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Comparative risk assessments for Guadeloupe: earthquakes and storm surge

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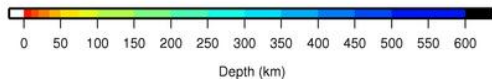
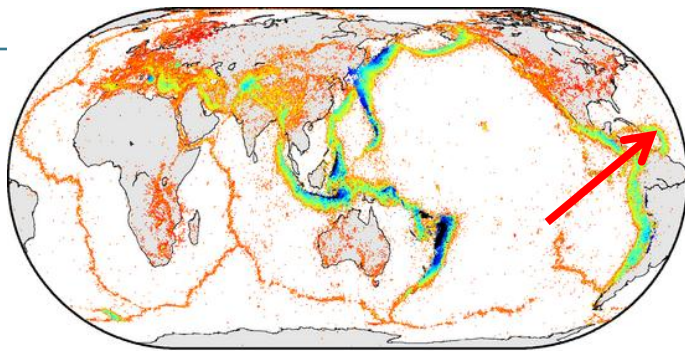
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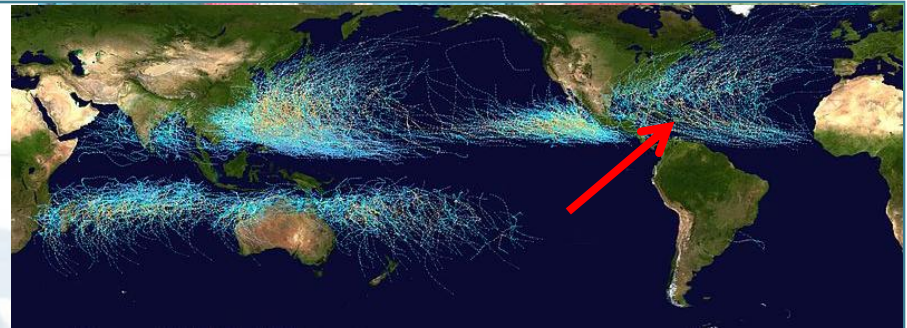
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ISC earthquakes locations: 1960 to present



1985 – 2005 cumulative cyclone tracks (NHC / JTWC)

Comparative risk assessments for Guadeloupe: earthquakes and storm surge

Réveillère, Monfort, Lecacheux, Grisanti, Müller, Bertil, Rohmer, Sedan, Douglas, Bails, Modaressi
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Presentation outline

- Assets estimation & seismic loss estimation methodology
- Validation based Les Saintes 2004 M6.3 earthquake
- Probabilistic seismic losses
- Probabilistic storm surge hazard methodology



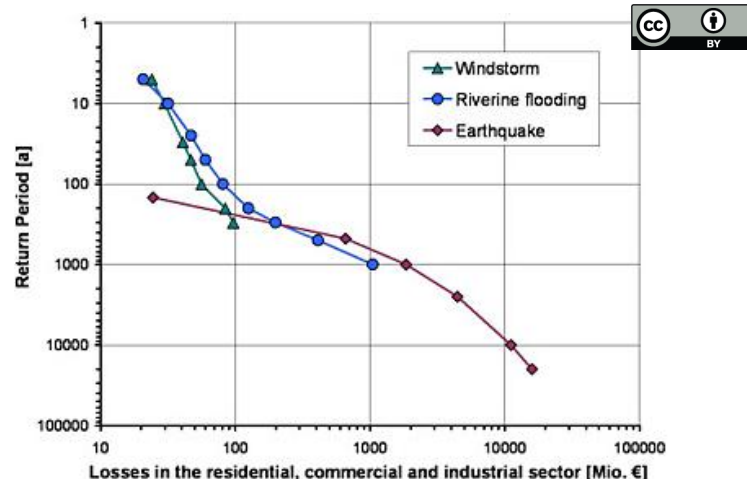
Probabilistic risk assessment & comparison



> Risk is characterized by :

- its likelihood → Return period
- its measurement → Direct economic losses

> Incomplete but quantitative measure of the disaster



Grünthal et al., 2006, for the city of Cologne

		Measurement	
		Tangible	Intangible
Form of damage	Direct	Physical damage to assets: - buildings - contents - infrastructure	- Loss of life - health effects - Loss of ecological goods
	Indirect	- Loss of industrial production - Traffic disruption - emergency costs	- Inconvenience of post-flood recovery - Increased vulnerability of survivors

Adapted from Uhlemann et al., 2011



Assets estimation – construction cost / m²



Building value
per net floor area
per construction type,

- > **based on the construction value** rather than on the market value of the building

similarly to Kleist & al., 2006; FEMA, 2003; Dutta et al., 2003

- > **Local and recent data** are used, if possible

Construction type	Construction cost (€ per net floor area)	Source (incl. year and location)
Individual housing	1127	EPTB 2010 for Overseas Territories
Collective housing	1000	Based on the average social housing price in Guadeloupe
Shelter	600	Assumption
Industrial / large business	1390	Based on market price



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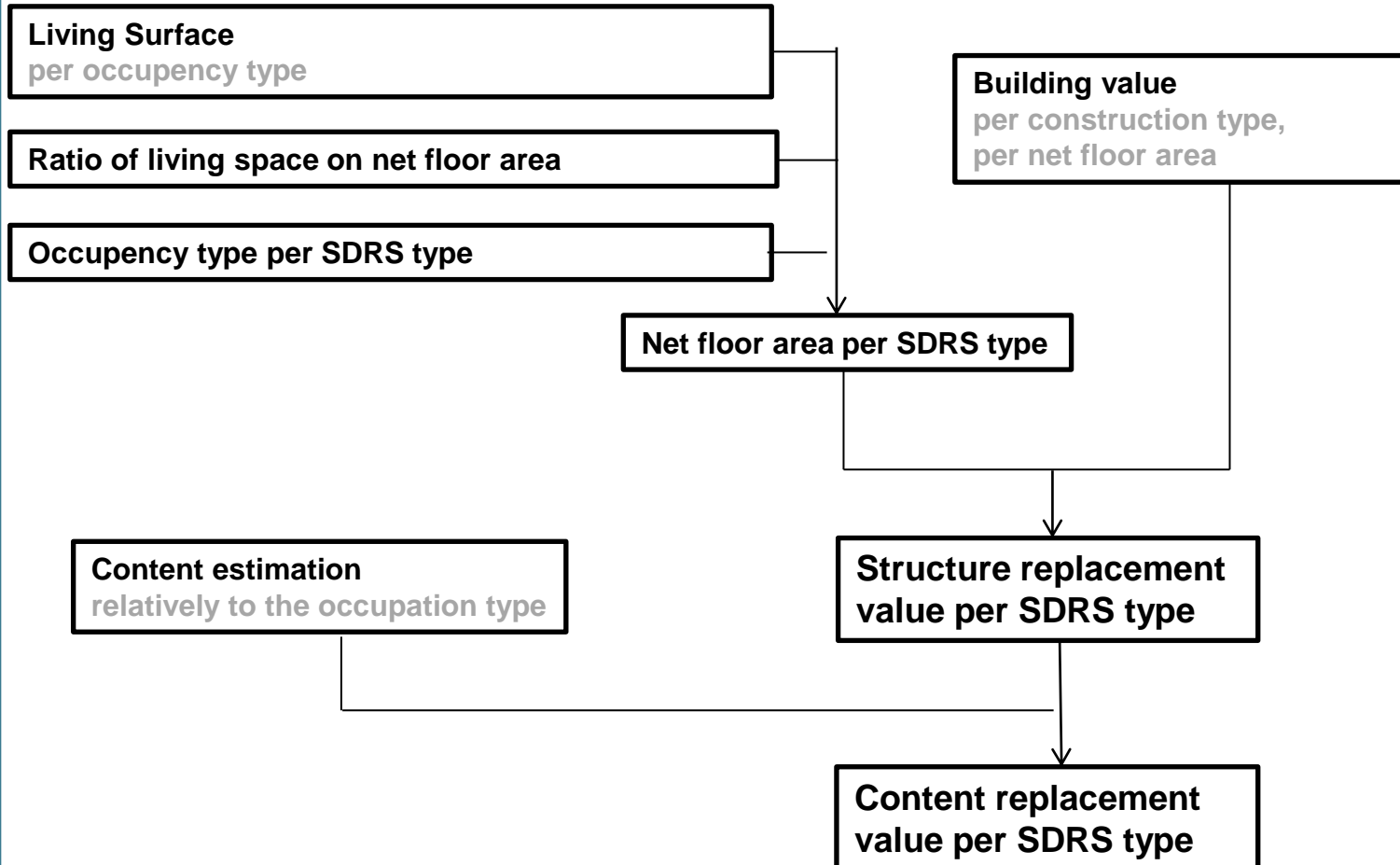
Assets estimation – average surface



Living Surface
per occupancy type

Occupancy type	Average living space per dwelling	Source (incl. year and location)
Traditional housing	71 m ²	INSEE, 2006, for Guadeloupe
Recent private housing	101 m ²	INSEE, 2006, for Guadeloupe
Villa	150 m ²	Assumption
Collective housing	65 m ²	INSEE, 2009 for France & DGAFP, for France
Makeshift shelters	50 m ²	Assumption
Industrial buildings	300 m ²	CCI, for Guadeloupe

Assets estimation – overall methodology



« SDRS type »: building vulnerability typology defined by the « *Regional Scenario for Seismic Risk* » study & surveys. Cf. Bertil et al., 2009

Assets estimation - results



> Per vulnerability type

SDRS type		Building stock in Guadeloupe		Replacement value	
Name	Description	Nb of dwellings	Share	Building (€ per dwelling)	Content (€ per dwelling)
HABFOR	makeshift shelter	6 424	3%	37 500	18 750
MCPIER	stone houses	609	0.3%	100 021	50 011
CASTRA	traditionnal houses (wood)	15 710	7%	100 021	50 011
...

> → Total assets

Economic sector	Guadeloupe exposed assets		
	Total (G €)	k€/hab	share
Private housing	36.5	91.2	77%
Industry	1.1	2.7	2%
Commerce & service	5.7	14.3	12%
Schools & hospitals	4.4	11.0	9%
Others (roads, energy & water supply, etc.)	0.0	-	0%
Total	47.6	119.1	100%



Loss estimation per Damage State



Loss ratio per DS

EMS 98 DS - % loss
relation for:

- Structural repairs
- Content replacement

> Structural repairs

EMS-98 DS	Structure damage ratio	Central damage factor
0	0%	0%
1	0-1%	0.5%
2	1-20%	10%
3	20-60%	40%
4	60-100%	80%
5	100%	100%

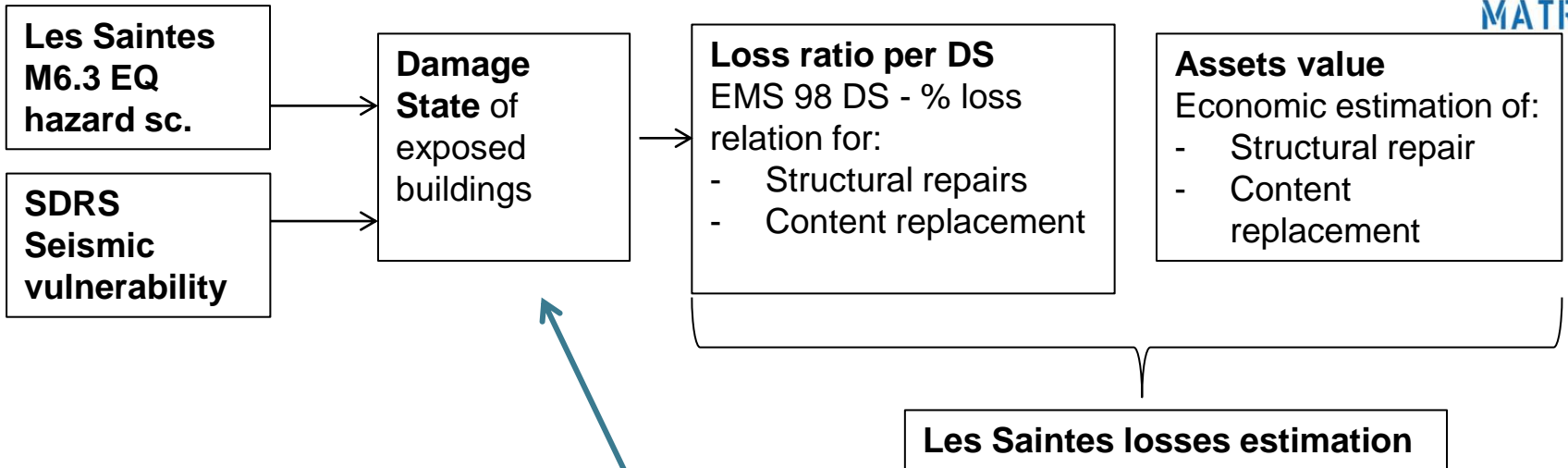
From Tyagunov et al. (2006)
for German buildings typology

> Content replacement

EMS-98 DS	Replacement ratio
0	0%
1	1 %
2	2 %
3	12 %
4	25 %
5	50 %

Adapted from FEMA (2003)
for US buildings typology

Validation using les Saintes (2004) EQ



Damage & loss model



Available data

> Post-seismic damage observations

> Post-disaster cost estimations

Validation using les Saintes (2004) EQ

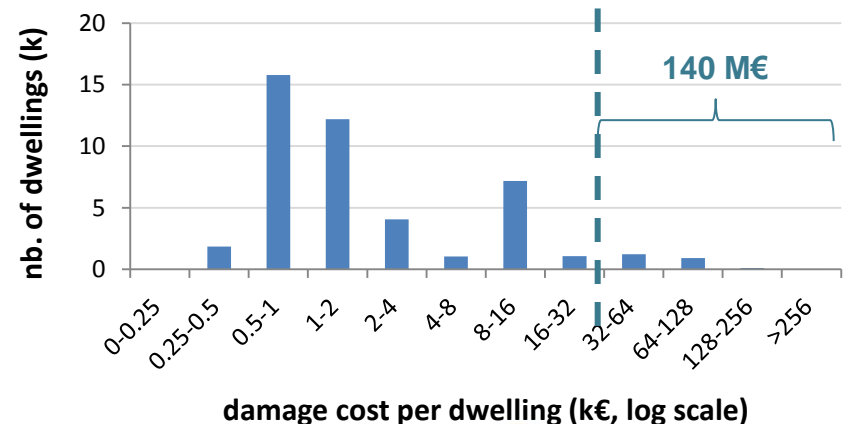


> Observations

- Damage: a few D4/D5 buildings, mostly light damages (cracks), concentrated in Les Saintes islands and the South of Basse Terre
- Direct economic losses:
 - CCR (French public reinsurance institution) : estimated 60 M€
 - 43 % of households in Guadeloupe have a home insurance
 - ➔ Estimated cost: **140 M€**

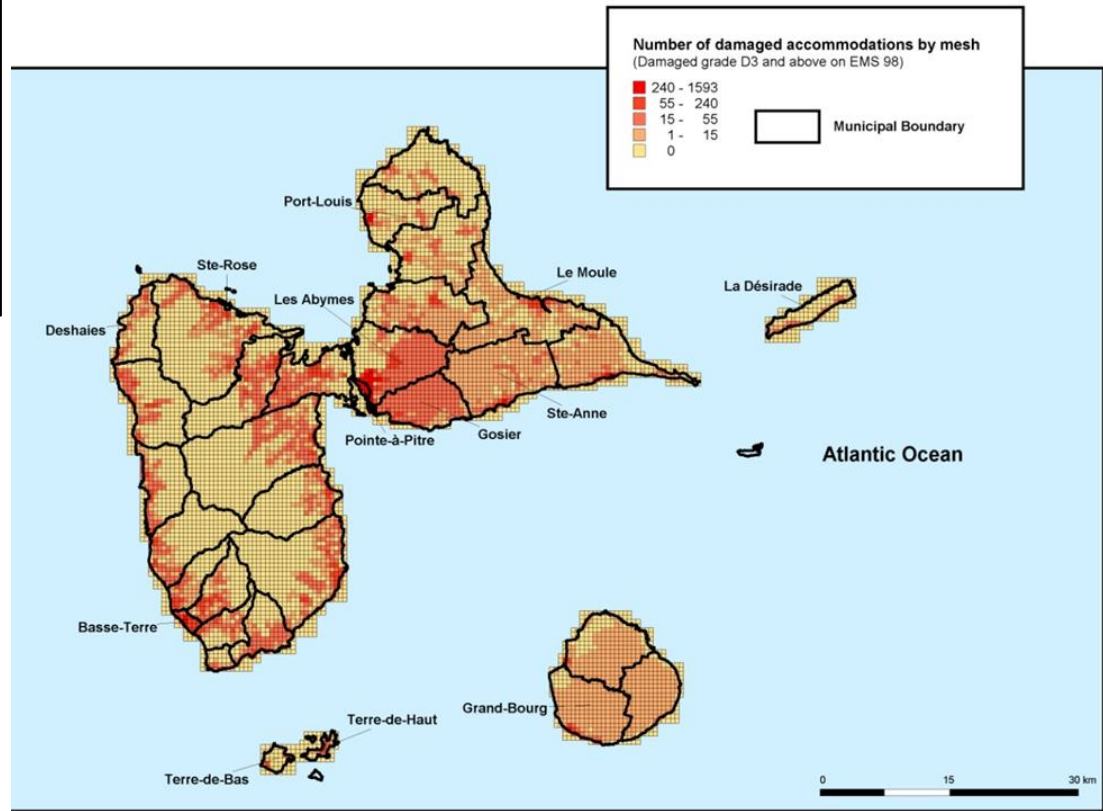
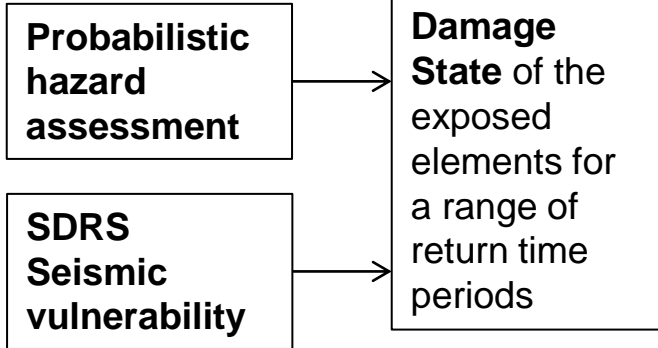
> Loss modeling

- Damage localization and number coherent but slightly higher than the post-seismic observations
- Losses: **148 - 513 M€**, central damage factor: **325 M€**



➔ **Overestimated cost.** Hypotheses: no reimbursement of light damage (no declaration, insurance excess), signification of the CCR number, %loss - DS relation ...

Probabilistic seismic risk: losses (DS)



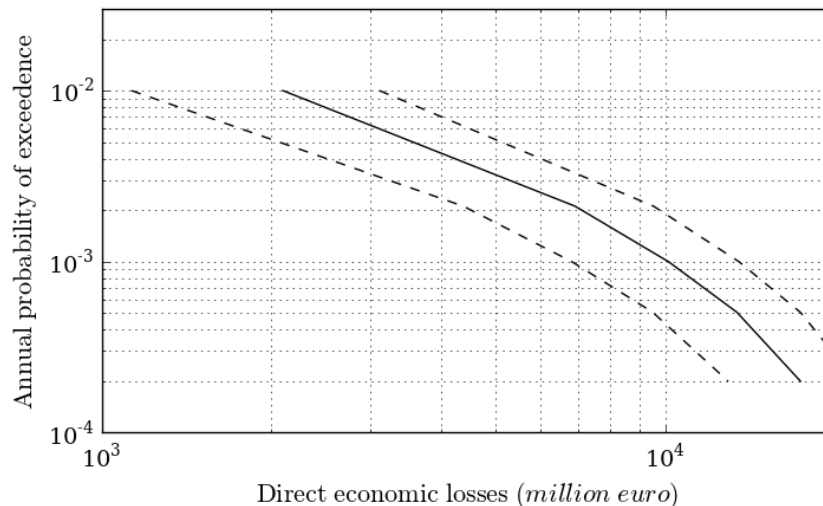
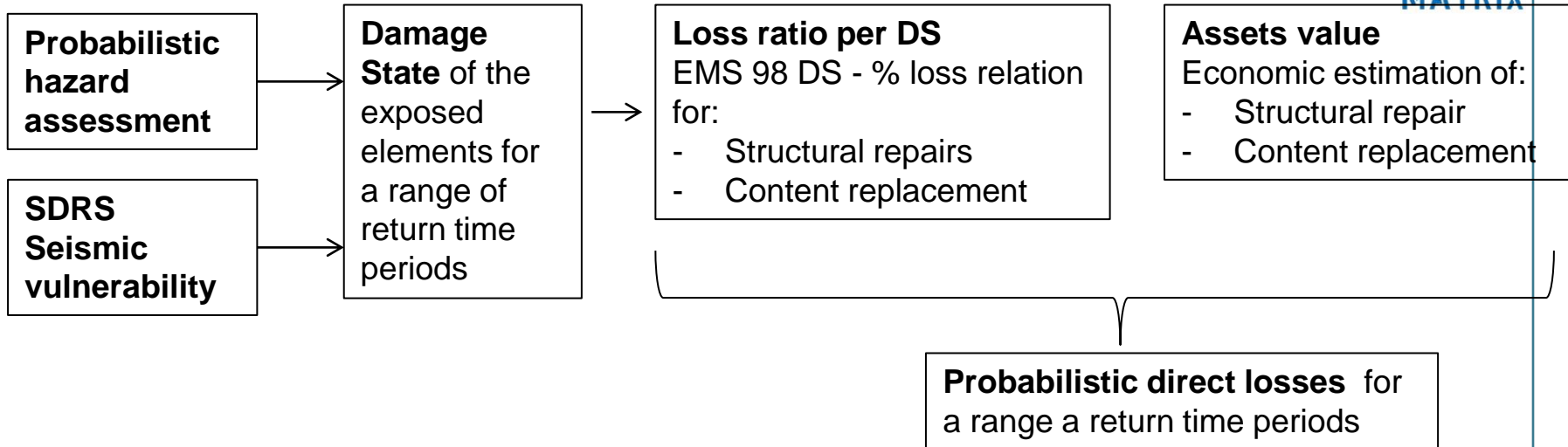
Sources : BRGM (2008) Design : Grisanti.L (2011)

> Loss calculations are based on a probabilistic seismic hazard map. This approach leads to slightly conservative results (Bommer and Crowley, 2006)

Damage map obtained using Armagedom loss estimation software (Sedan, 2003)

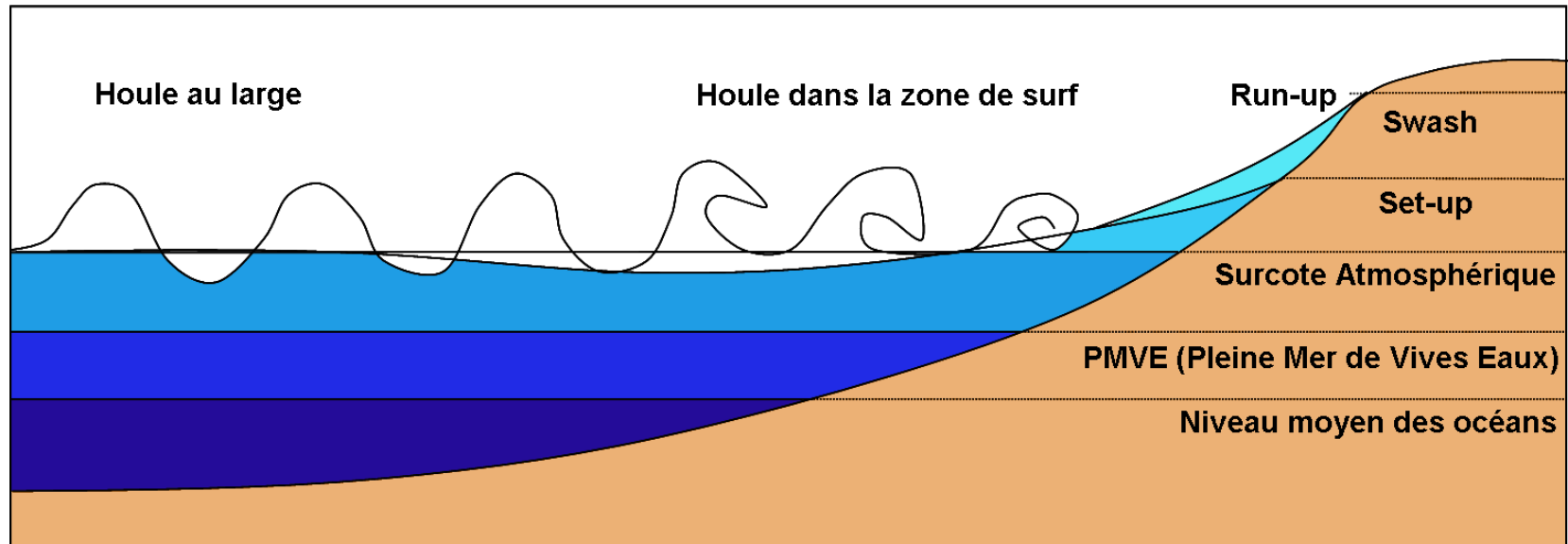


Probabilistic seismic risk: losses (€)



Preliminary results

Storm surge hazard

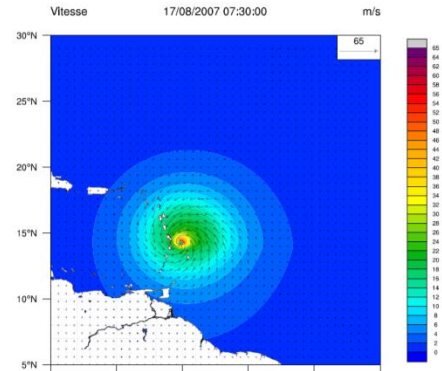
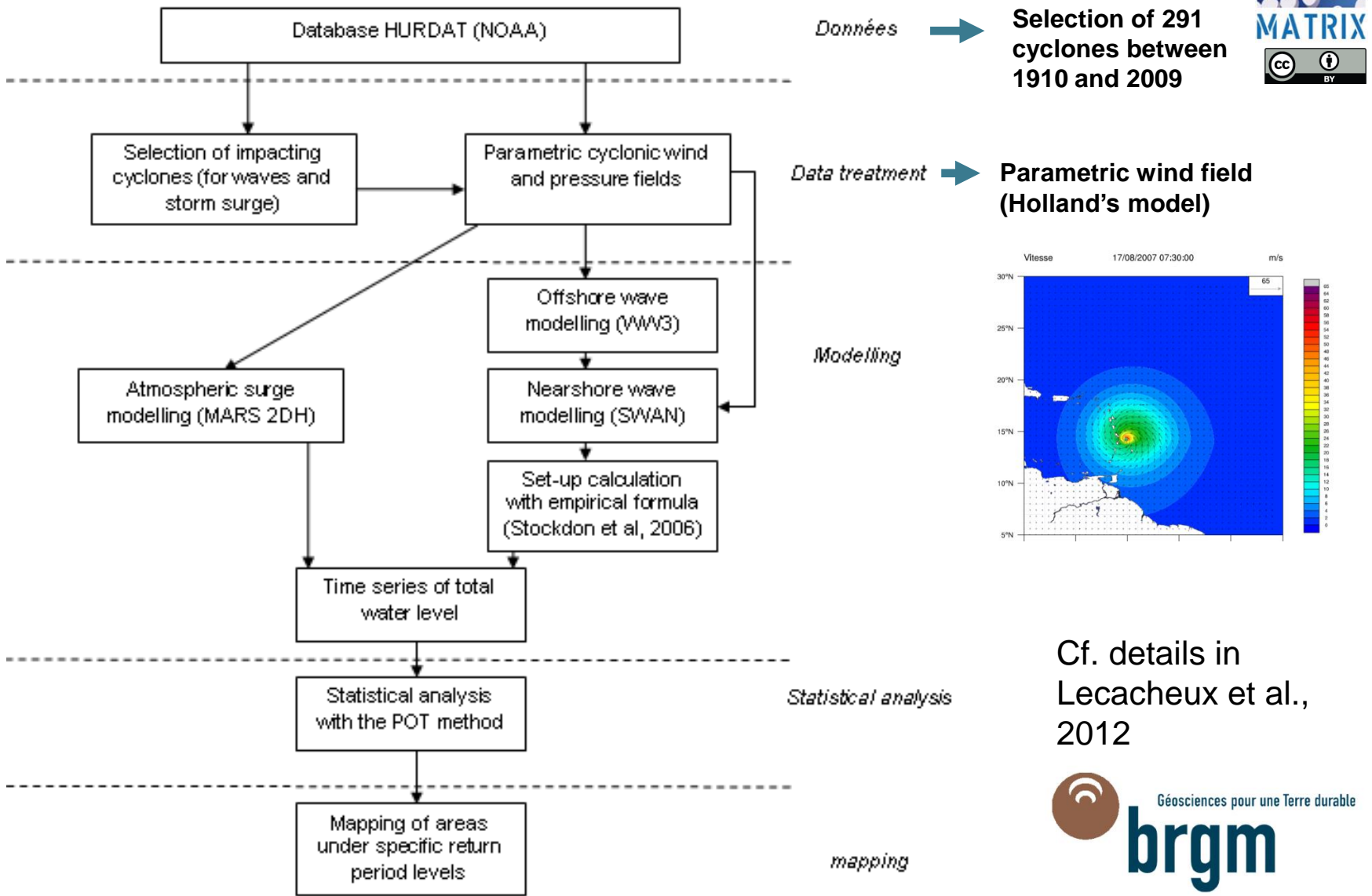


> **The marine submersion of the coastal areas results from the conjugated effects of:**

- the tide
- the atmospheric surge (due to wind and low atmospheric pressure)
- the waves set-up (local elevation of the mean sea level due to wave breaking)

→ **The maximum level reached by the water is the run-up**

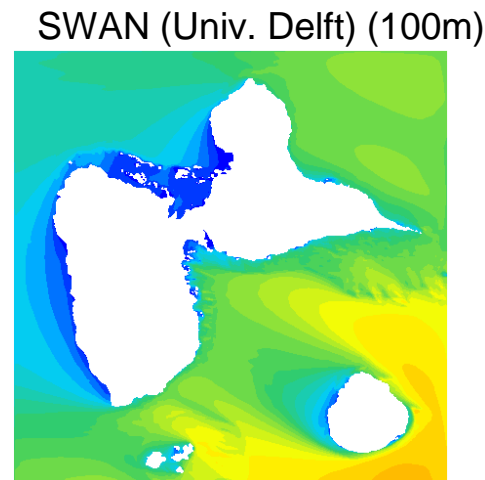
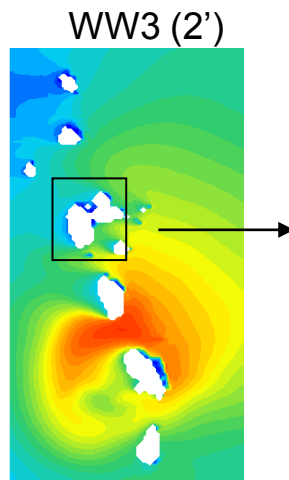
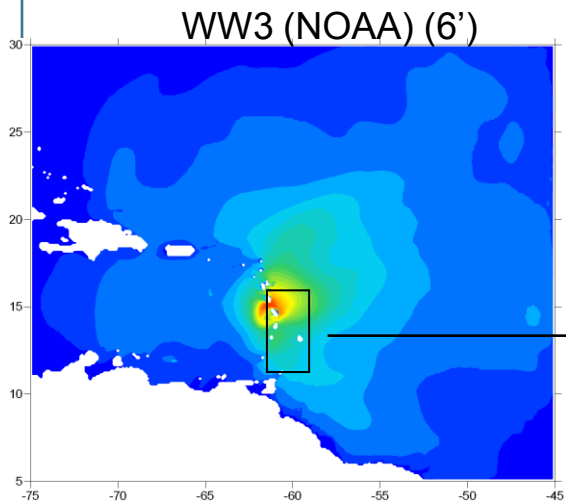
Probabilistic storm surge hazard: methodology



Cf. details in
Lecacheux et al.,
2012

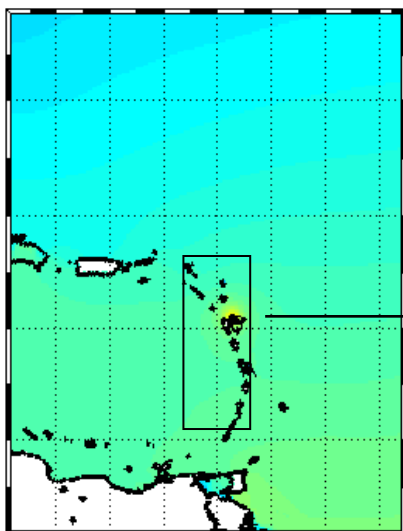


Storm surge hazard: events modelling

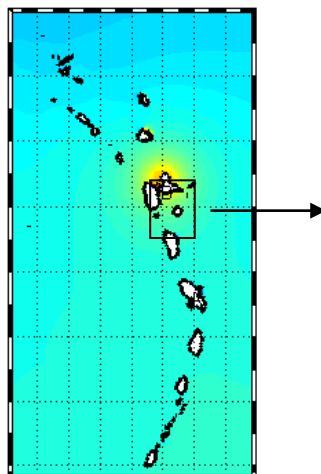


Waves
(example : Dean 2007)

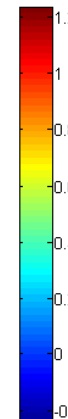
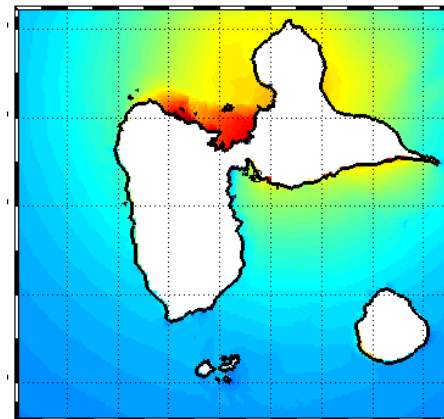
MARS (Ifremer)



MARS



MARS



Atmospheric surge
(example : Hugo 1989)

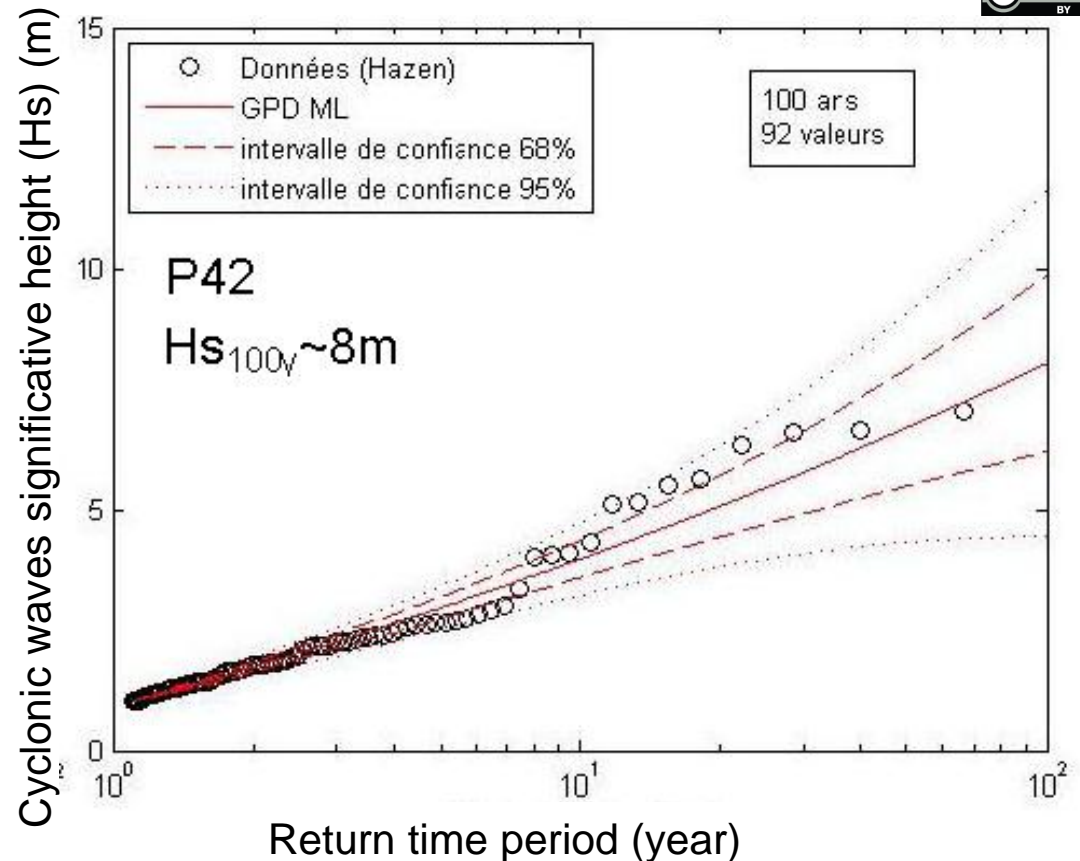
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Probabilistic storm surge hazard: waves results



- > Peaks Over Threshold sampling of the simulations for different locations around Guadeloupe
- > Maximum likelihood fit with a Generalized Pareto Distribution



from Lecacheux et al., 2012



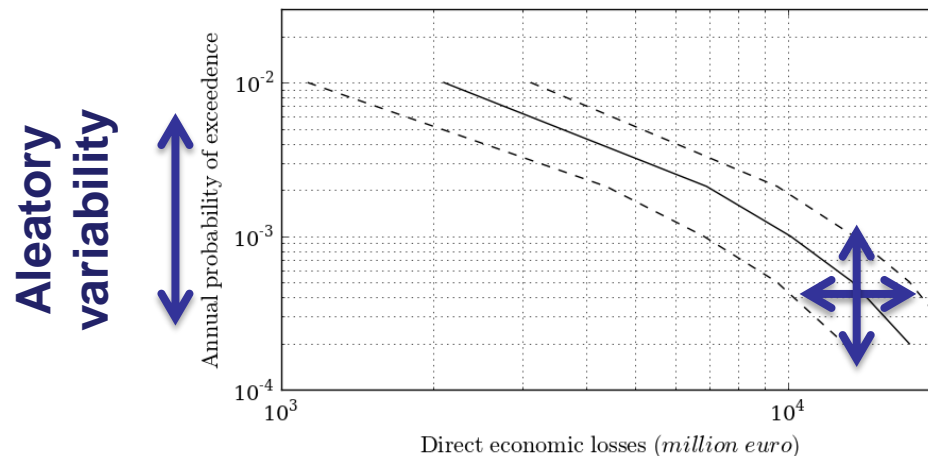
Further steps



> Direct hazard comparison

- Validation of the economic losses (Les Saintes)
- Finalization of the probabilistic storm surge hazard
- Mapping inundated areas and estimating storm surge losses

> Identification, quantification and propagation of uncertainties in the seismic loss calculation



Epistemic uncertainty

Conceptual view



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→ Restriction to the area of Pointe à Pitre

> **Thank you!**

> **Acknowledgment**

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