Coarse resolution SAR imagery to support flood inundation modelling in near-real time

Giuliano Di Baldassarre, Guy Schumann, Paul Bates

UNESCO-IHE Institute for Water Education

University of Bristol

BHS Meeting on “Remote sensing & flooding”
18 February 2010, School of Geographical Sciences, University of Bristol
Flood inundation models

Predicting floodplain inundation and river hydraulics

- Flood hazard/risk mapping
- Floodplain management
- Sediment dynamics
Remote sensing & Flood inundation models

Airborne laser altimetry (LiDAR):
High resolution topography (1m DTM; 10 cm accuracy)

*e.g.* Upton-on-Severn *(UK)*
Remote sensing & Flood inundation models

Flood imagery (e.g. Bates, 2004; Horritt et al., 2007): Calibration, validation and uncertainty analysis

e.g. River Severn (Upton) during the November 2000 flood

4 airborne SAR images:
Flood extent maps

After image classification (Snake; e.g. Horritt, 1999)
Flood inundation model results

2D Hydraulic models (e.g. Horritt et al., 2007)
Floodplain mapping - Resolution

Flood images spatial resolution:
- **High** (1-2 m; airborne SAR)
- **Fine/medium** (10-25m; ERS-2 SAR)
- **Coarse/low** (about 100m; ENVISAT ASAR)
Coarse resolution SAR imagery

Relationship between spatial resolution and revisit time:

Monitoring floods from space is currently only possible through coarse resolution SAR imagery

(ENVISAT ASAR; River Nile, EOLI ESA)
EOLI ESA (Catalogue & Ordering Services)

- Browse the metadata
- Preview satellite data (e.g. ENVISAT, ERS, Landsat, IKONOS, DMC, ALOS, SPOT, Nimbus, NOAA, SCISAT, SeaStar, Terra/Aqua)
- Order or download products of various processing levels

BHS Meeting on “Remote sensing & flooding”
18 February 2010, School of Geographical Sciences, University of Bristol
Aim of the study

Assess the usefulness of coarse resolution SAR images to support flood inundation modelling in near real time (NRT)

Medium-to-large rivers, inundation width is one order of magnitude larger than the image resolution
Test site

98 km reach of the River Po (Northern Italy)

Channel width = 200-300m
Floodplain width = 800-4,000m
Slope = 0.02%
Hydraulic model - HECRAS

UNET hydraulic code (Barkau, 1997)
part of the software package HEC-RAS
(Hydrologic Engineering Center, 2001)
River Po - Topography

High (1m) resolution DTM
(*LiDAR* + *Multi-beam*; Camorani et al., 2006)
River Po – Cross sections

Cross sections were extracted from the DTM
River Po – Model Calibration (2000 flood)

High water marks October 2000 flood (~ 60 yr)
River Po – Model Calibration (2000 flood)

2 parameters (floodplain and channel roughness)
River Po – Calibration Results

Best fit model results and high water marks

BHS Meeting on “Remote sensing & flooding”
18 February 2010, School of Geographical Sciences, University of Bristol
River Po – 2008 flood

2008 Flood: low magnitude event (2-3 yr)

ENVISAT-ASAR image acquired and processed in NRT
Resolution: about 100m
Timing: 1 hour before the peak flow at Cremona

*ENVISAT-ASAR sensor in WSM, provided through ESA’s Fast Registration system at no cost 24 hours after the acquisition

BHS Meeting on “Remote sensing & flooding”
18 February 2010, School of Geographical Sciences, University of Bristol
Inundation width (2008 flood)

River Po – Model evaluation in NRT

BHS Meeting on “Remote sensing & flooding”
18 February 2010, School of Geographical Sciences, University of Bristol
River Po – Model evaluation in NRT

A well calibrated flood inundation model may poorly perform when it is used to predict different events.

Confirmation of previous studies on the parameterisation of flood inundation models:

Aronica et al. (1998)
Horritt and Bates (2002)
Romanowicz and Beven (2003)
Pappenberger et al. (2006)
Di Baldassarre et al. (2009)
River Po – Model re-calibration in NRT

Model response (2008 flood)

BHS Meeting on “Remote sensing & flooding”
18 February 2010, School of Geographical Sciences, University of Bristol
Discussion

Coarse resolution SAR imagery allowed a quick validation and re-calibration of the flood inundation model in a time shorter than the flood travel time.

- Increase the reliability of model predictions (e.g. water elevation and inundation extent)

- Assist flood management authorities in undertaking the necessary prevention activities
Discussion

Cope with uncertainty in flood extent mapping (e.g. Schumann et al., 2009; Di Baldassarre et al., 2009)

Deterministic binary (wet/dry) maps - Uncertain inundation maps

River Dee (UK): 2 different images acquired at the same time during 2006 flood:

Execution of 5 image processing techniques

Uncertainty analysis and Probability of inundation map
Conclusions

Potentials of coarse resolution SAR imagery to monitor large floods in medium-to-large rivers in near real time

Uncertainties in flood extent mapping

How can we cope with this type of observation uncertainty in flood inundation modelling?
Thank you very much!