P. Archambeau , B. Dewals,
M. Pirotton & **S. Erpicum**

Hydraulic structures and their influence on flood management in the context of the 2021 flood and beyond

INTERNATIONAL MEUSE SYMPOSIUM

Hydraulic structures

Structures interacting with water

Pont du Gard (France)

Cornalvo Dam (Spain)

At the heart of the development of civilizations

Hydraulic structures

Structures interacting with water

Block ramp fishway in the USA (courtesy L. Aadland)

Paris sewers (France), with a sediment flushing boat

Present and useful almost everywhere in our environment

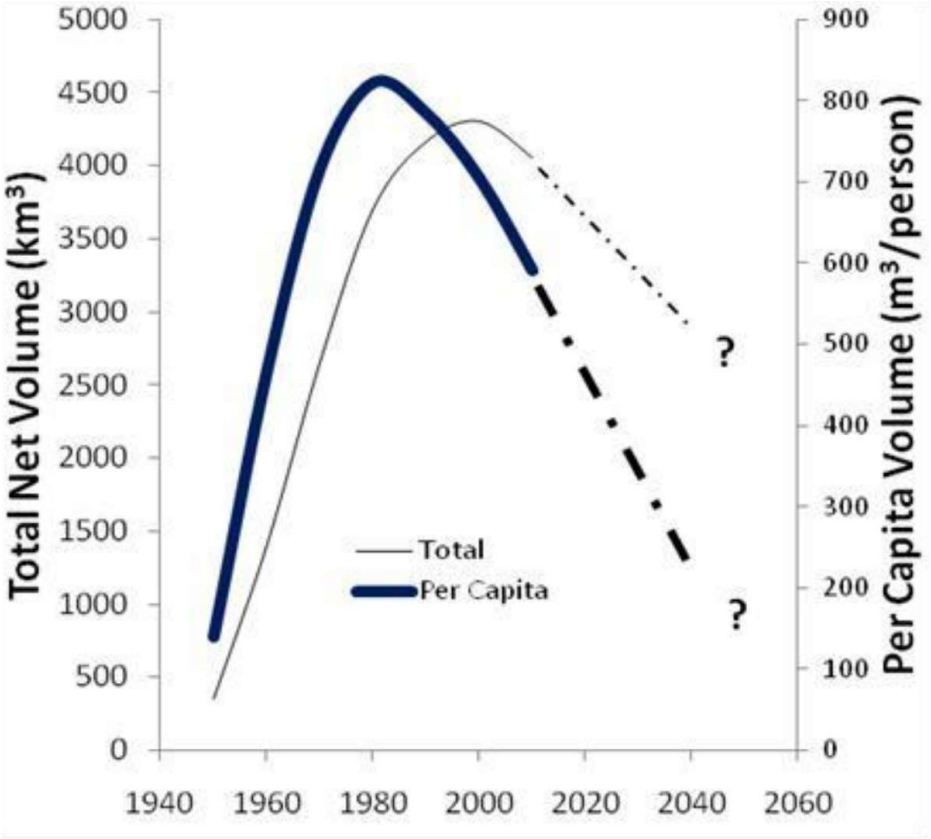
Hydraulic structures

A key element in achieving SDGs

Hydraulic structures

Water supply for growing population

Eupen Dam and water treatment plant (Belgium)



Annandale, 2013
& ICOLD Bulletin 169, 2017

Hydraulic structures

Low impact transport system

Lanaye locks - © JL DERU / photo-daylight.com

Belgium navigation network
http://worldcanals.org/

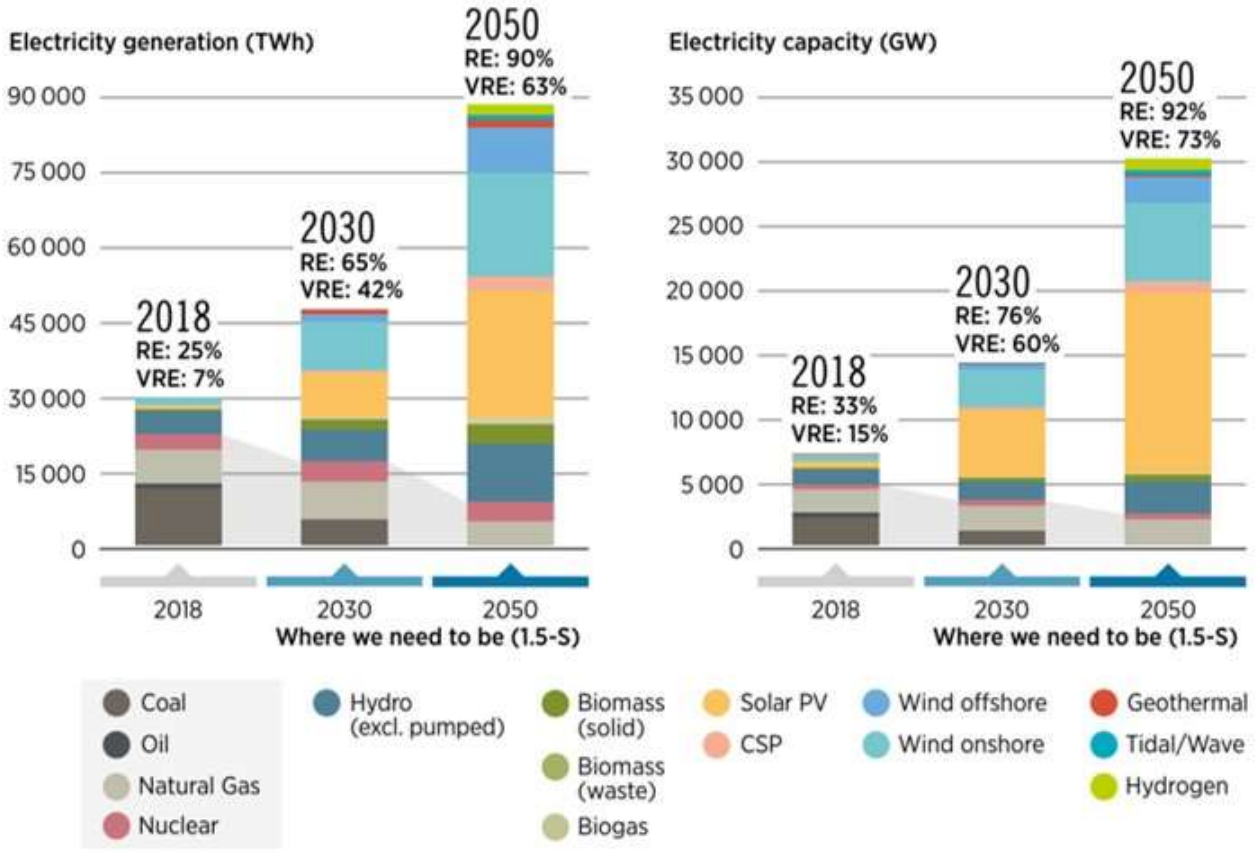
Hydraulic structures

Part of the energy transition (flexible renewable production + storage)

Median g CO2equ/kWh emission

Solar PV	48
Geothermy	38
Hydro	24
Nuclear	12
Wind	11

IPCC, 2014; Ubierna et al., 2022



Note: 1.5-S = 1.5°C Scenario; CSP = concentrated solar power; GW = gigawatts; PV = photovoltaic; RE = renewable energy; TWh/yr = terawatt hours per year; VRE = variable renewable energy.

IRENA, 2022

Hydraulic structures

Water management in changing conditions

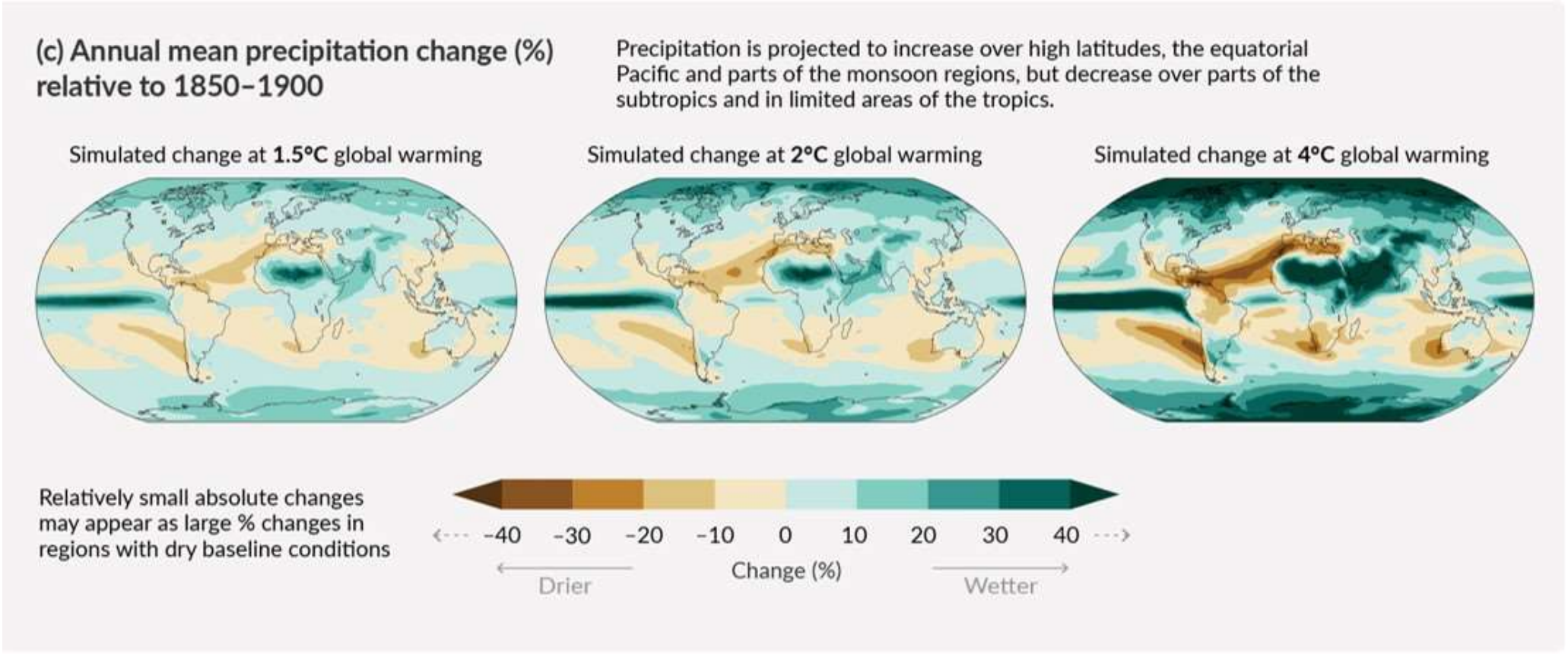


Figure SPM.5 in IPCC, 2021

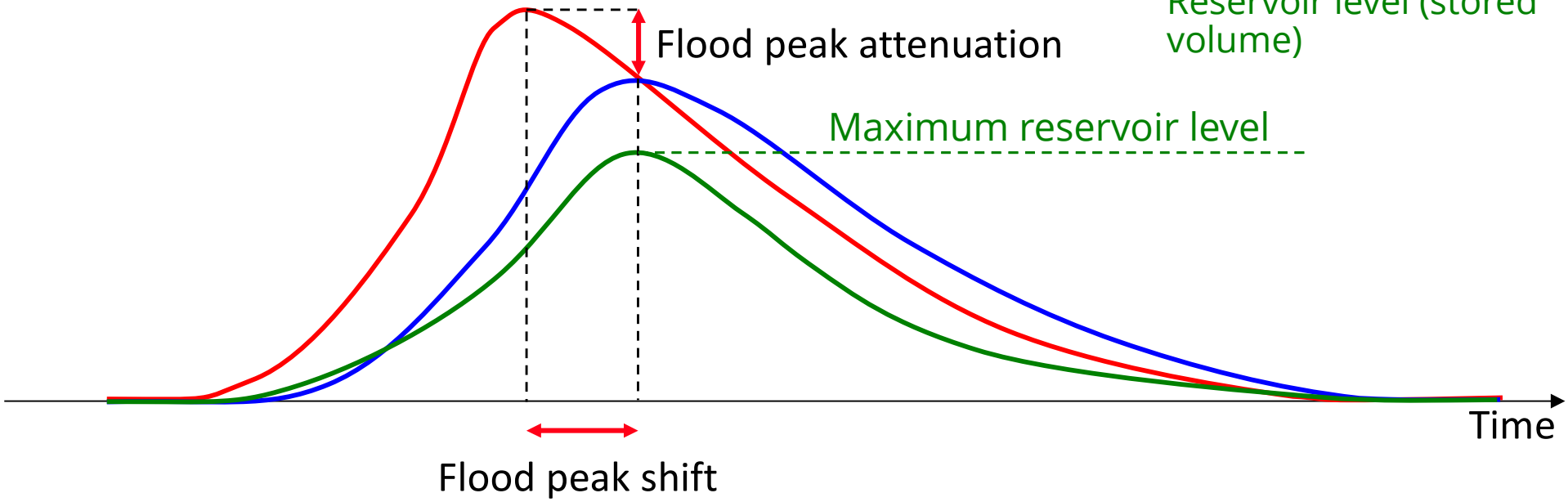
Hydraulic structures

Dam reservoirs and flood management

Hydraulic structures

Reservoir dams and flood management

Reservoir dam = hydraulic structure with a (large) upstream storage capacity



Hydraulic structures

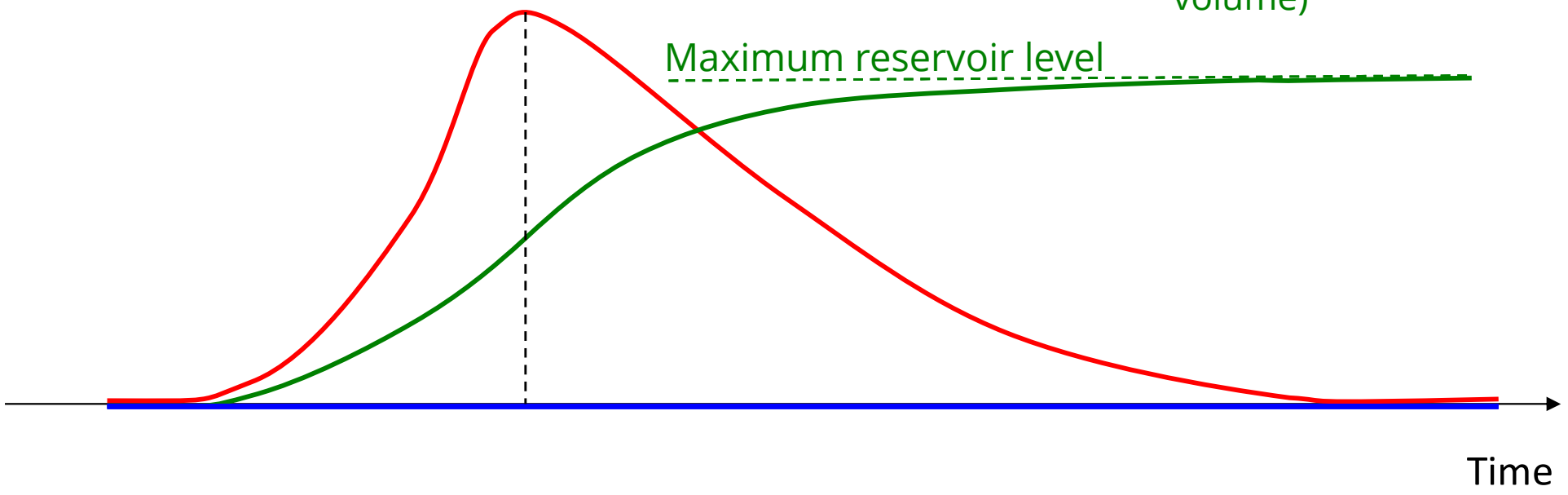
Reservoir dams and flood management

If storage capacity is 0

Hydraulic structures

Reservoir dams and flood management

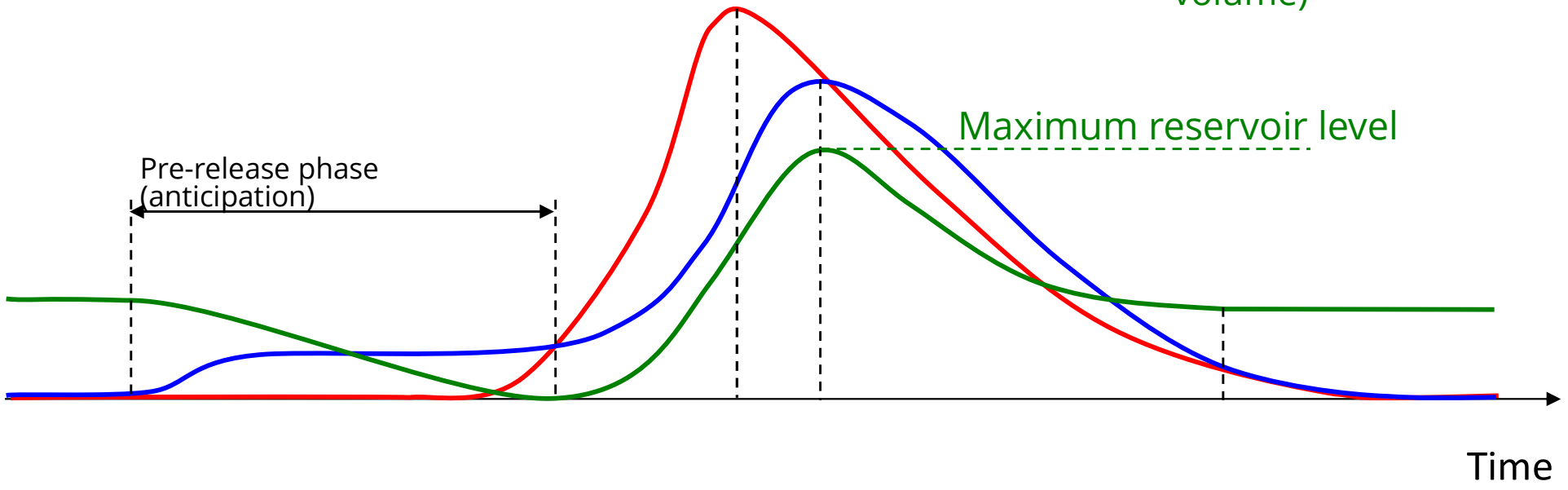
If storage capacity is equal to or higher than flood volume



Hydraulic structures

Reservoir dams and flood management

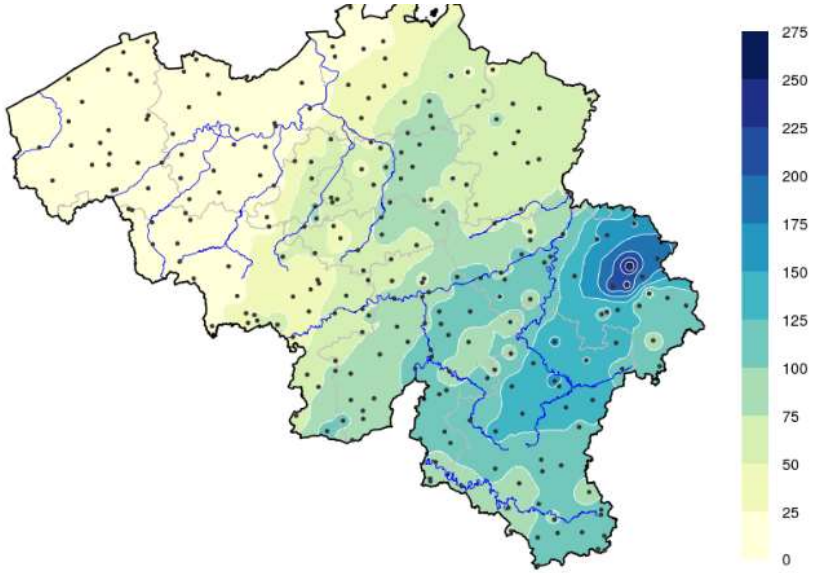
If flood is anticipated (pre-release to increase storage capacity)



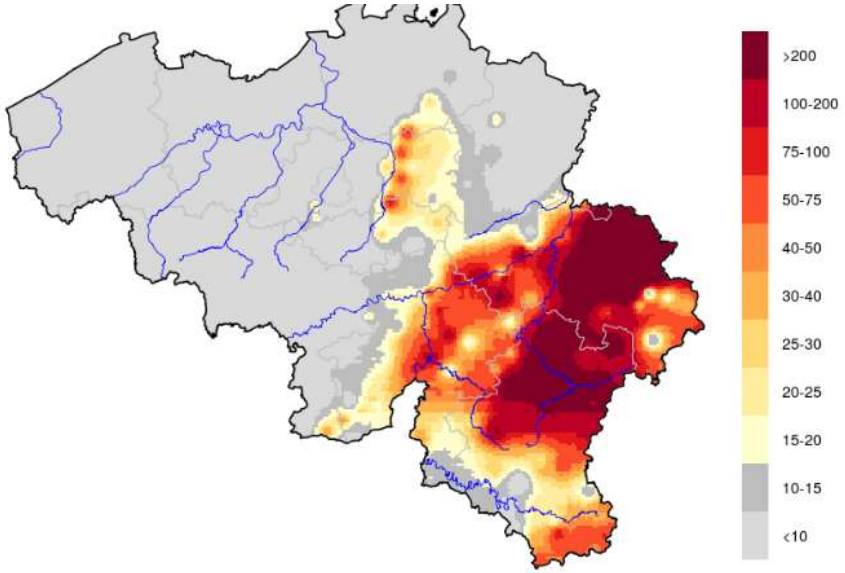
Hydraulic structures

Reservoir dams and 2021 flood management

Rainfall over 48h



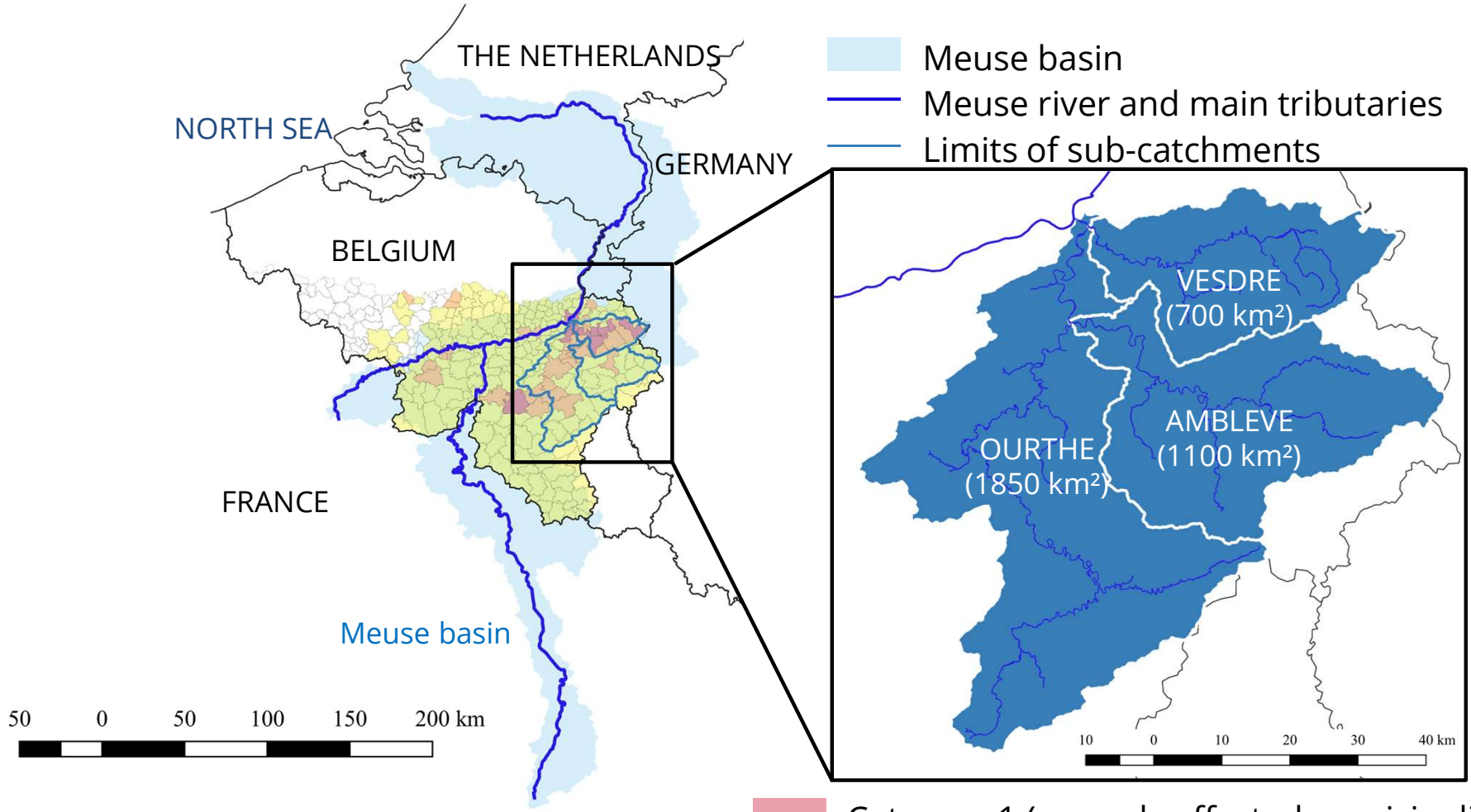
Cumulated volumes (mm)



Return period (years)

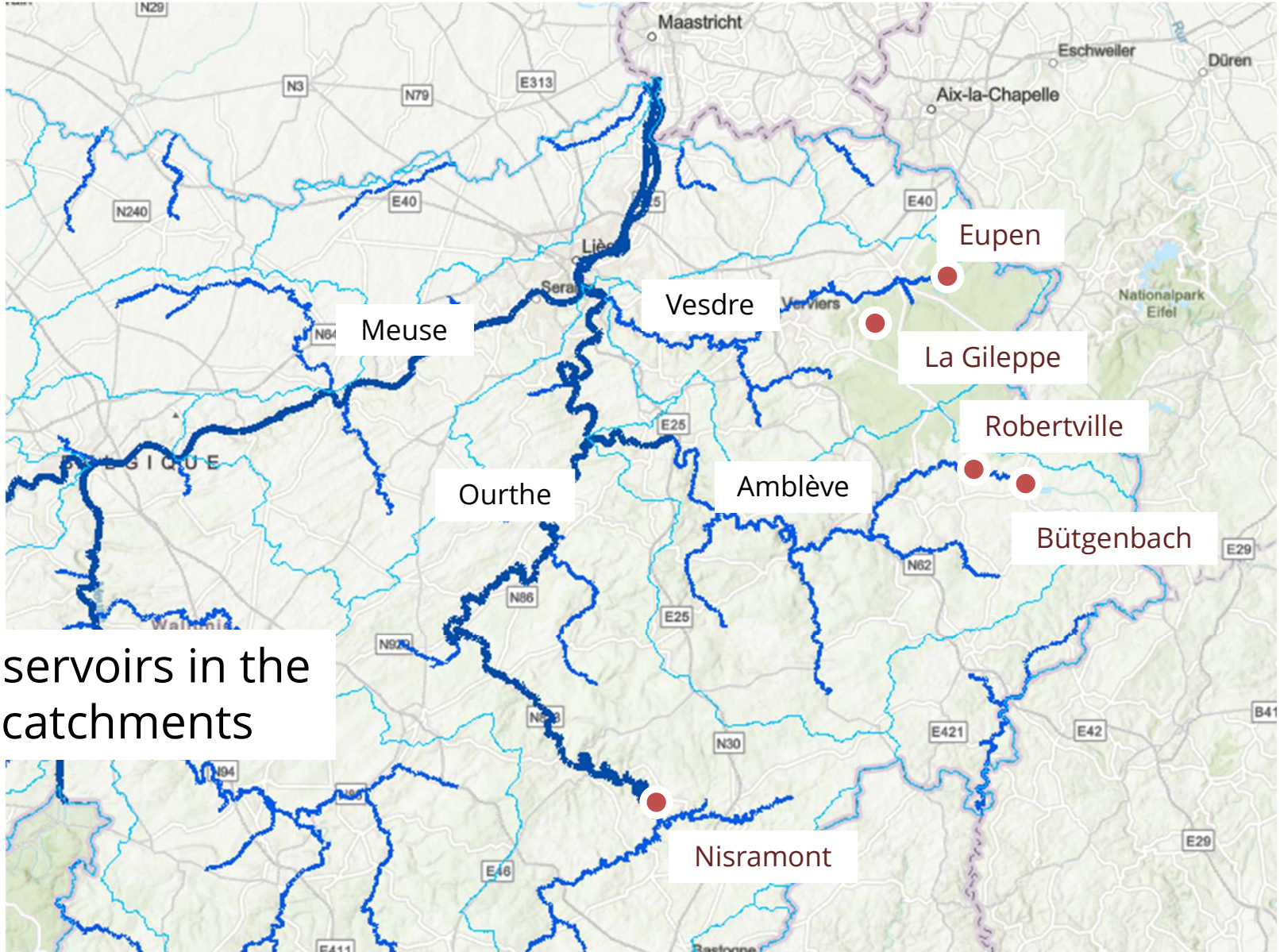
Hydraulic structures

Reservoir dams and 2021 flood management



Hydraulic structures

Reservoir dams and 2021 flood management



5 large dam reservoirs in the most affected catchments

Hydraulic structures

Reservoir dams and 2021 flood management

	Eupen	La Gileppe	Bütgenbach	Robertville	Nisramont
River	Vesdre	La Gileppe (Vesdre)	Warche (Amblève)	Warche (Amblève)	Ourthe
Type	Concrete gravity	Embankment	Multiple arch	Concrete gravity	Concrete gravity
H [m]	66	68	28	57	21
Cat. [km²]	70 (+ 37)	35 (+ 20)	71	118 (incl. Bütg)	729
V_{res} [hm³]	25	26,4	11	7,7	3
Spillway [m³/s]	230	185	100	200	427

- Inflow (limited) from adjacent valleys in Eupen and La Gileppe reservoirs
- Gated spillways
- Multipurpose dams: water supply, hydropower, flood mitigation, tourism, low flow mitigation

Hydraulic structures

Reservoir dams and 2021 flood management

	Eupen	La Gileppe	Bütgenbach + Robertville	Nisramont
Catch. [km²]	70 (+ 37)	35 (+ 20)	71 + 47	729
V_{res} [hm³]	25	26,4	11 + 7,7	3
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Hydraulic structures

Reservoir dams and 2021 flood management

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V_{rain} [hm³]*	12,1 (+ 6,6)	8,5 (+ 4,1)	7,6 + 4,3	-
V_{in} [hm³]*	9,9 (+ 2,5)**	6,6 (+ 2,1)**	4,9	30,6
V_{in}/V_{rain} [%]*	**82**	**77**	**41**	-
V_{in}/V_{res} [%]*	**50**	33	26	**1020**
V_{out} [hm³]*	9,3	1,4	4,7	30,6

* From 13 July at 0h00 to 17 July at 0h00
** Volume from adjacent valleys limited by diversion galleries capacity

Hydraulic structures

Reservoir dams and 2021 flood management

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V_{out} [hm³]*	9,3	1,4	4,7	30,6
$Q_{max, in}$ [m³/s]	**235**	104	48	227
$Q_{max, out}$ [m³/s]	197	13	26	227
Timeshift [h]	1,5	15,5	2,5	0

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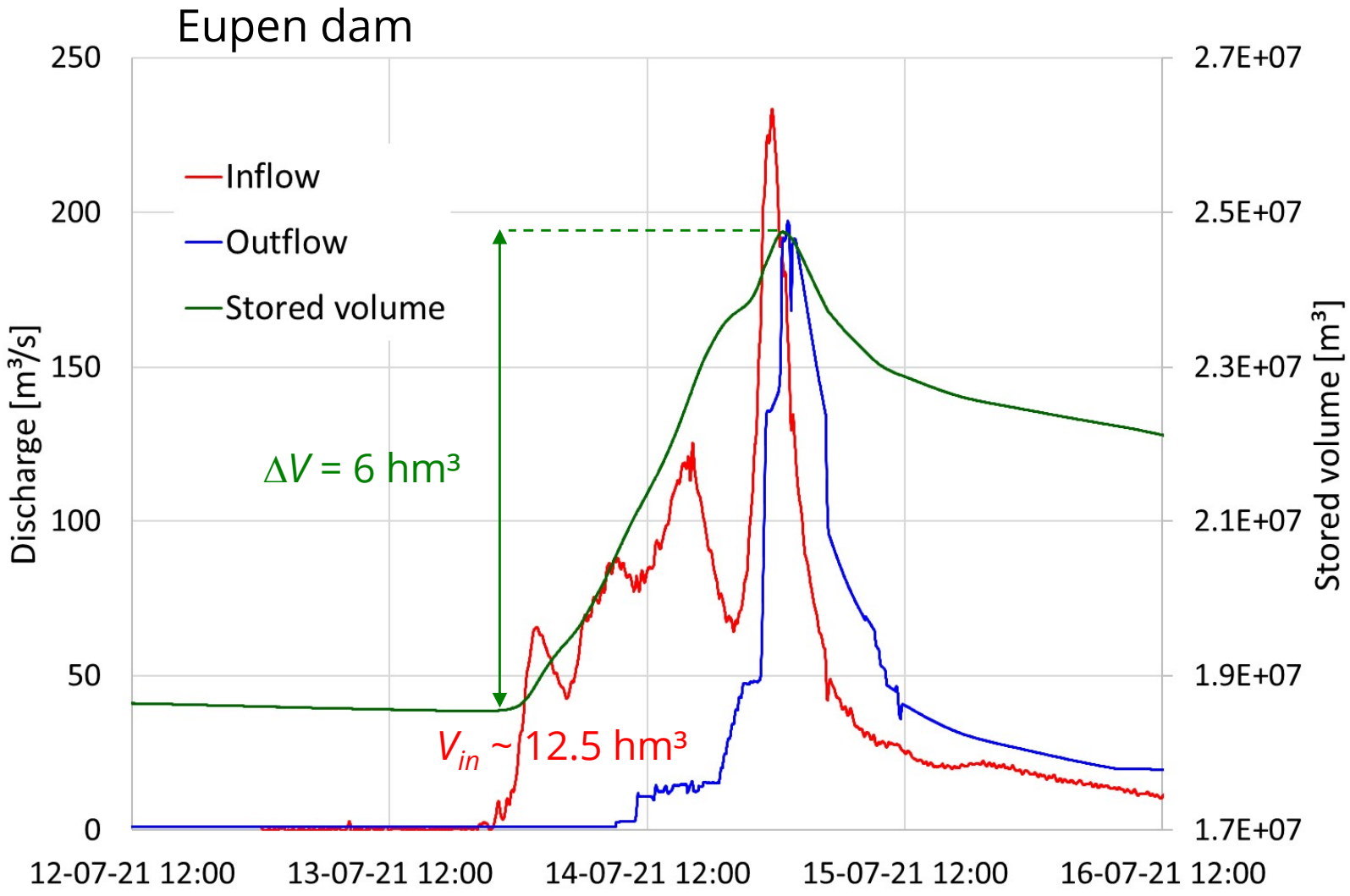
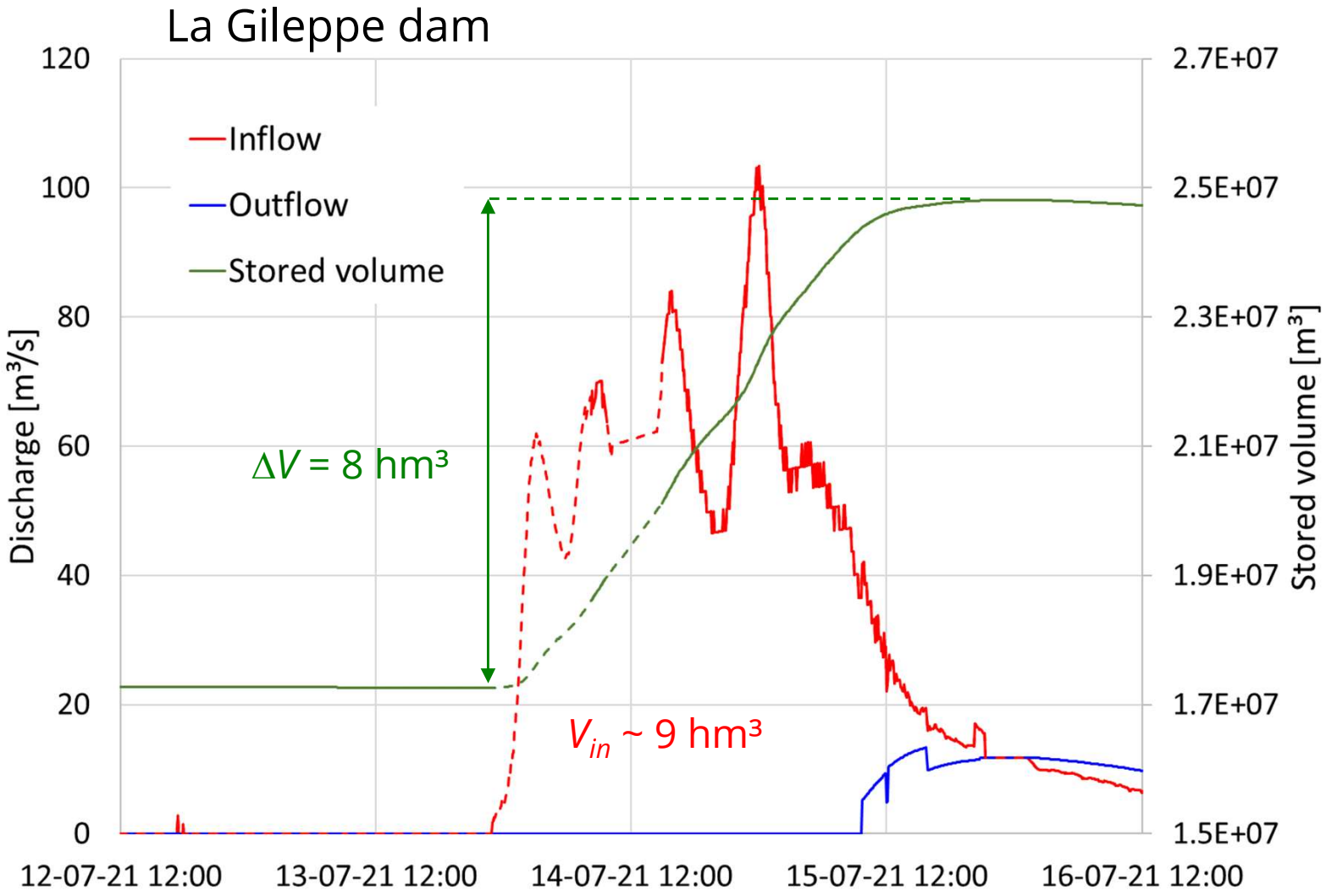
Hydraulic structures

Reservoir dams and 2021 flood management



Hydraulic structures

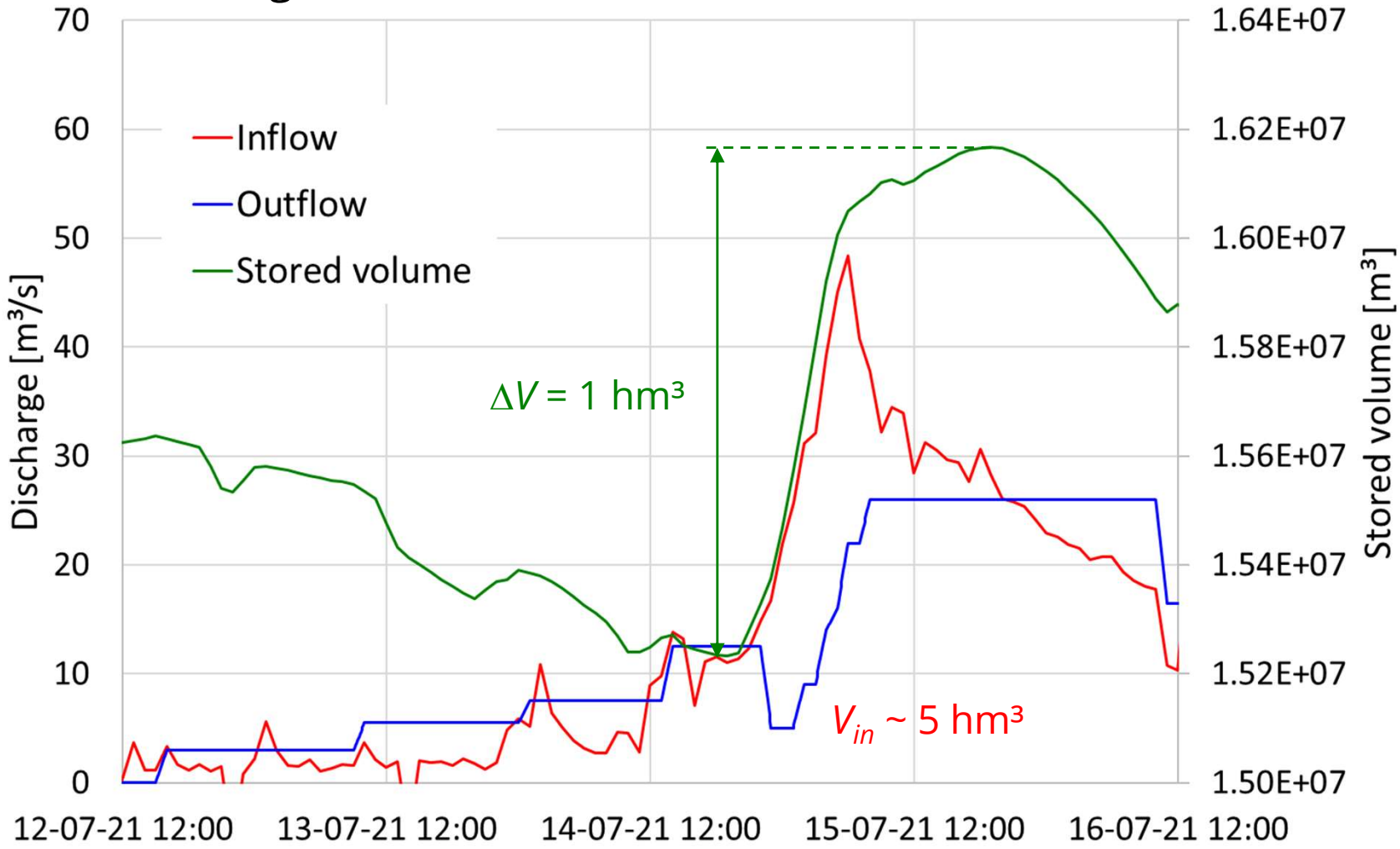
Reservoir dams and 2021 flood management



Hydraulic structures

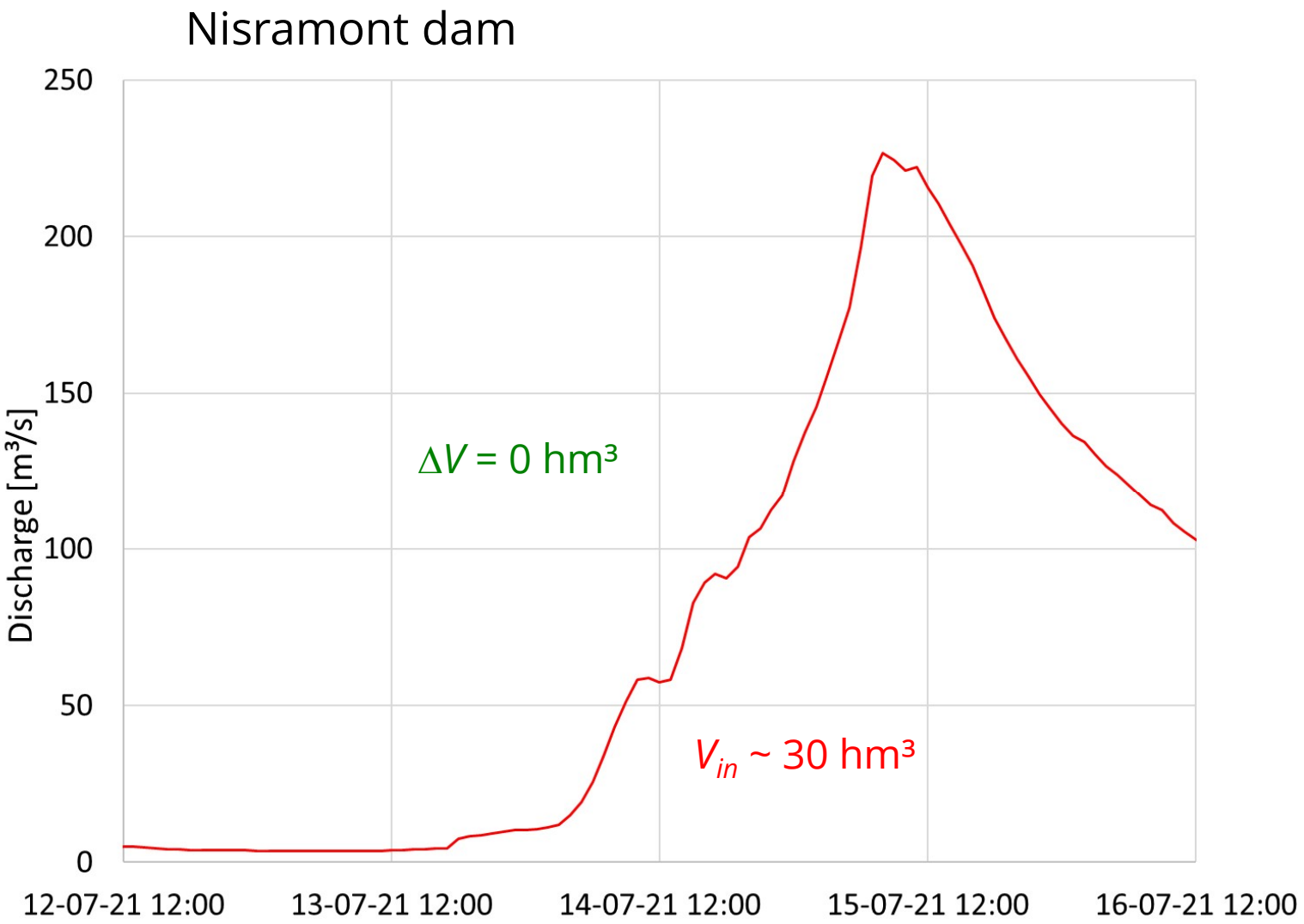
Reservoir dams and 2021 flood management

Bütgenbach and Robertville dams



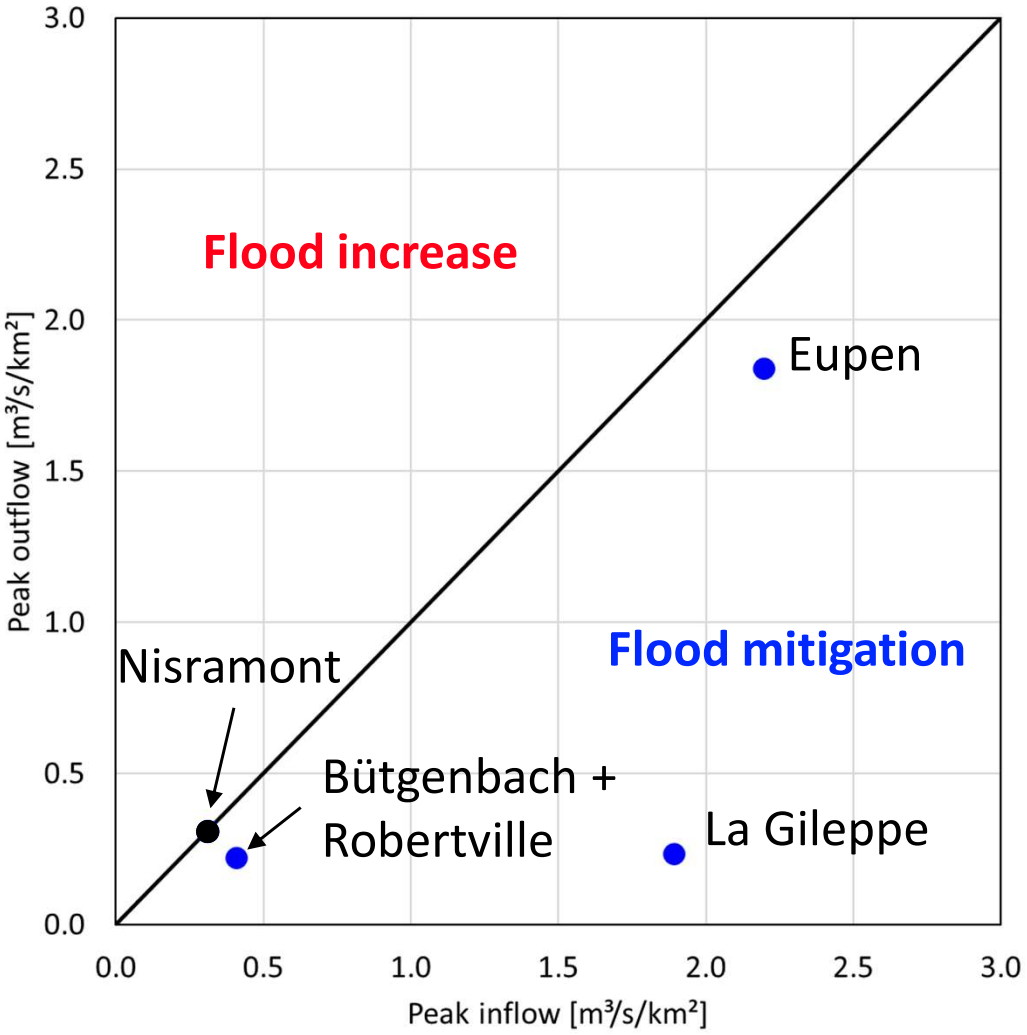
Hydraulic structures

Reservoir dams and 2021 flood management



Hydraulic structures

Reservoir dams and 2021 flood management



Take-home messages

Hydraulic structures = key elements for human society well being and development

Ability of dam reservoirs to mitigate floods is bounded by their storage capacity

Accurate weather forecasting models are a pre-requisite for optimized flood management by dam reservoirs