IRSN
INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

Faire avancer la sûreté nucléaire

Update of IRSN activities on Probabilistic Flood Hazard Assessment

5th Annual Probabilistic Flood Hazard Assessment Research Workshop

Rockville, Maryland, February 19-21, 2020

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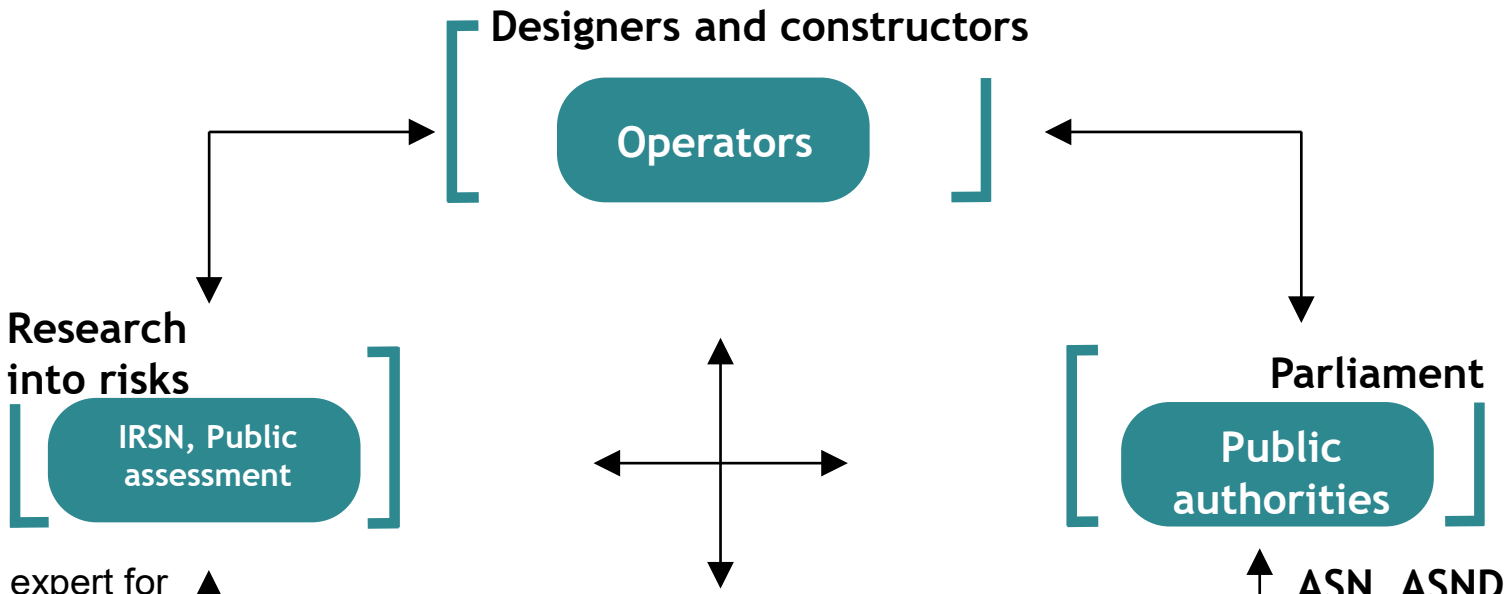
MEMBER OF
ETSON
EUROPEAN TECHNICAL SAFETY ORGANISATIONS NETWORK

Institutional environment



IRSN

- National expert for research and technical support on radiation protection and nuclear safety risks
- Public body with industrial and commercial activities
- 1800 employees

Main recent activities

- Completion of the **reviews** of EdF first implementation of the new guidelines on flooding risk assessment and EDF first PSA studies (4th Periodic Safety Review of 900 MWe NPP)

- **Research**
  - Extension of usable data (historical data from archives)
  - Comparison of USACE and IRSN statistical approaches on extreme sea levels (to be completed)
  - Improvement of modeling capacities (IMC): implementation of meta-models to cope with time consuming calculations
  - IMC: uncertainty propagation in flood routing, methods to address dependency between input parameters (tbc)
  - IMC: aggregation of contributions of flooding phenomena to define a hazard curve at a point of interest (coincidences)

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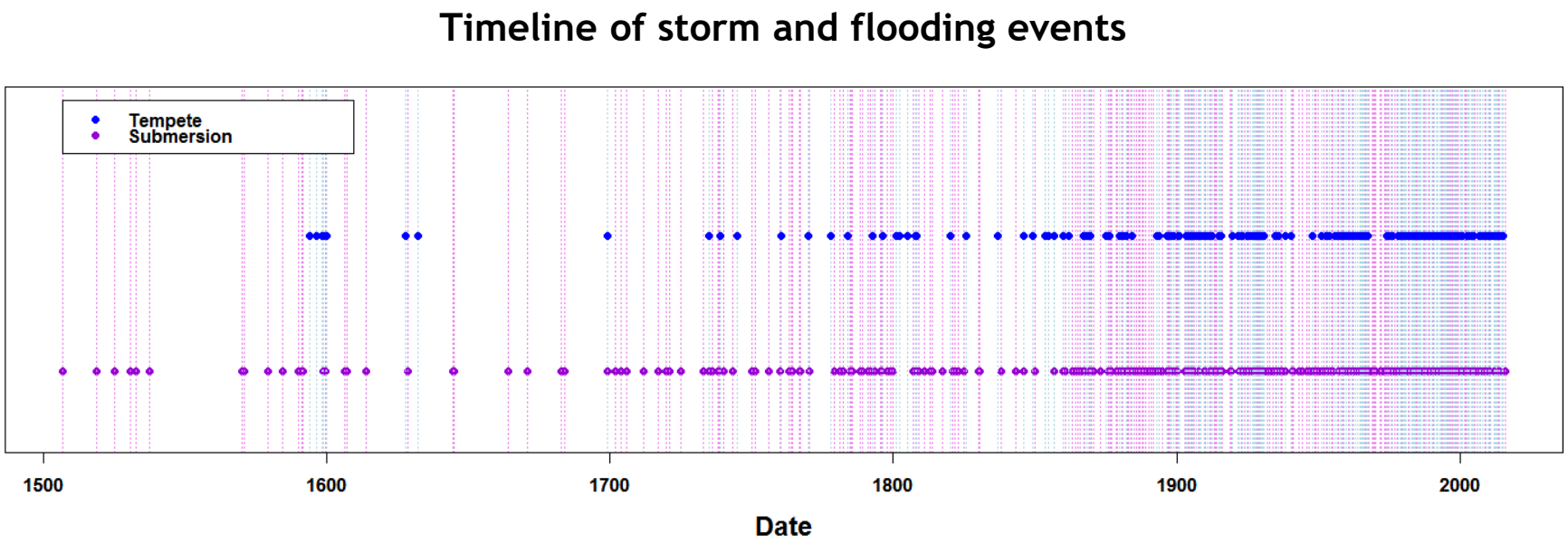
  - **IMC: aggregation of contributions of flooding phenomena to define a hazard curve at a point of interest (coincidences)**

Extend usable data (1)

- **Working Group** (WG) « **Historic Storms and Marine Floodings** » created in 2016
  - Mutualize information on historic storms and marine floodings on the french Atlantic coast
  - Perform a multidisciplinary expertise of historical archives (engineers, researchers, statisticians, historians …)
  - Developp a DataBase on Historic Storms and Marine Flooding
  - Current members

Extend usable data (2)

- **Content of the DB (January 2020): 813 identified events, from 16th century to today.**
  - 565 Marine Flooding: events where flooding is mentioned
  - 248 Storms: events where no indication of flooding is given



Extend usable data (3)

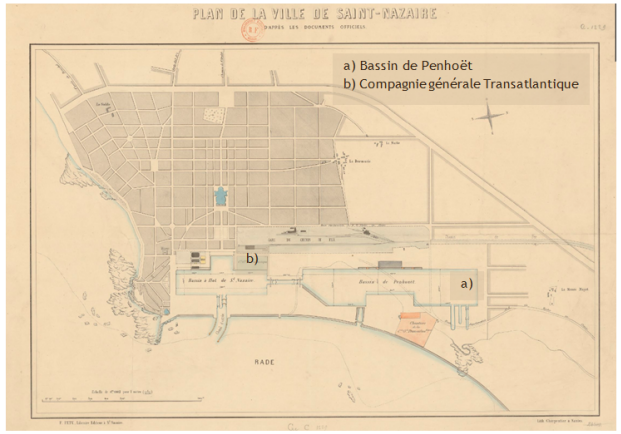
- **Content of the DB (January 2020) : 3 storm sheets**
  1. Meteorological Synthesis - Retranscription without any interpretation
  2. Flooding description for each locality – idem
  3. Reconstructed water levels for each locality using flooding description + complementary documents
     Including hypotheses taken during the reconstruction process (interpretation hypothesis, temporal hypothesis, spatial hypothesis, verification of chart datum)

Le petit journal 7th Jan 1877:*" In Saint-Nazaire […] the whole rue Neuve was flooded. The bassin has overflowed on the docks and hangar of the transatlantic company"*

8.2 INFORMATIONS COMPLEMENTAIRES

Ce plan permet d'illustrer la configuration du Port de la ville de Saint Nazaire 17 ans avant l'événement, il montre l'emplacement du bassin de Penhoët et la Compagnie transatlantique. Il ne retrace pas l'inondation.

Source : Plan de la ville de Saint-Nazaire, d'après les documents officiels 1860 (BNF, en ligne) [22]



Source : Catégorie 4.

Extend usable data (4)

Storm sheet

4. **Synthesis** (1st January 1877 event)

Locality	Tide Gauge Data	Type	Total Water Level [m Fr. Chart Datum]	Surge [m]	
				Instant. surge	Skew surge
Le Havre		○	-nc-	-nc-	-nc-
Cherbourg	yes	△	7.16 M	0.95	0.75
Saint Servan	yes	△	12.97 M	-nc-	0.94
Brest	yes	△	8.02	0.75	0.75
Lorient		■	6.20 Δ	-nc-	0.87
Gavres		●	-nc-	-nc-	-nc-
Vannes		●	-nc-	-nc-	-nc-
Saint-Nazaire	yes	▲	7.23	1.19	1.19
Fort-Boyard	yes	△	6.97	0.85	0.94
Rochefort	yes	△	8.19 M	-nc-	-nc-
Socoa	yes	△	4.45 M	-nc-	0.20

○ Affected locality
No reconstructed water level

△ Affected locality
Water level reconstructed using quantitative data

□ Affected locality
Water level reconstructed using qualitative data

● Affected locality – Flooding confirmed
No reconstructed water level

▲ Affected locality – Flooding confirmed
Water level reconstructed using quantitative data

■ Affected locality – Flooding confirmed
Water level reconstructed using qualitative data

Perspectives

- Regular analysis of new events
- Numerical modeling of historical events

Improvement of modeling capacities (1)

Aggregation of flooding phenomena

Ben Daoued PhD *"Modeling coincidence and dependence of flood hazard phenomena in a Probabilistic Flood Hazard Assessment (PFHA) "*. Development of a method to deal with coincidence of two phenomena.

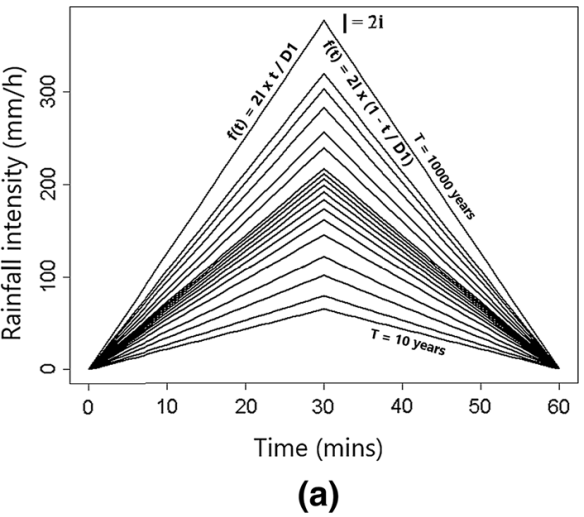
- Coincidence: the chance of occurrence of two phenomena (A and B) at the same time or with an offset time (coincidence does not imply any dependence between A and B)

- The non-coincidence (separate occurrences) case serves as a benchmark background

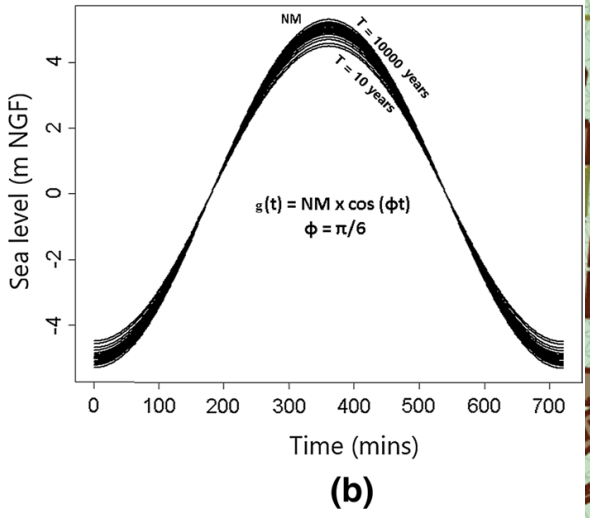
Improvement of modeling capacities (2)

- Aggregation to get a hazard curve at a point of interest (water levels exceedence frenquencies)

- *Le Havre Case study Local precipitation (LP) and Marine Flooding (MF) in an urban area (with sewerage network)*



(a)

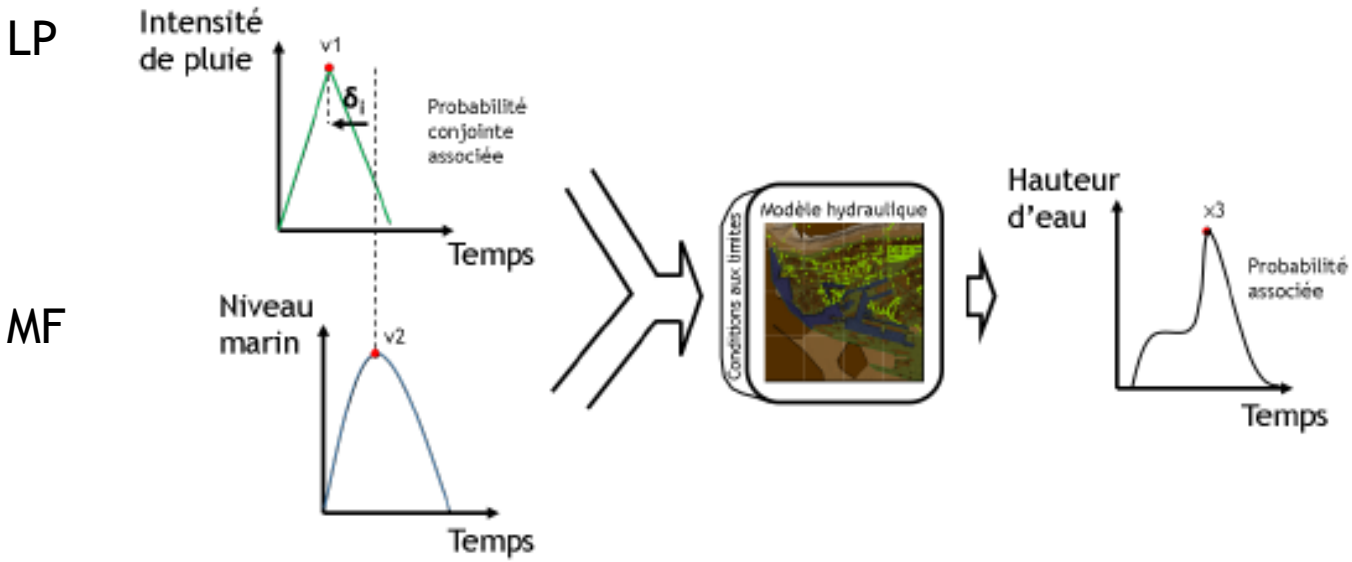


(b)

Intensity f(duration) for LP (a) and MF (b) for 10 to 10 000 y return periods

Improvement of modeling capacities (3)

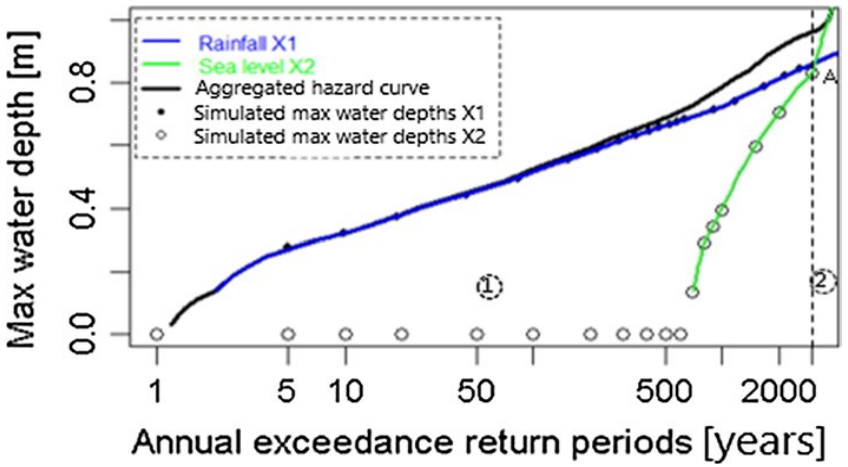
Aggregation throught hydraulic modelling



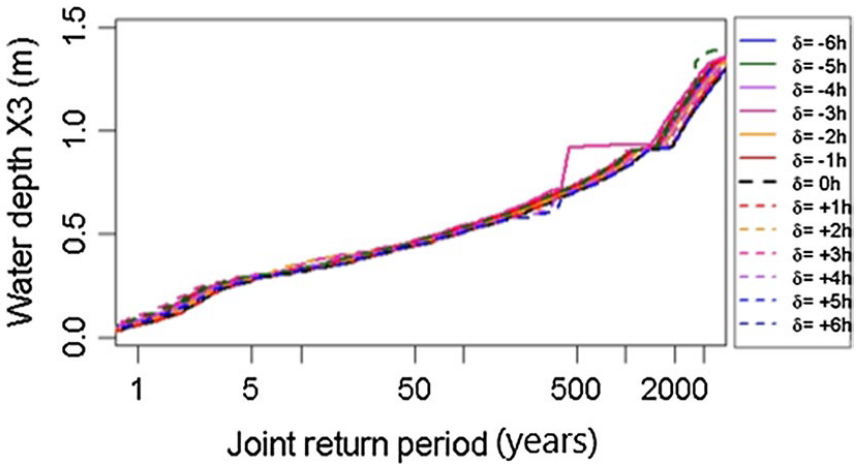
Provide a large set of max water level associated with input parameters probabilities (LP, MF and delta)

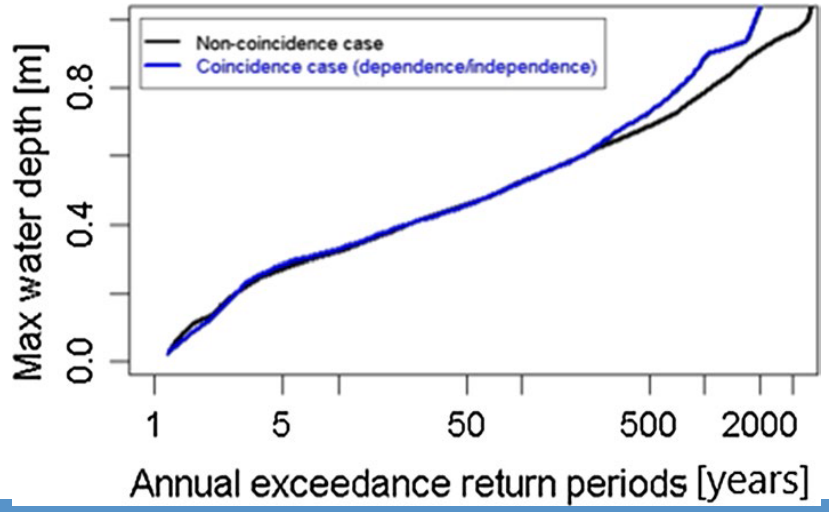
Improvement of modeling capacities (4)

Non-coincidence



Coincidence (offset time [-6h, +6h])





Comparison:

- Significant effects of coincidence beyond 500-y return period

Perspectives

- Improvement of statistical approaches for regional and historical data (PhD 2020-2022, Collab. with INRS/Canada and Ifsttar/France)

- Comparative study on the use of two fluid-modeling methods (Neutrino/Telemac 2D) to simulate surface runoff induced by intense rainfall at the scale of an industrial site (2020 Collab. with Centroid Lab/USA)

- Robust inversion for risk analysis – application to failure of defences (artificial and natural) for probabilistic flooding analysis (PhD 2021-2023, Collab. with BRGM/France and Ecole des Mines Saint-Etienne/France)

Thanks for your attention