



Rijkswaterstaat
Ministry of Infrastructure
and Water Management

The 2021 exceptional floods in the Meuse basin: Insights from the Netherlands

Ir. David F. Kroekenstoel
Rijkswaterstaat Water Verkeer en Leefomgeving
David.kroekenstoel@rws.nl

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Introduction: the Meuse in The Netherlands

Meuse and tributaries:



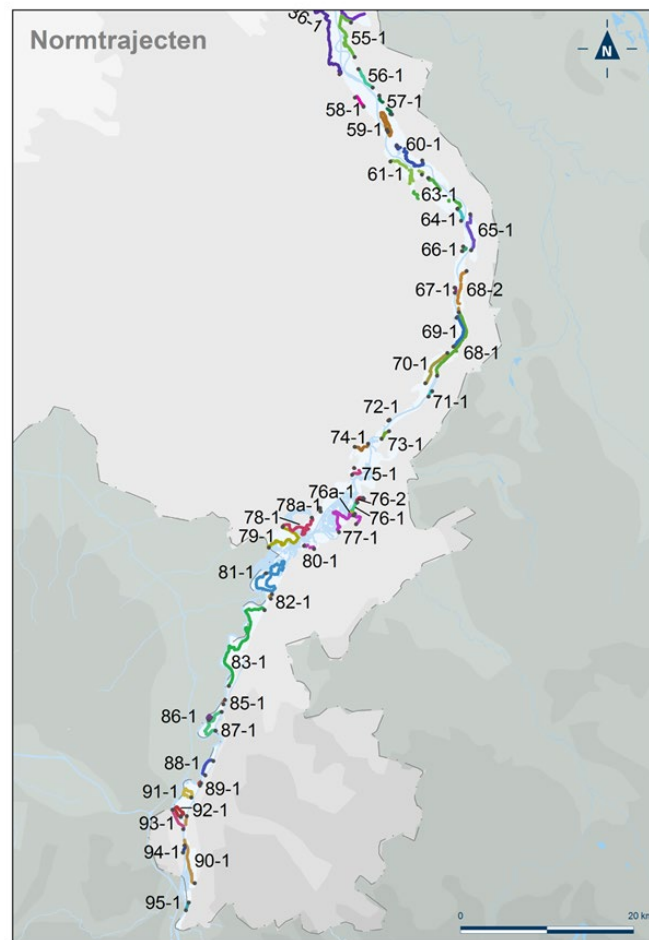
Elevation:



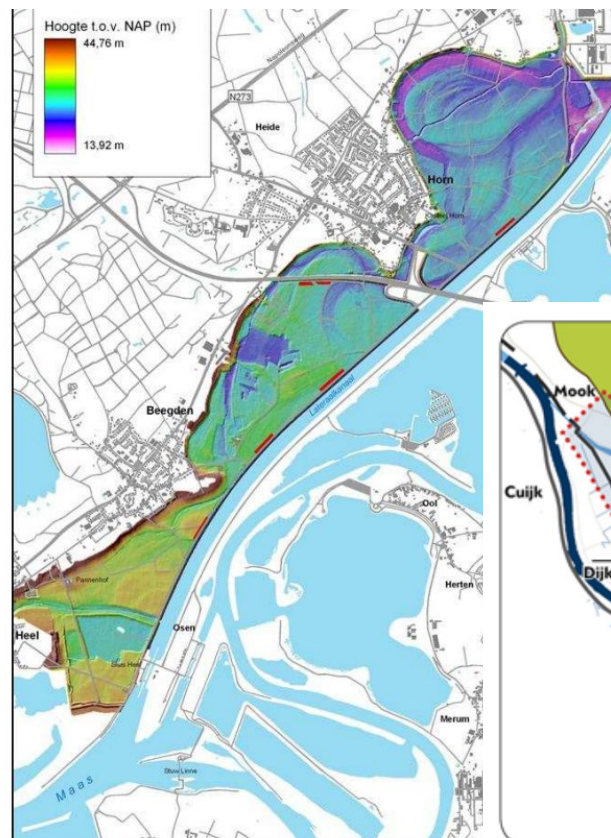


Flood protection along Meuse

Dikes:



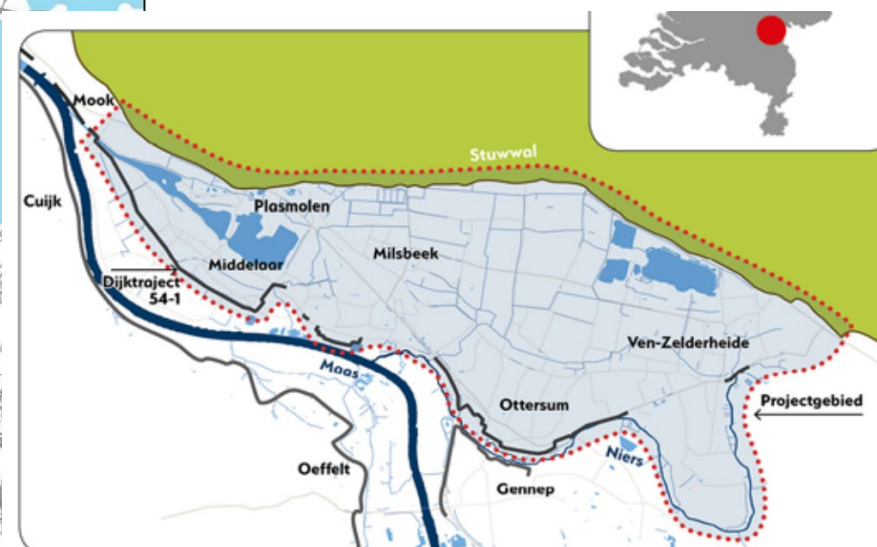
Retention basins:



Lateraal kanaal West

River widening measures:

- Meuse Works / Maaswerken



Lob van Gennepep



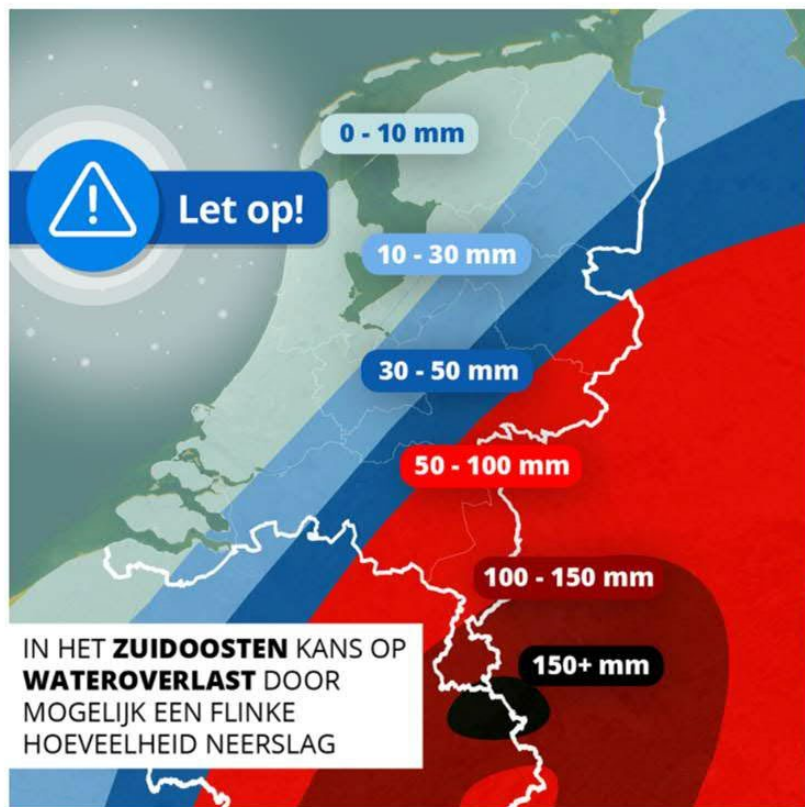
Responsibilities

- National government is responsible for legislation (e.g. Water Act) and the management of rivers, large lakes and the sea (and some large dams like the Delta Works)
- Water boards are responsible for management of (most) flood defenses, next to management of the local water system
- Safety regions are responsible for regional disaster- and crises management (= public body of municipalities; cooperation of police, fire brigade and ambulance services)
- Rijkswaterstaat is manager of river Meuse and canals (including sluices and weirs)
- Water Management Centre Netherlands is responsible for flood forecasting and warning



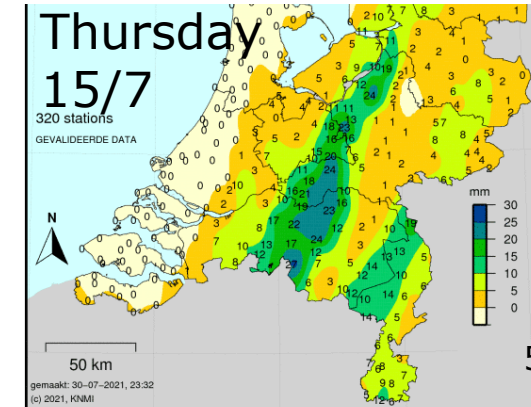
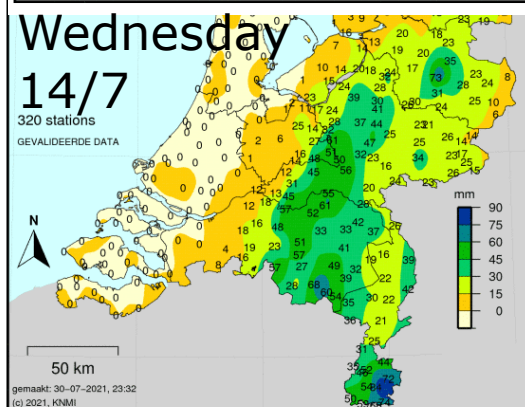
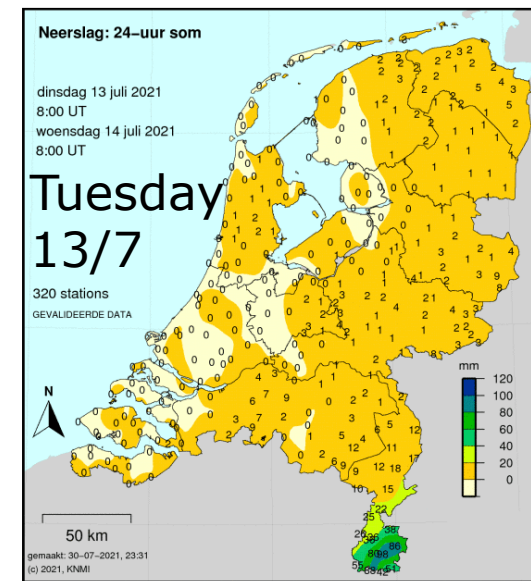
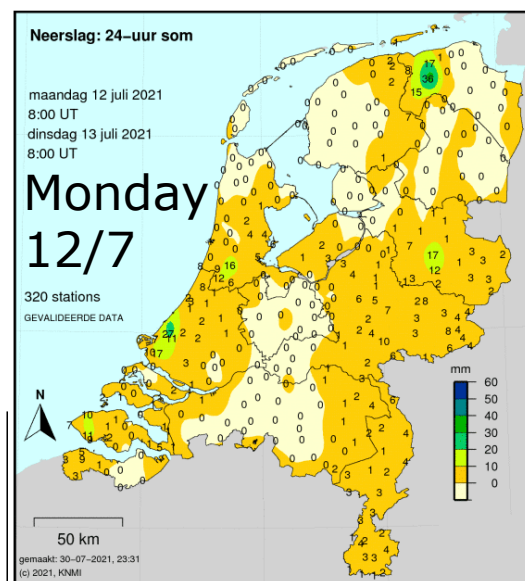
Precipitation flood of July 2021

Expected rainfall a few days before July 15th 2021:



Verwachte neerslaghoeveelheden tot en met donderdag

Measured rainfall:

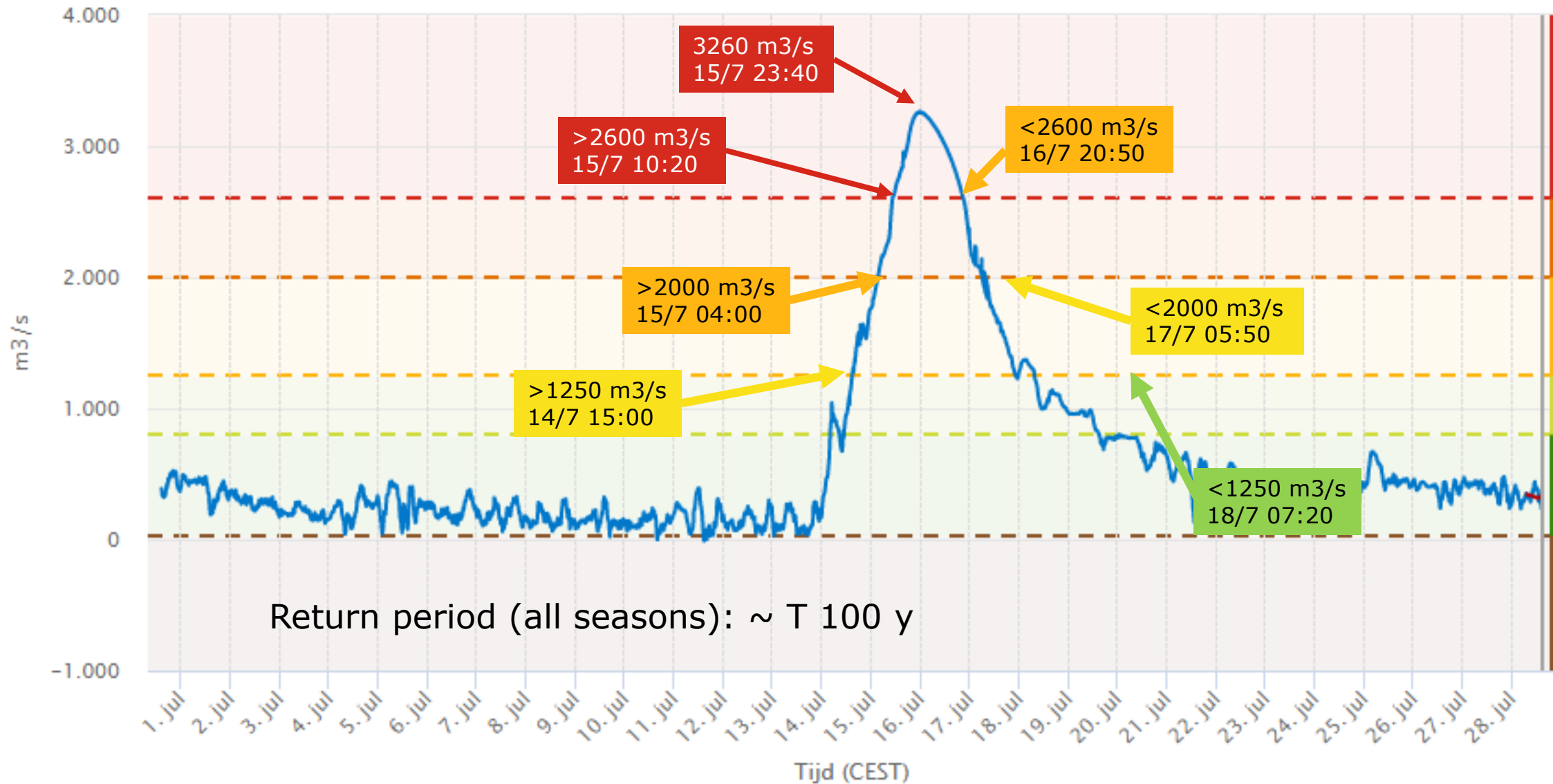




Flood forecasting flood of July 2021

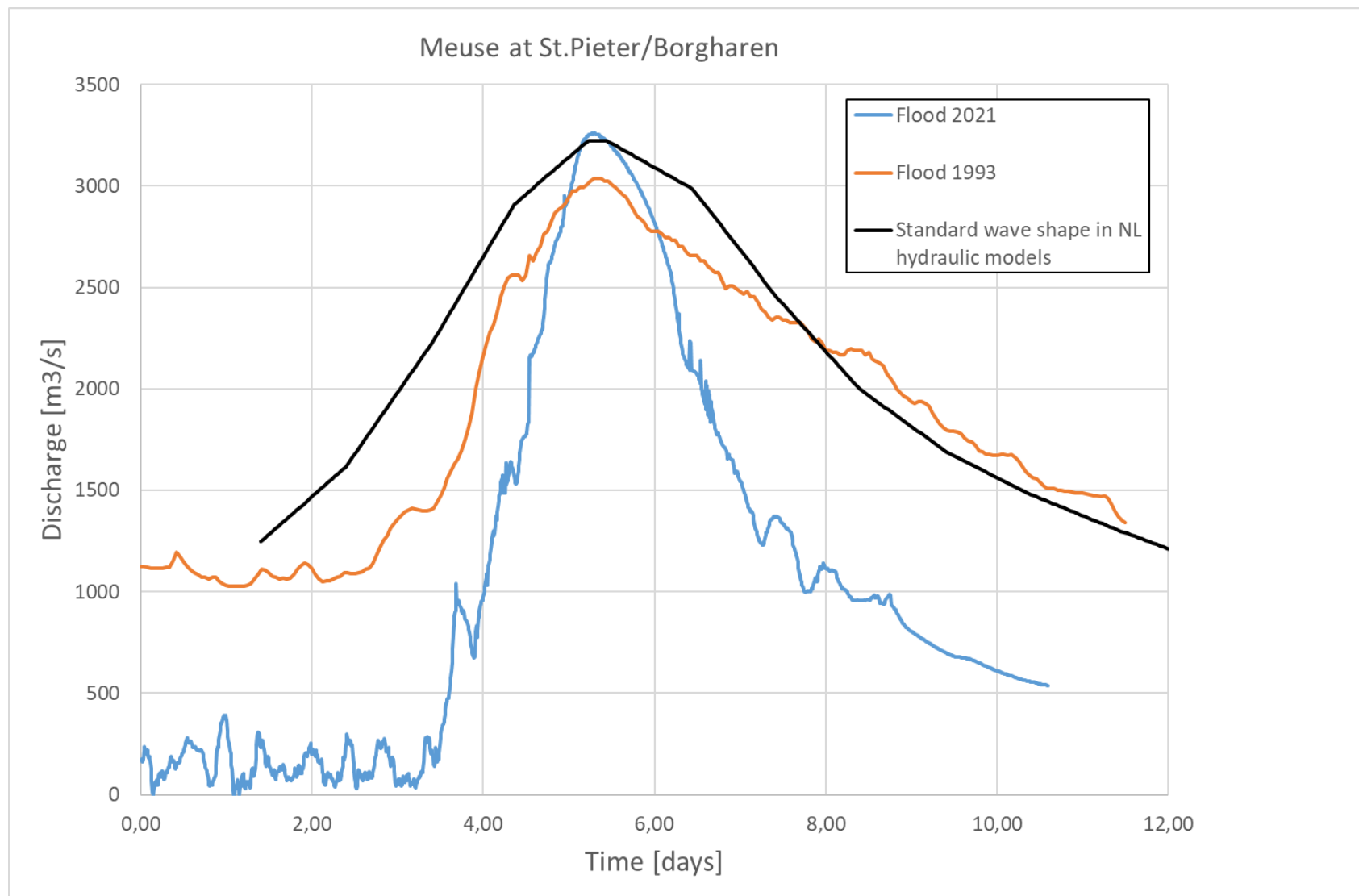
- Forecast of Monday 12/7: 700 – 900 m³/s
- Forecast of Tuesday 13/7: up to 2750 m³/s (“unbelief, can’t be right”)
- Wednesday 14/7: 2575 m³/s (less spread between models)
→ first flood alert message
- Thursday 15/7:
 - First forecast (08:00 h): 3040 m³/s (range 2700-3200)
 - Second forecast (14:00 h): 3375 m³/s (range 3300 – 3700)
 - Third forecast (20:00 h): 3330 m³/s (range 3300 – 3600)
- Friday 17/7: Discharge at St. Pieter starts to decrease, peak moves downstream

Measured discharge at St. Pieter (to be validated)





Comparison of flood waves



Comparison peak discharges:

1926: ~ 3000 m³/s
1993: 3039 m³/s
1995: 2761 m³/s
2021: 3260 m³/s

Highest summer discharge until 2021:

1980: 2200 m³/s



Comparison of water levels

RKM	Naam	HW1993	HW1995	HW2021
3	Eijsden grens	50.45	50.16	50.64
16	Borgharen Dorp	45.9	45.71	45.23
53	Maaseik	29.5	29.44	30.17
70	Linne beneden	21.05	21.08	21.88
80	Heel beneden	20.53	20.59	20.49
101	Belfeld boven	19.13	19.16	18.89
132	Well Dorp	15.34	15.43	15.48
155	Gennep	12.95	13.22	12.34
177	Grave beneden	10.39	10.58	9.47
202	Lith Dorp	6.32	6.54	5.79

Reasons for differences:

Higher water levels due to:

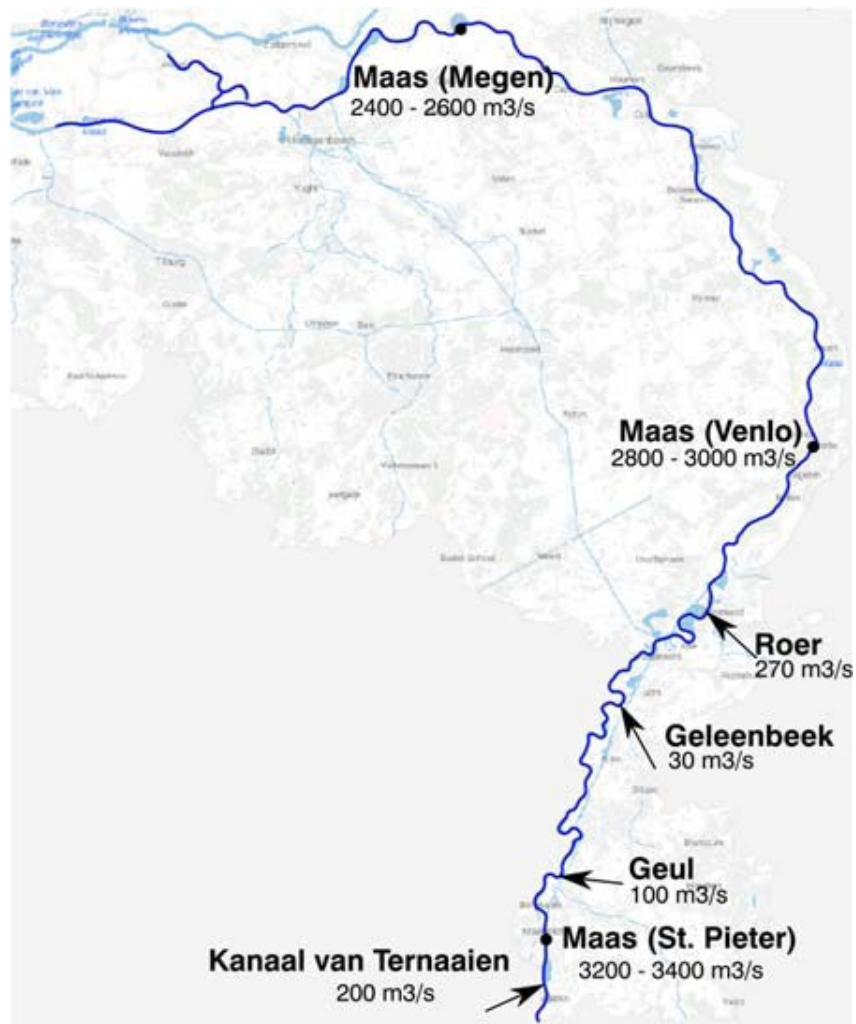
- Higher peak discharge at entry Netherlands
- Record discharges from tributaries (Geul, Roer)
- Construction of local flood defences after flood '93/'95 (dikes, walls, etc)

Lower water levels due to:

- River widening measures and retention basins
- Peak attenuation



Discharges of important tributaries



Estimated peak discharge:

- Geul: $\sim 100 \text{ m}^3/\text{s}$ (1995: $32 \text{ m}^3/\text{s}$)
- Geleenbeek: $\sim 30 \text{ m}^3/\text{s}$ (1993: $24 \text{ m}^3/\text{s}$)
- Roer: $\sim 270 \text{ m}^3/\text{s}$ (1993: $109 \text{ m}^3/\text{s}$)

Measures



Regular / structural measures



Measures



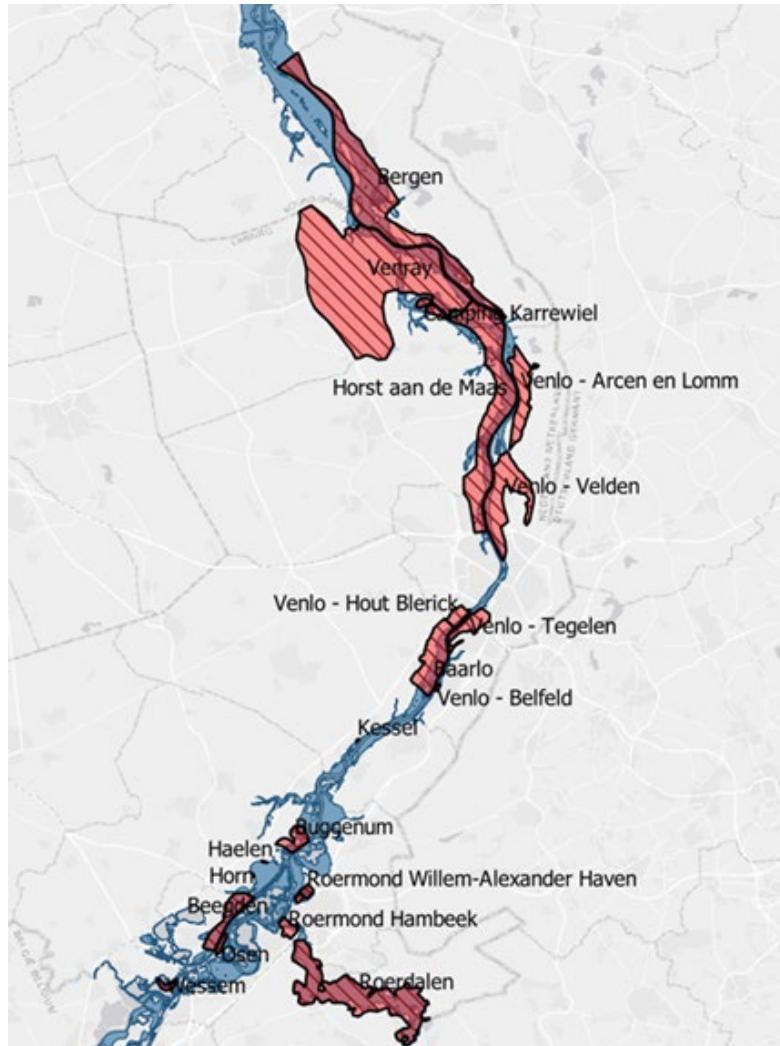
Improvised measures:
sand bags and big bags



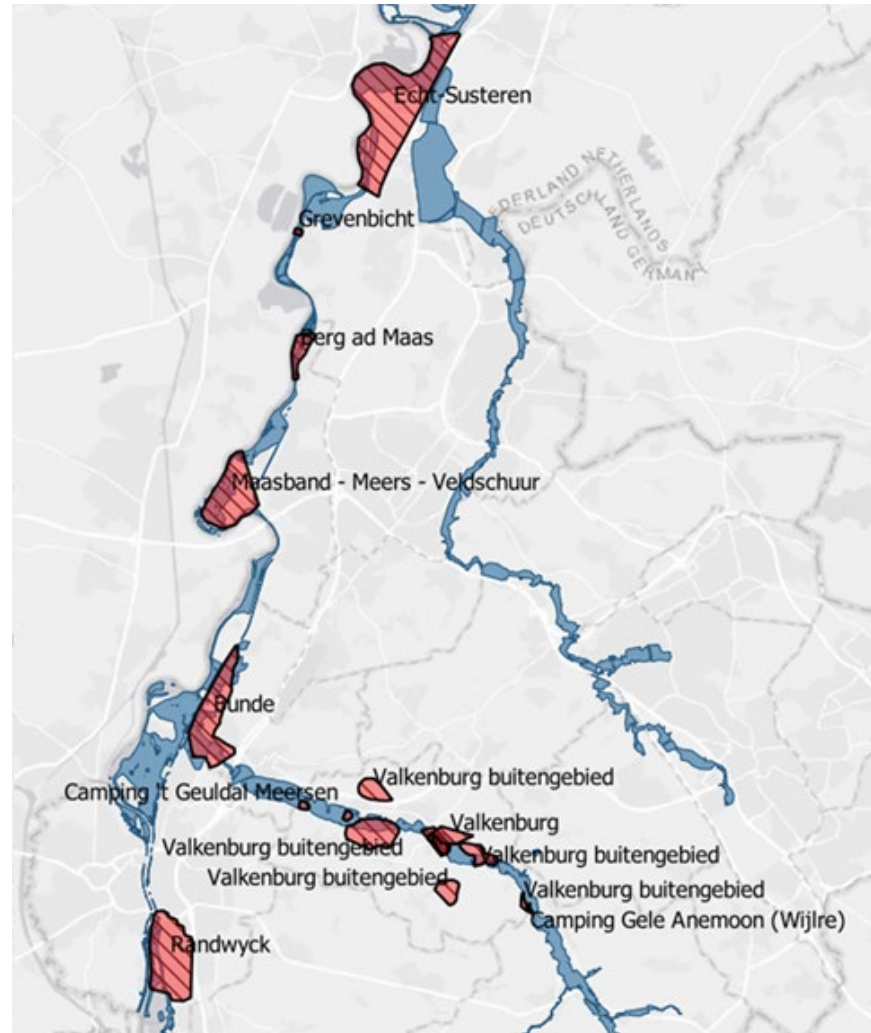


Evacuations

Northern part Province Limburg:



Southern part Province Limburg:



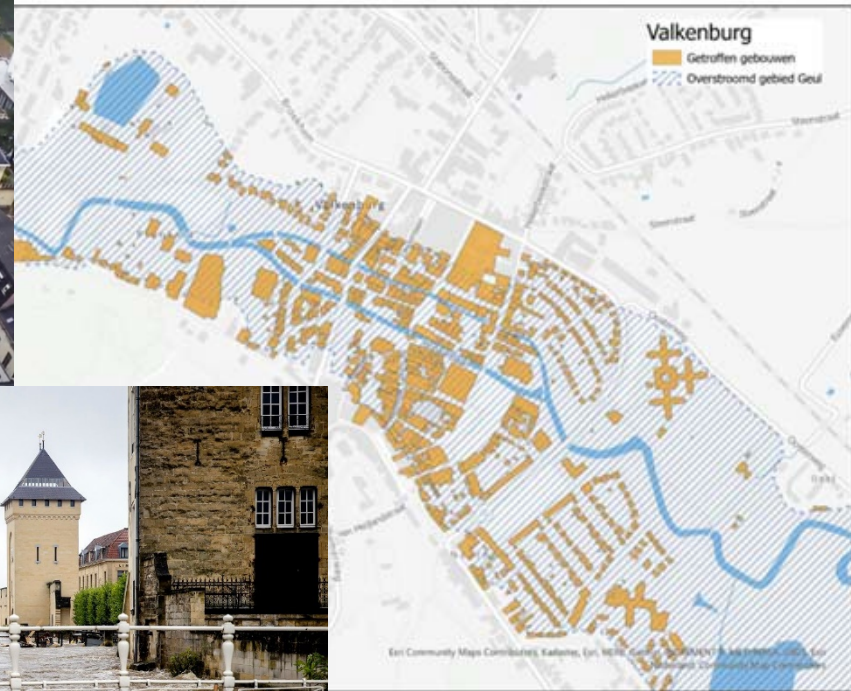
July 14th:
- first evacuations
along Geul
(Valkenburg)

July 15th and 16th:
- further
evacuations along
Geul, Roer and
Meuse

In total:
-50.000 persons
evacuated

Damage

Buildings, especially along Geul
(e.g. Valkenburg, 200-400 mln €)



Agriculture:

- Floodplains of Meuse
and tributaries



Other damage

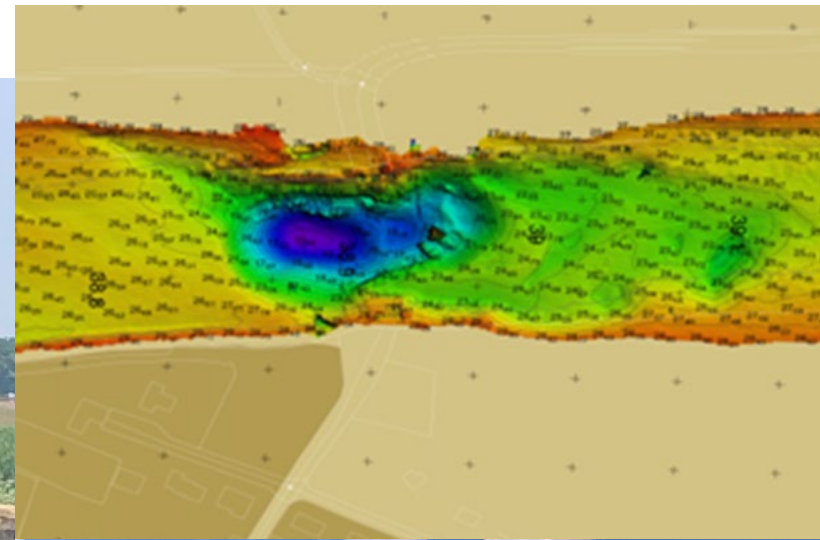
River bank erosion

River bed erosion

Damage to constructions:

- Bridge foundations
- Pipeline
- Weir

Debris



Special events



- Several locations with piping
- Failure local dike at Roermond
- Damage weir Bosscherveld





Summery flood of July 2021

- A record amount of precipitation
- Highest discharge ever recorded (3260 m³/s)
- Extremely sharp wave shape
- 50.00 people evacuated
- Damage 0.35 – 0.6 billion €, zero casualties
- No dike-failure primary river dikes Meuse
- Regional flooding's along Geul (and tributaries) and Roer
- Past river widening measures (Meuse Works) and construction of dikes after '93/'95 did their job
- Luckily we have escaped worse...

Thank you for your attention

David.Kroekenstoel@rws.nl

