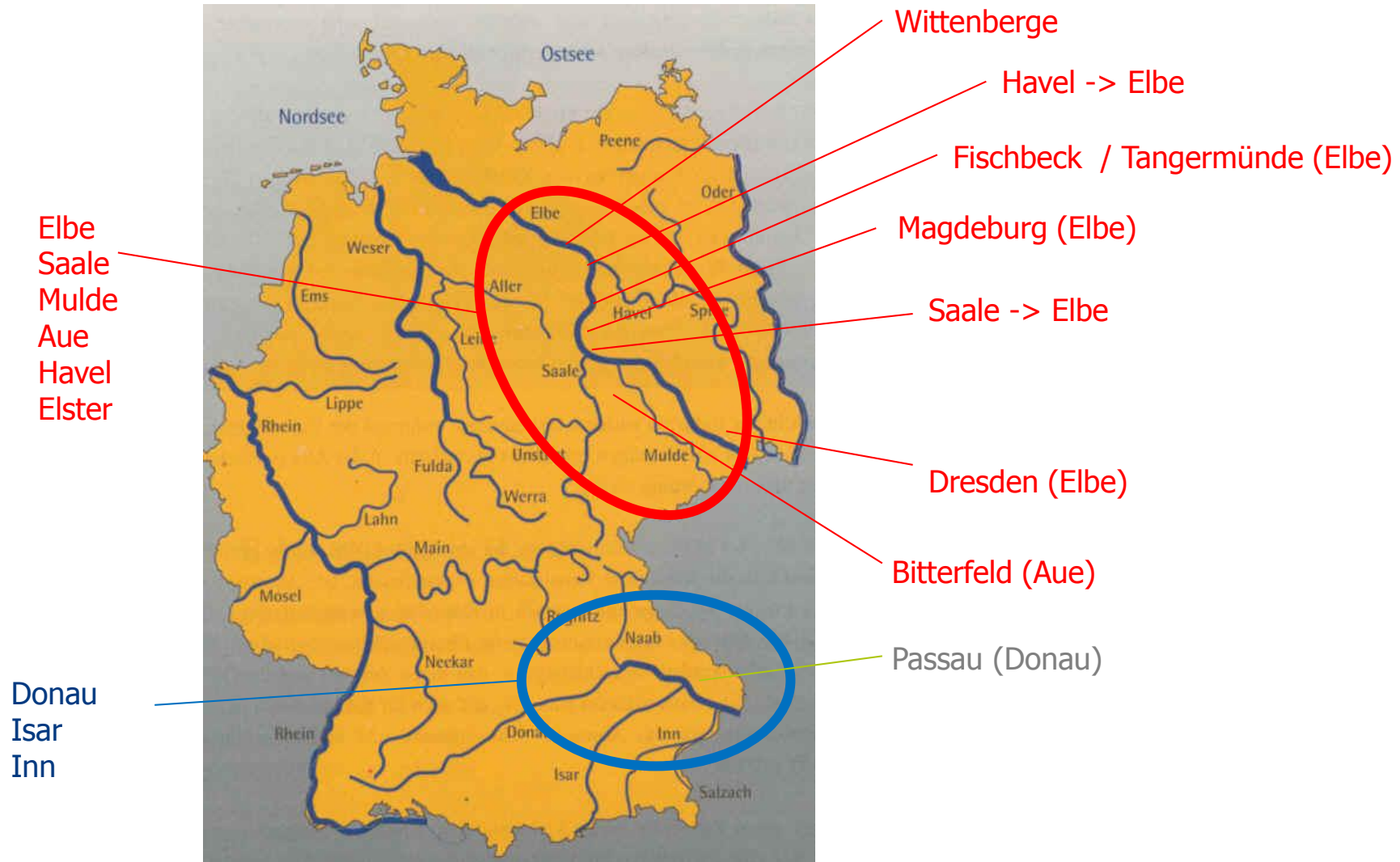


NRC 6 June 2013



- Large flood event:
  - Return period 50 – 500 year depending on location / river
  - At some places larger than 2002 flood event

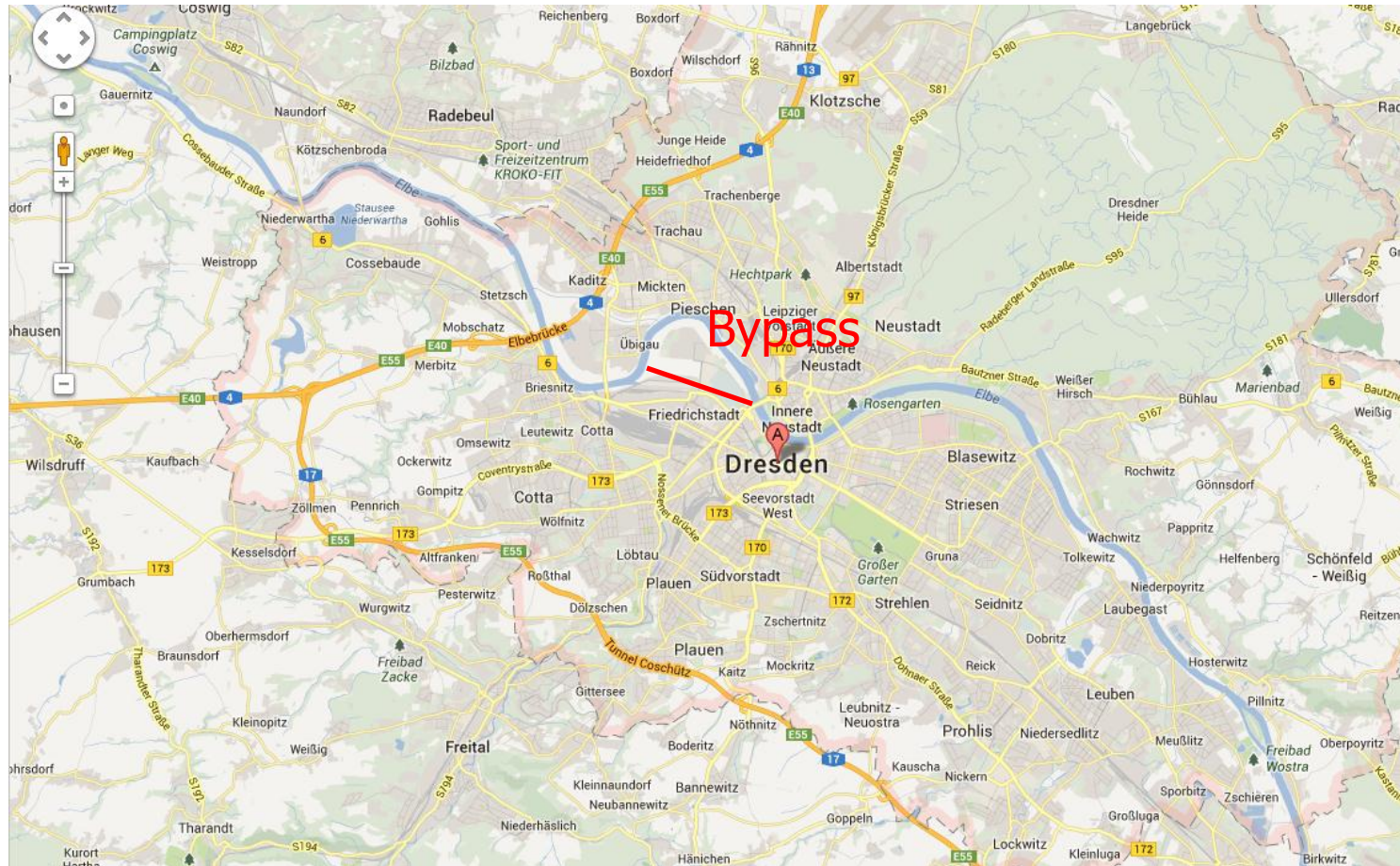
# Affected areas



# Overview of investigated sites



# Dresden – overview



# Dresden – facts and figures

- 2002 flood event:
  - +9.40 meter water level in the Elbe (1/200 per year event), 1000 million euro in damage
  - The Weißeritz river, a tributary river to the Elbe, had a 1/500 per year event
- Various measures were taken after this event: floodgates, mobile flood protection, improvement of hydraulic roughness, increasing protection to at least 1/100 per year
- 2013: +8.77 m water level Elbe (1/50 per year event)

# Dresden – impressions



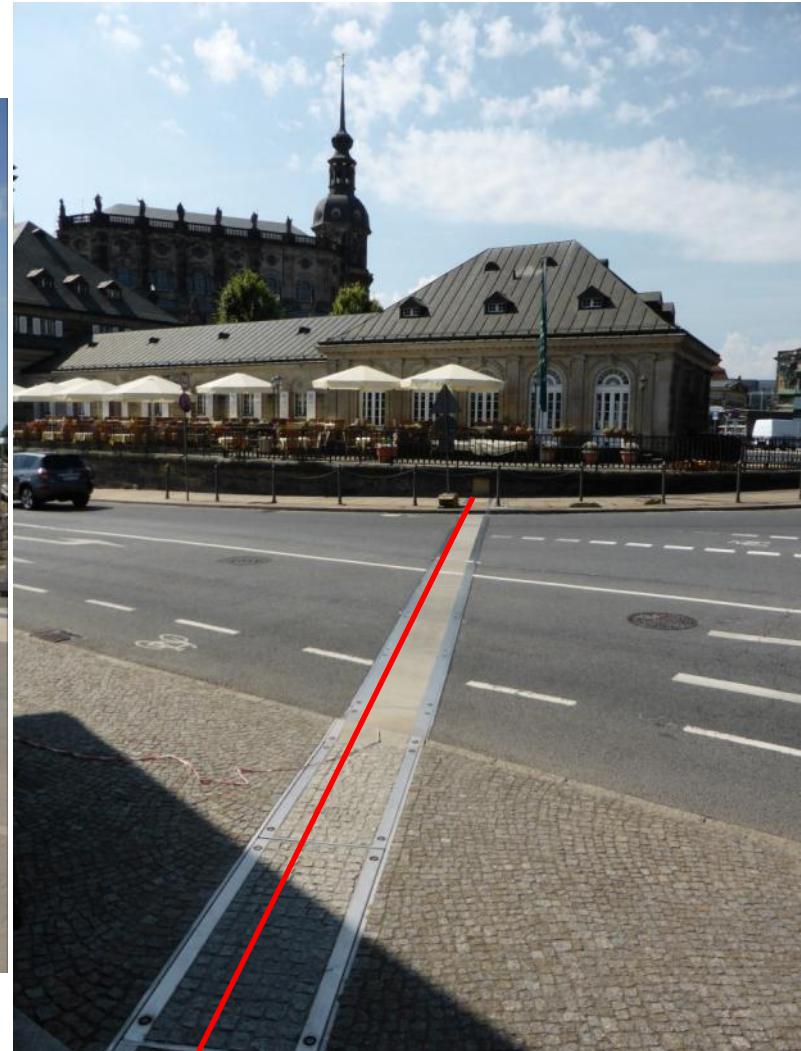
2013 - Picture taken by Reinhard Pohl

# Dresden - impressions

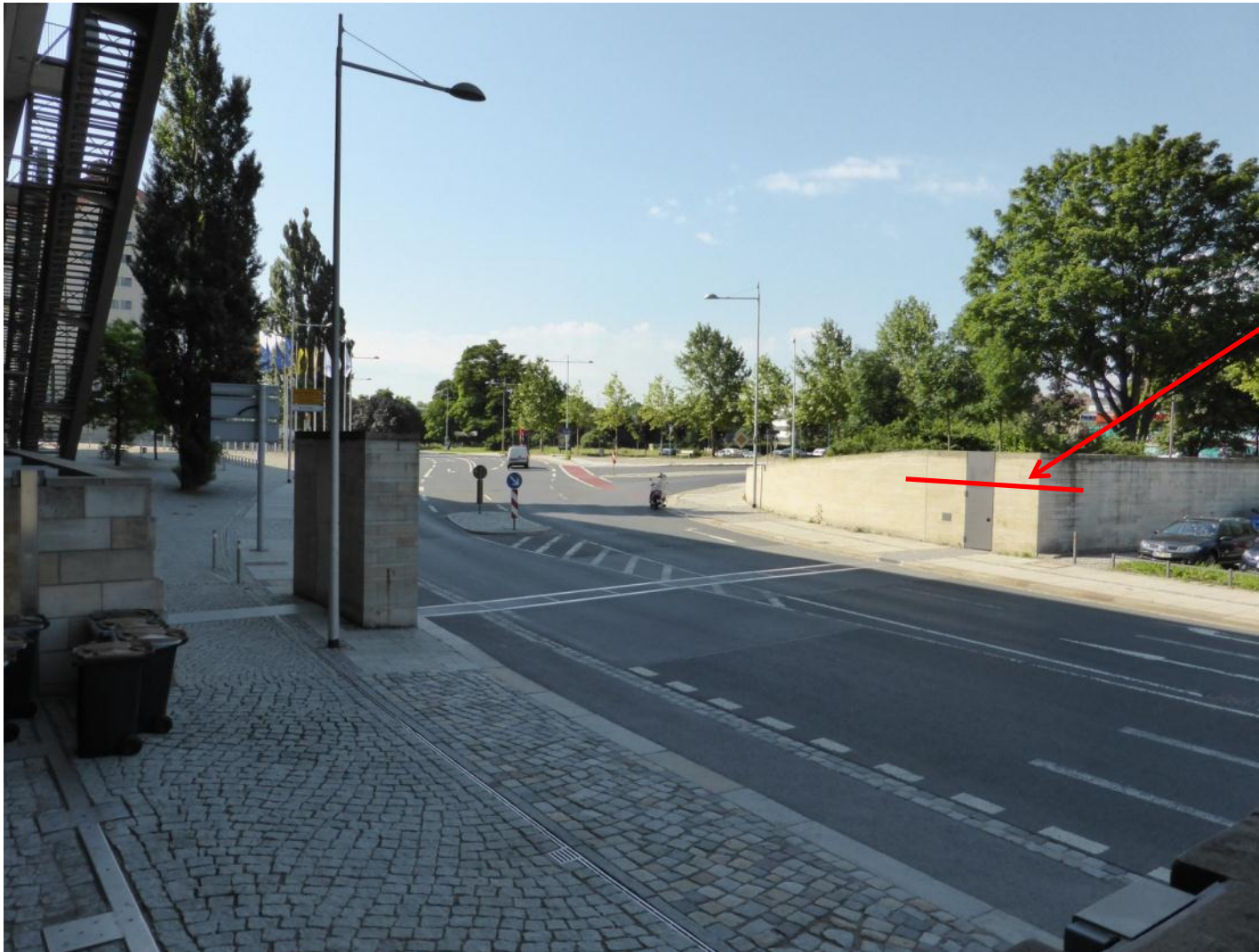


2013 - Picture taken by Reinhard Pohl

# Dresden – flood gates



# Dresden – flood gates



Gate lower  
than floodwall  
to allow  
overflow

# Dresden – erosion



unexpected erosion next to the Marienbrücke in the bypass (after removing obstacles downstream)



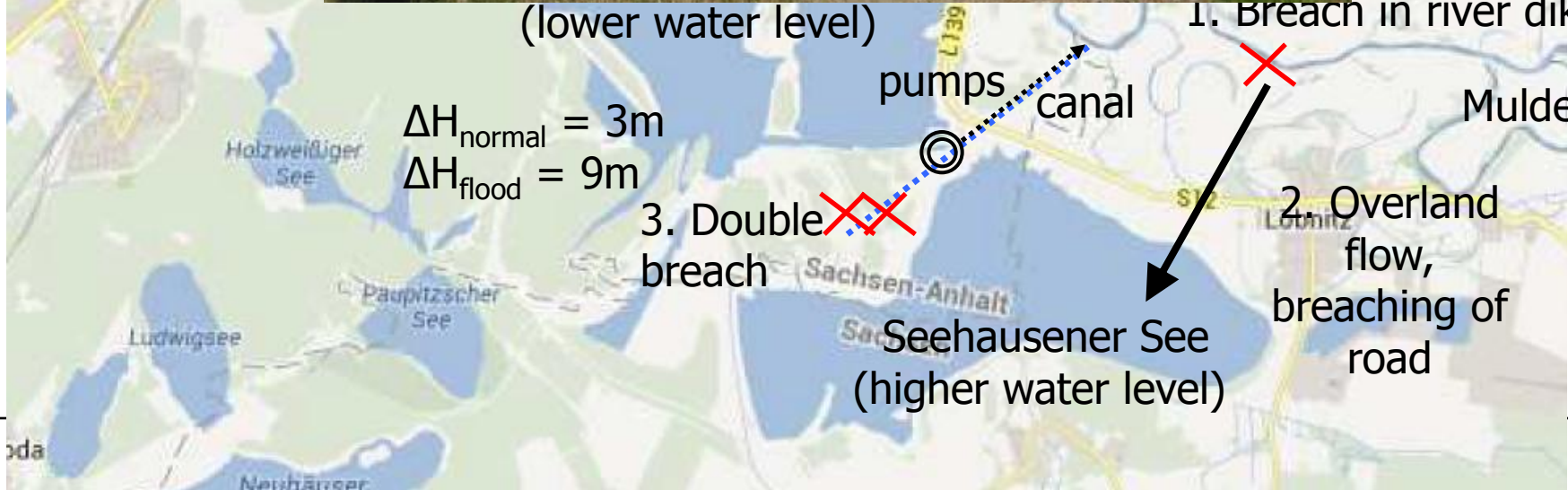
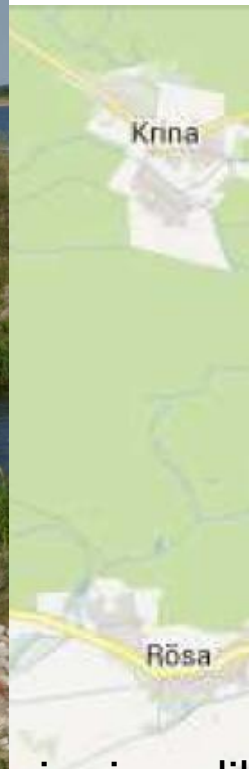
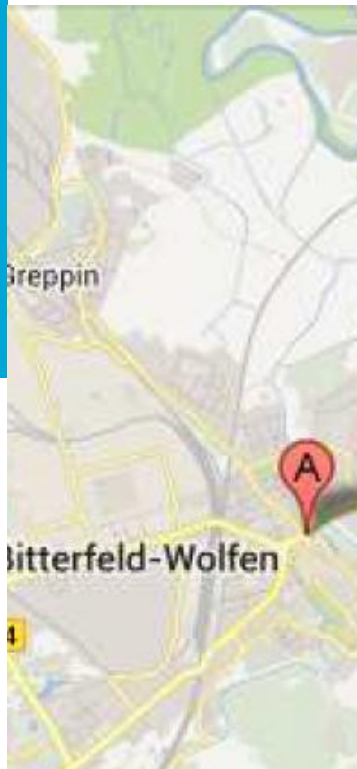
# Bitterfeld - situation

- Coal mining, leaving pits of 60 meters deep
  - Mining activities have stopped
  - Turned into a recreational area with shipping harbour
- Concentration of chemical industry in the area
- City of Bitterfeld
  - On the border between Sachsen en Sachsen-Anhalt
  - Thousands of people were evacuated because of threat from lakes

# Bitterfeld (pre-breach situation)



© Jens Wolf/dpa

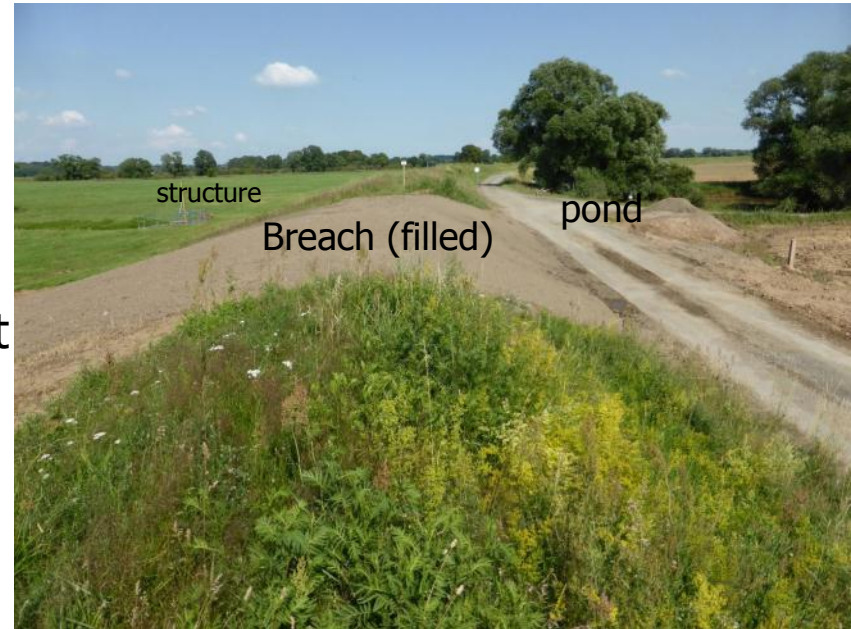


# 1. Bitterfeld – Mulde breach

- Breach on the Mulde river, one of multiple breaches
- 25 m wide breach, relatively high on slope
- Wells on the inside of sandy material, possibility of piping mechanism
- Highest water about 1m (?) below crest

## Context:

- Next to small dewatering structure and small pond
- In 2002 a breach occurred in the same area, a few hundred meters upstream from the current breach.



## 2. Bitterfeld - Breaches in Road Nr. S12

- Large breach in road (200m or more)
- Overtopping and erosion of road and bike path



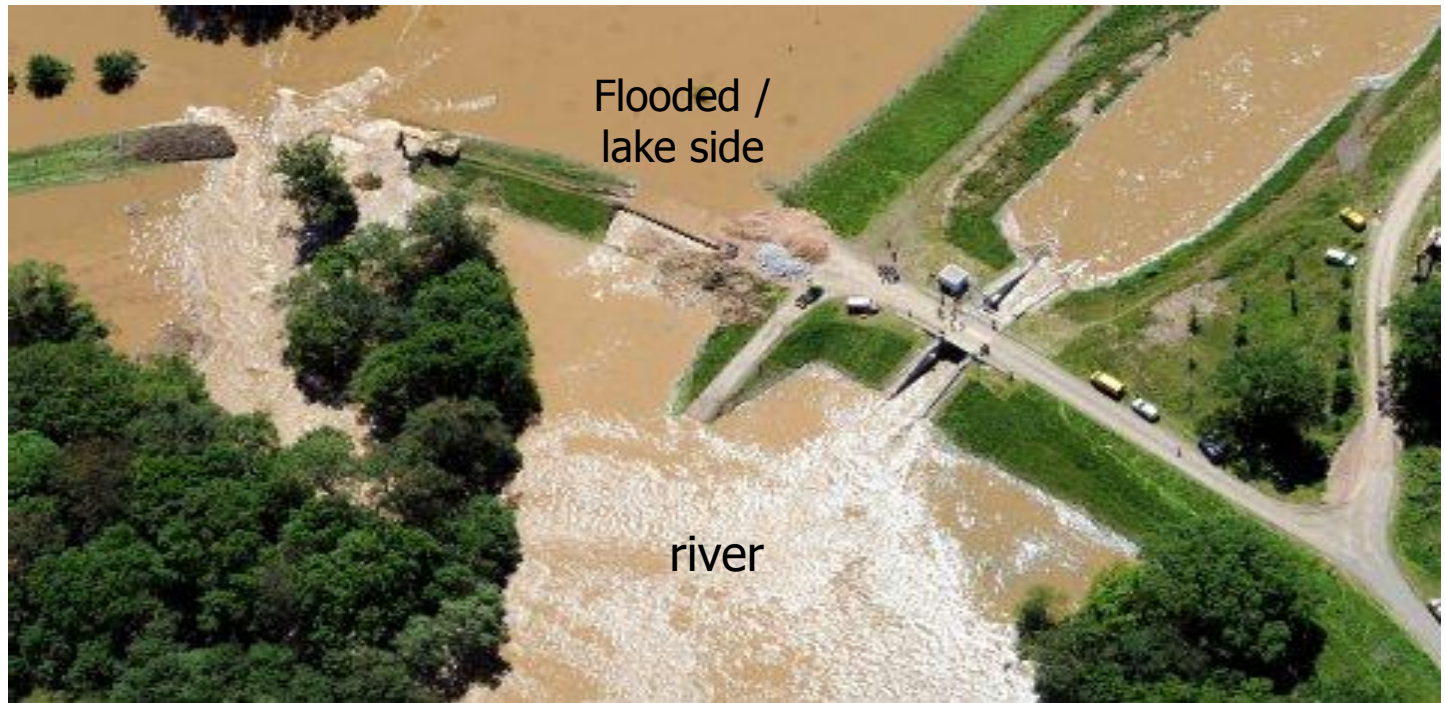
### 3. Bitterfeld, Breaches in Channel embankments between lakes

- Seelhausener Lake fills due to breach (several meters)
- Overflow and breaching of adjacent canal dikes
- Unsuccessful attempt to close breaches with bigbags by helicopters
- Cascading effects to Grosse Goitscherzee, threatening city of Bitterfeld



# Bitterfeld – dewatering

- Breaches created with dynamite for dewatering



Source???

# Breitenhagen - levee breach



DPA / Salzlandkreis

# Breitenhagen - inner slope failure



[Reuters](#)

# Breitenhagen

- Located on Saale river, water levels about 1~1.5m below crest
- Trees located in front of dike
- Dikes consisted of clay, slope about 1:2.5 to 1:3
- Slip circle occurred on inside, on landside of the road
  - Part of the dike remained for 10 hrs, then breached
  - 150m breach
- Dike reinforcement plan was available, but not yet implemented
- Emergency measures:
  - First round of bigbags delivered by helicopters
  - After that no army assistance available anymore
  - For dewatering:
    - Explosions were not effective to blow up dike
    - Breach opened by equipment for dewatering
    - Pumps installed to dewater the urban area

# Fischbeck (levee breach)



River Elbe

Foto: REUTERS/Thomas Peter

# Fischbeck dike breach - general

- breach location located at “corner”
- Western side of the Elbe,
- water level below crest (0.2m ~ 0.4m)
- dike: about 5m high, moderate/steep slope (about 1:3?), no berm
- dike body: clayey sand (sandy clay in lower part)

# Fischbeck dike breach

Failure process (according to eye witnesses)

- cracks in crown, stage-wise settlement of the inner slope
- heavy flood fighting to prevent breach (sand bags, big packs)
- breach occurred around midnight (Sunday 9 June around 00:01 AM)
- inner slope sliding/breach occurred fast (10 ~ 20s)
- initial width 50m, growth to 100m within hours, 2-3m deep scour hole
- estimated inflow up to 700-1000 m<sup>3</sup>/s (different figures in BfG report)
- Water was within town of Fischbeck (~ 2km) within 5 minutes
- Fischbeck had been evacuated previously
- flooding extended in a wide area (up to the Havel river, tens of km)

# Fischbeck - post-breach



modified after dpa photo



breach

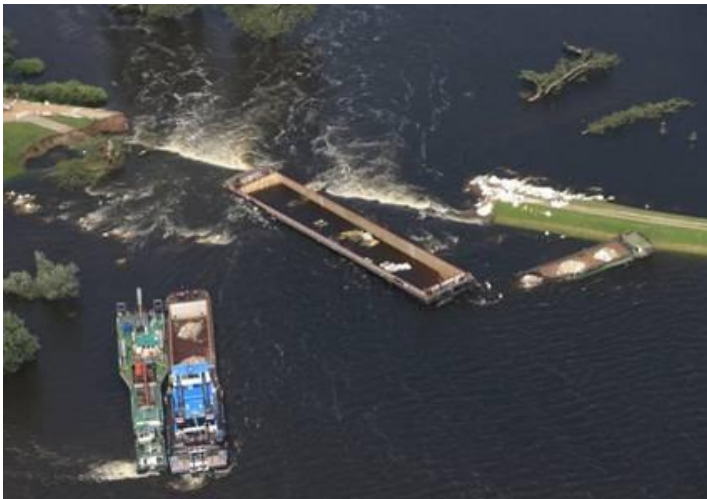
barges

river

Temporary  
dike &  
sheetpile



# Fischbeck breach emergency



[dpa](#) / [dpa](#)

- Three barges sunk in front of the breach using explosives
- inflow reduced significantly
- breach finally closed when water was levelled out
- Temporary flood defence:
  - Sheet pile in the breach (8 ~ 11m)
  - Earthen dike / roadway in front
  - Ships are being removed, new dike will follow different alignment

# Fischbeck breach emergency repairs



[Photo: Doreen Jonas / MDR](#)

# Fischbeck emergency repair



Source: MDR Sachsen-Anhalt

VIDEO

# Fischbeck - local instability

- Few hundred meter from breach site
- Seems initiation of slip circle over about 25 ~ 30m
- Sheet pile in dike and bigbags on slope implemented as emergency measures



# Concluding remarks

- Large flood event:
  - Return period 50 – 500 year depending on location / river
  - At some places larger than 2002 flood event
- Water levels mostly close to the crest of dikes (no overflow)
- Several dike failures
- Visited failures were due to geotechnical mechanisms at several sites
  - Instability at Fischbeck and Breitenhagen
  - Possibly piping at Bitterfeld river dike breach, and overflow for canal and road breaches
- Complex system / cascading effects at Bitterfeld
  - Dike failure -> road breaching -> lake fills -> canal dikes fail -> Second lake fills up, threatens town of Bitterfeld

# Recommendations

- Analyze and hindcast dike failures (data collection, stability and piping analysis)
- Large reliance on emergency measures
  - Implemented almost everywhere in the system
  - During inflow breaches could not be closed by bigbags or barges⇒ Recommended to evaluate performance of emergency measures
- Evaluate evacuations and emergency response
- Further analysis of other topics:
  - Hydrological system performance (incl. cascades and retention)
  - Damage
  - Risk management / multi-layered safety
- For the Netherlands:
  - Pay attention to dewatering and breach closure plans

# Acknowledgements

