Simulating coastal flooding during Xynthia : an improved static inundation method

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Aims of this study

→ Studying the advantages and limitations of a simple raster-based flood modeling and overflowing discharge calculations because they are fast methods that can be used following storm alerts.

→ Accurate observed flood inundation maps and high resolution topographic LiDAR data offer the opportunity to evaluate those fast modeling methods.

Methods

A – Static flood modeling

→ **Maximum water level retrieved from the storm surge numerical model**

→ **Intersection between this level and the LiDAR DEM**

B – Surge overflowing on dikes

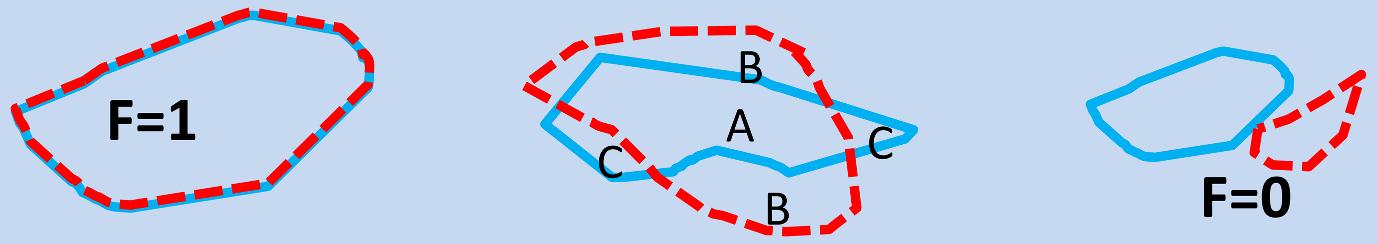
→ **Surge overflowing volume over dikes computed from time series of water levels from the model**

$$Q = \mu . L . (2.g)^{1/2} . h^{3/2}$$

Q is the water discharge in $m^3.s^{-1}$
μ is the discharge coefficient
L is the width of the discharge area in m
g is the acceleration of gravity in $m.s^{-2}$
h is the water height over the dike in m

→ **Spreading of this water volume within marshes**

Fit measurements (F) between observed and modeled flooded areas



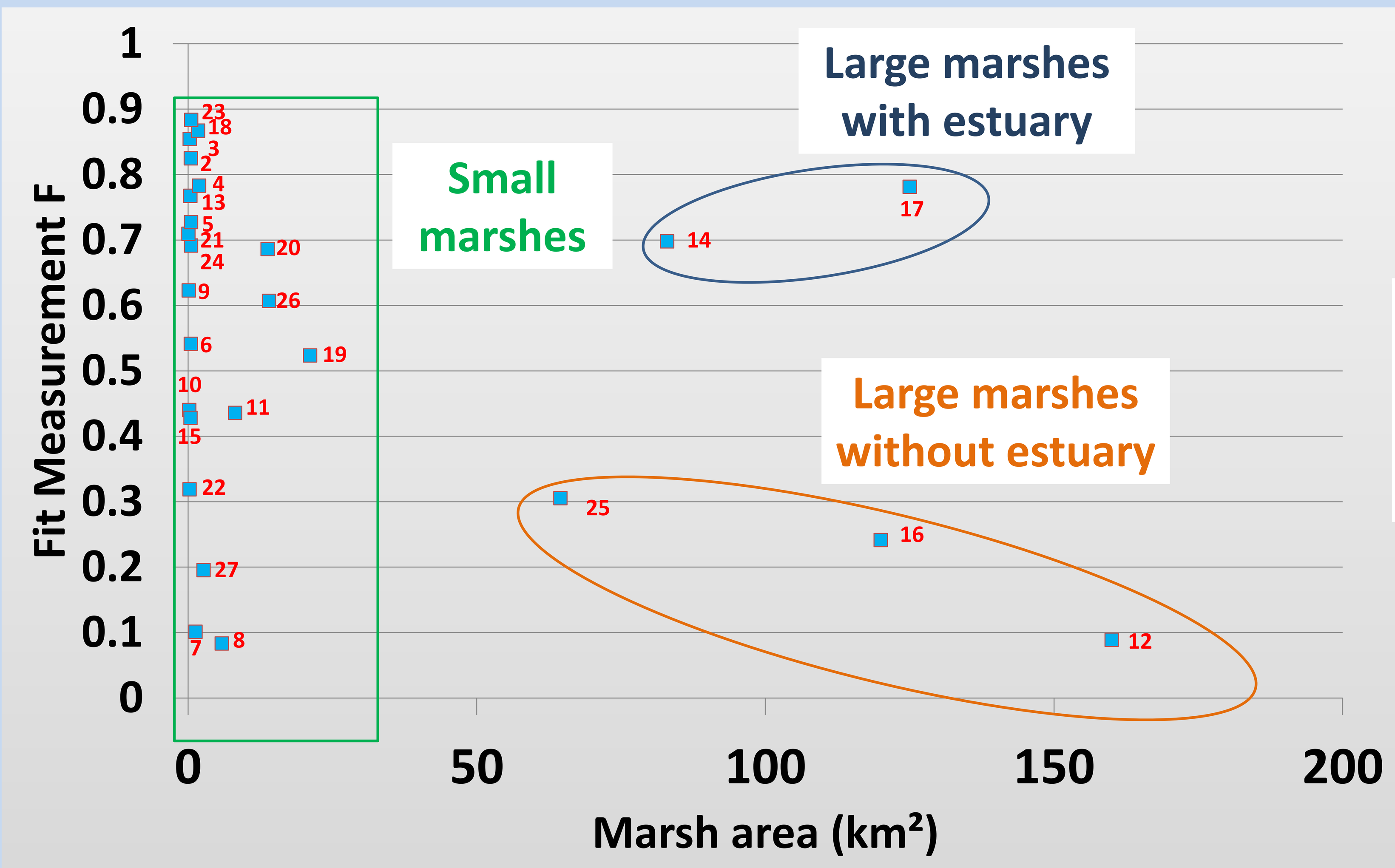
Observed flooded area
Modeled flooded area

A is the area correctly predicted as flooded by the model
B is the area predicted as flooded that is actually dry (over-prediction)
C is the flooded area not predicted by the model (under-prediction)

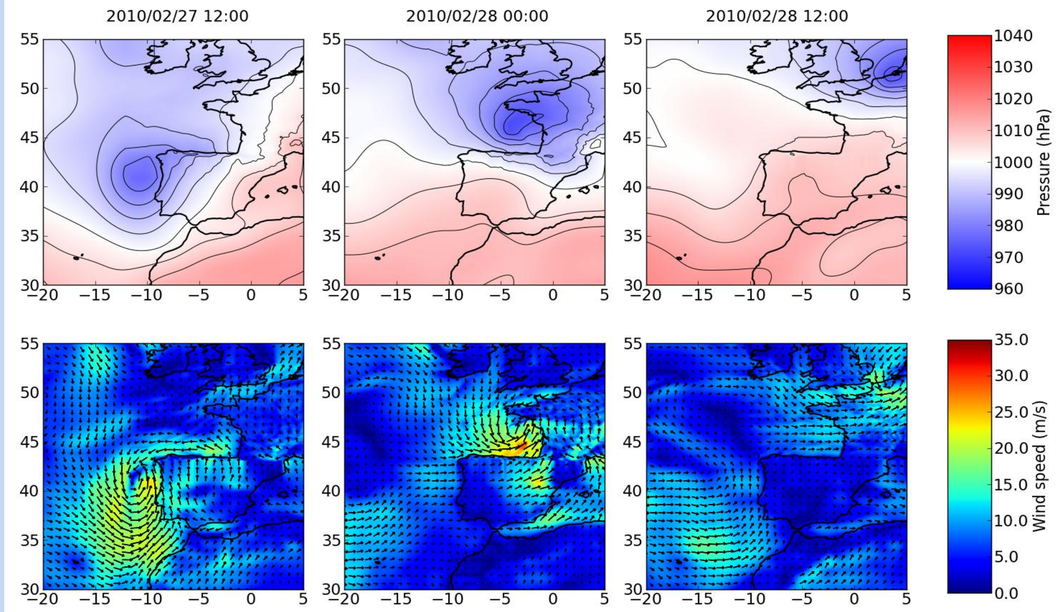
$$F = \frac{A}{A + B + C}$$

Aronica, G., Bates, P. D., and Horritt, M. S. (2002) : Assessing the uncertainty in distributed model predictions using observed binary information within GLUE, Hydrol. Processes, 16, 2001–2016.

Marsh sizes vs Fit measurements (method A)



The Xynthia storm and associated flooding

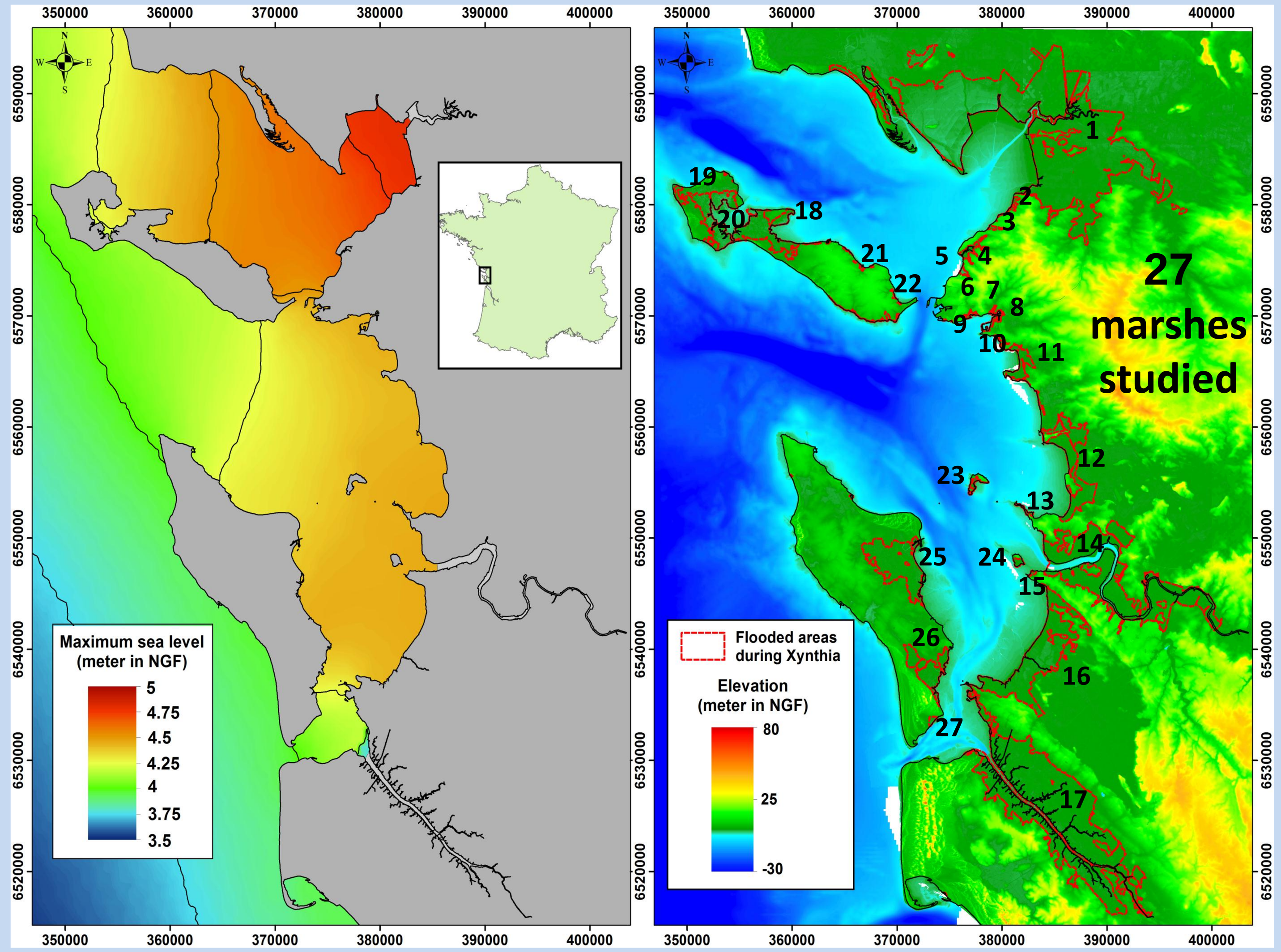


→ Atypical SW – NE storm trajectory

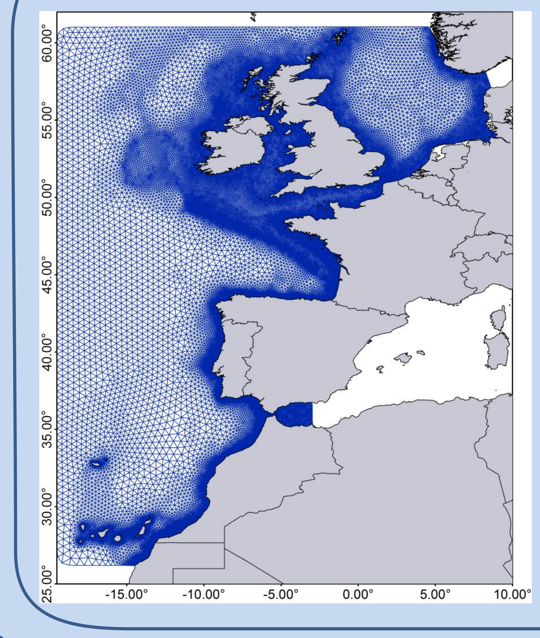
→ Minimum atmospheric pressure : 969 hPa

→ Maximum hourly mean wind :130 km/h

→ Huge flooded areas (up to 10 km inland)



Storm surge numerical modeling

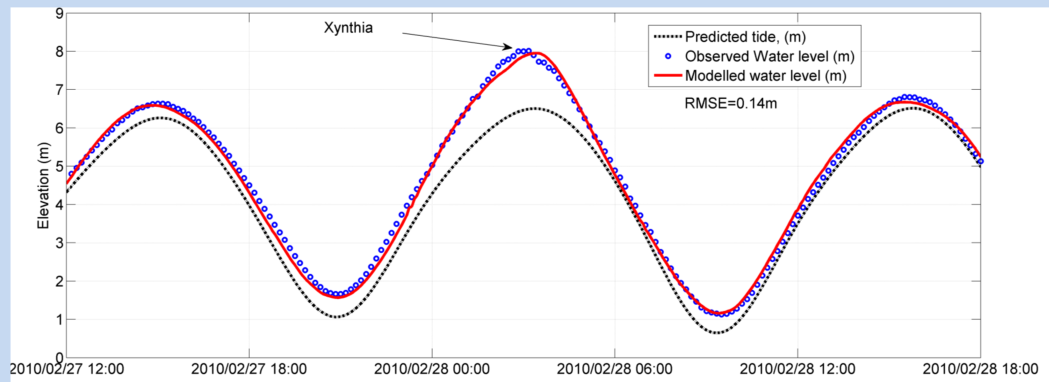


→ 2DH Circulation model SELFE (Zhang and Baptista, 2008).

→ Wave model WWIII (Tolman, 2009).

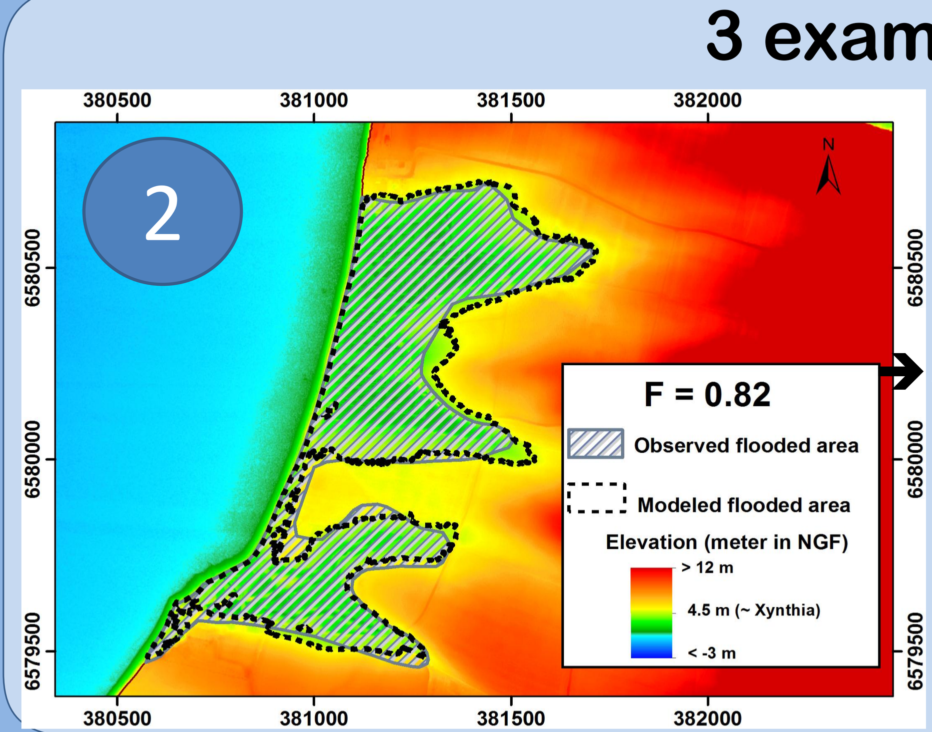
→ Coupling through the friction velocity, wave-dependent surface stress.

Bertin, X., Bruneau, N., Breilh, J.F., Fortunato, A.B., Karpytchev, M., (2012) : Importance of wave age and resonance in storm surges: the case Xynthia, Bay of Biscay. Ocean Modelling 42 (4), 16-30. 11
Tolman H.L. (2009). User manual and system documentation of WAVEWATCH III version 3.14. NOAA/NWS/NCEP/MMAB Technical Note 276, 194 p.
Zhang Y.L., Baptista A.M. (2008). SELFE: A semi-implicit Eulerian-Lagrangian finite-element model for cross-scale ocean circulation. Ocean Modelling 21(3-4), pp 71-96.

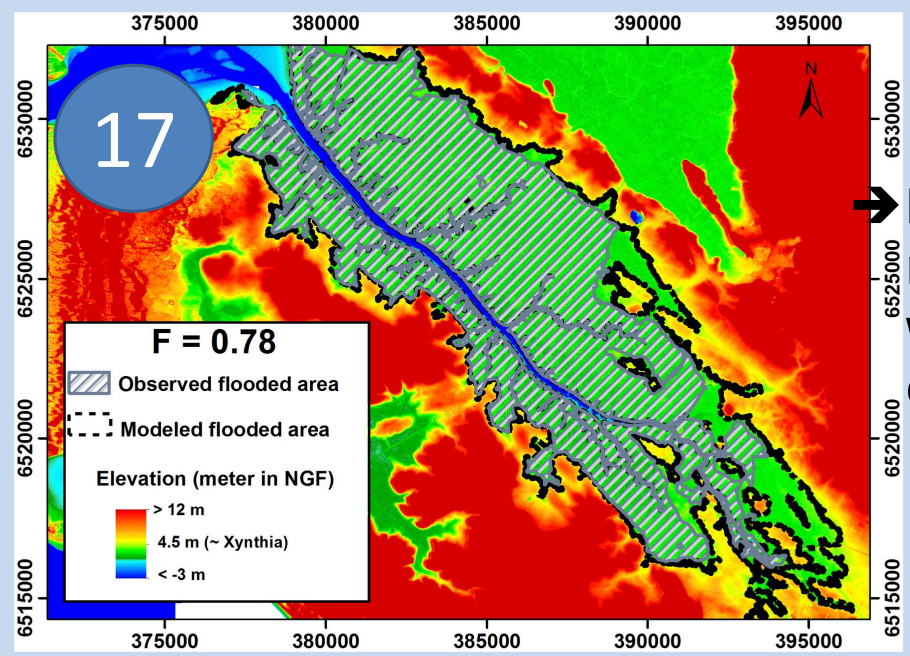


→ 1.5 m storm surge at La Rochelle tide gauge

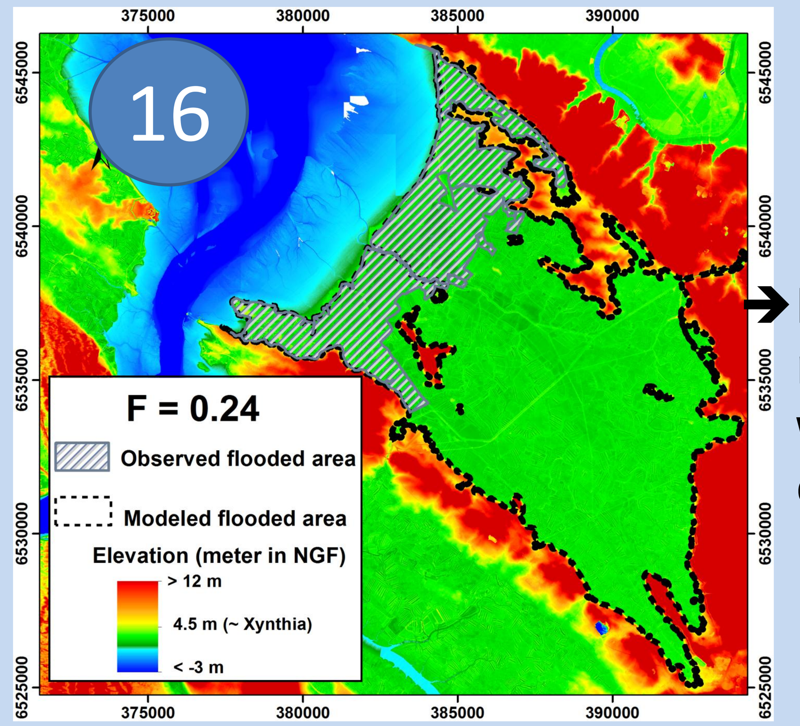
3 examples of static flood modeling results



→ Small marsh

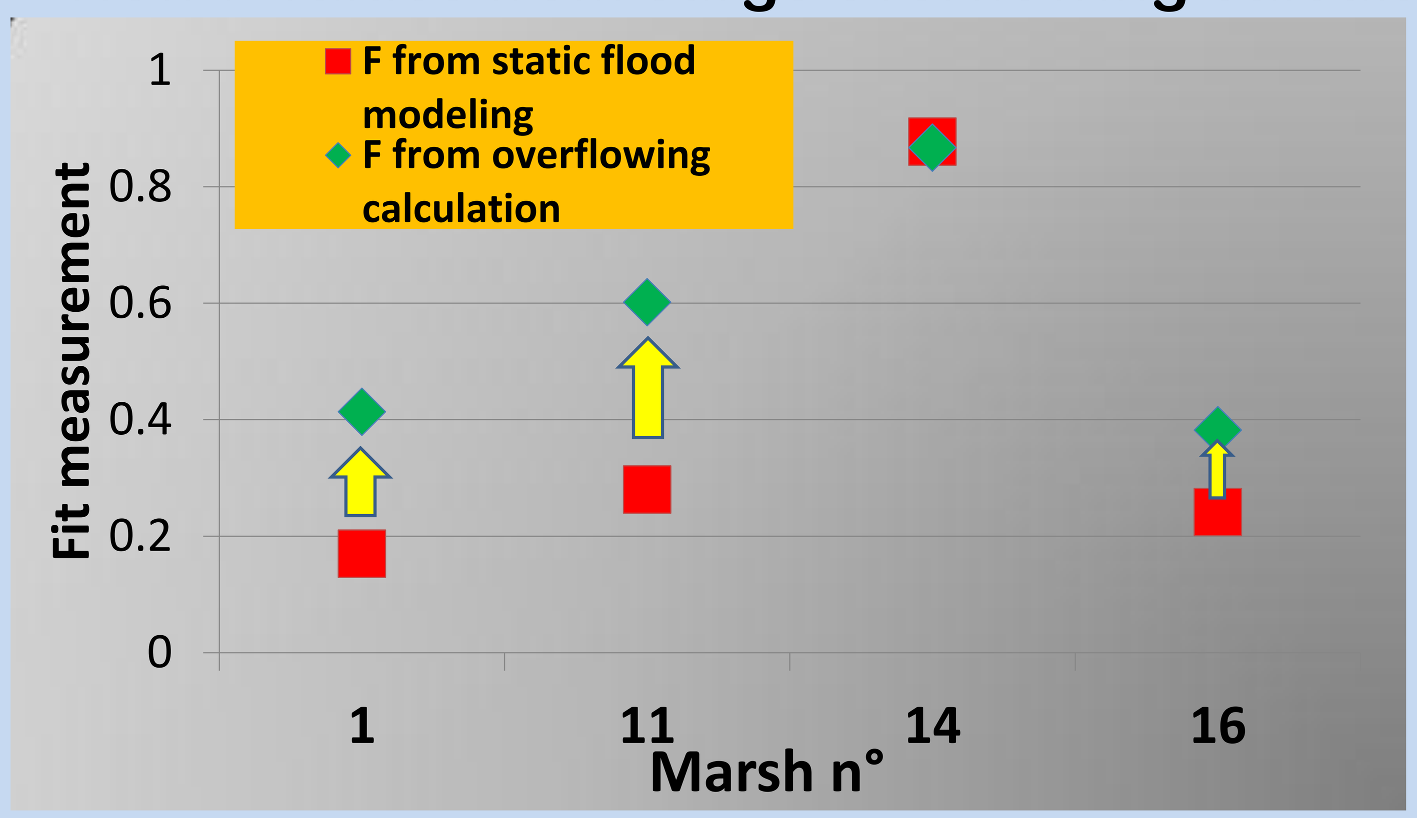


→ Large marsh with estuary



→ Large marsh without estuary

New F values from surge overflowing calculation (method B)



→ **Surge overflowing water volume calculation significantly increases fit measurement**

Conclusions

→ Static flood modeling gives good results for small marshes and large marshes with estuary

→ Surge overflowing calculation over dikes improves bad results of static flood modeling

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- …