Large water infrastructures: some challenges and some solutions for sustainable maintenance

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IAHR AIRH International Association for Hydro-Environment Engineering and Research

Hosted by Spain Water and IWHR, China

IWHR

Flash Flood Program

UNIVERSITÉ CÔTE D'AZUR

POLYTECH NICE-SOPHIA

What are we talking about?

- Large water infrastructures are frequently designed for centuries
- Life cycle is frequently used today
- Long term maintenance is always an issue …
- Changes of uses in time (cf. reservoirs)
- How to ensure sustainable maintenance in long term perspective?

Lacs de Seine, France

Designed for floods mitigation
and welcoming touristic activities…
Multi purposes/ multi objectives

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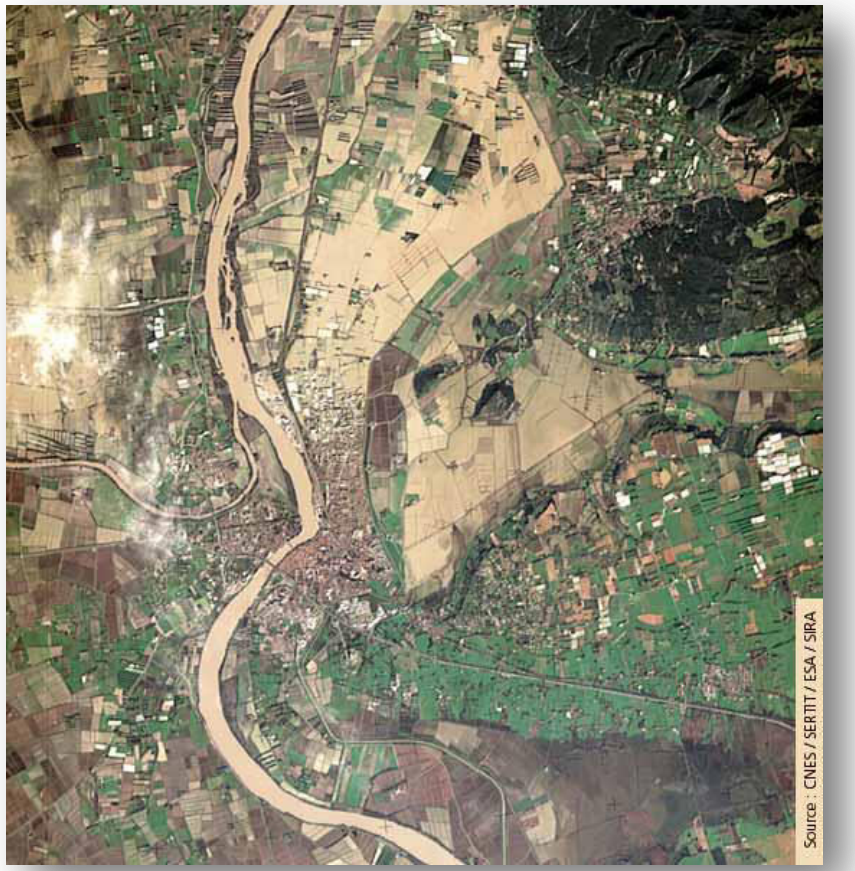
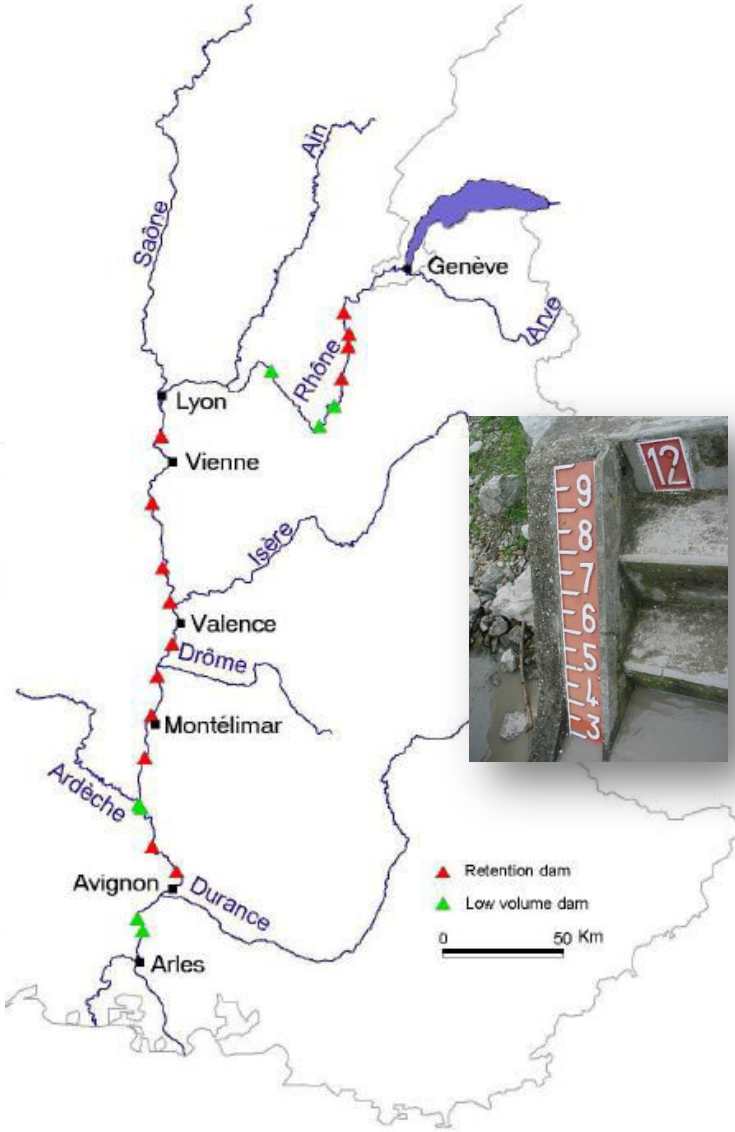
- 2003 Flood of Rhône river, France
- Return period = 100 years

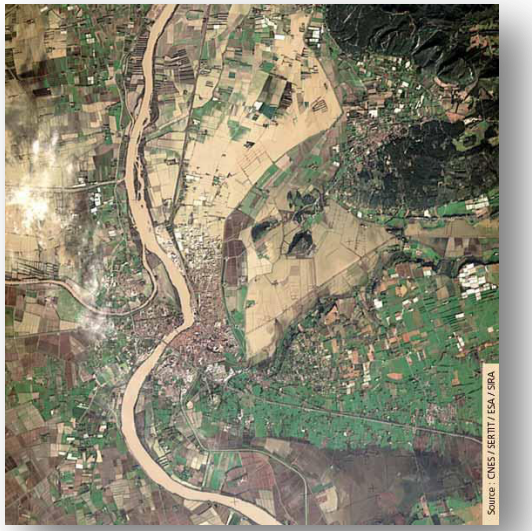




- 2003 Flood of Rhône river, France

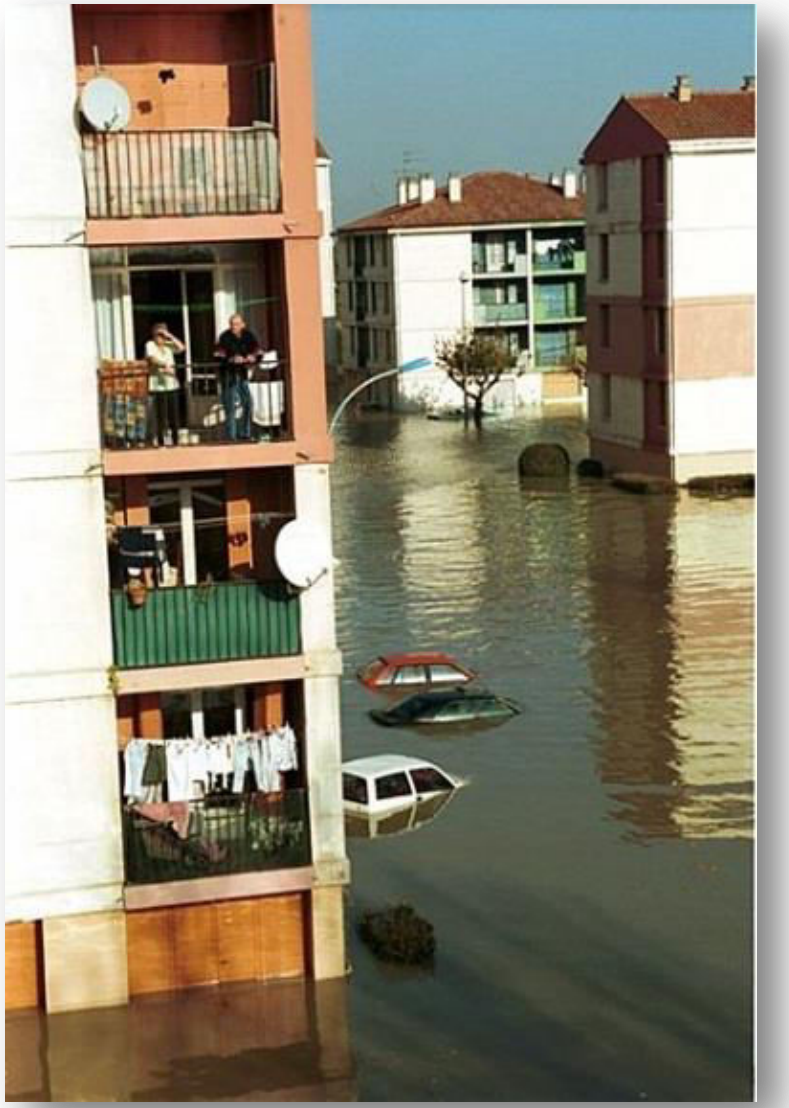
Extreme floods (m^3/s)

RANG	VALENCE 1855-2003		VIVIERS1910-2003		BEAUCAIRE 1856-2003	
1	31/05/1856	8300	**03/12/2003**	**7950**	**04/12/2003**	**13000**
2	01/11/1896	7400	09/10/1993	7715	31/05/1856	11640
3	08/10/1993	6700	07/01/1994	7590	08/01/1994	11000
4	11/11/1886	6620	17/11/2002	7550	10/09/2002	10500
5	26/11/1944	6620	21/11/1951	6660	12/11/1886	10200
6	16/11/2002	6600	14/06/1941	6470	26/11/2002	10200
7	17/02/1928	6480	20/01/1955	6320	10/10/1993	9800
8	19/01/1955	6300	23/03/2001	6270	14/11/1935	9600
9	26/12/1918	6100	27/11/1944	6180	22/11/1951	9170
10	03/01/1883	6040	13/11/1935	6000	21/03/1872	9080
11	23/03/2001	6020	18/02/1928	5975	02/11/1896	9060
12	06/01/1936	5830	28/02/1957	5900	13/11/1996	8980
13	18/05/1983	5690	11/12/1954	5860	30/09/1900	8940
14	27/02/1957	5680	19/05/1983	5850	01/01/1889	8780
15	31/12/1923	5630	07/01/1936	5800	11/11/1976	8690
16	**02/12/2003**	**5570**	13/11/1996	5795	08/12/1910	8660



- 2003 Flood of Rhône river, France
- Massive inundation in Arles & Avignon

Source: SDIS



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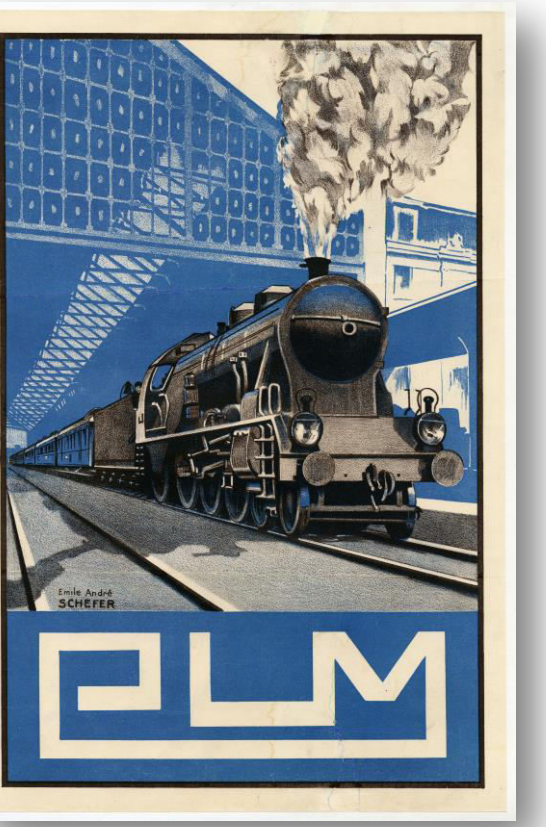
1840 new railway track PLM
Paris Lyon Marseille
How to travel faster?
… Simple answer: reduce distance!



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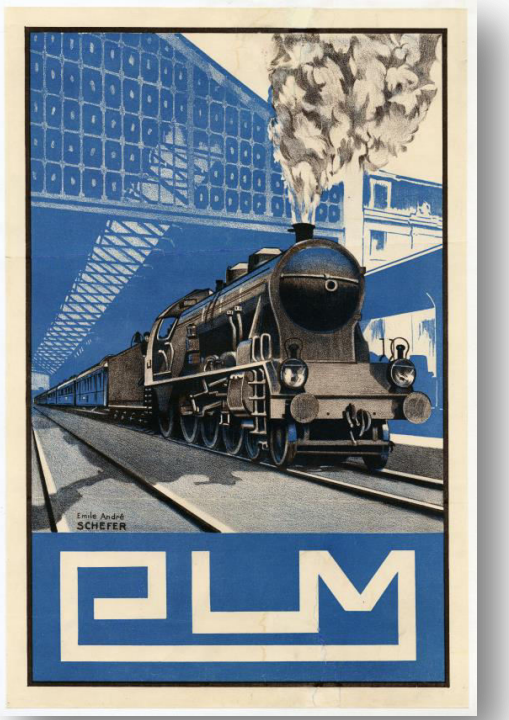

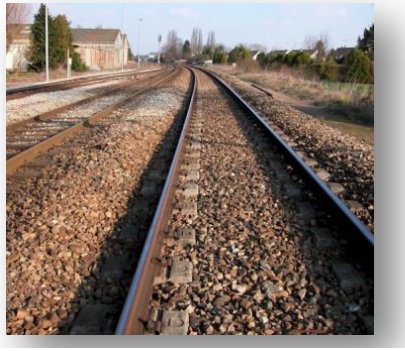

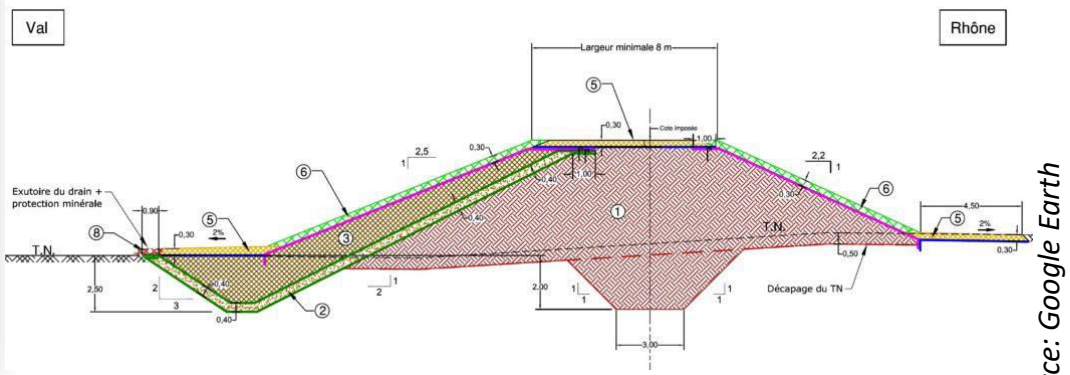

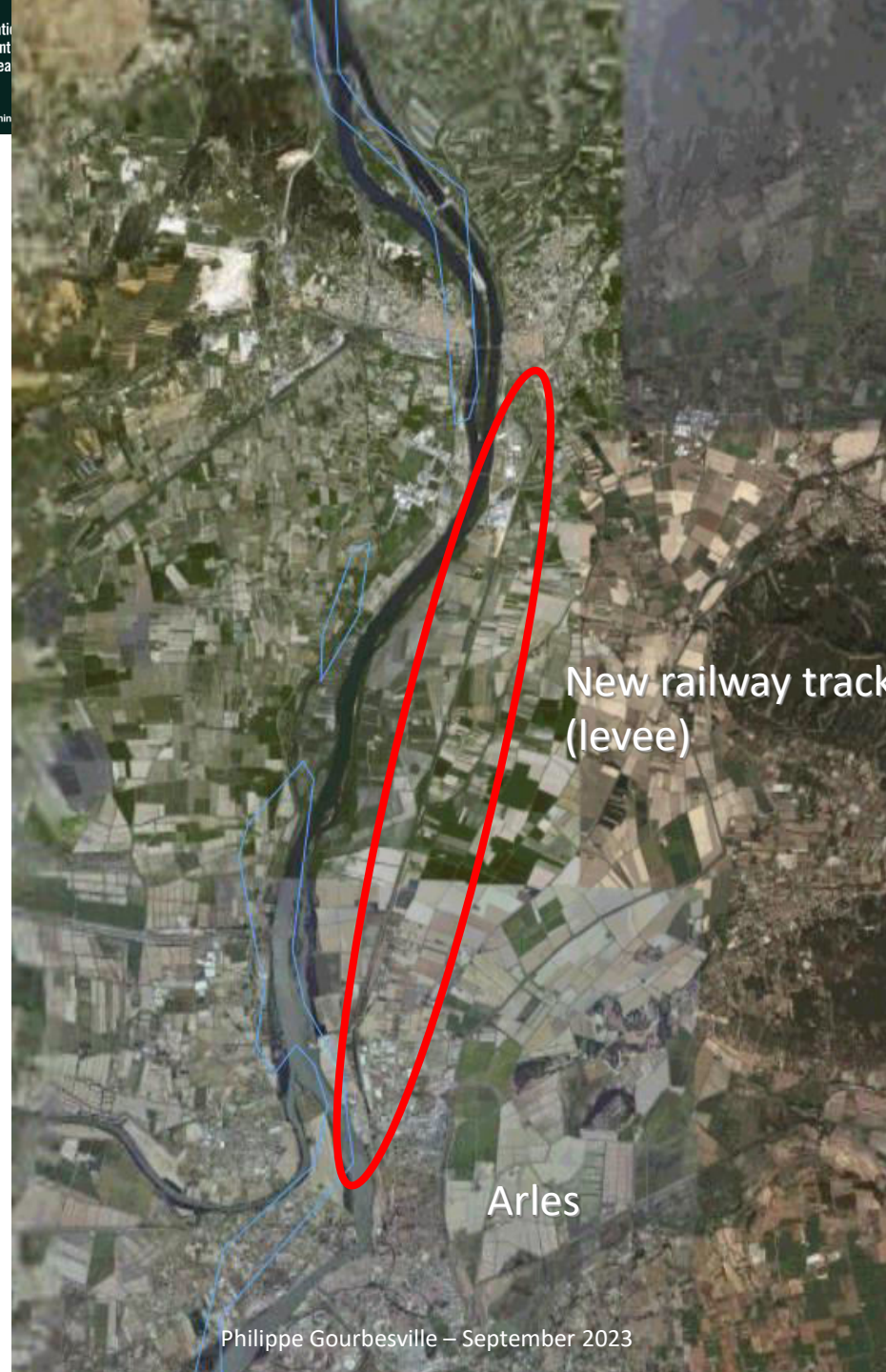

Source: Google Earth

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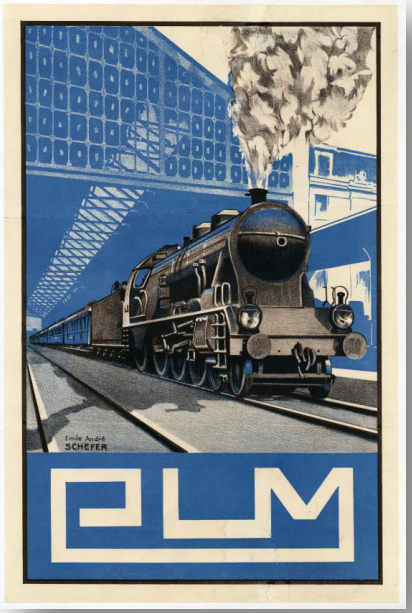
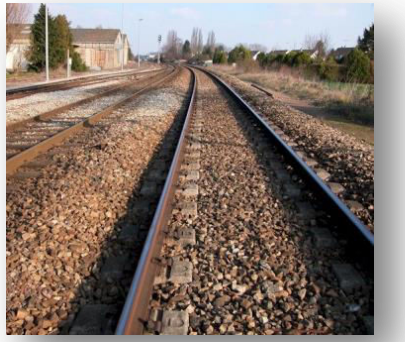
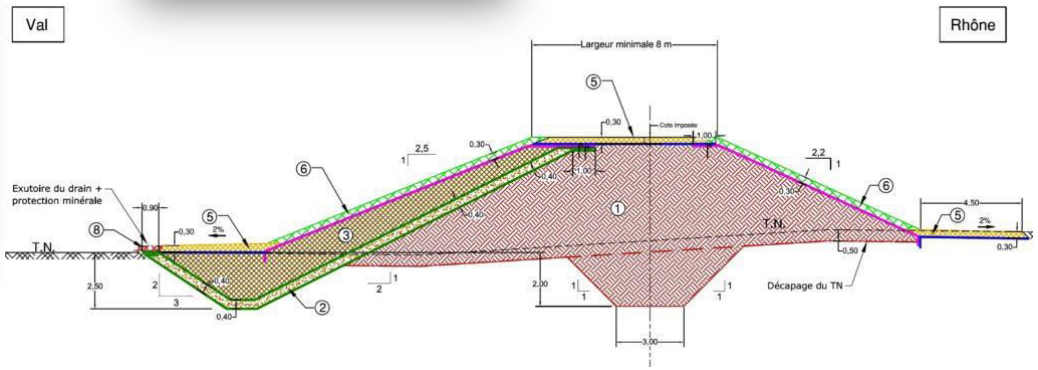
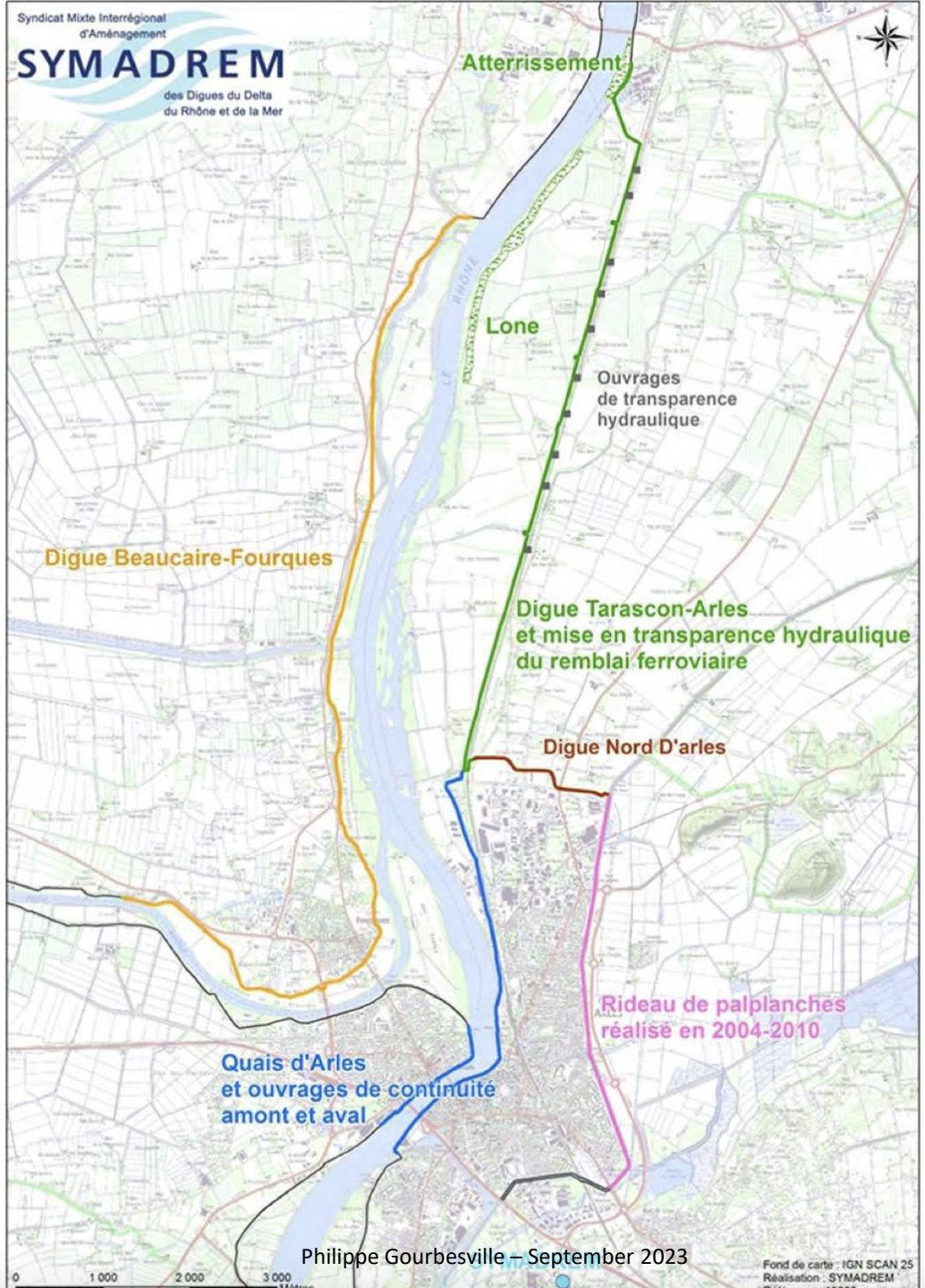






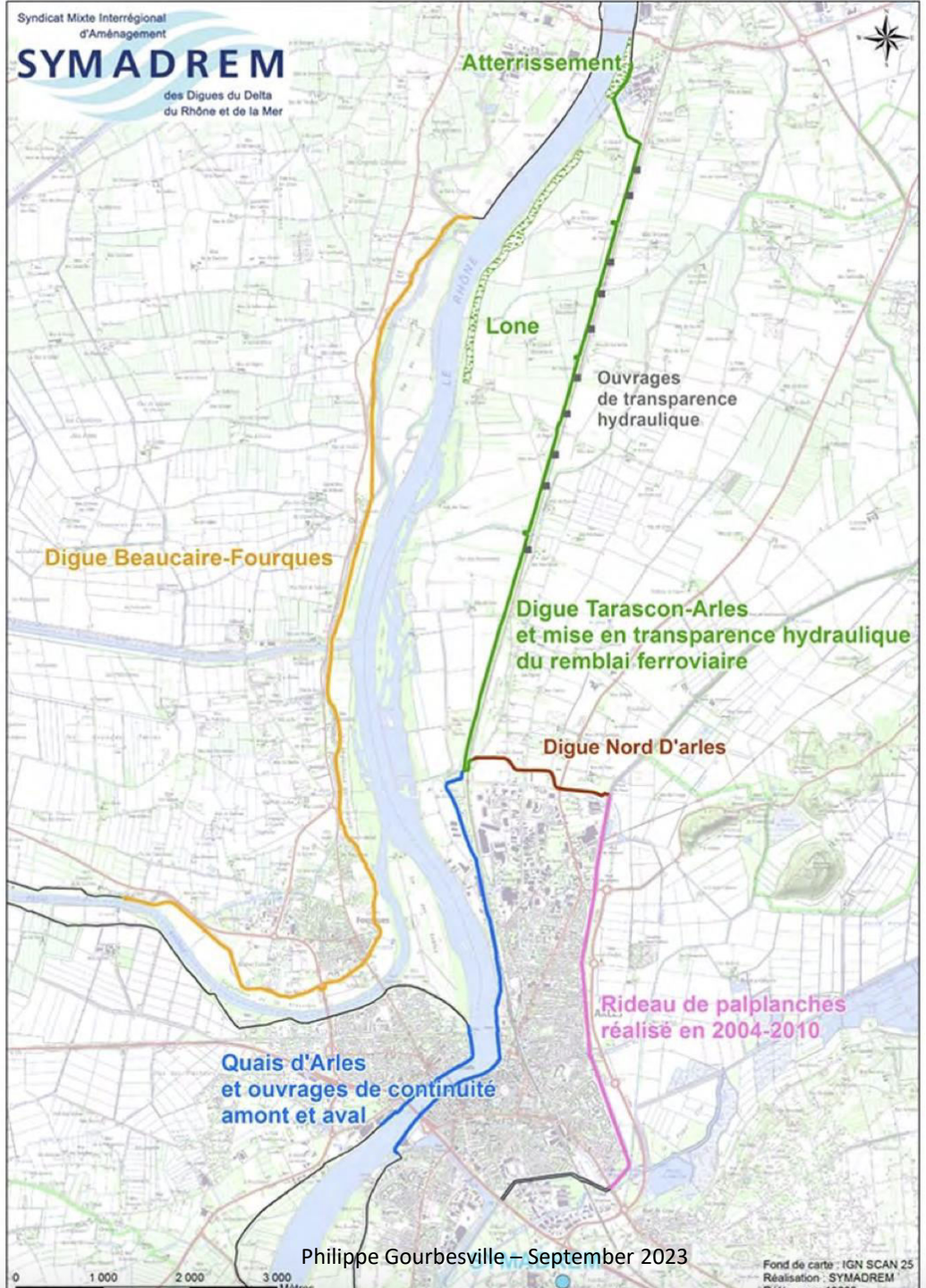


1840 new railway track PLM: the new structure becomes a levee and reduce modify vulnerability & risk …

Consequence: urban development within the disconnected floodplain …

New urban & industrial areas ”protected” and never exposed to inundation …

The newly created structure induces new uses and practices…



1950 electrification of railway track PLM

1980 new standards for safety… especially for crossing…

Objective: to remove all crossing accesses

Two options: above or below…

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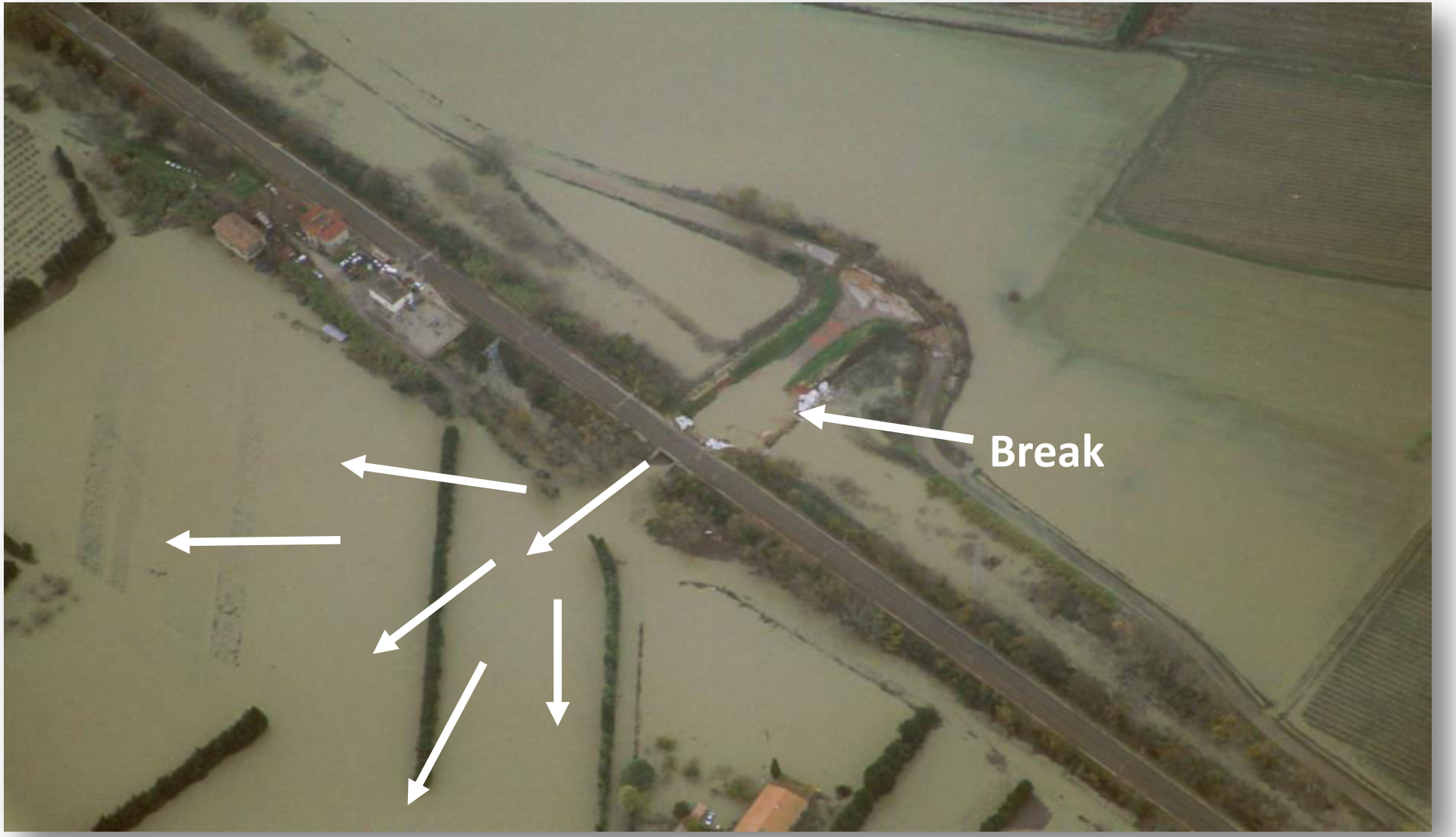
For economical reasons, the “below” solutions were selected and implemented

- 2003 Flood of Rhône river, France



Source: SDIS

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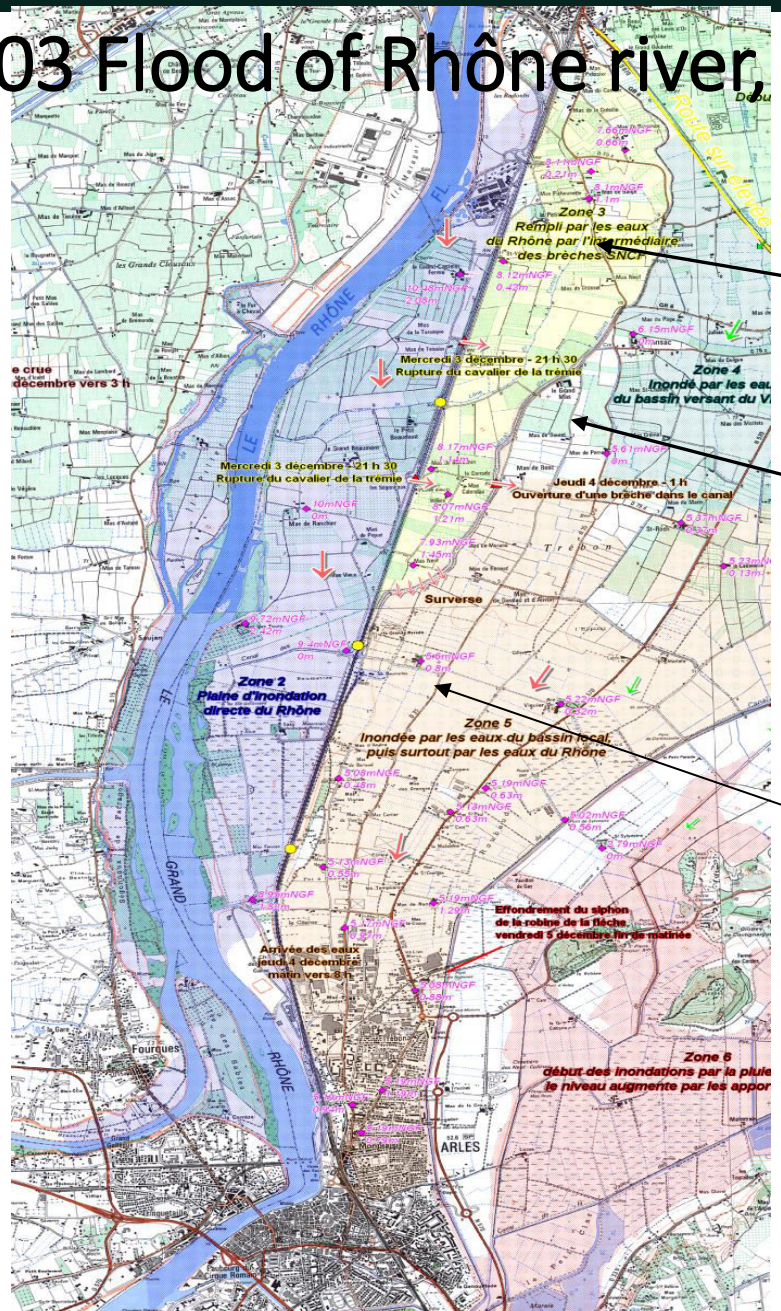

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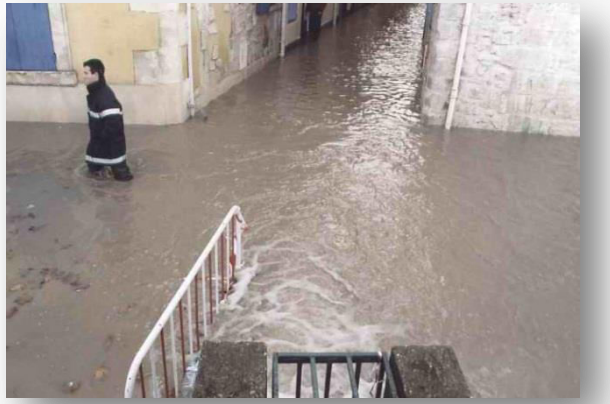


- 2003 Flood of Rhône river, France
- Inundation continuous for several weeks
- Major damages for populations and industrial activities (many relocated afterward)
- Analysis of responsibilities through a lengthy legal process especially regarding the status of the railway track & levee providing – or not – an efficient protection regarding flooding
- New strategy for the floodplain defined

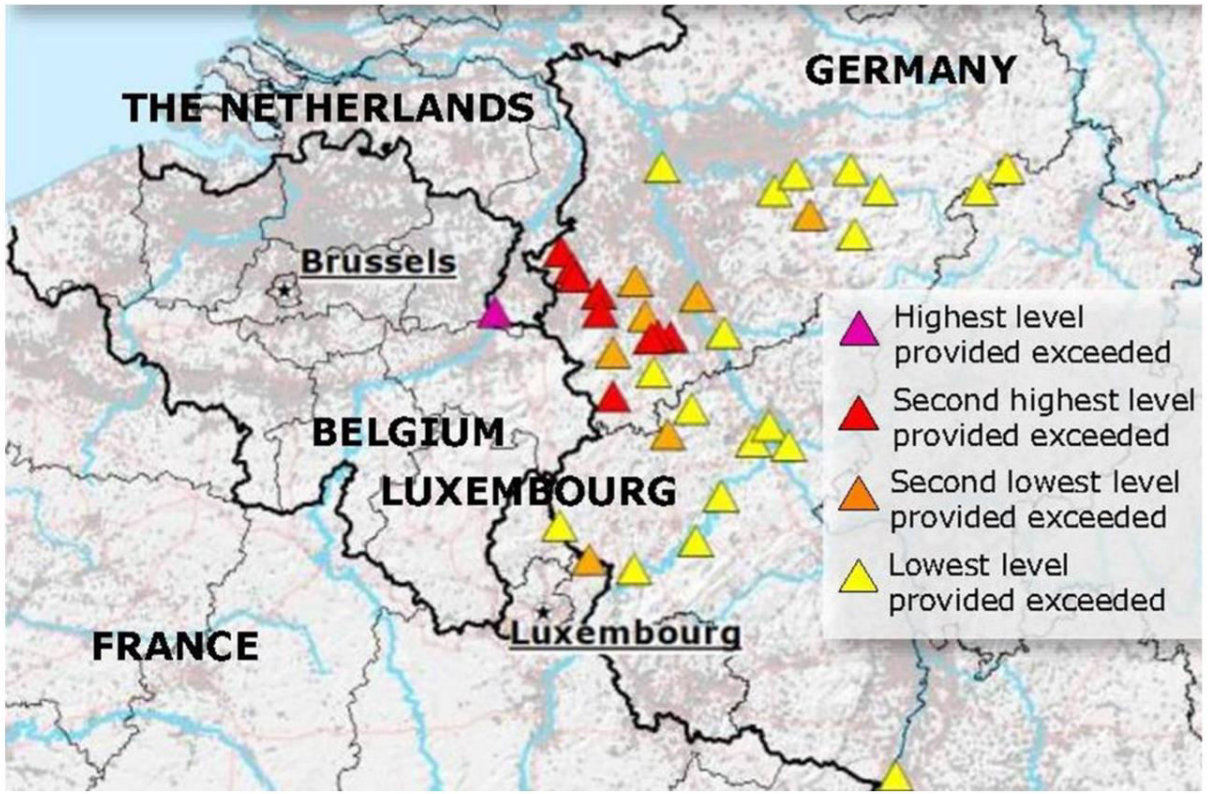
Source: SDIS

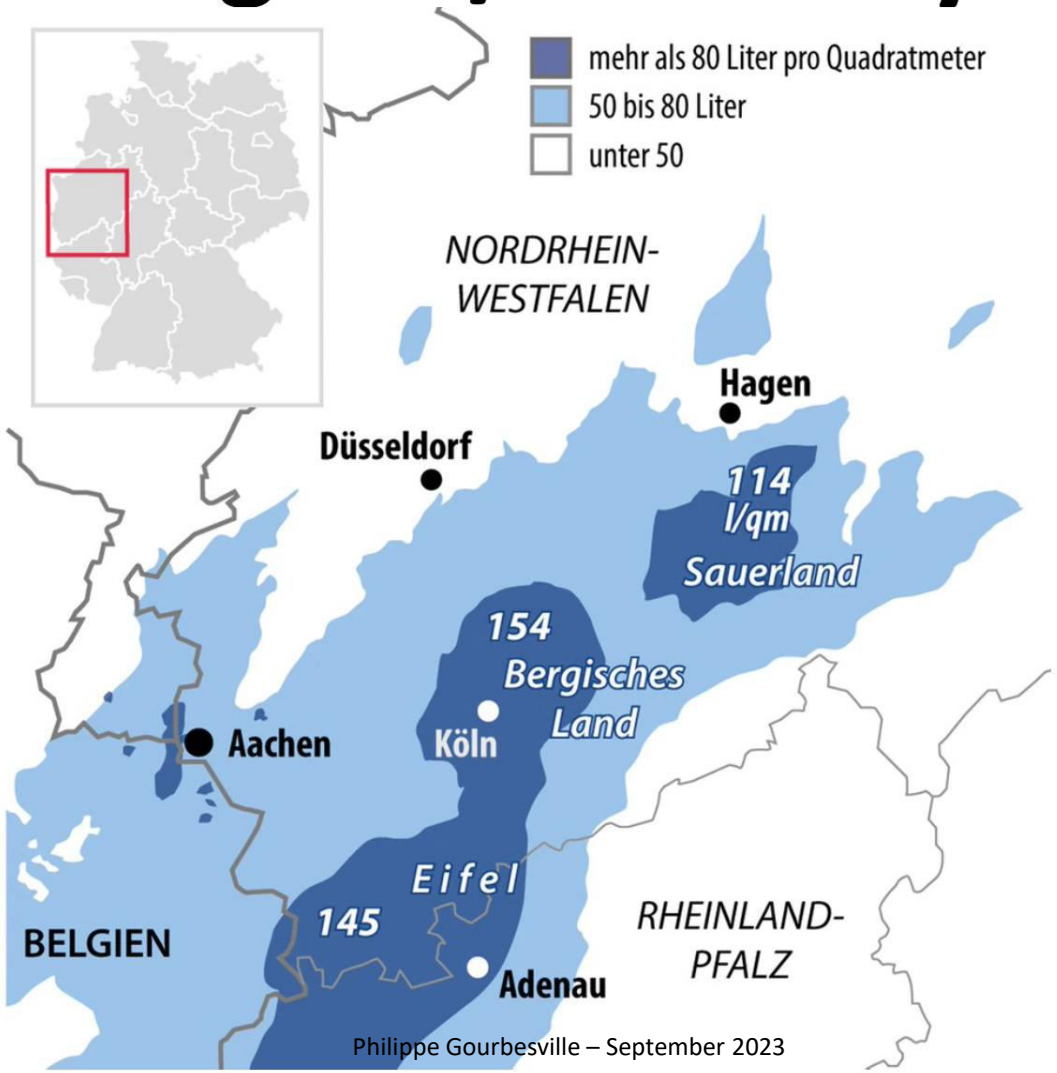
Eifel Region: Mountain Range Belgium/Germany

Situation

Source: F. Molkenthin

larger mid-range mountainous region
low pressure area Bernd remains for days





Philippe Gourbesville – September 2023

rainfall within 24 hours © Grafik: A: Brühl, Redaktion: J. Schneider / DPA, Quelle: DWD

Eifel region – Germany

- Tragic event in July 2021
- 181 deaths
- Damages: 10 Billions €

Similar situation already observed in 1910 (same magnitude) and in 1804 (x2 bigger than 2021) …

Source: F. Molkenthin

Lessons learned

- The extreme flooding was not integrated within the initial design.
- Need to integrate extreme situations at least to understand the potential crisis (extension of inundation & revise code) especially under climate change situation (new rainfall patterns).
- Initial design purpose was lost over time and new uses came up. Proper governance was not ensured over time due to complexity. The new uses have increased vulnerability and risks.
- Implement specific governance able to handle long-term objectives with efficient cost management.
- Promote a risk culture: *you are living by a river (a levee) be ready to be inundated!*

Thank you for your attention!

感谢您的关注！

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