

A GLOBAL FLOOD FREQUENCY MAP DERIVED FROM >10 YEARS OF SAR OBSERVATIONS:

CONCEPT AND FIRST RESULTS

Patrick Matgen, Marco Chini, Ramona Pelich, Renaud Hostache, José Manuel Delgado, Giovanni Sabatino



Global Flood Partnership Conference, Tuscaloosa, 27-29 June 2017



FLOODING-RELATED R&D AT LIST RTO

WATER SECURITY AND SAFETY UNIT



Objective: strengthen capacities for evidence based decision support in the three main phases of flood management, with a special focus on satellite EO:

- **Prediction:** Flood forecasting
- **Emergency response:** Rapid mapping of flood extent and associated impacts
- **Prevention:** Flood hazard and risk mapping, design of mitigation plans



Litern pro Quadratmeter fiel in 24 Stunden so viel Regen, wie sonst in einem Monat



Der Ortskern von Junglinster war bereits am Mittwochabend

Luxemburg unter Wasser

INTRODUCTION

Objective

- To generate a record of temporal and spatial variations of floodwater at large scale
- To enable efficient near real-time applications in the context of emergency response

Existing approaches

- On demand / systematic mapping products based on satellite EO imagery
- Hydrodynamic modelling (across various spatial and temporal scales)
- Processing of unstructured data
- Combination of all of these

Challenges

- Selection and parameterization of retrieval algorithm & models, processing and storage of very large datasets, fast and reliable access to imagery and input data, characterization of uncertainties



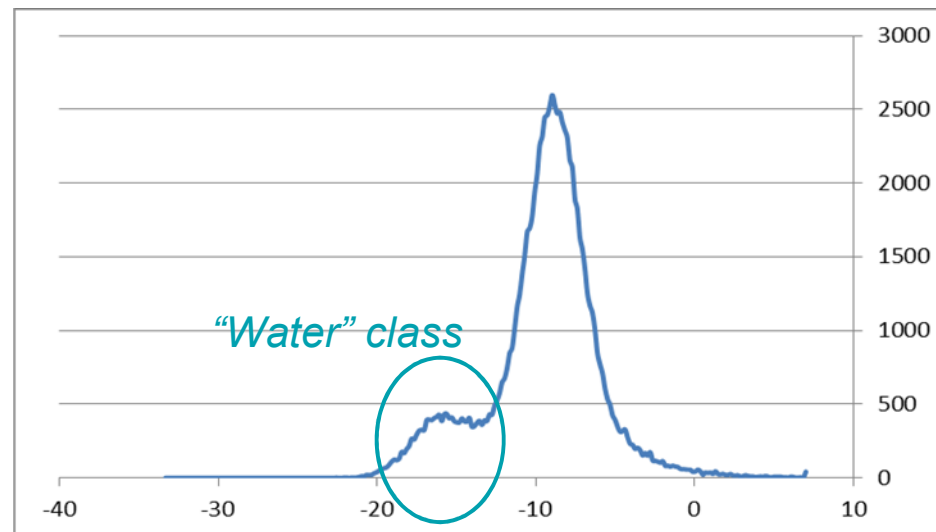
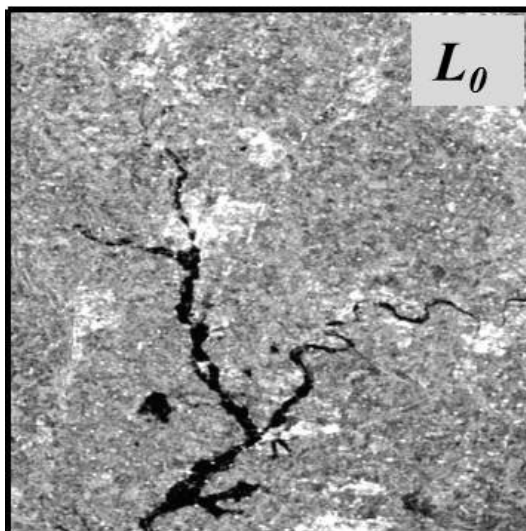
etc.

OUTLINE

- SAR-based retrieval algorithm
- Implementation of software into ESA's processing environment
- Applications:
 - ENVISAT-based generation of 'flood record'
 - Sentinel-1 based Rapid flood mapping service
- Perspectives within GFP

SAR-BASED RETRIEVAL ALGORITHM

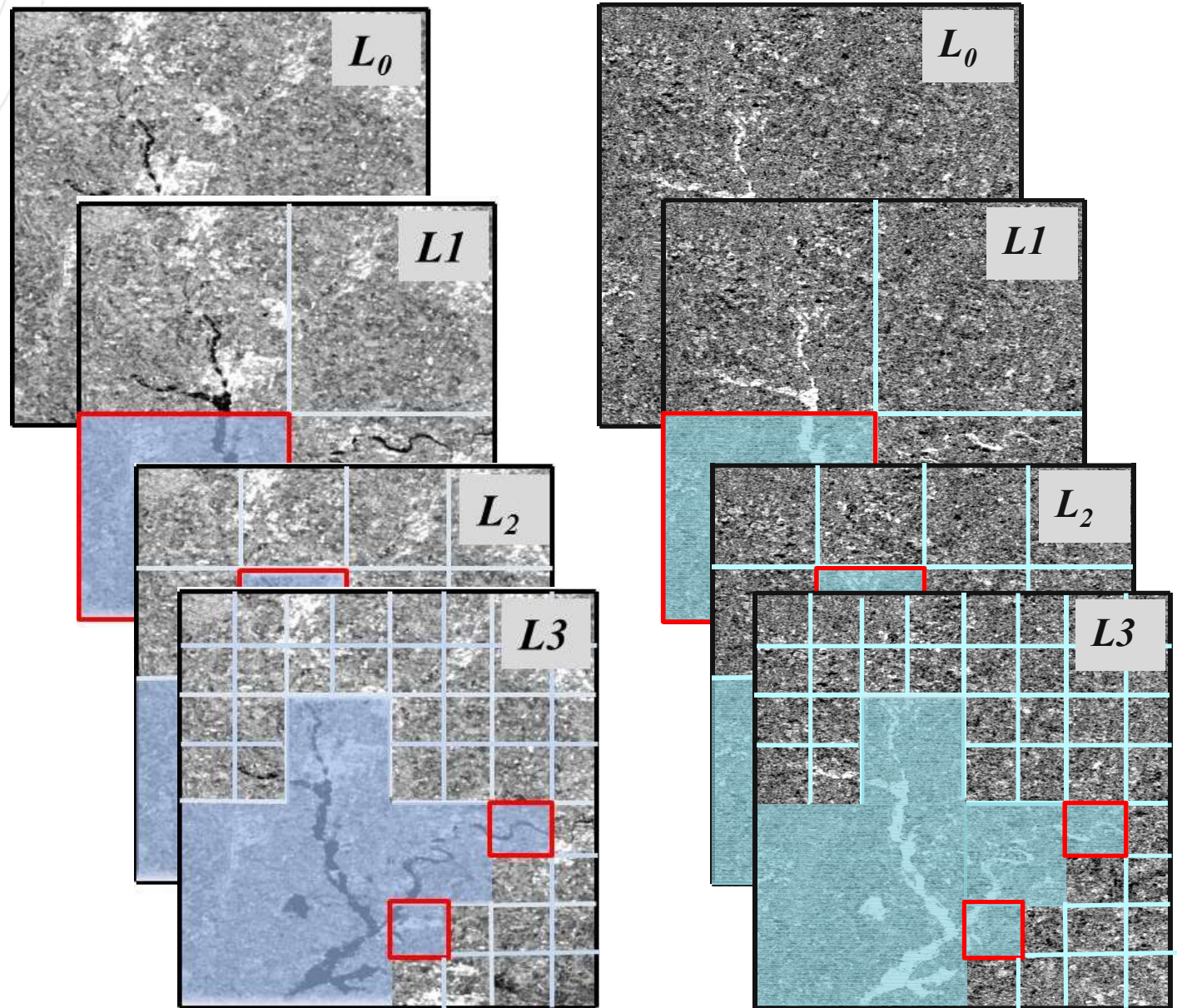
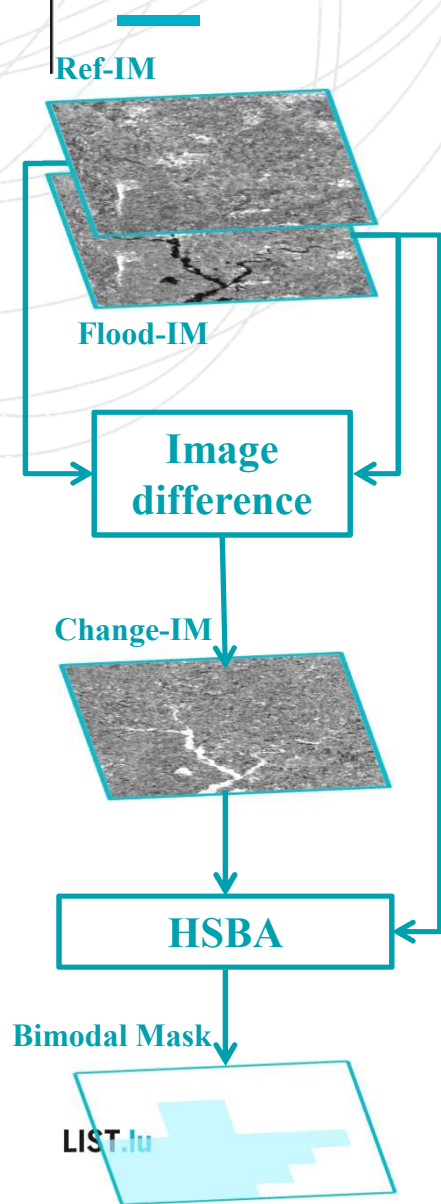
- **Statistical modelling-based** algorithms typically parameterize distribution functions to assign pixels to 2 semantic classes of interest: 'water' & 'no-water' (and/or 'change' & 'no-change')
- Flooded areas often represent only a **small fraction** of an entire SAR scene: difficulty in parameterizing such a distribution function because the distribution of a SAR scene's backscatter values is often **not clearly bimodal**
- A sufficiently **high percentage of flooded pixels** is typically required to estimate a reliable and robust distribution function that can be used for delineating water bodies at larger scale



SAR-BASED RETRIEVAL ALGORITHM

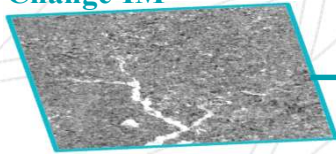
Flood-IM

Change-IM

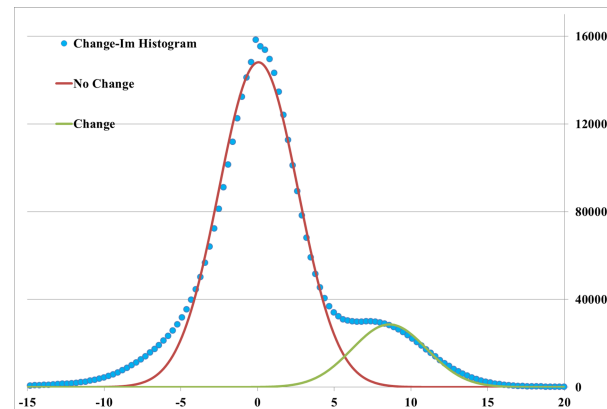


SAR-BASED RETRIEVAL ALGORITHM

Change-IM



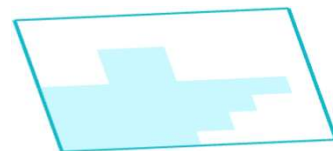
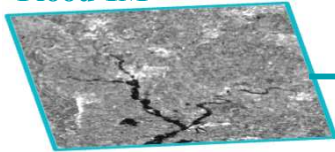
Distribution Fitting: Change & No-Change



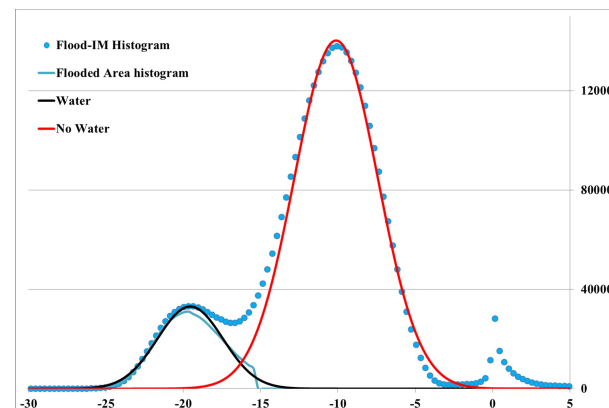
THR & RG & CD (iterative procedure)

Distribution Fitting: Water & No-Water

Flood-IM



Bimodal Mask



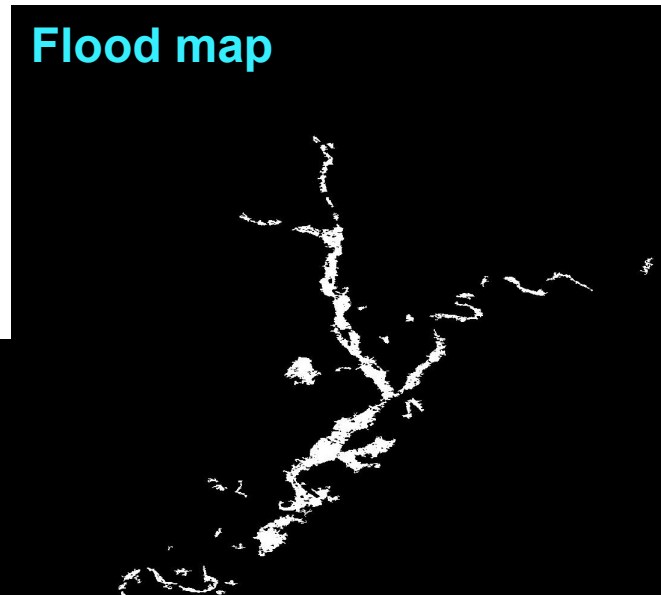
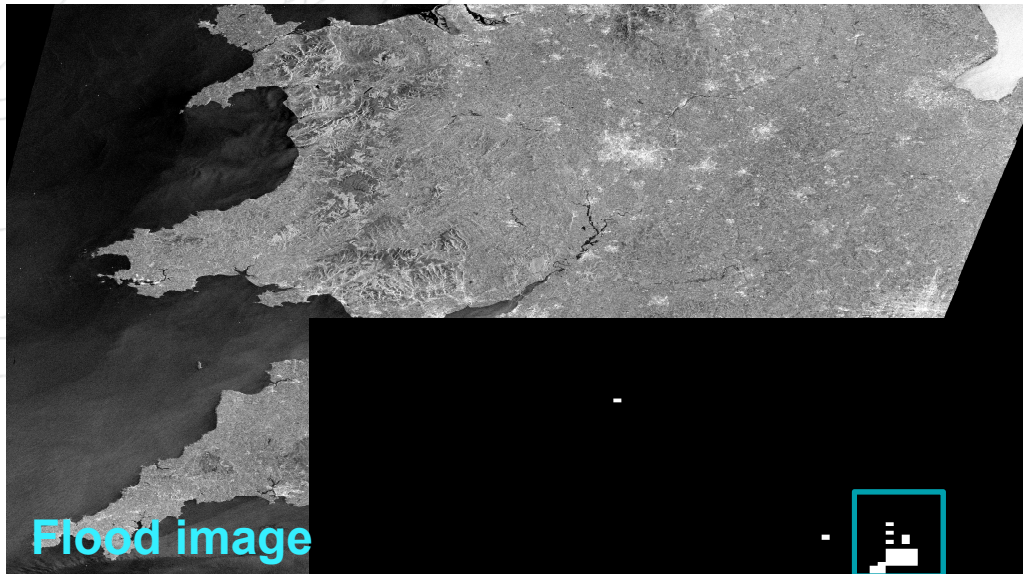
Flood map

Post-processing

Value adding (classification uncertainty, water depth, return period, etc.)

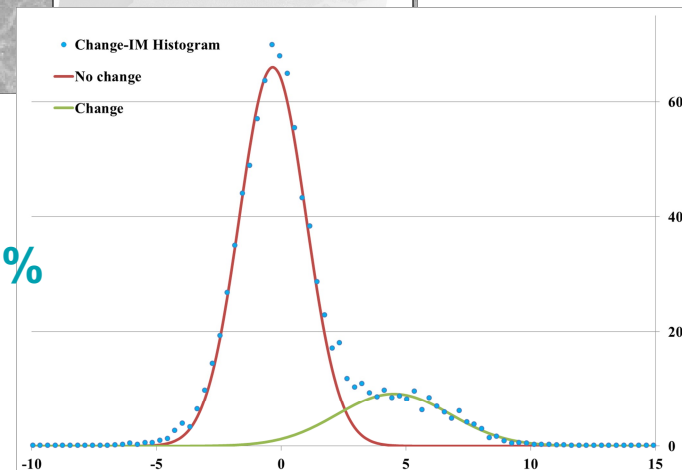
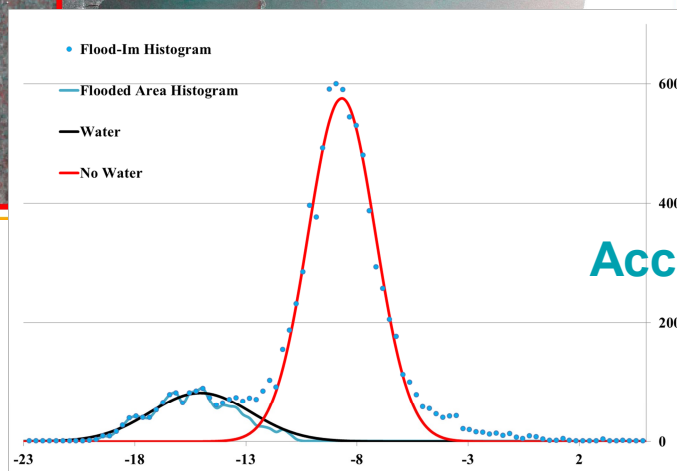
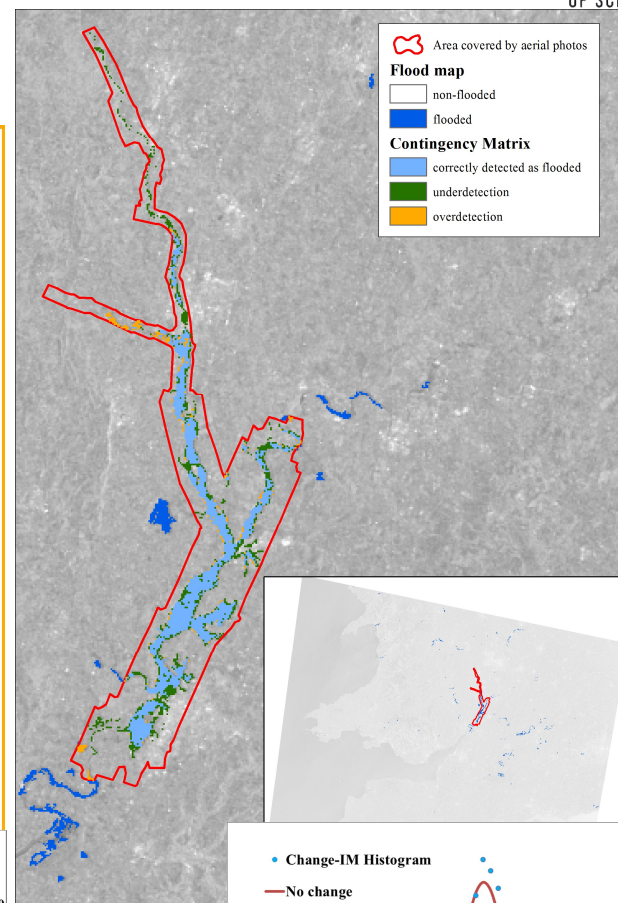
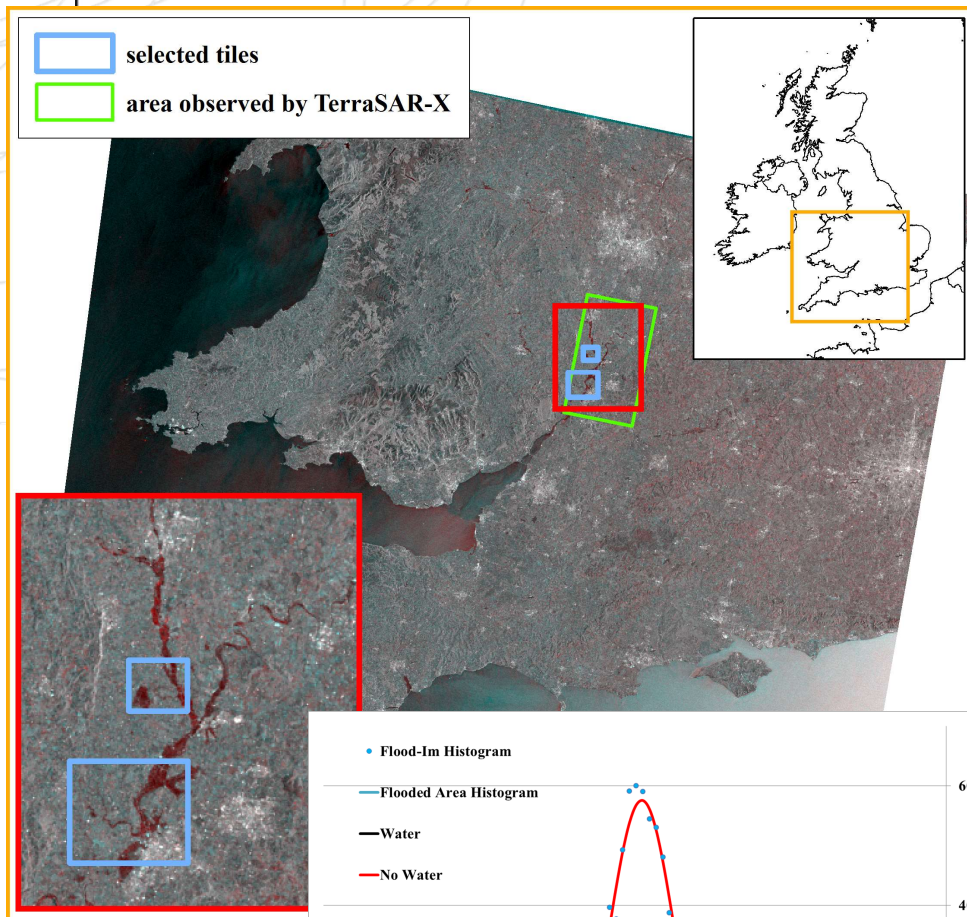
TEST CASE: SEVERN RIVER 2007

Envisat WS



TEST CASE: SEVERN RIVER 2007 (UK)

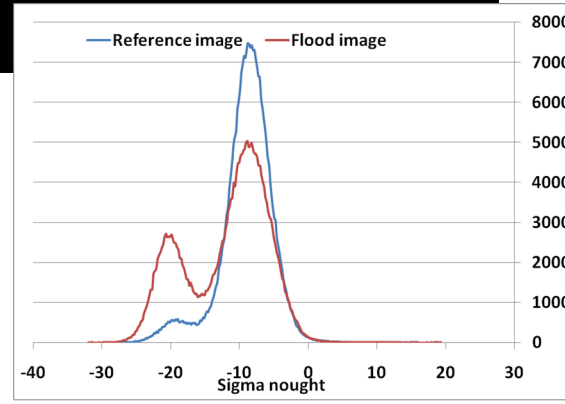
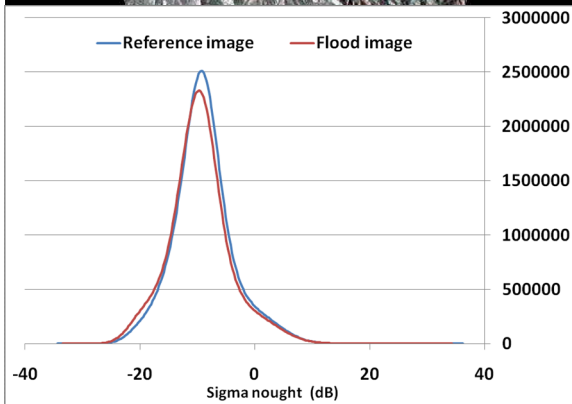
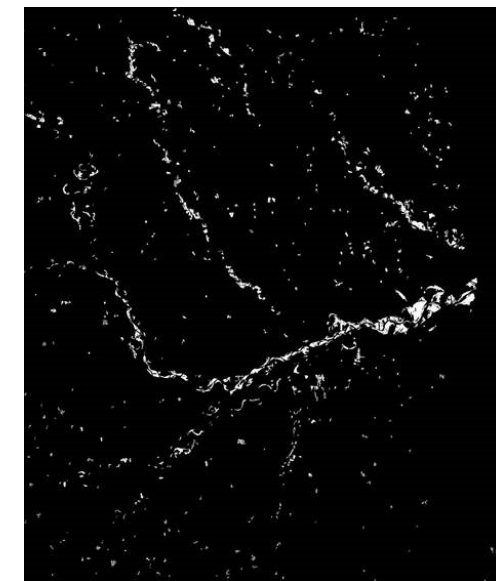
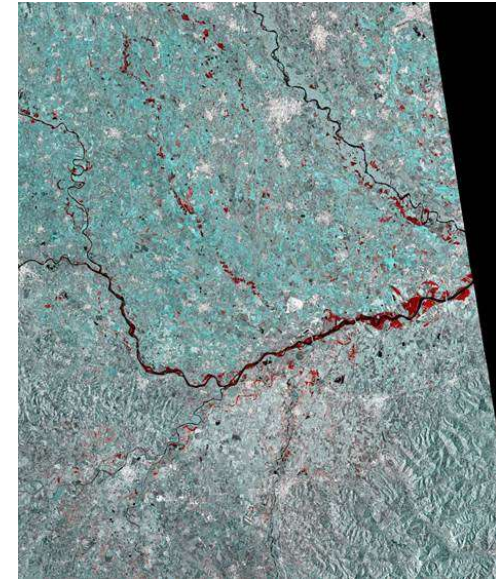
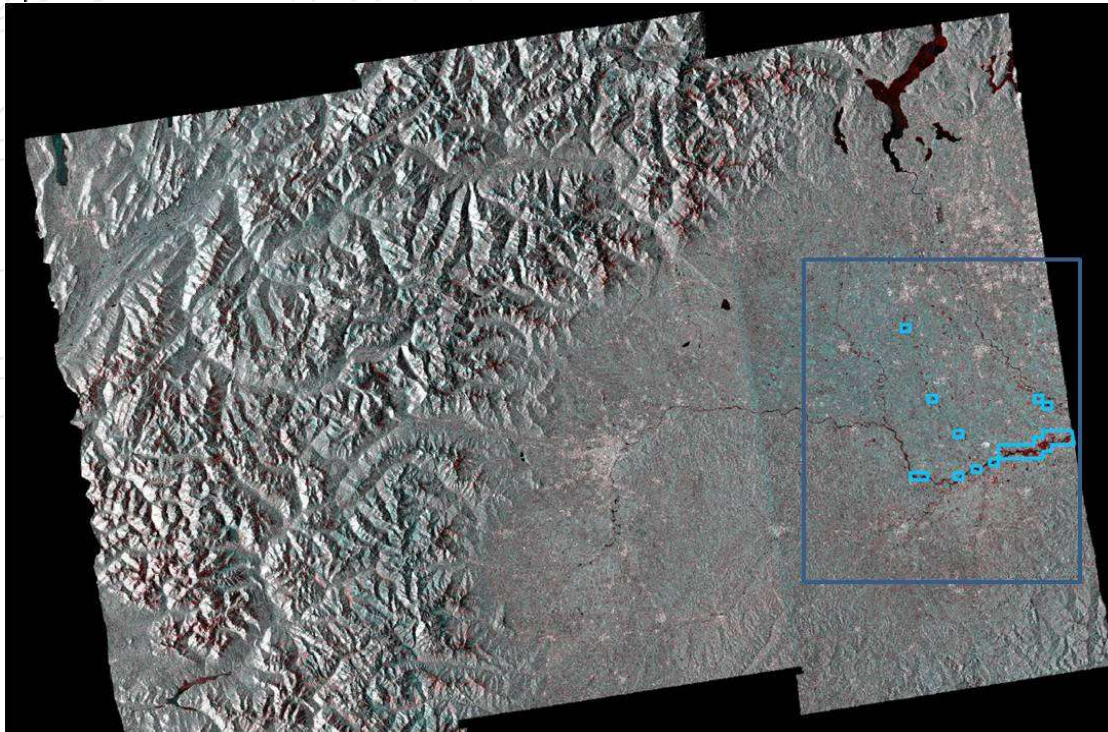
Envisat WS



Accuracy: 89%

TEST CASE: PO RIVER 2014 (IT)

Sentinel-1



IMPLEMENTATION ON GPOD

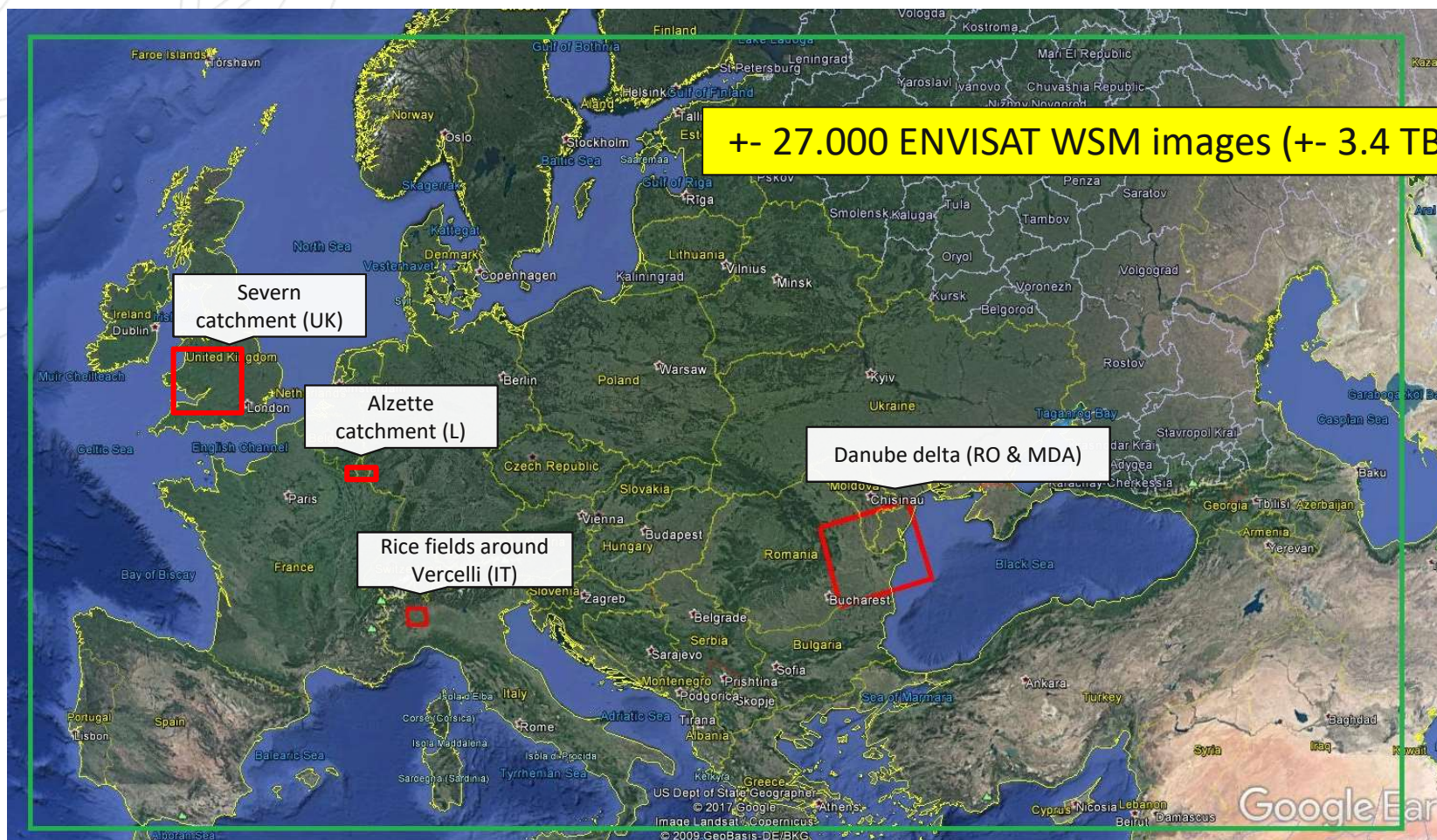
ESA RSS service overview

- The ESA RSS service is a ESA service since 2006 offering a wide range of support possibilities for bursting the EO data exploitation with:
 - Data access : <http://eogrid.esrin.esa.int>
 - Data processing with direct access to the data:
 - Development environment: *RSS CloudToolbox*: <http://eogrid.esrin.esa.int/cloudtoolbox>
 - Massive processing environment: *RSS Processing on demand* : <http://qpod.esa.int>
 - User only download results, saving storage, processing power and time

- RSS users are :
 - EO Principal Investigators,
 - Research Institutions,
 - EO Service Providers and Universities
- Supporting more than 20 projects during 2016



FLOOD RECORD GENERATION (2002 – 2012)

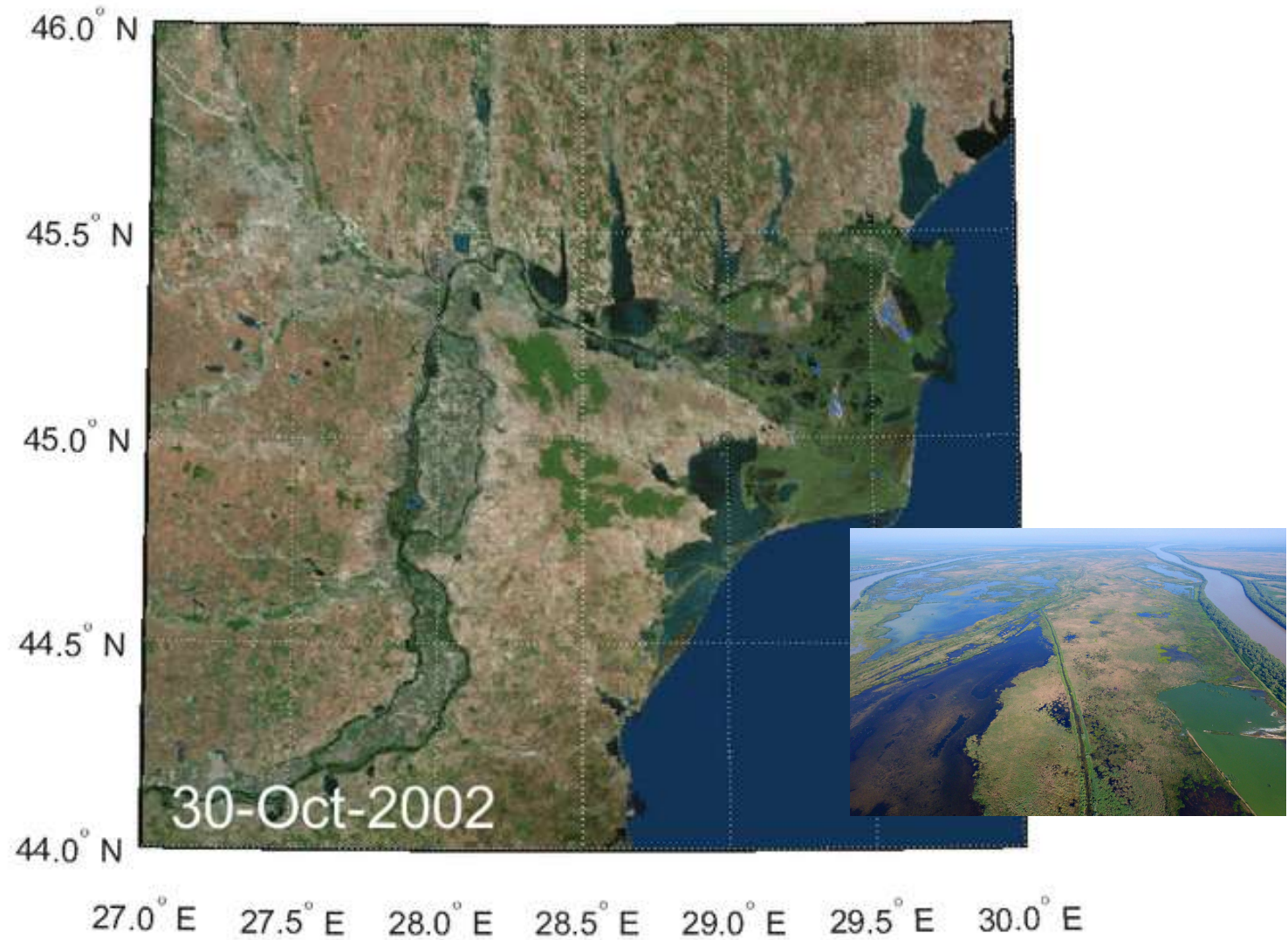


Area of interest



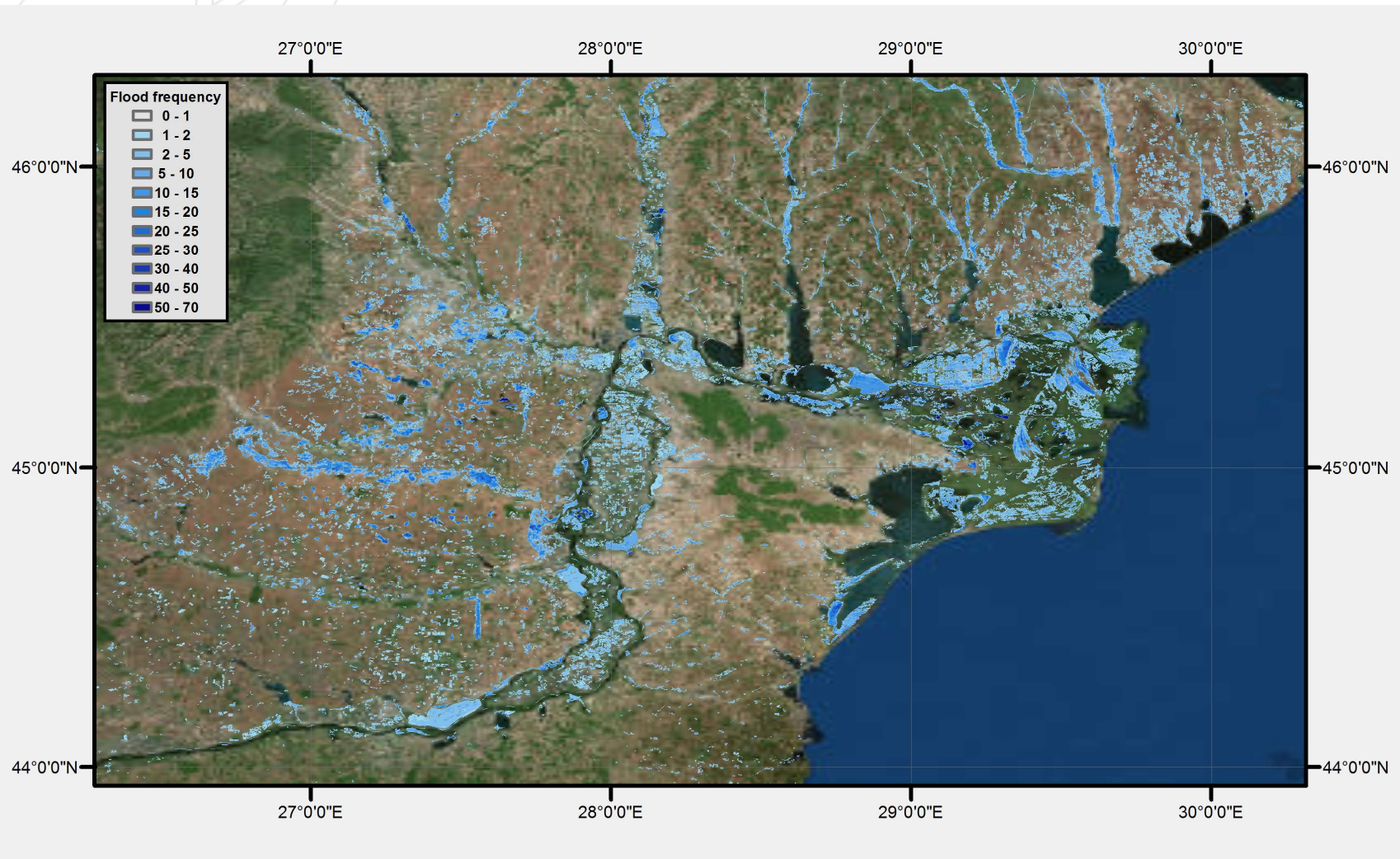
(Main) test areas

ENVISAT-BASED FLOOD RECORD THE DANUBE DELTA (RO & MDA)



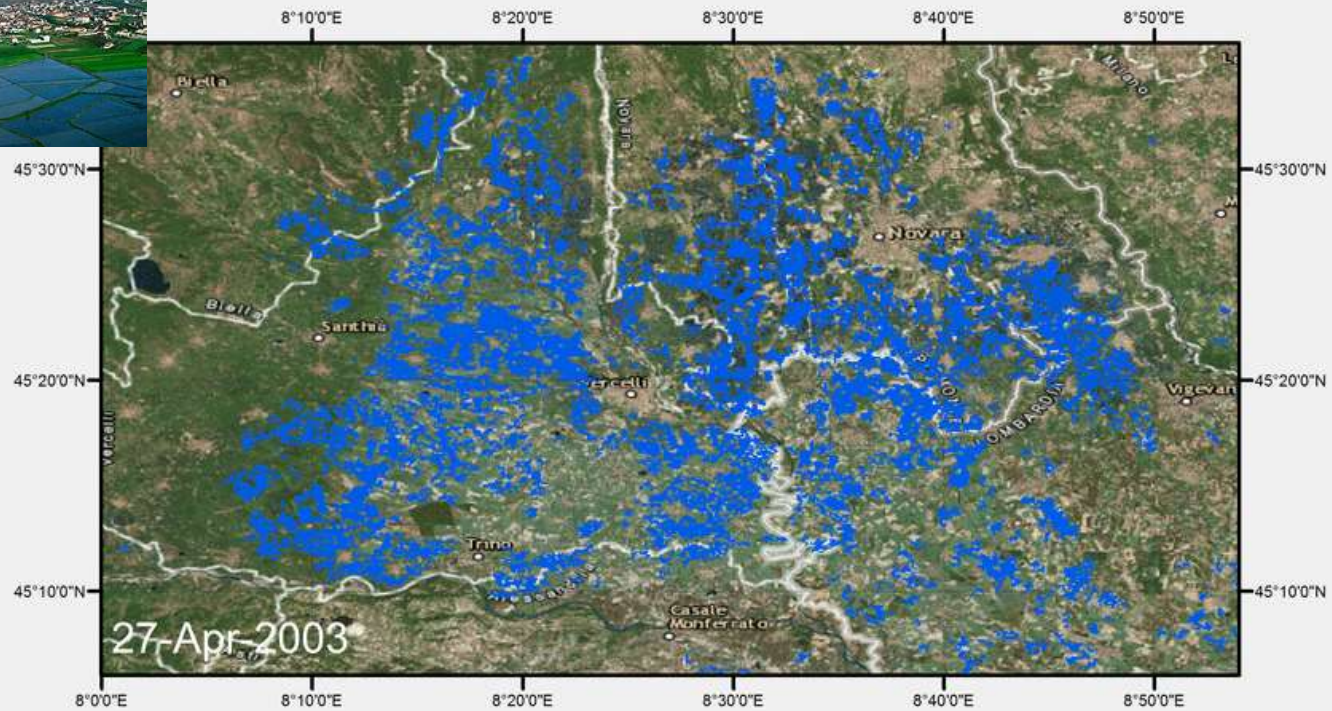
ENVISAT-BASED FLOOD FREQUENCY MAP THE DANUBE DELTA (RO & MDA)

LUXEMBOURG
INSTITUTE
OF SCIENCE
AND TECHNOLOGY



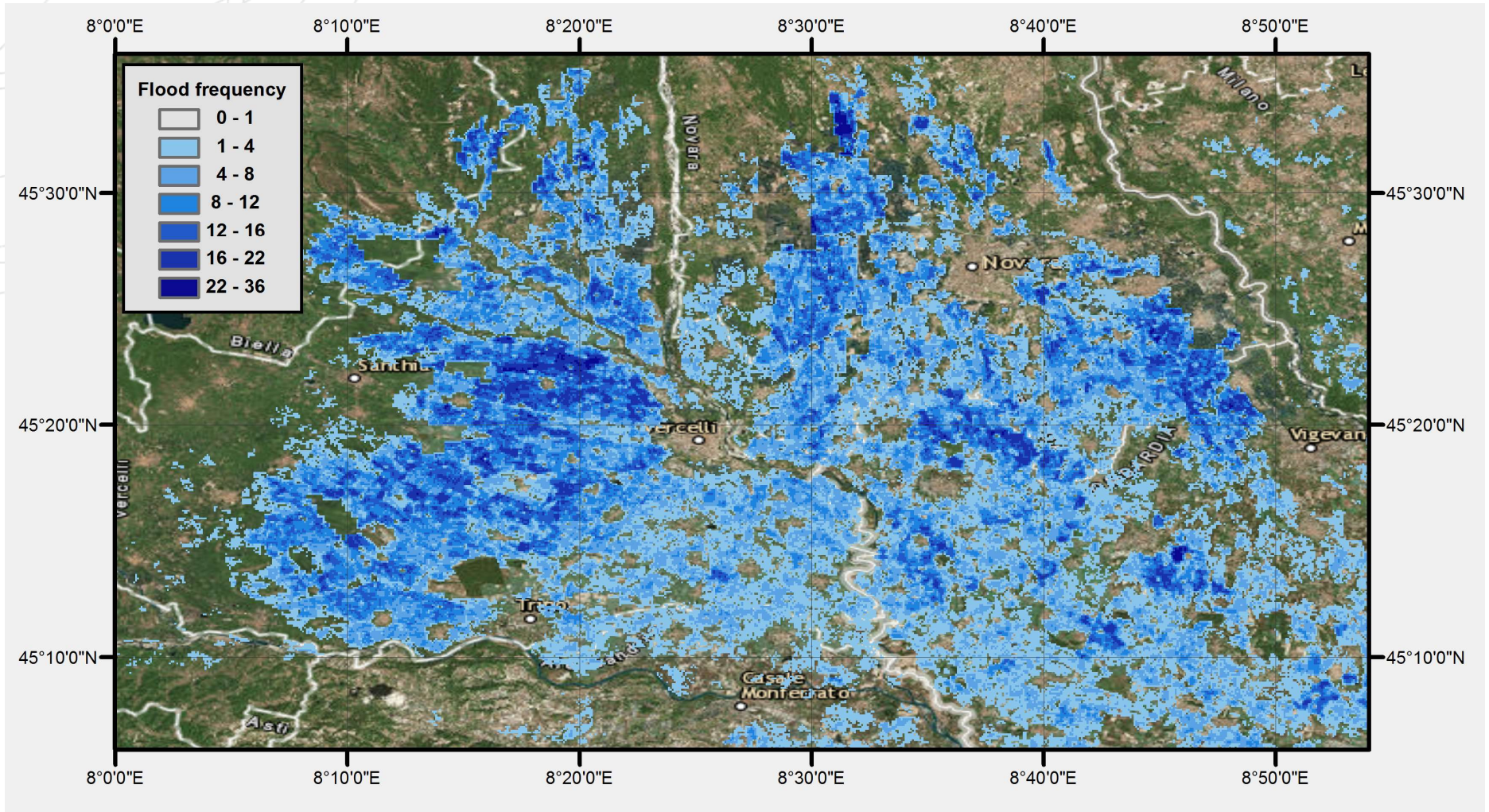
ENVISAT-BASED FLOOD RECORD VERCELLI RICE FIELDS (IT)

LUXEMBOURG
INSTITUTE
OF SCIENCE
AND TECHNOLOGY



ENVISAT-BASED FLOOD FREQUENCY MAP VERCELLI RICE FIELDS (IT)

LUXEMBOURG
INSTITUTE
OF SCIENCE
AND TECHNOLOGY

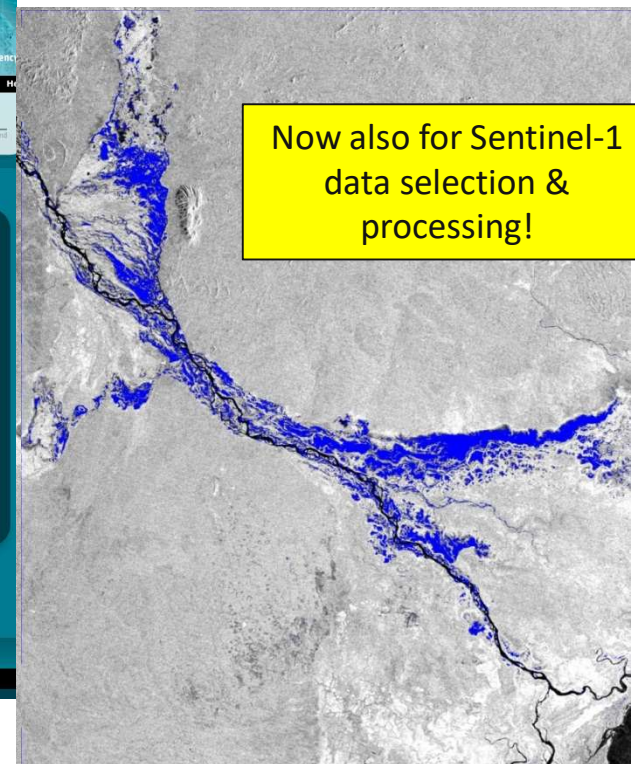


RAPID FLOOD MAPPING SERVICE

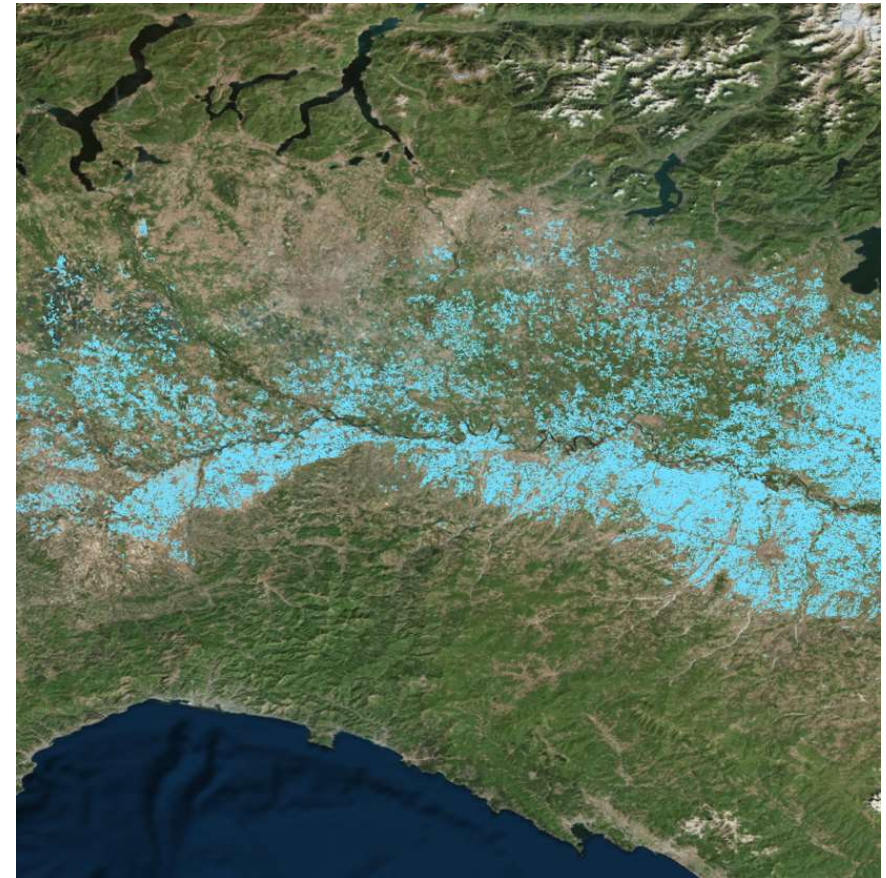
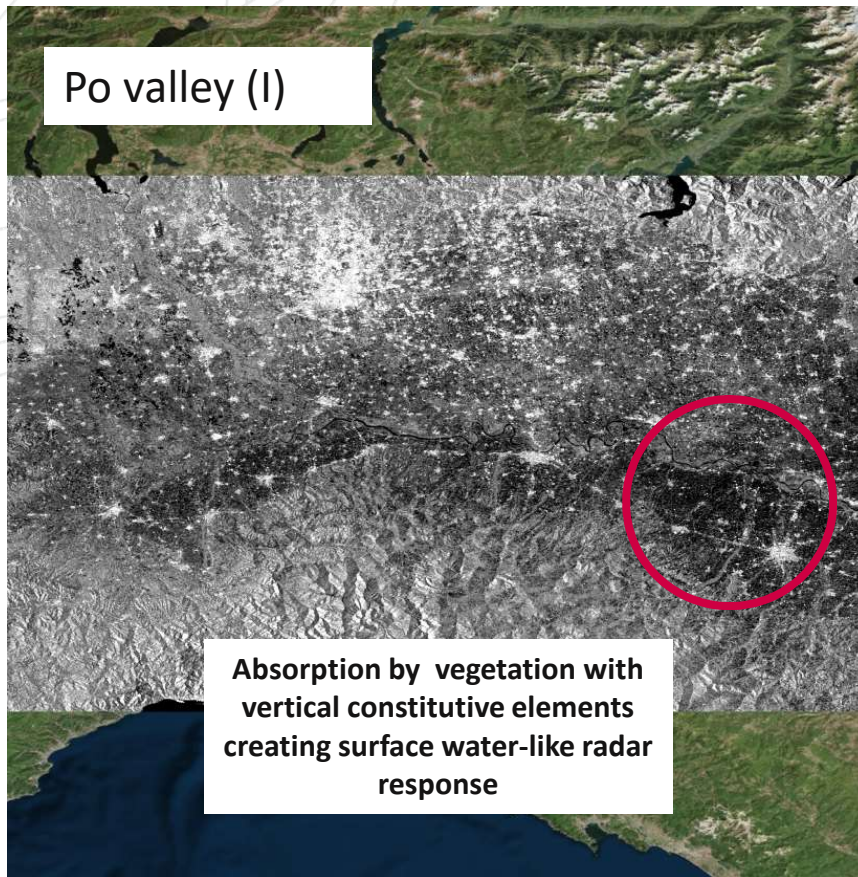
<https://gpod.eo.esa.int/>



- Consultation of data collection w.r.t. to ECMWF-based simulations of flood inundation
- Manual selection of «flood images» from ESA data collection
- 'on demand' flood mapping
- Download of results

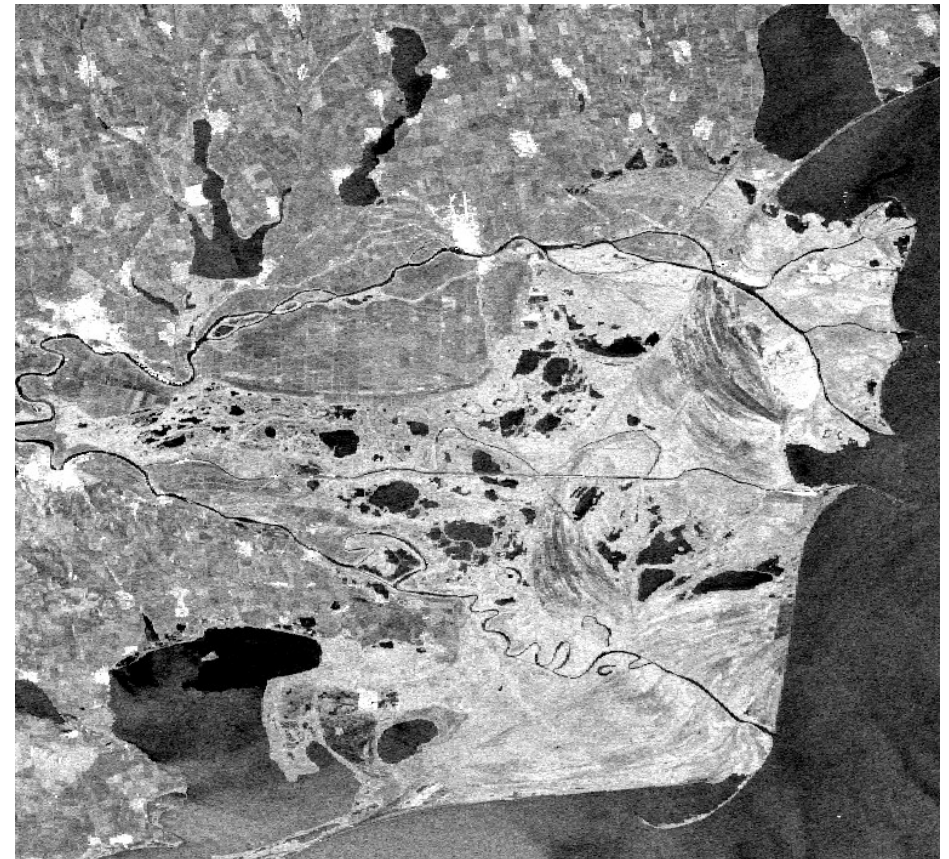
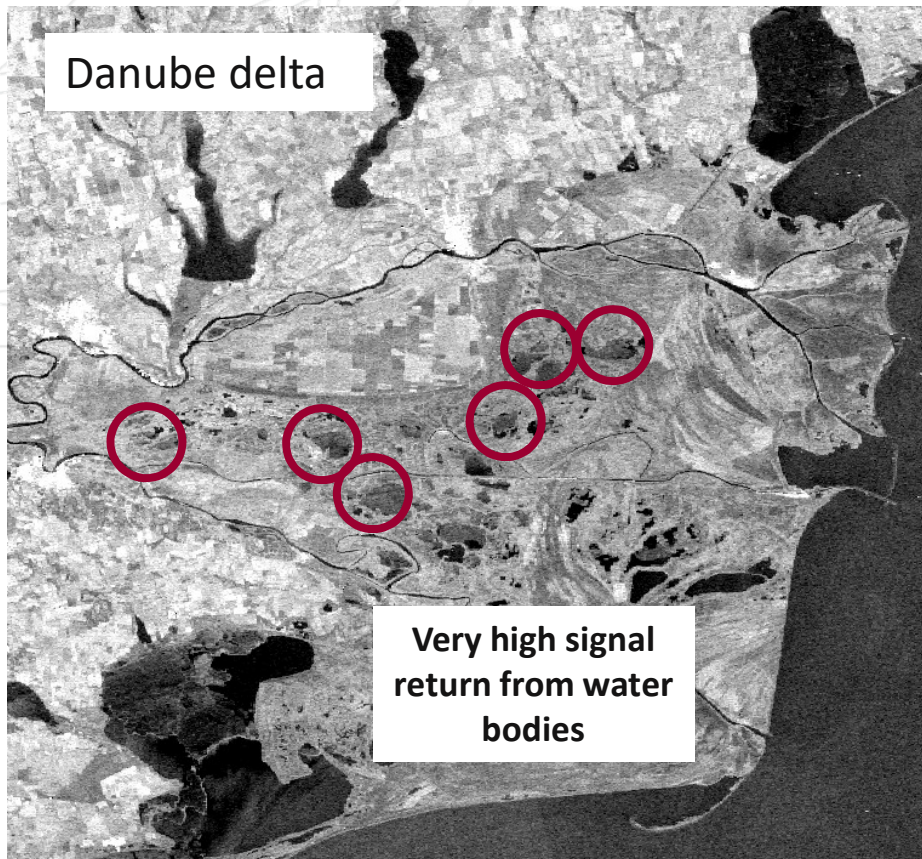


PROBLEM SOLVING (1/2): AMBIGUOUS RADAR SIGNATURE DUE TO VEGETATION



To do: Careful selection of adequate reference image
Exploitation of coherence information and alternative polarization (if possible)

PROBLEM SOLVING (2/2): ROUGHENING OF WATER SURFACES DUE TO WIND



To do: Topography data sets and model results (flood models and NWP) to reduce wind-related under-detection of floodwater

NEXT STEPS AND PERSPECTIVES FOR INVOLVEMENT IN GFP

- Refinements of processing chain and generation of flood record at global scale
- Setting up web portal for distributing the data, integration with existing databases
- Evaluation with independent data sets, inter-comparison with similar products
- Development of value added products (e.g. water depth maps, flood probability maps, return period assignment etc.)
- Seeking collaborations for developing applications of ‘flood record’ (hazard/risk mapping, data assimilation into flood inundation models, NWP, crop models, etc.)

Thank you

patrick.matgen@list.lu

rss_team@esa.int



LUXEMBOURG
INSTITUTE
OF SCIENCE
AND TECHNOLOGY



Global Flood Partnership Conference, Tuscaloosa, 27-29 June 2017

