EurOtop overtopping guidance applied in a tool with large variety of coastal protections at Ile de Ré

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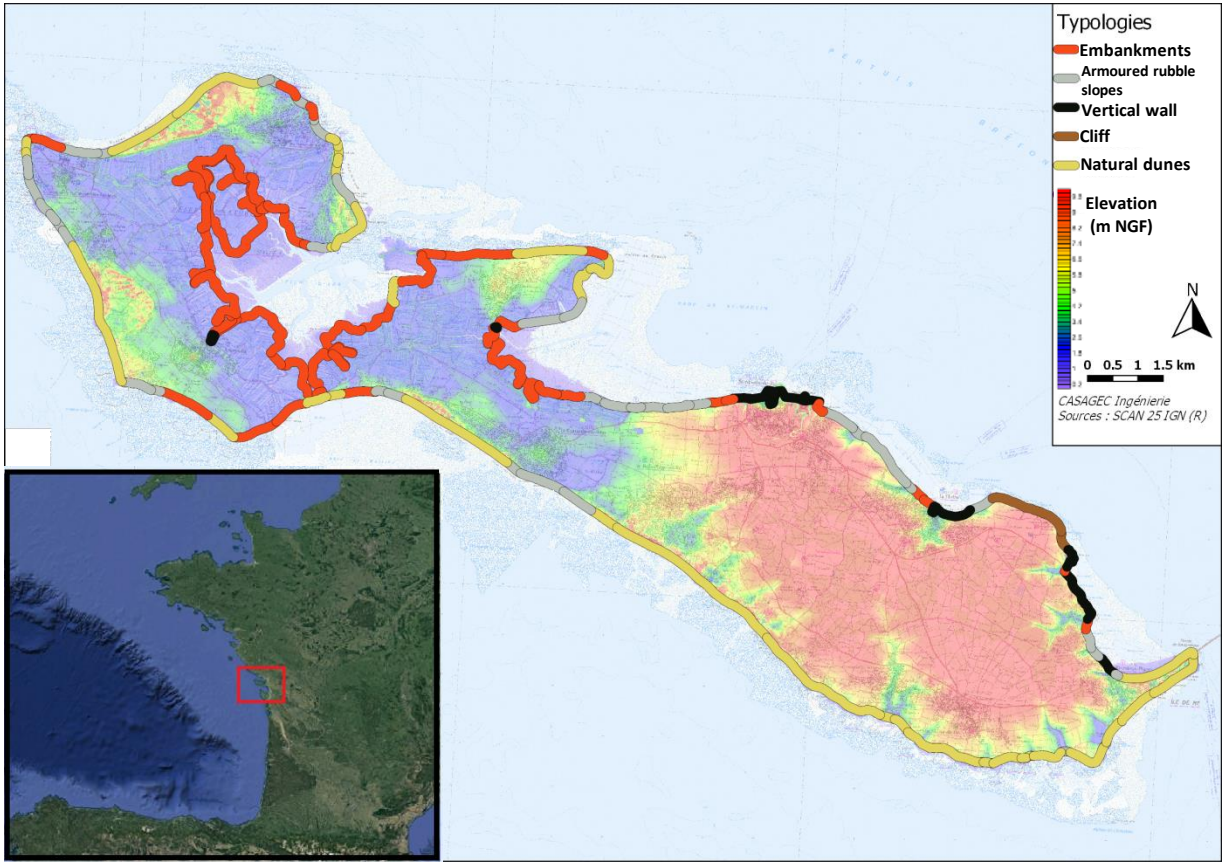
ICCE 2018
36TH INTERNATIONAL CONFERENCE ON COASTAL ENGINEERING 2018
Baltimore, Maryland | July 30 – August 3, 2018

CONTENTS

STUDY AREA



ILE DE RÉ :

- 85 KM²
- 38 KM² BELOW STORM SURGE LEVEL
- 14 000 RESIDENTS
- 10 COUNCILS
- 103 KM OF COASTLINE
- 68 KM COASTAL PROTECTIONS (136 DIFFERENT STRUCTURES)

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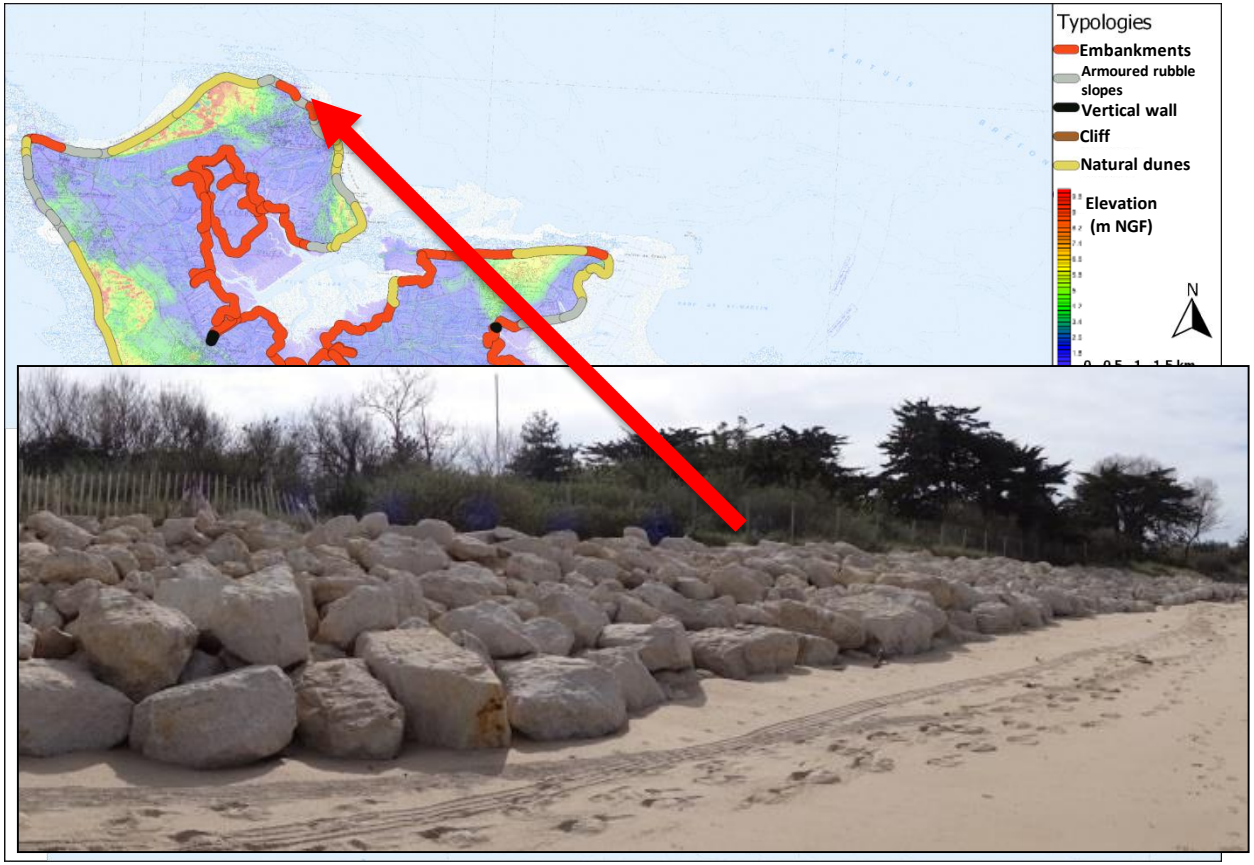

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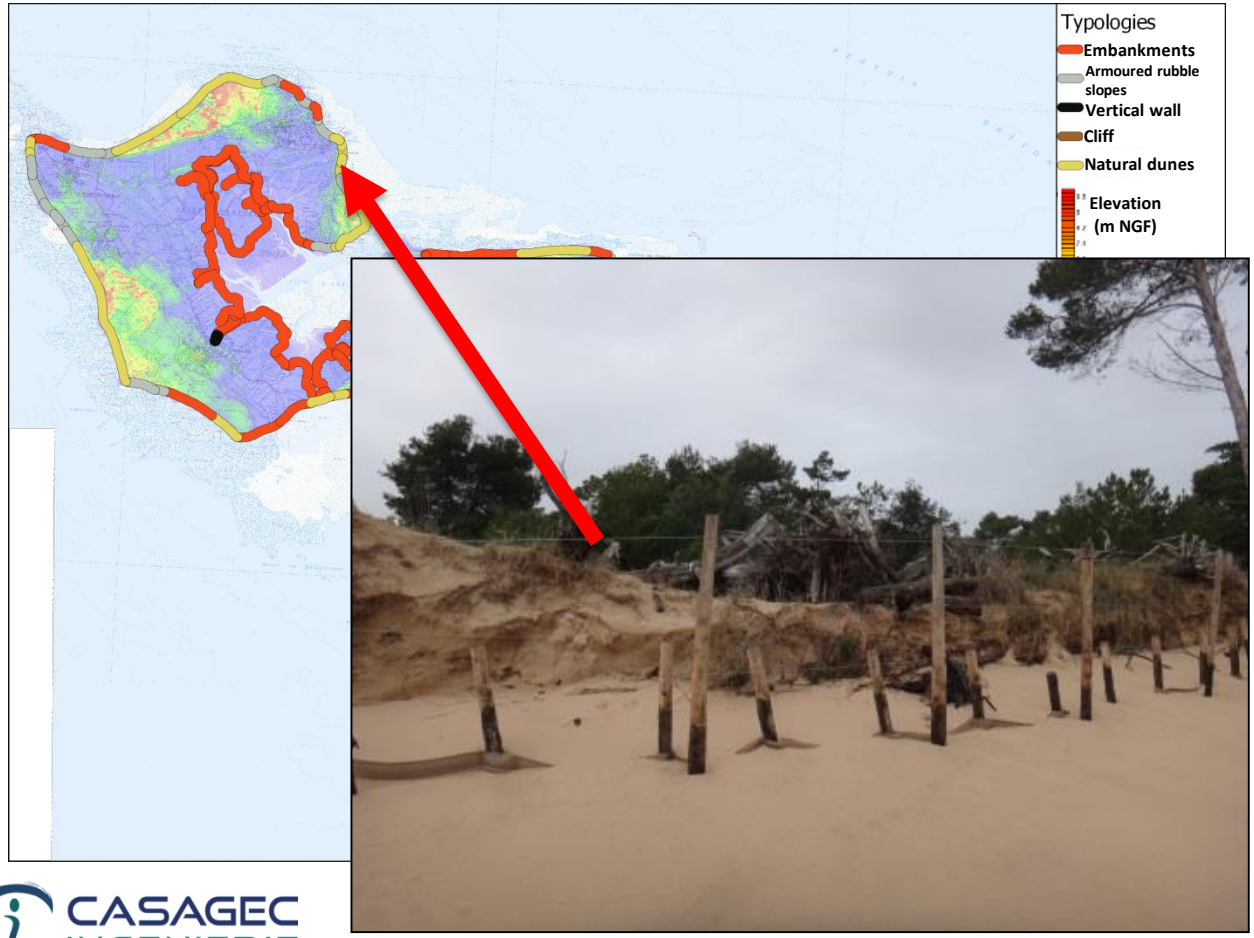

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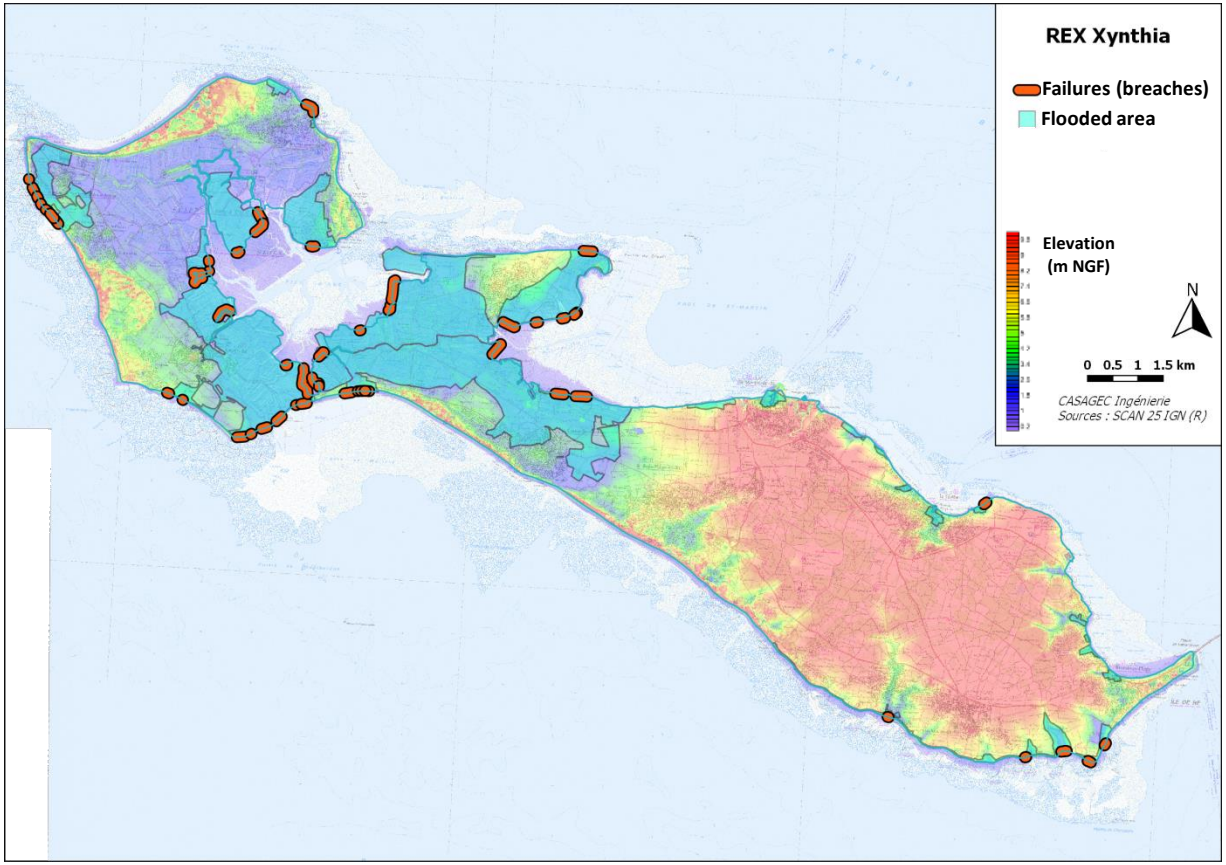
  - VERTICAL WALLS
  - SANDY DUNES

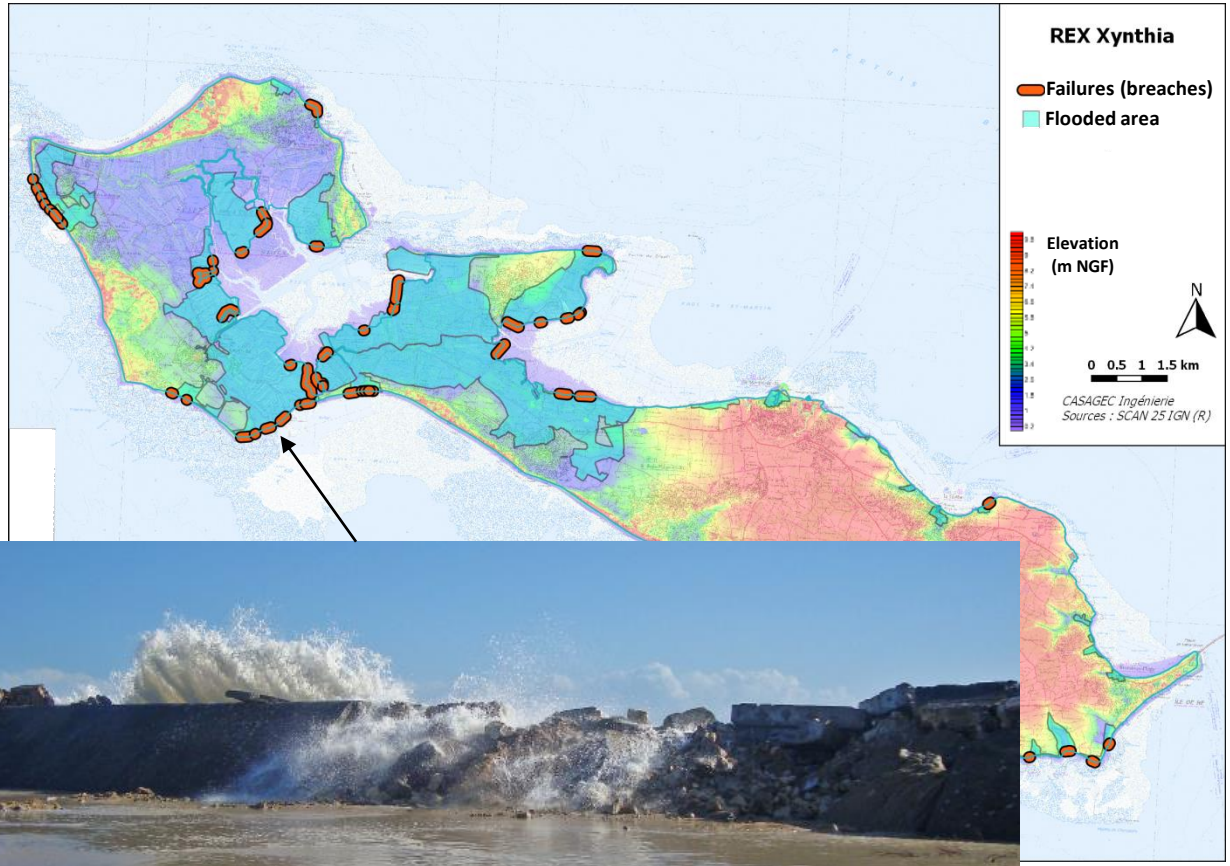
REFERENCE EVENT



XYNTHIA (28/02/2010)

- 19 KM² FLOODED
- 22 % OF THE ISLAND
- 6400 M OF PROTECTION FAILURES
- EMERGENCY WORKS
- 100 M€ OF COASTAL PROTECTION REHABILITATION

REFERENCE EVENT



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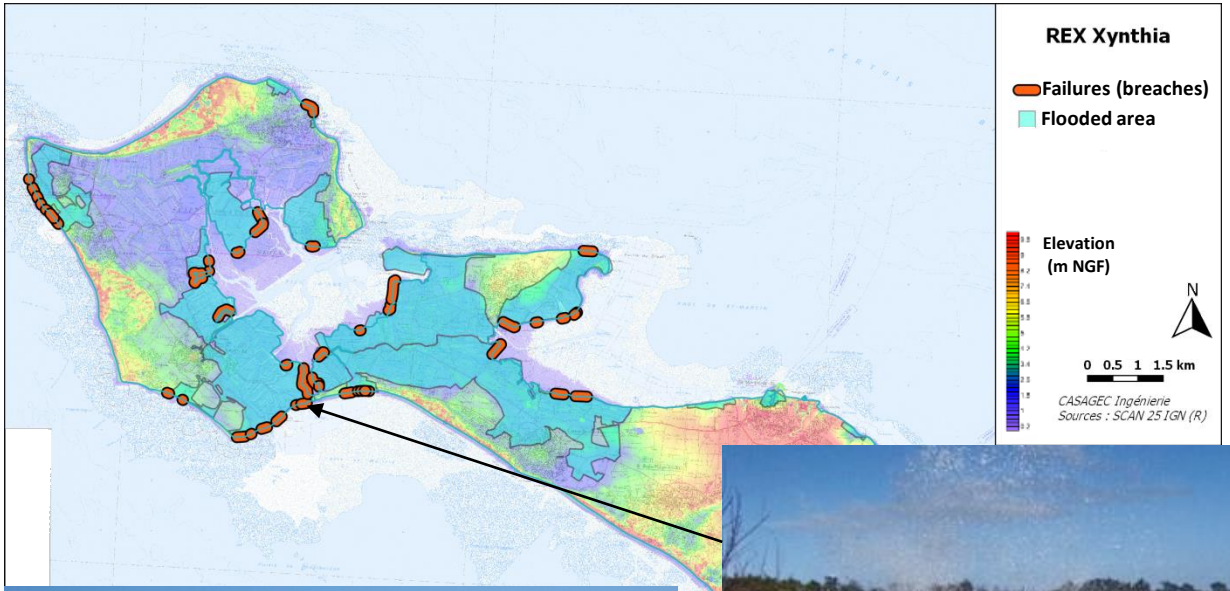

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STUDY AREA

CURRENT SITUATION :

MANY STRUCTURES ARE VULNERABLE REGARDING WAVE OVERTOPPING OR WATER OVERFLOWING :

→ NECESSITY TO MONITOR FREQUENTLY OLD STRUCTURES AFTER STORMS

→ NECESSITY TO PRIORITIZE MAINTENANCE ON THIS LONG STRETCHES OF HETEROGENEOUS COASTAL PROTECTIONS

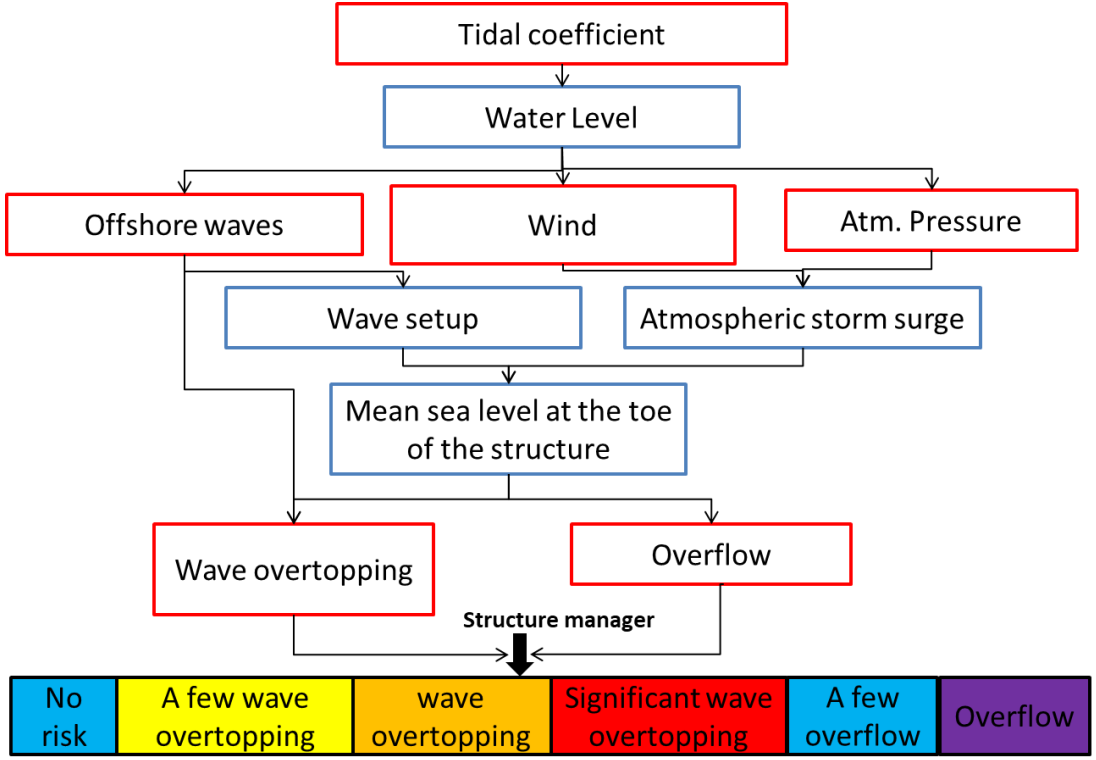
→ **DEVELOPMENT OF A DEDICATED TOOL**

TOOL DESCRIPTION

NECESSITY TO HAVE ON EACH STRUCTURE:

- WATER LEVEL
- WAVE CHARACTERISTICS

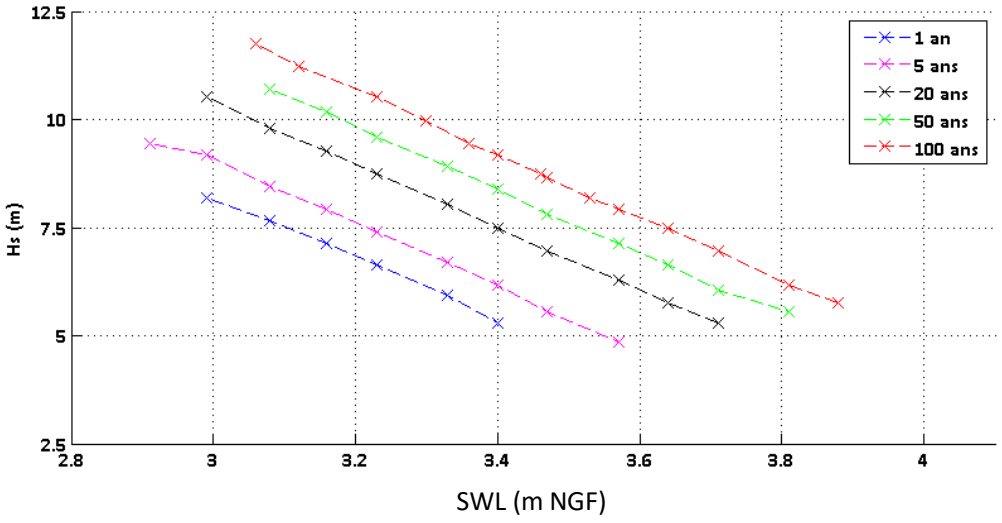
TO MAKE DECISIONS EASIER, A SHORT LIST OF SCENARIOS IS DEFINED TO CREATE CHARTS FOR EACH STRUCTURE REGARDING OFFSHORE CONDITIONS



TOOL DESCRIPTION

TOOL BASED ON DEFINED CHARTS REGARDING OFFSHORE CONDITIONS

1. OFFSHORE WAVES CHARACTERISTICS
2. WATER LEVEL ELEVATION
3. JOINT PROBABILITY ON WAVE AND WATER LEVEL TO DEFINE A FINITE NUMBER OF SCENARIOS WITH AN EQUIVALENT RETURN PERIOD
4. 90 SCENARIOS WERE SIMULATED WITH AN HYDRODYNAMIC MODEL COUPLED TO A SPECTRAL WAVE MODEL (TELEMAC 2D / TOMAWAC)
5. WAVE OVERTOPPING EVALUATION ON EACH STRUCTURE



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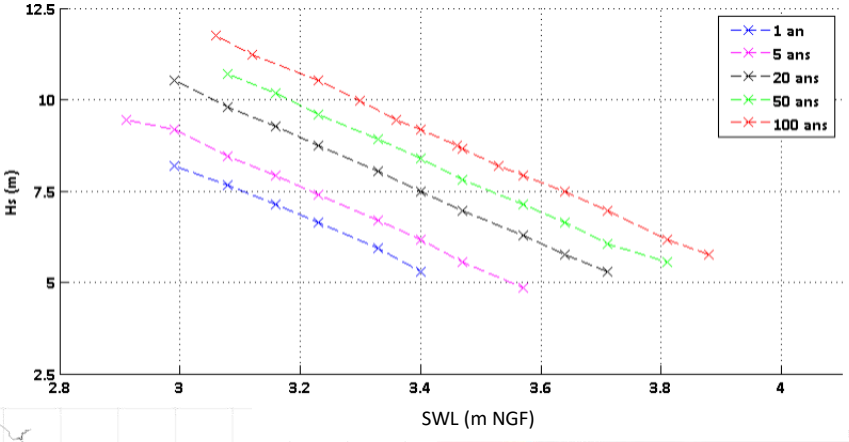
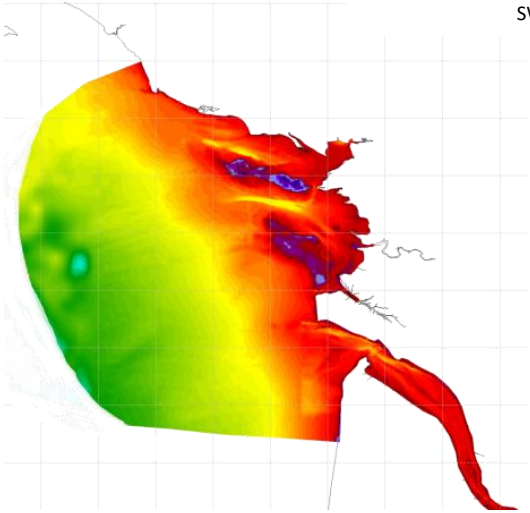
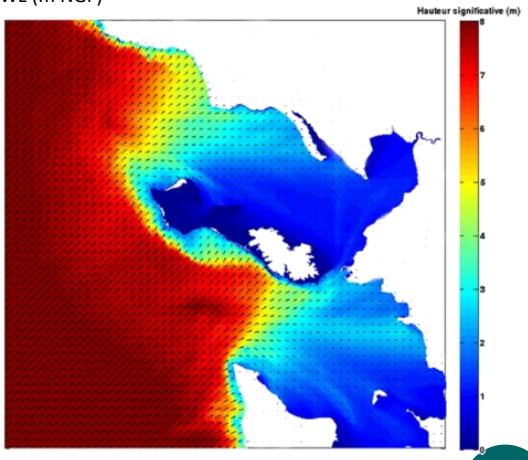






TOOL DESCRIPTION

WAVE OVERTOPPING EVALUATION

- CREST FREEBOARD VERIFICATION (OVERFLOW)
- EUROTOP (2016) – MANUAL ON WAVE OVERTOPPING
- EVALUATION METHOD FOR EACH TYPE OF STRUCTURE:

What kind of structure ?

1) Coastal dikes and embankment seawalls

(chap. 5)

2) Armoured rubble slopes and mounds

(chap. 6)

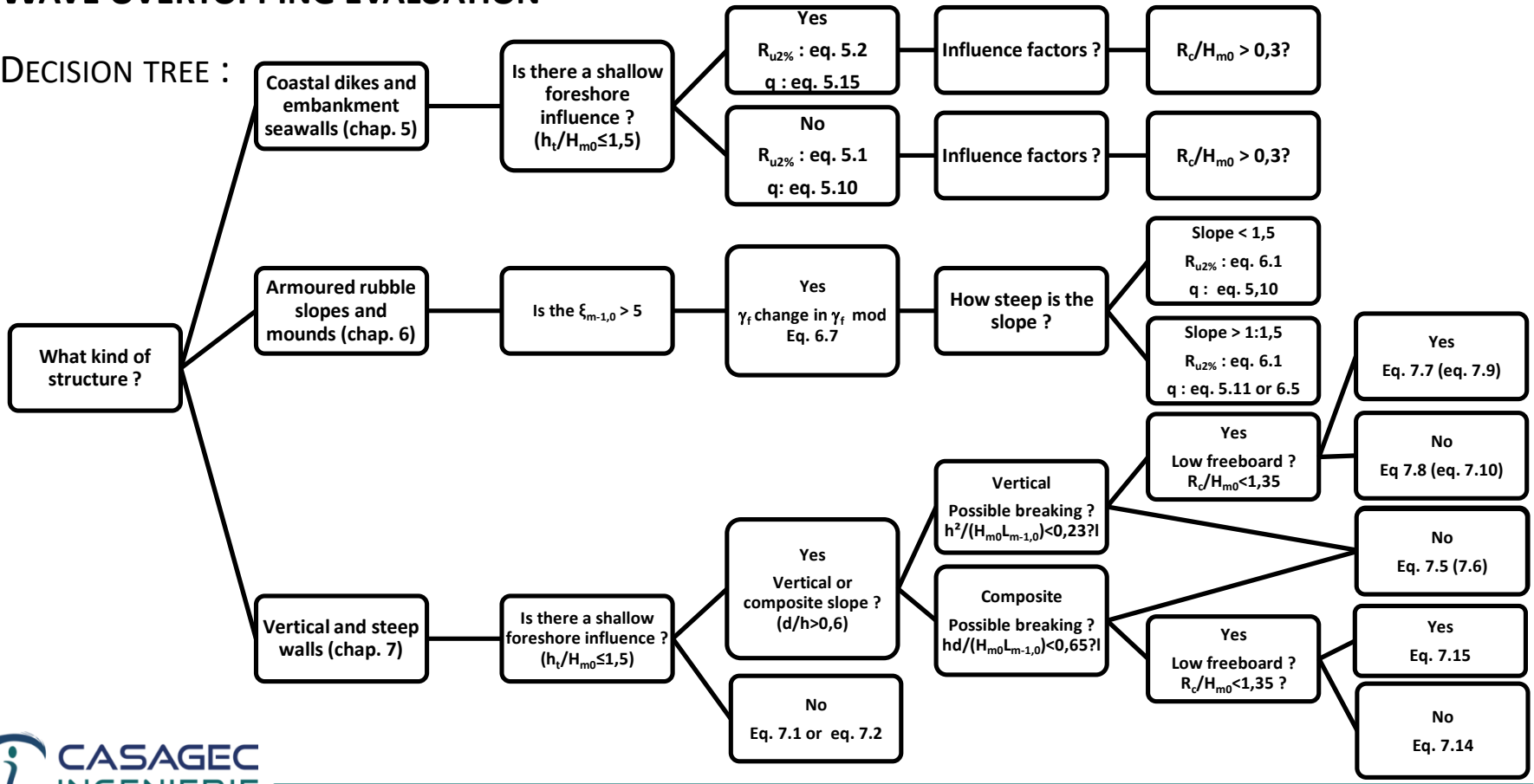
3) Vertical and steep walls

(chap. 7)

TOOL DESCRIPTION

WAVE OVERTOPPING EVALUATION

DECISION TREE :



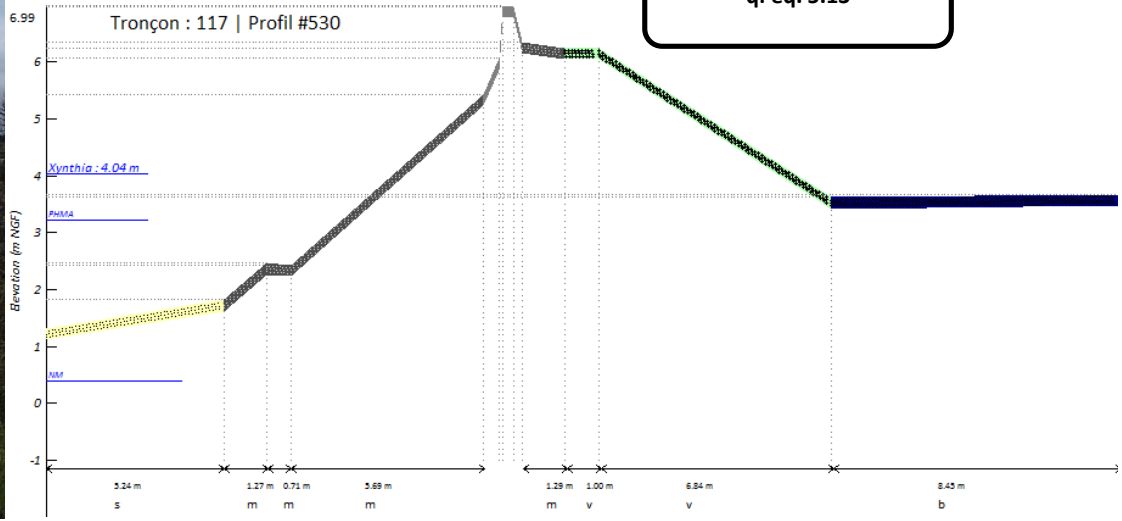
TOOL DESCRIPTION

WAVE OVERTOPPING EVALUATION

- EXAMPLE : DIGUE DU MARTRAY

What kind of structure ? → **Coastal dikes and embankment seawalls (chap. 5)** → **Is there a shallow foreshore influence ? (ht/Hm0=<1,5)**

- **Yes**
  - $R_{u2\%}$: eq. 5.2
  - q: eq. 5.15
- **No**
  - $R_{u2\%}$: eq. 5.1
  - q: eq. 5.13



TOOL DESCRIPTION

WAVE OVERTOPPING EVALUATION

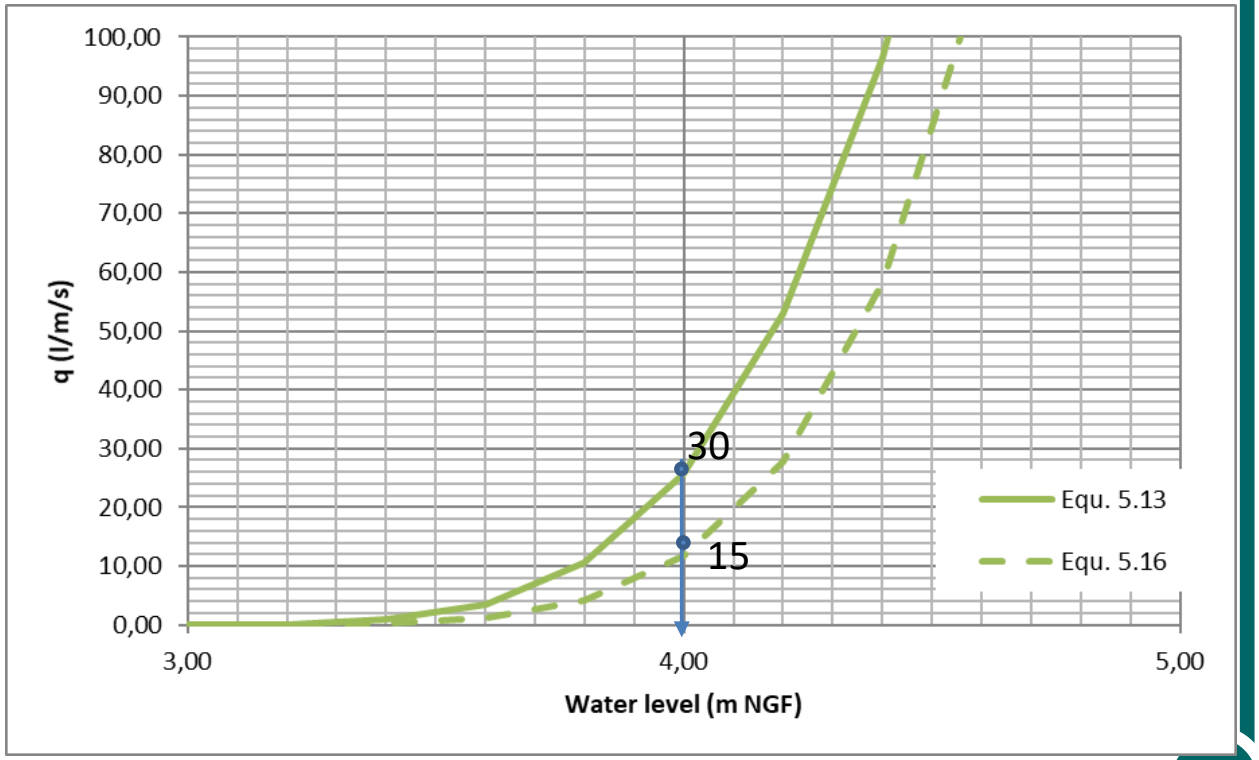
- EXAMPLE : DIGUE DU MARTRAY

<u>Xynthia conditions:</u>

- H_s = 1,3 m
- Average slope: 1H/1V
- R_c : (7-4) 3 m

<u>Sensitivity on formula choice:</u>

- Eq 5.13 *(general formulation Assessment approach)* q= 30 l/s/m
- Eq 5,16 *(embankment with shallow foreshore)* q = 15 l/s/m



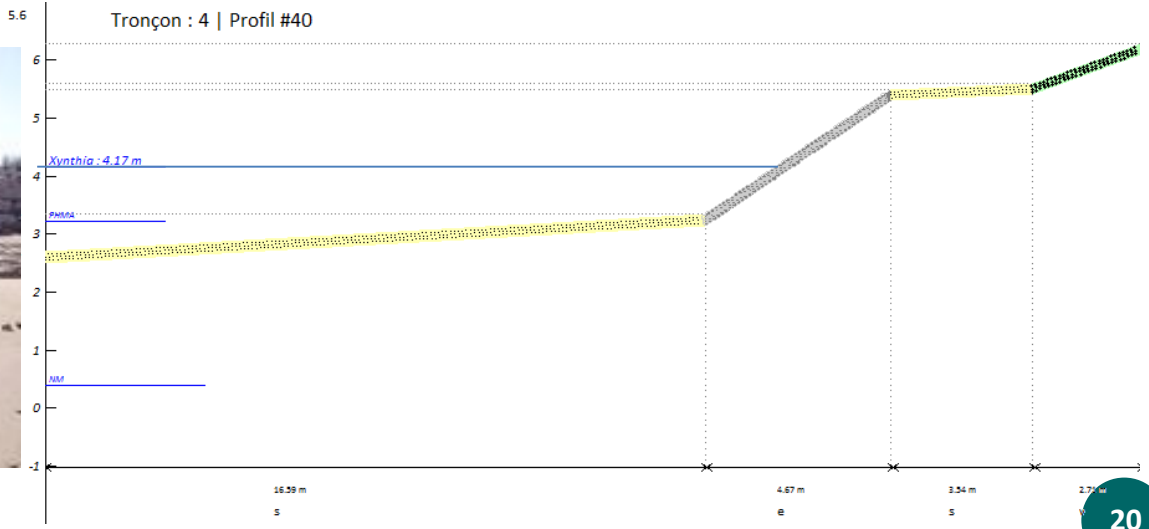
TOOL DESCRIPTION

WAVE OVERTOPPING EVALUATION

- EXAMPLE : GRAND MARCHAIS

What kind of structure ? → Armoured rubble slopes and mounds (chap. 6) → Is the $\xi_{m-1,0} > 5$? → Yes γ_f change in γ_{fmod} Eq. 6.7 → How steep is the slope ?

- Slope < 1:1,5 — $R_{u2\%}$: eq. 6.1 — q : eq. 5,10
- Slope > 1:1,5 — $R_{u2\%}$: eq. 6.1 — q : eq. 5.13 or 6.6



TOOL DESCRIPTION

WAVE OVERTOPPING EVALUATION

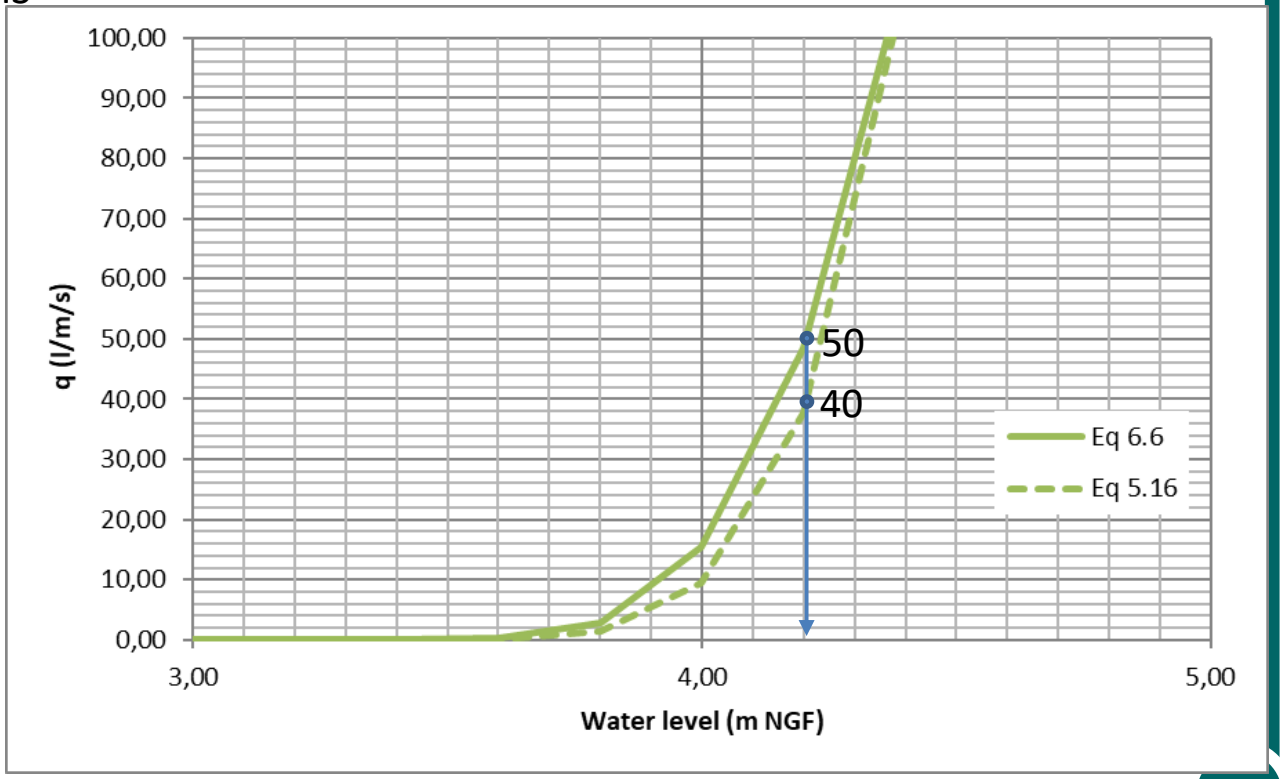
- EXAMPLE : GRAND MARCHAIS

<u>Xynthia conditions:</u>

- H_S = 1,1 m
- Average slope: 2H/1V
- R_c : (5,5-4,2) 1,3 m
- Friction: γ_f = 0,7-1

<u>Sensitivity on formula choice:</u>

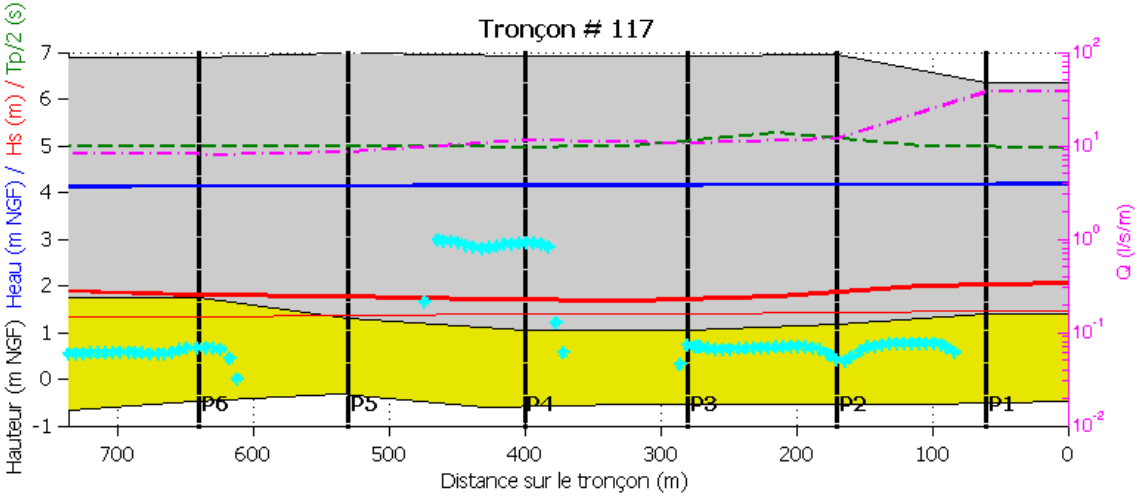
- Eq 6.6 *(Armoured slope no shallow foreshore)* q= 50 l/s/m
- Eq 5,16 *(embankment with shallow foreshore)* q = 40 l/s/m



TOOL DESCRIPTION

TOLERABLE OVERTOPPING DISCHARGE :

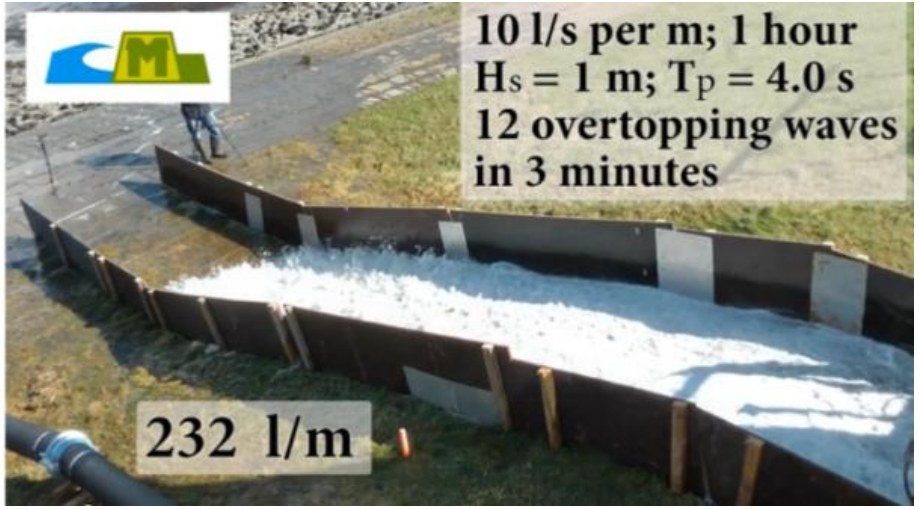
- BIBLIOGRAPHY
- XYNTHIA FEEDBACK :
  - OVERTOPPING ESTIMATION WITH XYNTHIA STORM PROTECTION FAILURE ANALYSIS REGARDING STRUCTURE
  - ASSUMPTIONS ON BREACH OR FAILURE INITIATION PARAMETERS



TOOL DESCRIPTION

TOLERABLE OVERTOPPING:

- BIBLIOGRAPHY
- XYNTHIA FEEDBACK
- OVERTOPPING SIMULATOR (*HTTP://WWW.OVERTOPPING-MANUAL.COM*)



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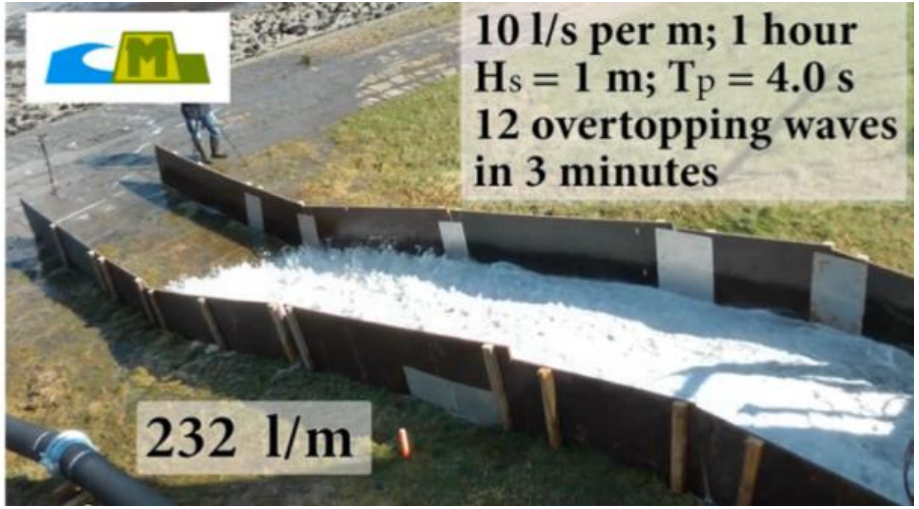
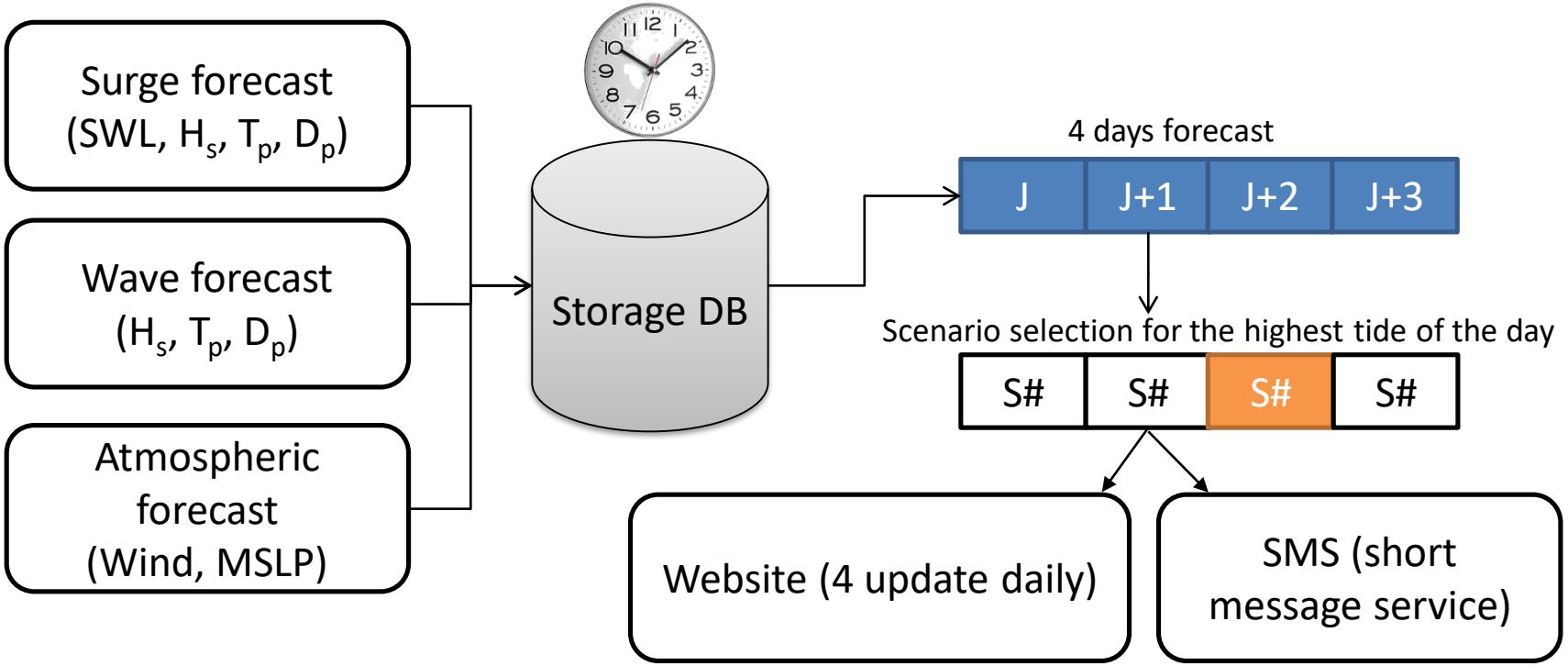


No overtopping	Rare overtopping Q < 0,1 l/s/m	Overtopping Q < 10 l/s/m	Important overtopping Q > 50 l/s/m	Local overflow	Overflow

TOOL DESCRIPTION

→ OPERATIONAL TOOL SCHEME



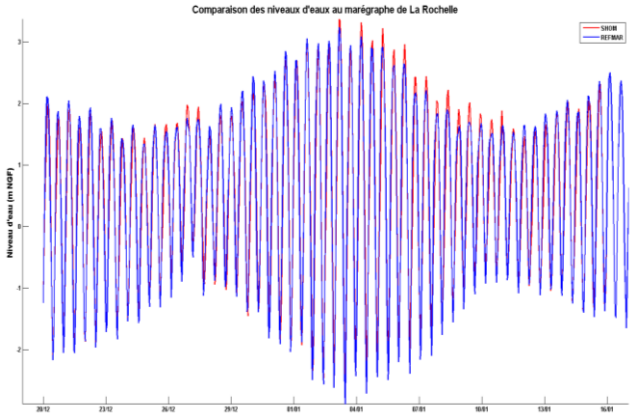
METHOD CALIBRATION

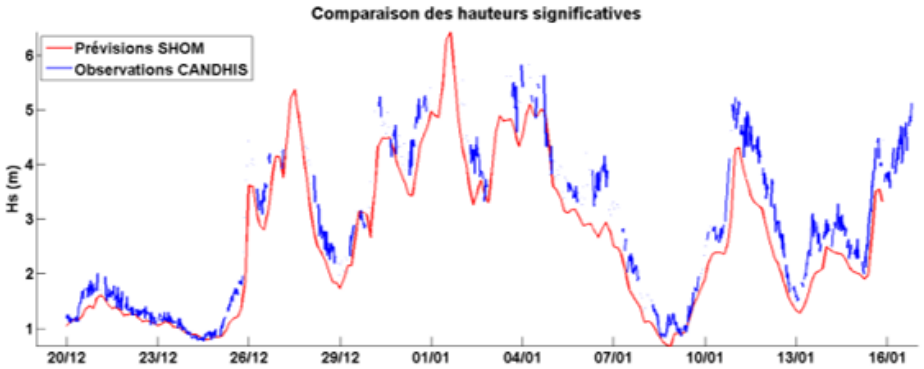
UNCERTAINTIES ESTIMATION

Forecast model comparison with observations (winter storms in early 2018) :

- Bias of 9 cm for water level (closest tide gauge)
- Bias of 39 cm for wave height (closest wave buoys)

→ Consideration of threshold to detect scenario with offshore conditions (10 cm for water level and 1 m for wave height Hs)



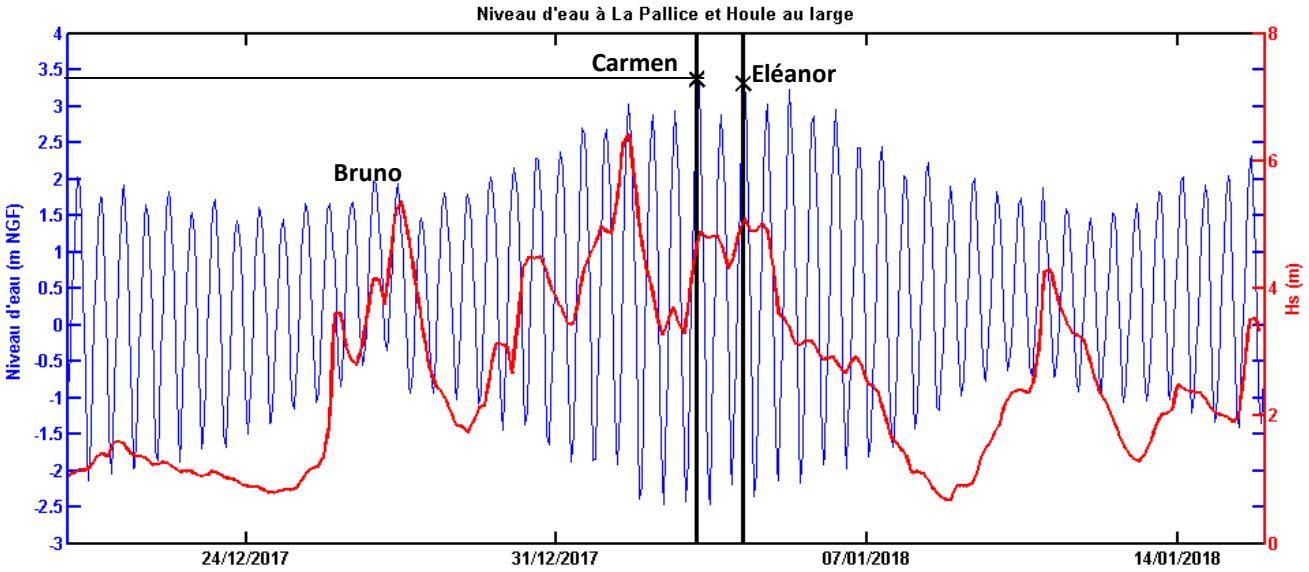


METHOD CALIBRATION

WINTER STORM – EARLY 2018

TOOL EVALUATION ON THE LAST WINTER :

- 3 IMPORTANT STORMS DURING 2018 WINTER
- WATER LEVEL > 3.4 M
- WAVE HEIGHT > 6 M

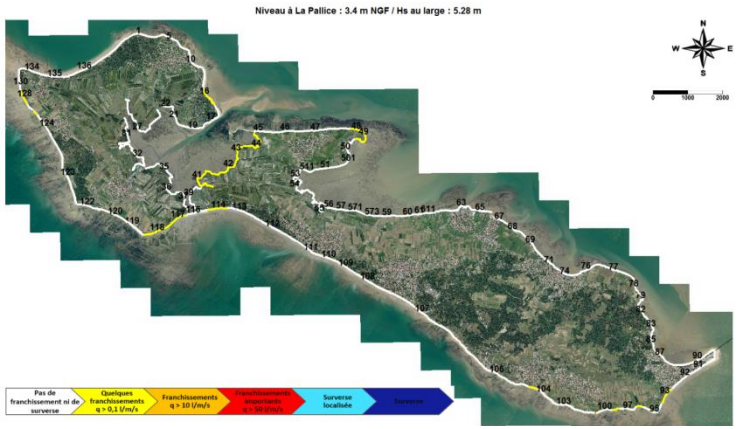


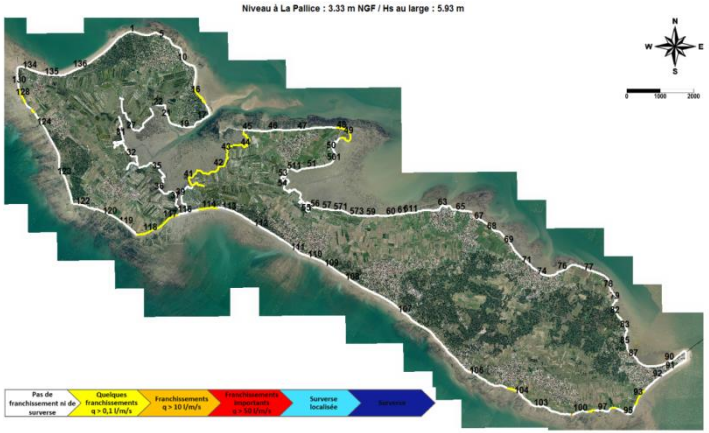
METHOD CALIBRATION

WINTER STORM – EARLY 2018

Tool evaluation

- 3 important storms
- 2 scenarios detected :
  - 3rd of January 2018 4am : SWL=3,37 m NGF and H_s =4,68 m (scenario 2)
  - 4th of January 2018 5am : SWL = 3,31 m NGF et H_s =5,03 m (scenario 5).





METHOD CALIBRATION

WINTER STORM – EARLY 2018

Area	Photo	Observation	forecast
Trousse-Chemise (profile16)		Weak overtopping	Weak overtopping (<0,1 l/s/m)
Maladrerie (profile103)		No overtopping observation	Pas de franchissements prévus
Pas des Huitres (profiles 60-61)		High water marks on crest (seaweed)	No overtopping
Martray (profile 116)	No photography available	Weak overtopping	Weak overtopping (<0,1 l/s/m)

CONCLUSIONS

CONCLUSIONS ON CURRENT TOOL :

- TOOL EASY TO USE, BASED ON CHARTS
- ALLOW A QUIK EVALUATION OF OVERTOPPING RISKS ON THE WHOLE ISLAND
- POSSIBLE TO USE WITH GLOBAL FORECAST MODEL
- CALIBRATED ON RECENT OBSERVATIONS

FUTURE WORKS :

- IMPROVEMENTS WITH OTHER OBSERVATIONS (WITH STRONGER STORMS)
- POSSIBILITY TO INCREASE NUMBER OF SCENARIOS
- POSSIBILITY TO USE IT ON A LONG TERM ANALYSIS

EurOtop overtopping guidance applied in a tool with large variety of coastal protections at Ile de Ré

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