A PROBABILISTIC FRAMEWORK TO CHARACTERIZE UNCERTAINTIES IN SAR-BASED FLOOD MAPPING

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G-POD

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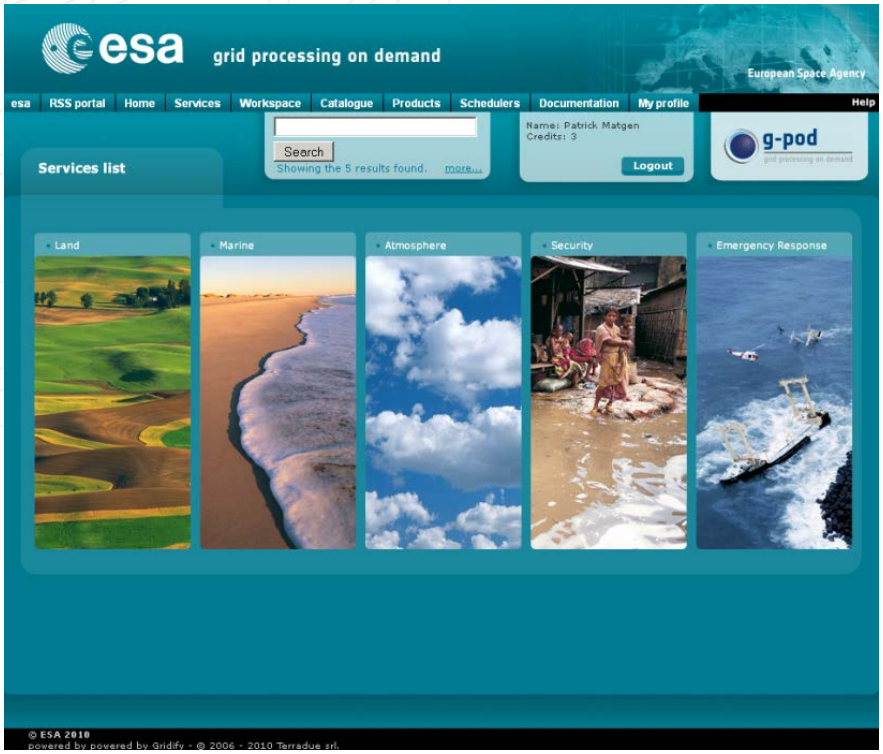
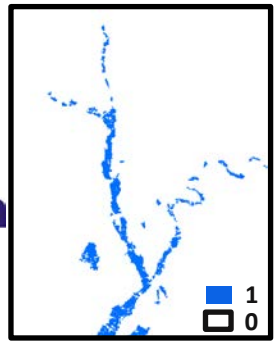


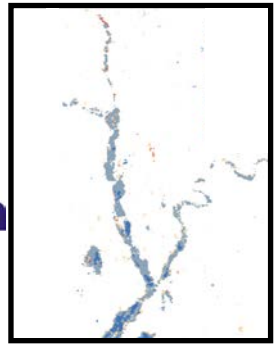
SAROTEC

BINARY MAP

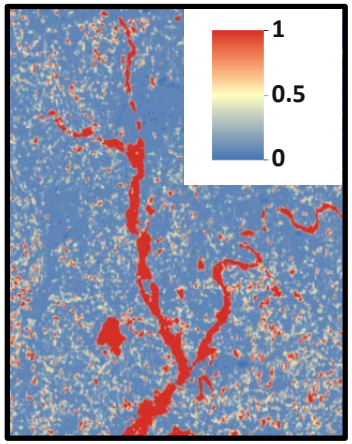


HASARD

HAZARD MAP



PROBABILISTIC MAP?

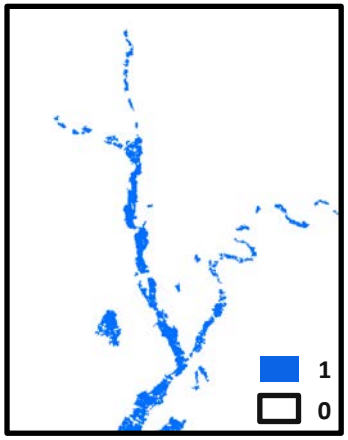


Applications:

Data Assimilation:
assimilation of uncertain flood extent into 2D hydraulic model

Additional Product:
characterization of uncertainty in flood mapping delineation for decision-makers

BINARY MAP
(binary values)

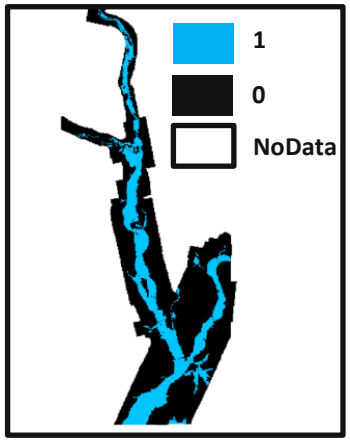


Research Questions:

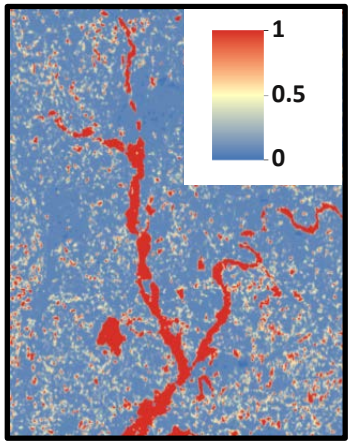
1) How to get a Probabilistic Map of flood?

2) How to evaluate its correctness?

VALIDATION MAP
(binary values)

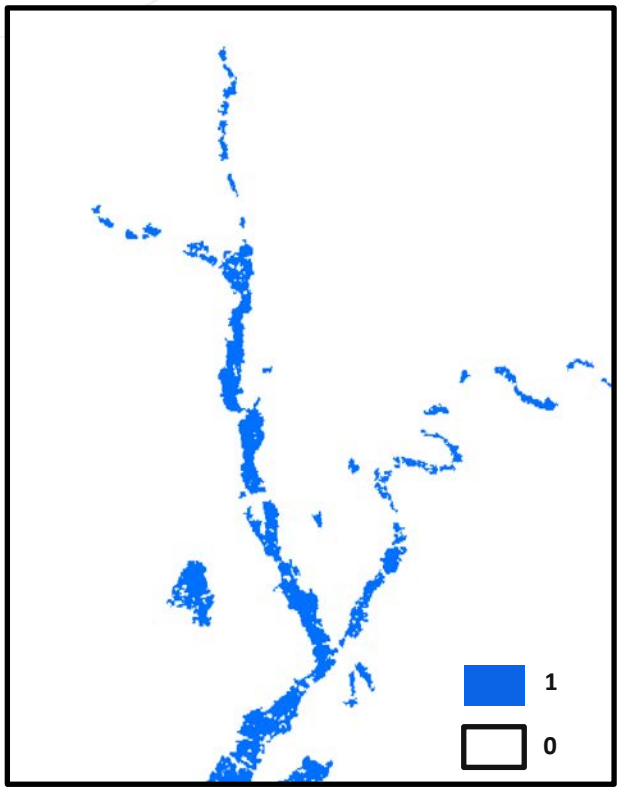


PROBABILISTIC MAP
(real values)

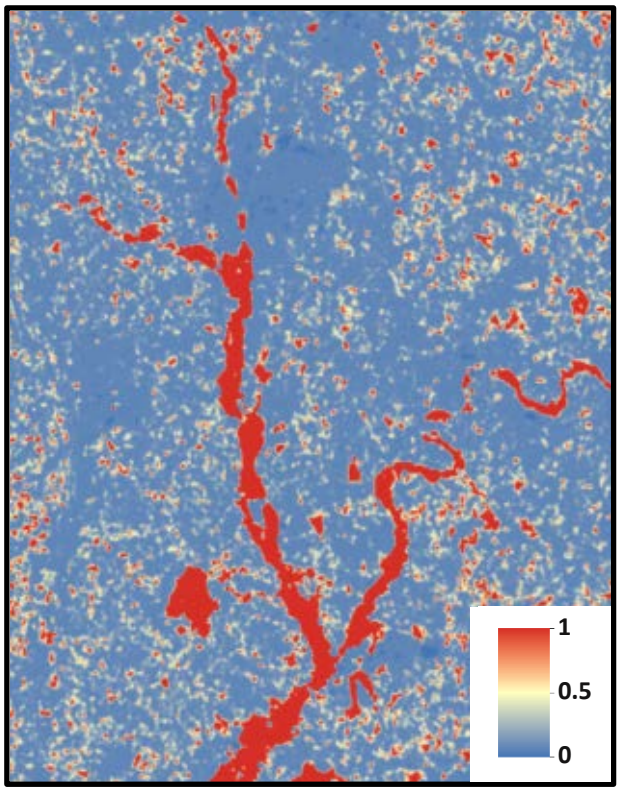


Satellite derived Inundation Map(s)

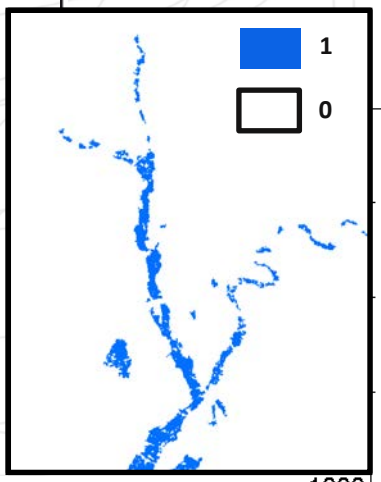
BINARY MAP



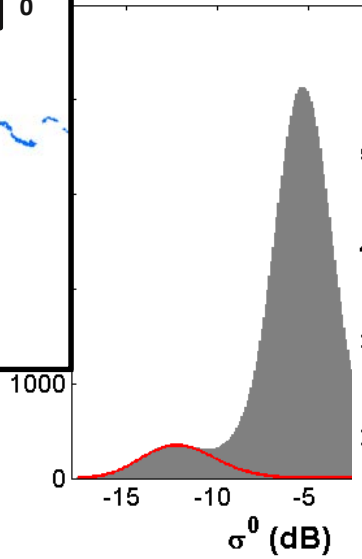
PROBABILISTIC MAP



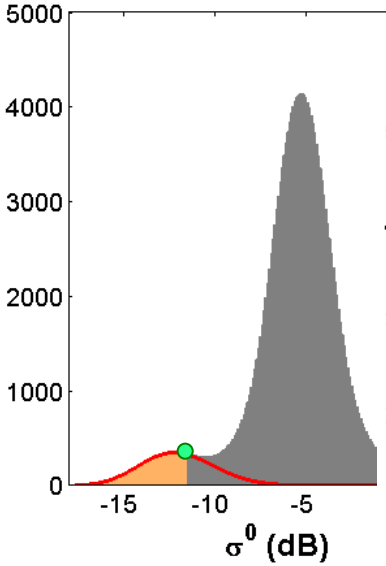
Binary Map



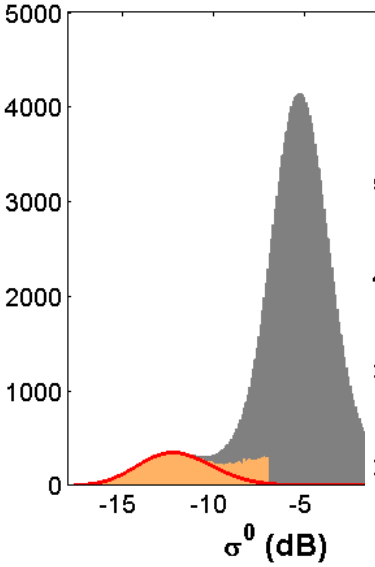
Gauss curve fitting

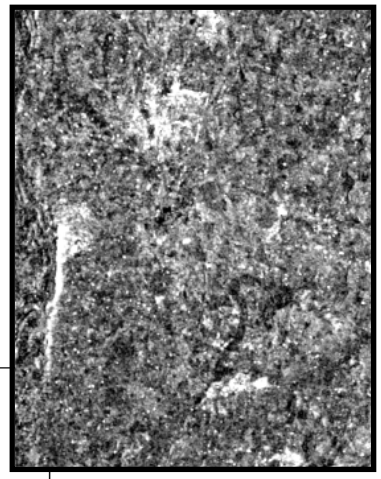


Threshold

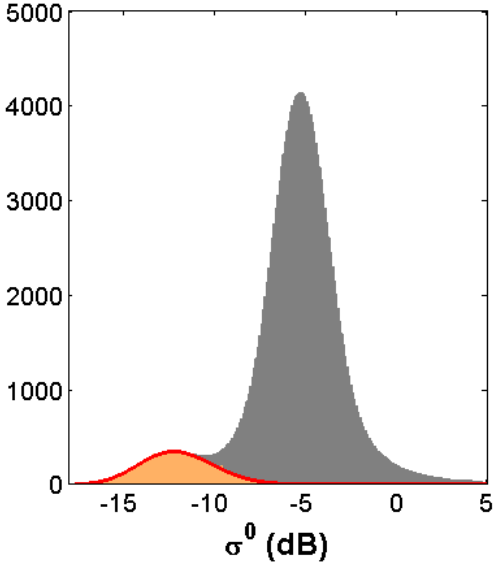


Region Growing

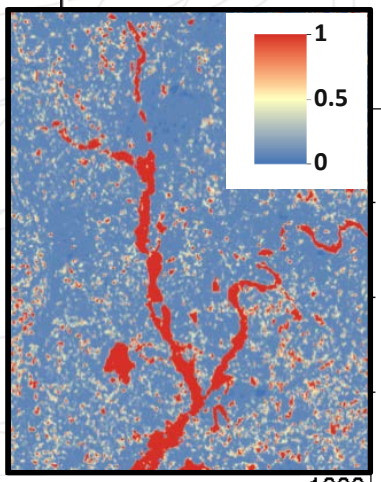




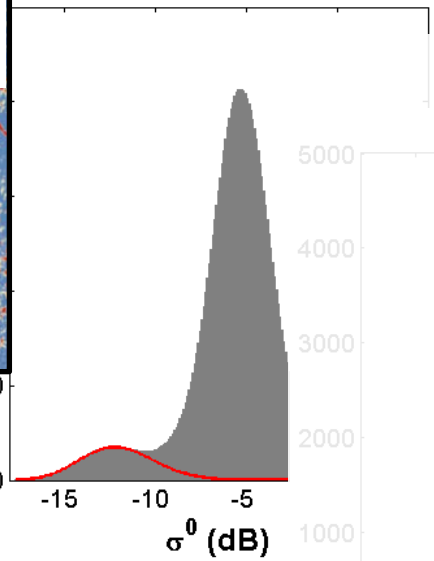
Change Detection



Probabilistic Map



Gauss curve fitting

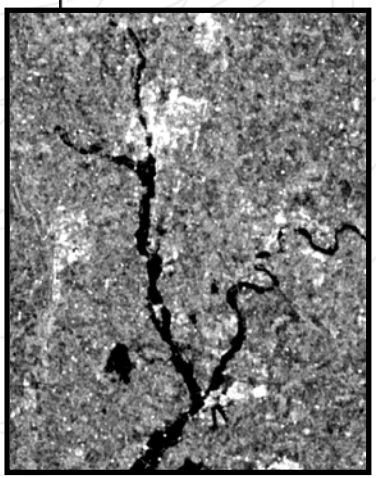


Threshold

Region Growing

Change Detection

How to get a probabilistic map?



Conditional probability of a pixel being flooded given its backscatter value:

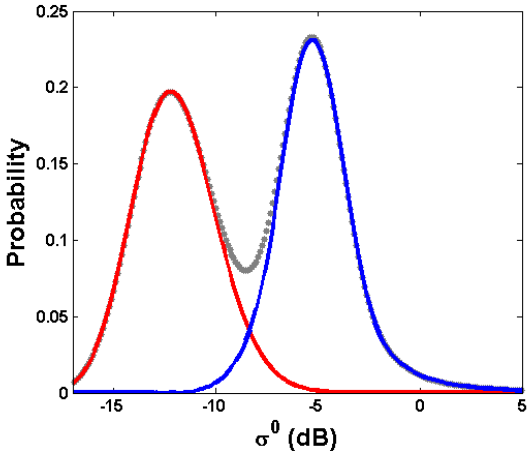
prior to the backscatter being measured

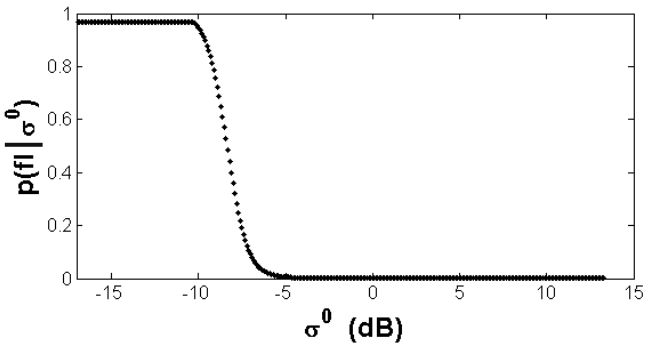
0.5 0.5

$$p(fl|\sigma^0) = \frac{p(\sigma^0|fl)p(fl)}{p(\sigma^0|fl)p(fl) + p(\sigma^0|nfl)p(nfl)} = \frac{p(\sigma^0|fl)p(fl)}{p(\sigma^0)}$$

prob. pdf of σ^0 values for flooded pixels

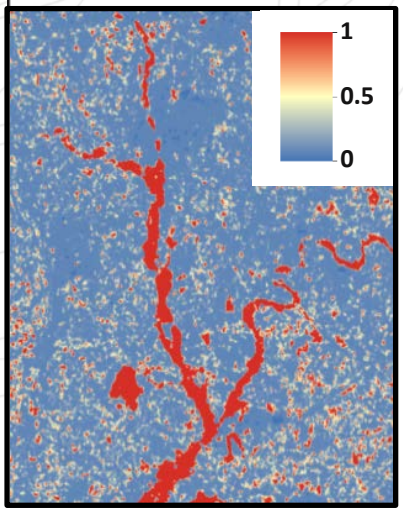
prob. pdf of σ^0 values for non-flooded pixels



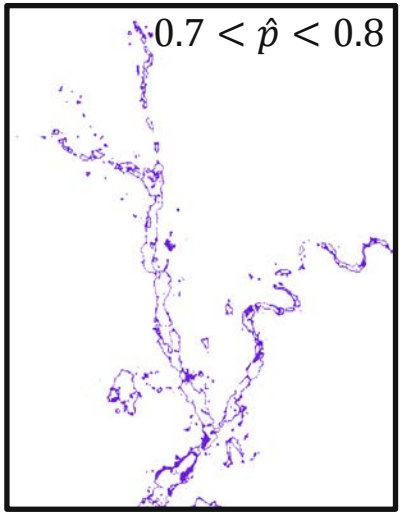


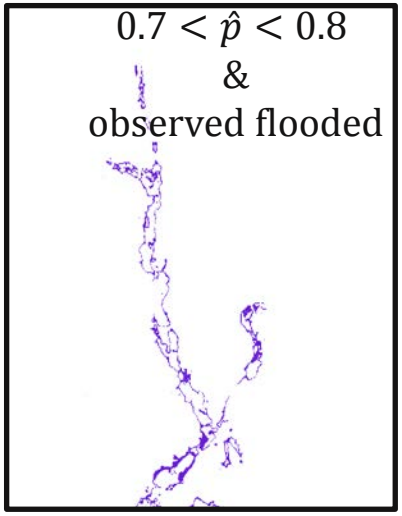
How to evaluate its correctness?

PROBABILISTIC MAP
(real values)

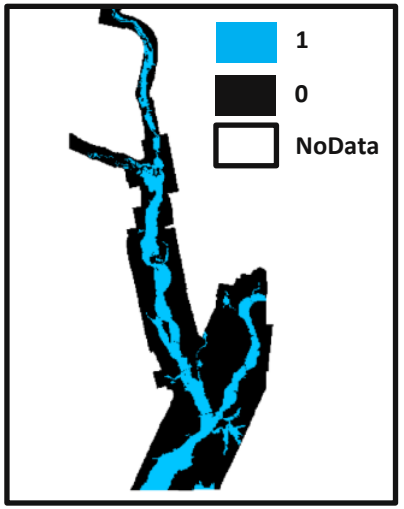


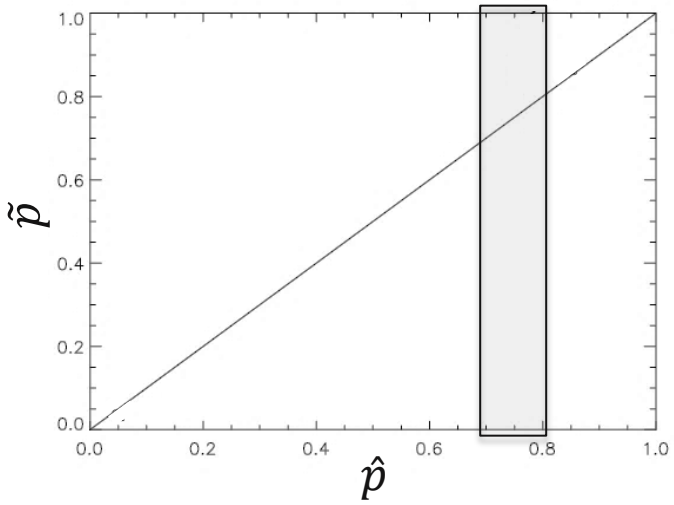
$\hat{p}$





VALIDATION MAP
(binary values)





$$\text{WRMS} = \sqrt{\frac{\sum_{i=1}^{N}\left((\hat{p}_i(\text{fl}|\sigma^0) - \tilde{p}_i(\text{fl}|\sigma^0))^2 \cdot \text{npx}_i\right)}{\sum_{i=1}^{N}(\text{npx}_i)}}$$

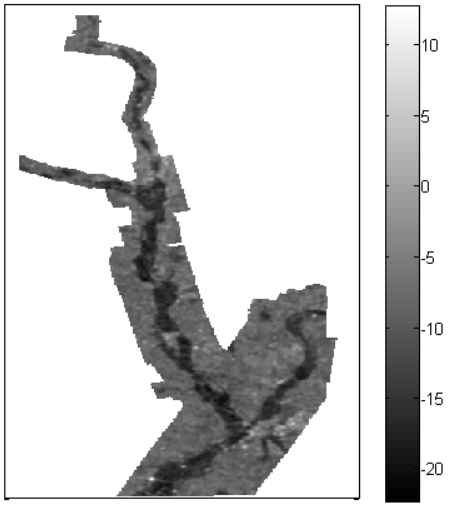
Horritt
A methodology for the validation of uncertain flood inundation models. JoH (2006)

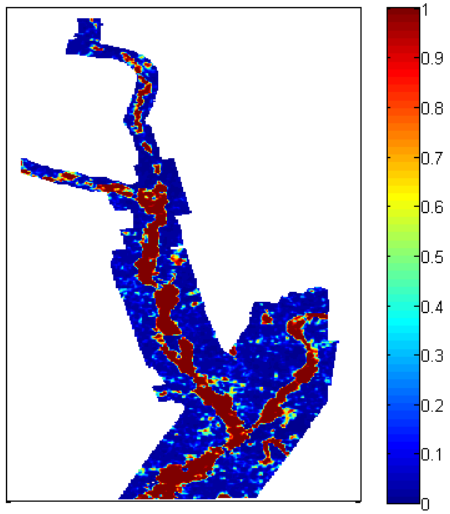
CASE STUDIES

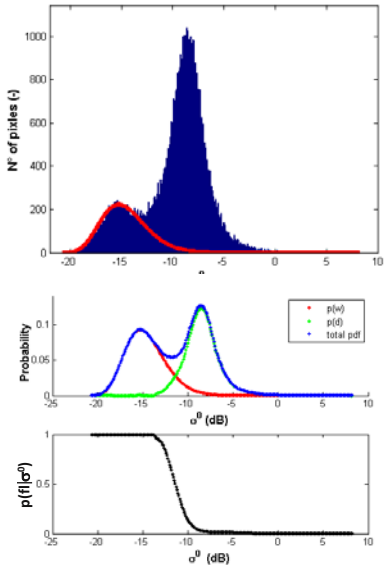
AOI	SAR			validation		
	type	time	Resolution [m]	type	time	% of water
Severn	ENVISAT	2007/07/23 10:27	150	aerial photos	2007/07/24	26
Severn	ENVISAT	2007/07/23 21:53	150	aerial photos	2007/07/24	26
Severn	TerraSAR-X	2007/07/25 06:34	3	aerial photos	2007/07/24	41
Red River	RADARSAT-1	1997/04/24 00:27	25	aerial photos	1997/04/24	74

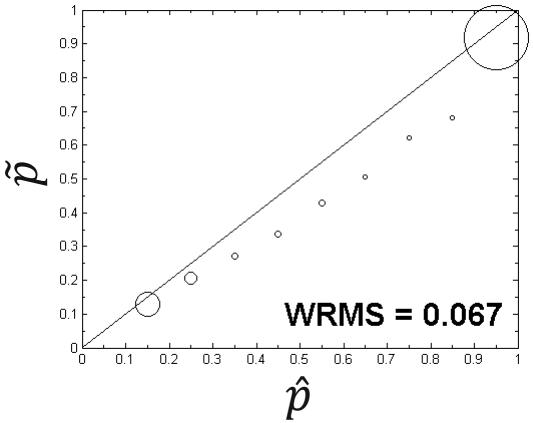
SEVERN

Envisat: 2007/07/23 10:27









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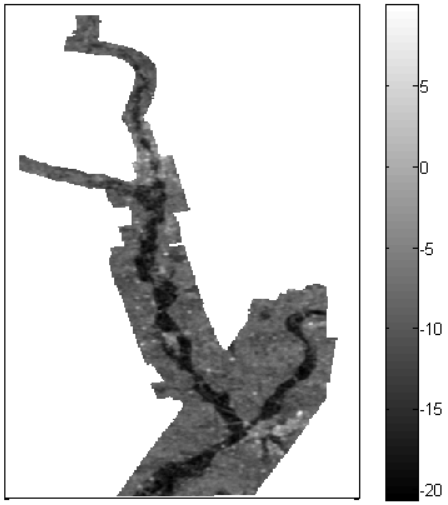
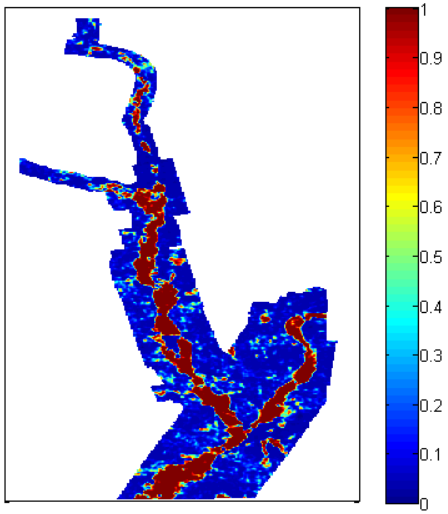
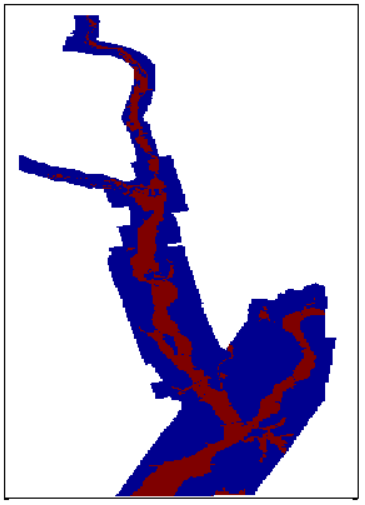
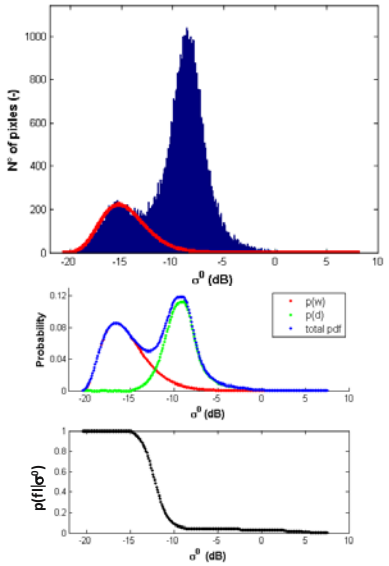
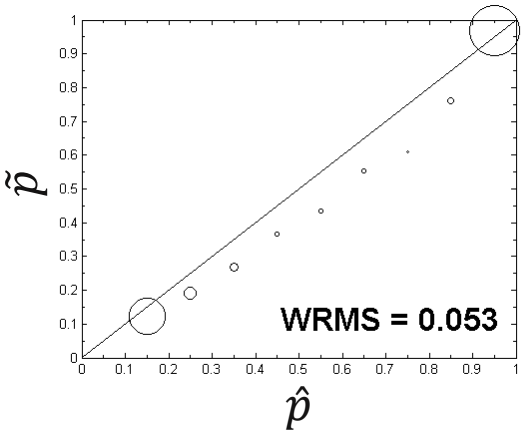




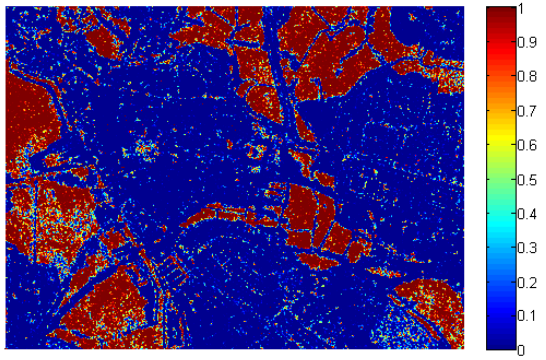


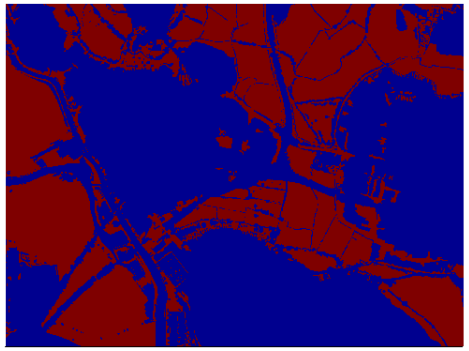


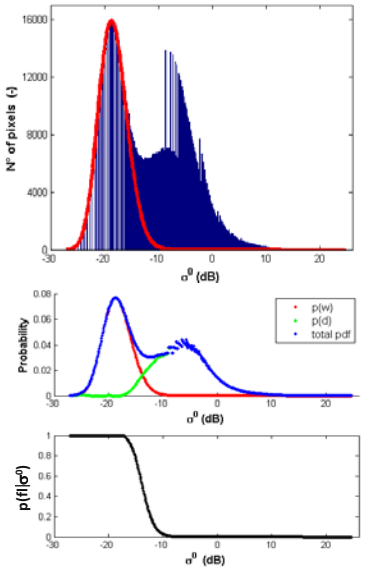


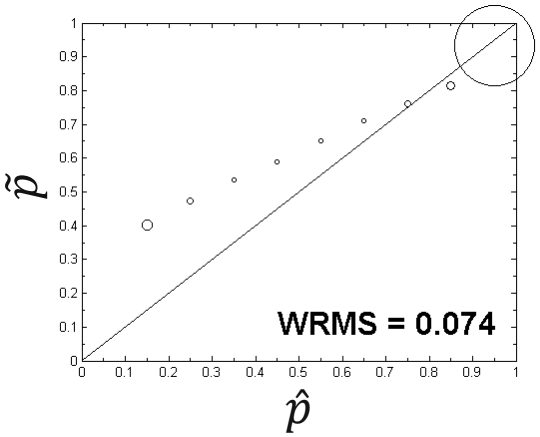
SEVERN

TerraSAR-X: 2007/07/25 06:34



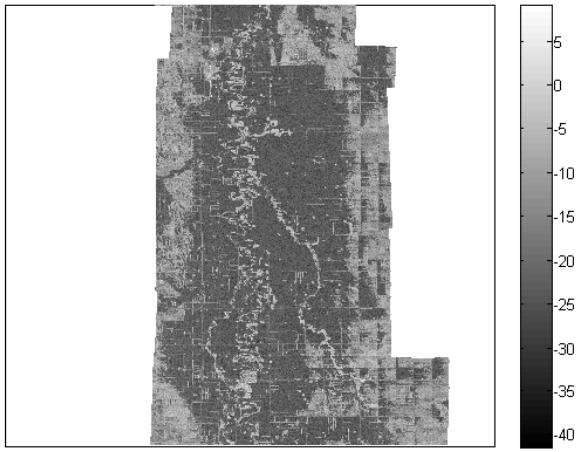


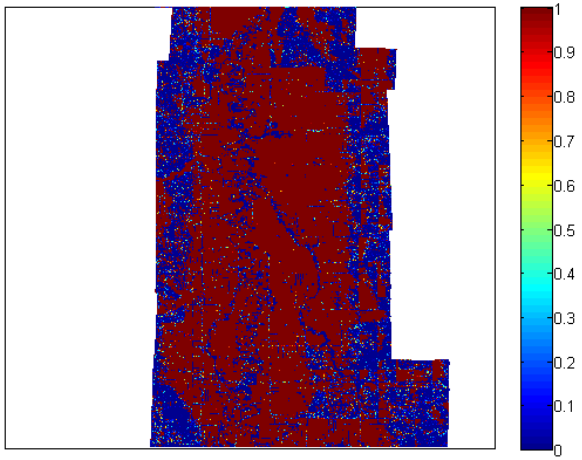


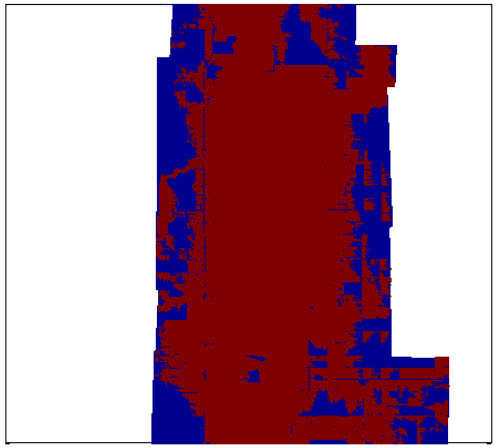


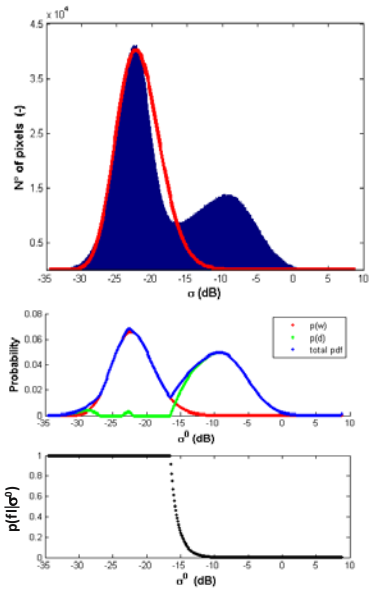
RED RIVER

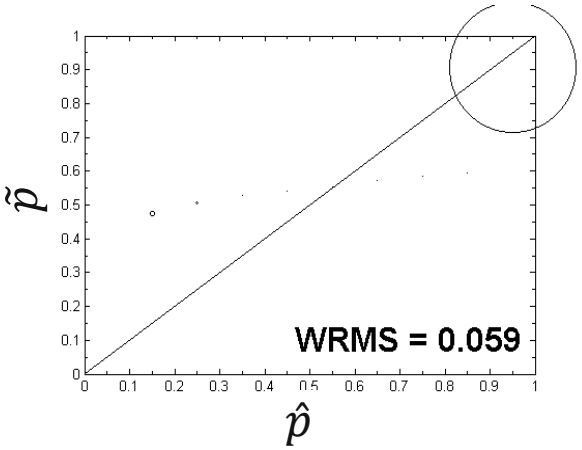
RADARSAT-1: 1997/04/24 00:27





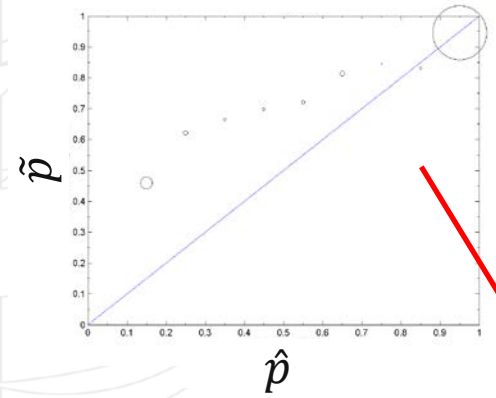


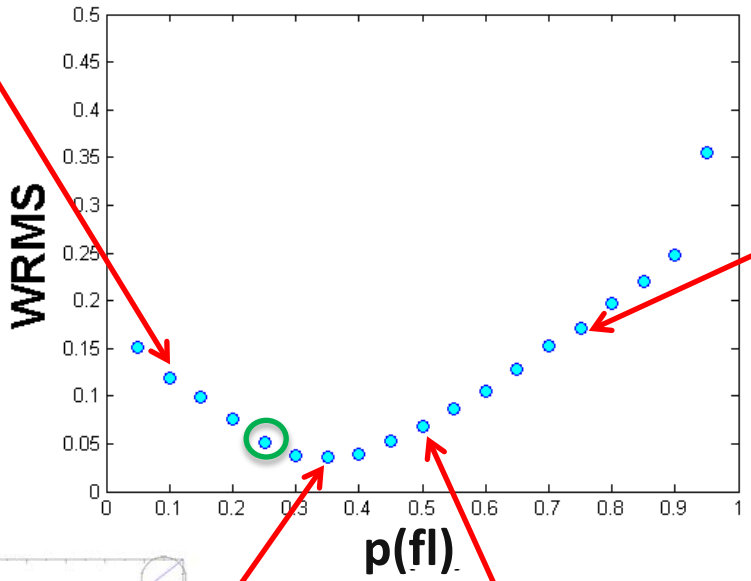


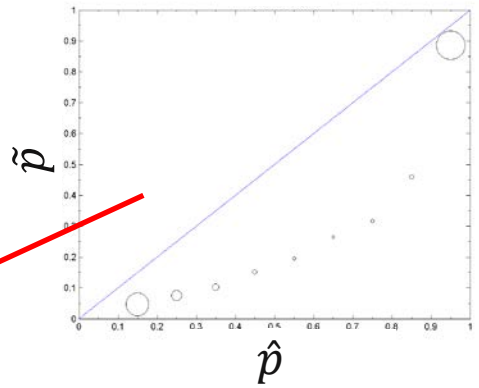


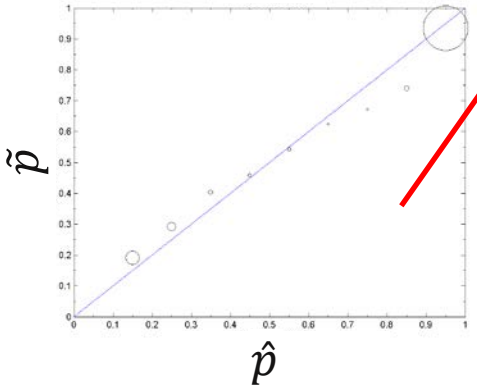
Analysis of prior pdf

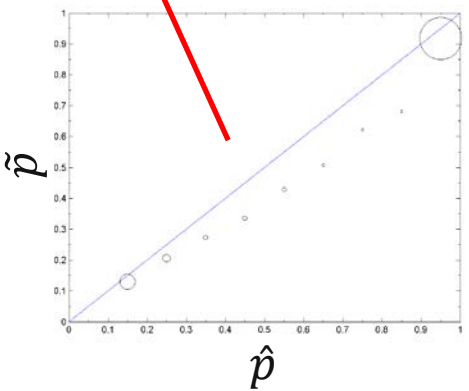
SEVERN: Envisat 2007/07/23 10:27

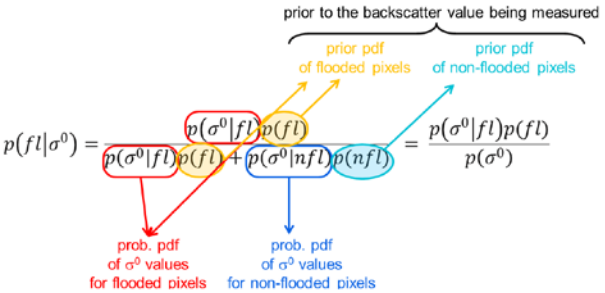




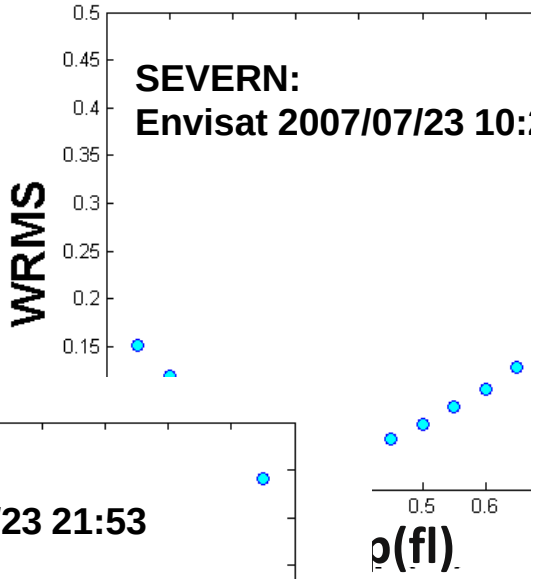


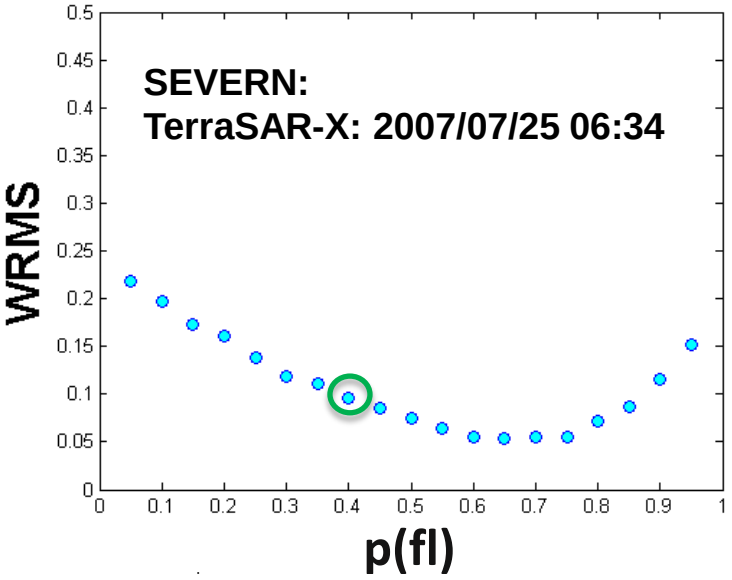


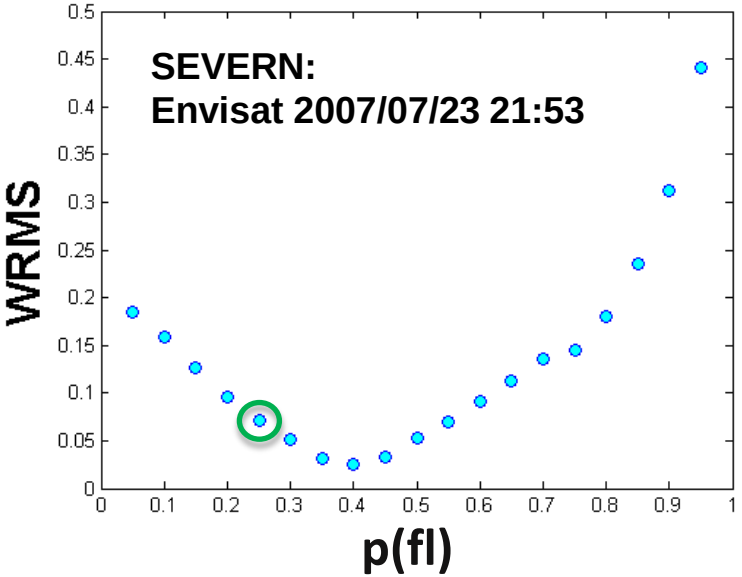


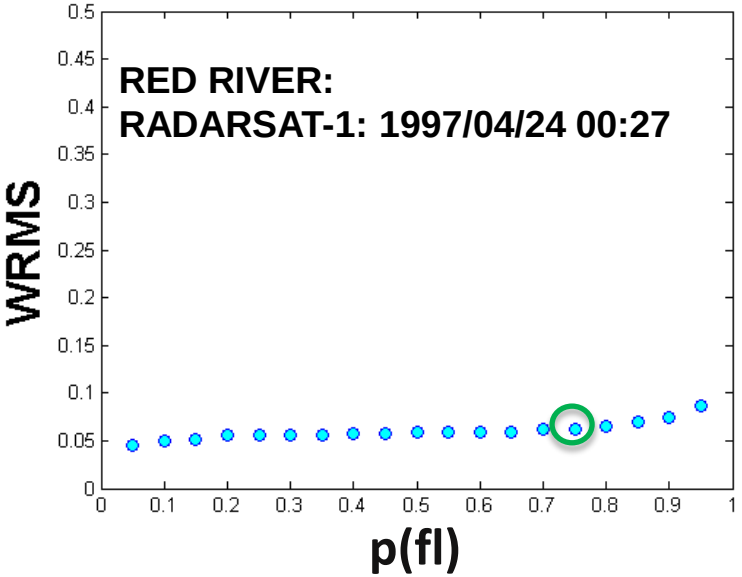


Analysis of prior pdf









CONCLUSIONS

1) How to get a Probabilistic Map of flood?

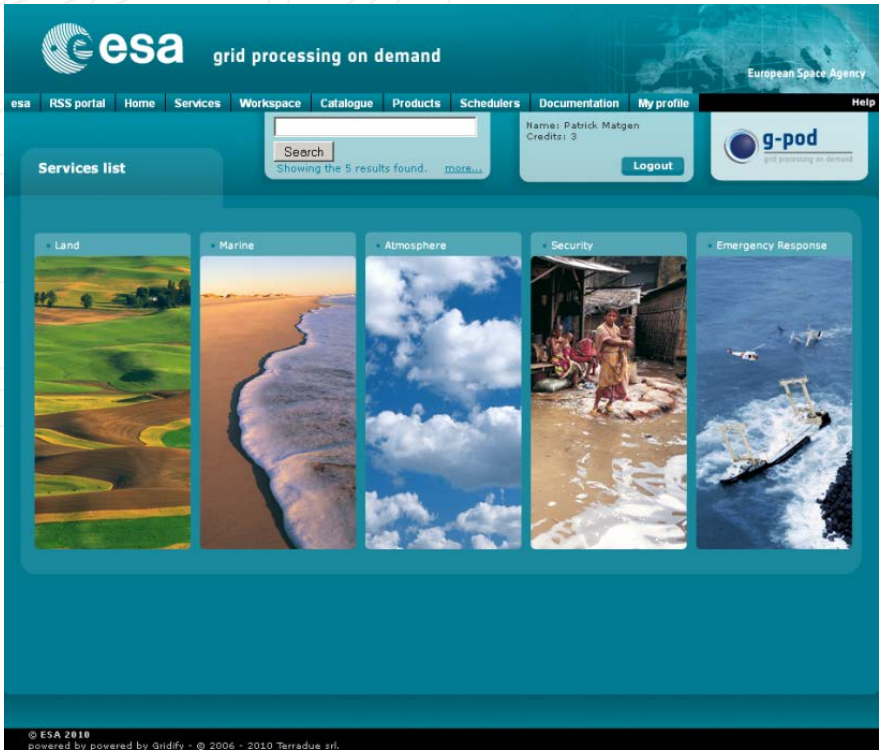
- Statistical framework on Bayes theorem;
- Uncertainty arising from a SAR image classification, based on backscatter values;
- Assumption on prior probabilities: 0.5

2) How to evaluate its correctness?

- Reliability plots, when ground truth is available: acceptable performance;
- Analysis of sensitivity on prior probabilities: 0.5 reasonable choice

AKNOWLEDGEMETS

http://gpod.eo.esa.int/



Algorithm available upon request:

laura.giustarini@list.lu
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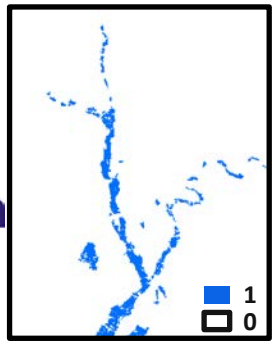
marco.chini@list.lu
patrick.matgen@list.lu

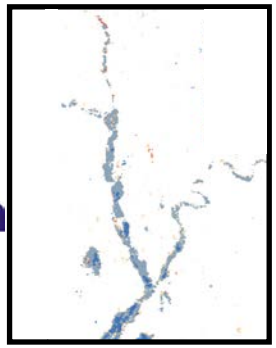
BINARY MAP

SAROTEC → esa



HAZARD MAP

HASARD → esa



THANK YOU