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

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G-POD

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

1) How to get a Probabilistic Map of flood?
2) How to evaluate its correctness?

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

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

Applications:
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:

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

Prior to the backscatter being measured

- prob. pdf of \( \sigma^0 \) values for flooded pixels
- prob. pdf of \( \sigma^0 \) values for non-flooded pixels

\[ p(\sigma^0) = 0.5 \text{ (for flooded pixels)} + 0.5 \text{ (for non-flooded pixels)} \]
How to evaluate its correctness?

PROBABILISTIC MAP
(real values)

VALIDATION MAP
(binary values)

How to evaluate its correctness?

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### CASE STUDIES

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<th>SAR</th>
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SEVERN

Analysis of prior pdf

SEVERN: Envisat 2007/07/23 10:27
Analysis of prior pdf

Graphs showing WRMS versus p(fl) for different locations:

SEVERN:
- Envisat 2007/07/23 10:27
- TerraSAR-X: 2007/07/25 06:34

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

Graphs highlight the variations in WRMS with p(fl) for each location.
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
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http://gpod.eo.esa.int/

Algorithm available upon request: laura.giustarini@list.lu renaud.hostache@list.lu marco.chini@list.lu patrick.matgen@list.lu

THANK YOU