# 2024 IEEE GRSS Data Fusion Contest

# **Flood Rapid Mapping**



Credit: CNES, FloodDAM

## The Challenge Task

As a result of climate change, extreme hydrometeorological events are becoming increasingly frequent. Flood rapid mapping products play an important role in informing flood emergency response and management. These maps are generated quickly from remote sensing data during or after an event to show the extent of flooding. They provide important information for emergency response, and damage assessment. The aim of this challenge is to develop data fusion algorithms that generate flood maps by processing spatial data from a variety of sources.

The goal of this challenge is to design and develop an algorithm that will combine multi-source data to classify flood surface water extent–that is, water and non-water areas. Provided data sources include optical and SAR remote sensing images as well as a digital terrain model. The output is a gridded flood map where each grid cell is labeled water or non-water.

The difficulty of detecting flooded areas can vary greatly depending on the conditions in the area of interest and the event. This data fusion challenge has two tracks representing this variance.

**Track-1: The standard case** where the water surface is visible without confounding factors.

**Track-2: Areas with confounding factors** that complicate analysis of SAR and optical signals.

No guidance is given on the method to be used for data fusion and classification; it could be based on a statistical approach, machine learning, deep learning, or a combination of different approaches.

## Track 1: Standard Case. Water surface is visible in the remote sensing images.

This track focuses on the detection of surface water from SAR and Optical imagery in cases where there are few confounding factors. A set of events will be provided from selected geographical areas and events. The goal is to determine water and non-water pixels in these event areas by fusing data from one or more of the provided data sets.

A baseline of machine learning and deep learning-based algorithms yields F1-scores that range from 0.70 on the most difficult cases in this set to 0.98 for the simplest ones. The goal of the challenge will be to maximize average F1-scores over the test set.
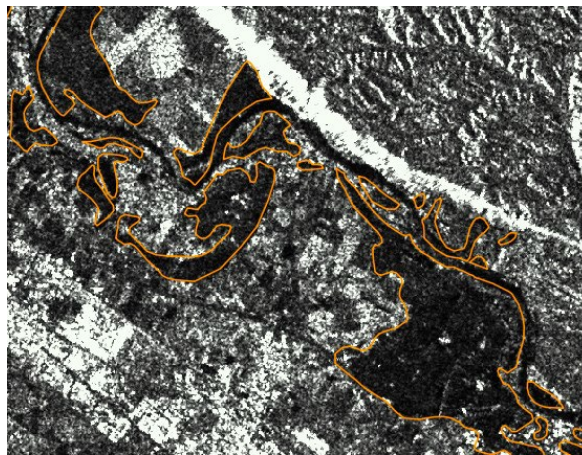


*Extract of Sentinel-1 image over Navarre, Spain, 2018-04-13, flooded area is contoured in orange*

## Track 2: Special Cases. Confounding factors complicate detection of water surface from SAR and optical imagery.

Track-2 focuses on events and areas where confounding factors make it more difficult to discriminate surface water from non-water. Fusing optical and SAR data sets can ameliorate these conditions. Events images that are difficult to interpret in optical imagery may be clearer in SAR, and vice versa. These cases include:
- Vegetated areas where the vegetation can be higher than the water level
- Urban areas where the water may be occluded
- Desert areas with a complex SAR response
- Areas with severe weather conditions, in particular severe wind, rainfall and high moisture

# Competition Phases

The contest in both tracks will consist of two phases. In Phase 1 participants will train and validate their algorithms against a common data set. In Phase 2, participants will have a week to run their algorithms against a new test set to determine the winners.

**Phase 1:** Participants are provided with training data and additional validation images (without corresponding reference data) to train and validate their algorithms. Participants can submit results for the validation set to the Codalab competition website (<track-1-url>, <track-2-url>) to get feedback on the performance. The performance of the best submission from each account will be displayed on the leaderboard. In parallel, participants submit a short description of the approach used to be eligible to enter Phase 2.

**Phase 2:** Participants receive the test data set (without the corresponding reference data) and submit their results within seven days from the release of the test data set. After evaluation of the results, four winners for each track are announced. Following this, they will have one month to write their manuscript that will be included in the IGARSS 2024 proceedings. Manuscripts are 4-page IEEE-style formatted. Each manuscript describes the addressed problem, the proposed method, and the experimental results.

## Calendar

PHASE 1
- January 3: Contest opening: release of training and validation data
- January 4: Evaluation server begins accepting submissions for validation data set
- March 1: Short description of the approach in 1-2 pages is sent to iadf_chairs@grss-ieee.org (using the IGARSS paper template)

PHASE 2
- March 7: Release of test data; evaluation server begins accepting test submissions
- March 14: Evaluation server stops accepting submissions
- March 18: Updated and final description of the approach

WINNER ANNOUNCEMENT AND PUBLICATIONS
- March 29: Winner announcement
- April 26: Internal deadline for papers, DFC Committee review process
- May 25: Submission deadline of final papers to be published in the IGARSS 2024 proceedings

# The Data

Data from the following datasets are available to participants. These consist of SAR remote sensing data, Optical remote sensing data, and a Digital Elevation Model. The datasets are well documented in their respective archives.

- Copernicus/Sentinel-1: C-band synthetic aperture radar, 10m resolution
- Copernicus/Sentinel-2: 10-20m multispectral images in the optical range
- Landsat-8 and Landsat-9: 15m panchromatic band, and 30m multispectral bands in the optical range
- Copernicus DEM (30m) and MERIT (90m) digital terrain models
- Global Surface Water Occurrence

Labeled training data sets will be curated from:
- Flood extent labeled by the Copernicus Emergency Management Service
- OPERA Dynamic Surface Water Extent CalVal database

Track-2 will be based on the same input data as for Track-1, with the addition of the following data sets. These data sets provide information about land cover, which could inform an algorithm as to what confounding factors may be present so it can adjust its strategy accordingly.
- ESA WorldCover
- High Resolution DEM/DTM derived from Pleiades stereoscopic acquisitions (1m resolution) on Garonne site.

There is scarce ground truth data for these special cases. Reference data will be generated from a detailed CERFACS hydrodynamic model in the FloodDAM Digital Twin (FloodDAM DT). The modeled water extents will be provided on flood events over two physical sites, the Garonne River/France and Ohio River/US.
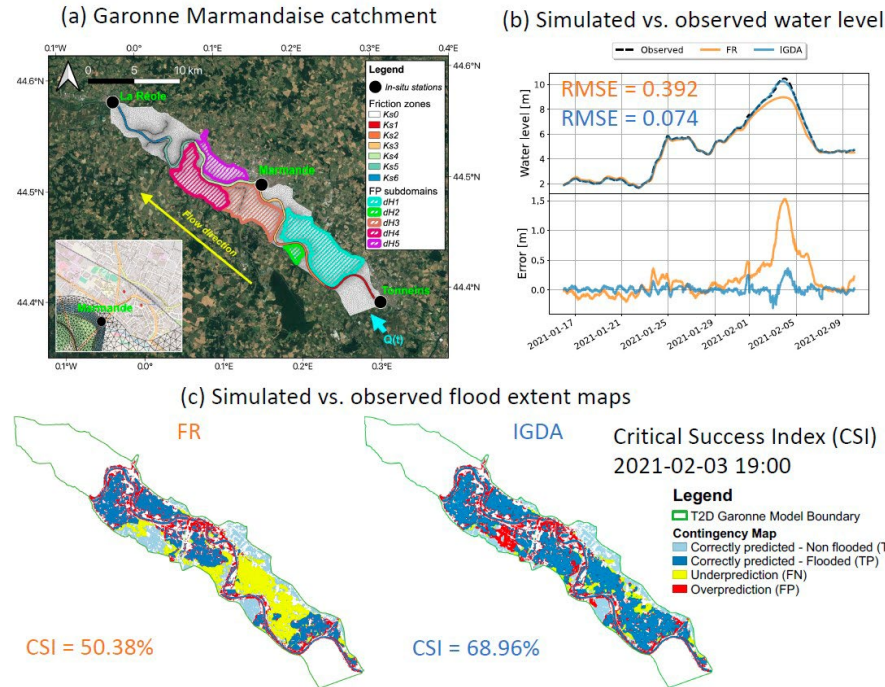
*Water level map on Garonne catchment for the flood event **January-February** 2021. (a) The studied 50 km-long catchment of the Garonne River [5]. Yellow arrow shows flow direction. (b) Comparison of observed water-level (black-dashed line) at Marmande station and simulated water-level by two experiments: the Telemac-2D free-run (FR) simulation without DA **in orange** and the result using DA **in blue**. (c) Flood extent contingency map representing the flood extent prediction by FR and DA, respectively, **at flood peak on** 2021-02-03.*

# Submission and Evaluation

In both tracks the task consists of a binary water / non-water classification. Participants will submit rapid flood maps to the codalab server. Flood maps shall be a TIFF gridded raster product where individual pixels are labeled water (1), or non-water (0). The flood map will be on the same grid and resolution as the identified test data file.

Classification accuracy will be evaluated against a test subsample of the reference dataset, which will not be provided to participants. The F1-score metric will be used to rank the results. The algorithm with the highest F1-score on the Phase 2 test set will be the winner.

# Results, Awards, and Prizes

The first, second, and third and fourth-ranked teams in each track will be declared as winners. Winning teams will:

- Present their approach in an invited session dedicated to the DFC24 at IGARSS 2024
- Publish their manuscripts in the proceedings of IGARSS 2023
- Be awarded IEEE Certificates of Recognition

- The authors of the first and second-ranked teams of each track will co-author a journal paper which will summarize the outcome of the DFC24 and will be submitted with open access to IEEE JSTARS.
- The first ranked teams of each track will receive one paid trip (flight and hotel) to IGARSS24.
- Top-ranked teams will be awarded during IGARSS 2024, Athens Greece, in July 2024. The costs for open-access publication in JSTARS will be supported by the GRSS. The winner team prize is kindly sponsored by the organizing partners.

# The Rules of the Competition

- The dataset can be openly downloaded at  https://ieee-dataport.org/competitions/data-fusion-contest-2024-dfc2024
- Validation and test data can be requested by registering for the Contest at IEEE DataPort.
- To enter the contest, participants must read and accept the Contest Terms and Conditions.
- Participants of the contest are intended to submit results as the Submission and Evaluation Section
- The results will be submitted to the Codalab competition website (<track-1-url>, <track-2-url>) for evaluation.
- Ranking between the participants will be based on the metrics as described in the Submission and Evaluation Section.
- The maximum number of trials of one team is five per day in the test phase.
- The submission server of the test phase will be opened on March 7, 2024 at 23:59 UTC-12 hours.
- The deadline for result submission and final description is March 15, 2024, 23:59 UTC-12 hours (e.g., March 16, 2024, 6:59 in New York City, 12:59 in Paris, or 19:59 in Beijing).
- Each team needs to submit a short paper of 1–2 pages clarifying the used approach, the team members, their Codalab accounts, and one Codalab account to be used for the test phase by March 1, 2024. Please send a paper to iadf_chairs@grss-ieee.org using the IGARSS paper template. Only teams that have submitted the short description complete with all information will be admitted to the test phase.
- For the winning teams, the internal deadline for full paper submission is April 26, 2024, 23:59 UTC – 12 hours (e.g., April 27, 2024, 07:59 in New York City, 13:59 in Paris, or 19:59 in Beijing).

- Important: Only team members explicitly stated on these documents will be considered for the next steps of the DFC, i.e., being eligible to be awarded as winners and joining the author list of the respective potential publications (IGARSS24 and JSTARS articles). Furthermore, no overlap among teams is allowed, i.e., one person can only be a member of one team. Adding more team members after the end of the development phase, i.e., after submitting these documents is not possible.
- Persons directly involved in the organization of the contest, i.e., the (co-)chairs of IADF as well as the co-organizers are not allowed to enter the contest. Please note that IADF WG leads can enter the contest. They have been actively excluded from all information concerning the content of the DFC to ensure a fair competition.

Failure to follow any of these rules will automatically make the submission invalid, resulting in the manuscript not being evaluated and disqualification from the prize award.

Participants to the Contest are requested not to submit an extended abstract describing their approach to tackle the DFC24 to IGARSS 2024 by the corresponding conference deadline in January 2024. Only contest winners (participants corresponding to the best-ranking submissions) will submit a 4-page paper describing their approach to the Contest by April 26, 2024. The received manuscripts will be reviewed by the Award Committee of the Contest, and reviews will be sent to the winners. Winners will submit the 4-pages full-paper to the Award Committee of the Contest by May 25, who will then take care of the submission to the IGARSS Data Fusion Contest Community Contributed Session by May 31, 2024, for inclusion in the IGARSS Technical Program and Proceedings.

## Terms and Conditions

Participants of this challenge acknowledge that they have read and agree to the following Contest Terms and Conditions:
- In any scientific publication using the data, the data shall be referenced as follows: "[REF. NO.] 2024 IEEE GRSS Data Fusion Contest. Online: www.grss-ieee.org/technical-committees/image-analysis-and-data-fusion/".
- Any scientific publication using the data shall include a section "Acknowledgement". This section shall include the following sentence: "The authors would like to thank the IEEE GRSS Image Analysis and Data Fusion Technical Committee, the Space for Climate Observatory, CNES, NASA, and CERFACS for organizing the Data Fusion Contest".

## Acknowledgements