TERRA-MED PhD PROGRAM - Marie Skłodowska-Curie Actions

Context on the program

TERRA-MED is an interregional doctoral program funded under the Marie Skłodowska-Curie COFUND Actions that will recruit and train a new generation of researchers to address the sustainability and resource stress (Water–Land–Energy nexus) in Mediterranean territories.



The Euroregion Pyrenees–Mediterranean, coordinator of the program, brings together the Regions of Occitanie (France), Catalonia and the Balearic Islands (Spain) forming a cross-border research ecosystem. Through this collaboration, TERRA-MED connects world-class universities, research centres and socio-economic actors committed to advancing resilience in the face of climate change. With more than 22,000 scientists across 10 universities and 2 research centers, encompassing 1000 research units, TERRA-MED provides a rich, interdisciplinary environment where doctoral candidates can excel and launch their research careers.

33 PhD positions will be offered to early-stage researchers with a unique interregional, interdisciplinary and intersectoral environment.

Fellows will benefit from having two supervisors (a principal supervisor and a co-supervisor) from two different regions and having a non-academic mentor. The fellows will undertake mandatory cross-border or international stays to the co-institution, as well as a secondment in a non-academic entity.
Moreover, doctoral candidates will receive a specifically designed training program related to their research topics, alongside modules on innovation, entrepreneurship, project management, ethics, open science, etc.

Benefits of TERRA-MED PhD program

- Top-tier PhD education and research training
- Access to world-class laboratories
- Interregional double supervision
- Double PhD degree (France / Spain) where applicable
- Interdisciplinary and cross-sector research experience
- Unique TERRA-MED's excellence training program on resources stress and climate change. See here
- Attractive salary in the frame of MSCA standards
- Extensive network of academic and non-academic partners
- 2 secondments: 1 in the co-supervisor's institution (9 to 12 months); 1 in a non-academic organization to gain extra academic experience and skills (3 to 6 months)

Reference of the thesis project: **UIB4**	**Title of the thesis project** **Assessing the Impacts of Climate and Land-Use Change on Early Warning Systems for Flash-Flood Risk Reduction in Mediterranean Areas**

Host institution: University of the Balearic Islands	**Co-supervision / co-host institution:** Toulouse INP
Country Spain	**Country** France
Host Research Unit: RiscBal will provide the main research environment, field sites, monitoring infrastructure, long-term hydrometeorological datasets and applied links with regional authorities in the Balearic Islands. IMFT will provide complementary expertise in fluid mechanics, hydrology, eco-hydraulics, hydraulic modelling and environmental flows. This joint hosting arrangement will allow the PhD candidate to combine applied Mediterranean risk assessment and early warning system development with advanced hydrological and hydraulic modelling, reinforcing the international and interdisciplinary dimension of the TERRA-MED co-thesis framework. *http://riscbal.uib.eu*	**Co-host Research Unit:** The IMFT will act as the co-supervising host research unit for the PhD candidate. As a leading research institute in fluid mechanics, hydrology, eco-hydraulics and environmental flows, IMFT will provide complementary expertise in hydrological and hydraulic modelling, flood processes, environmental fluid mechanics and the analysis of complex flow dynamics. The co-supervision by Prof. Hélène Roux will strengthen the methodological dimension of the PhD, particularly regarding flood modelling, catchment hydrology, model calibration and the evaluation of early warning system performance in Mediterranean contexts. *http://www.imft.fr/*
Name of the first co-supervisor Joan Estrany : **Email contact:** joan.estrany@uib.cat	**Name of the second co-supervisor** Hélène Roux : **Email contact:** helene.roux@imft.fr
Doctoral School: Escola de Doctorat de la Universitat de les Illes Balears (EDUIB), doctorat@uib.cat	**Doctoral School:** École Doctorale Sciences de l'Univers, de l'Environnement et de l'Espace (SDU2E)

Research field(s)

Physical geography and hydrology; environmental fluid mechanics and hydraulic modelling; climate change and natural hazards; disaster risk reduction and risk governance. ERC panels: PE10_17 Hydrology, hydrogeology, engineering and environmental geology; PE10_20 Geohazards; PE10_3 Climatology and climate change; PE10_13 Physical geography, geomorphology.

Keywords

Flash floods; early warning systems; hydrological and hydraulic modelling; climate change scenarios; land-use change; Mediterranean catchments; hydrometeorological monitoring; remote sensing and GIS; disaster risk reduction.

Description of the research project

Context and rationale

1. **Scientific Context**
   Flash floods are the deadliest and most damaging natural hazard in the Mediterranean. Small, steep and highly responsive catchments concentrate intense convective rainfall into runoff peaks that reach exposed urban, peri-urban and tourist areas within minutes to a few hours. Early Warning Systems (EWS) are the most cost-effective way of reducing the resulting losses, but their effectiveness depends on the skill of rainfall forecasts, on the density and reliability of hydrometeorological monitoring, on how well hydrological and hydraulic models represent land-surface processes, and on the institutional capacity to turn a warning into action. The Balearic Islands offer an outstanding laboratory for this question: RiscBal operates a network of about 100 hydrometric and hydrometeorological stations with more than 24 years of continuous records, and the October 2018 Sant Llorenç flash flood showed how rapidly the warning chain can be overwhelmed in a densely populated insular territory.
2. **Research Gap**
   EWS are normally designed, calibrated and evaluated under the implicit assumption that catchment behaviour is stationary. Both sides of that assumption are now breaking down. Climate projections point towards shorter and more intense sub-daily convective rainfall, while urban growth, tourism-driven land take, agricultural terrace abandonment and post-fire vegetation change are reshaping infiltration, runoff generation and hydrological connectivity. How these two drivers jointly modify rainfall-runoff thresholds, warning lead time and false-alarm rates has not been quantified, and no accepted framework exists for testing EWS performance under coupled climate and land-use scenarios. The transferability of such a framework between contrasting Mediterranean settings -insular Balearic catchments and continental Pyrenean and Occitan basins- remains equally untested.
3. **Relevance to resource stress and climate change (Water-Land-Energy Nexus)**

The project addresses Water as its main pillar, through extreme hydrological processes, flood dynamics and the protection of water-related infrastructure, and Land as its secondary pillar, through land-use change, exposure patterns and territorial planning, with strong Climate and Governance components. It contributes directly to the implementation of the EU Floods Directive, the EU Adaptation Strategy and the UN 'Early Warnings for All' initiative, and feeds operational civil-protection and water-management decision-making in two European regions facing converging climate and resource pressures.

Objectives:

The overall aim is to quantify how climate and land-use change modify flash-flood generation and the operational performance of Early Warning Systems in Mediterranean catchments, and to propose an adaptive EWS design that remains reliable under non-stationary conditions. The specific objectives are:

O1. Characterise the observed and projected evolution of sub-daily rainfall extremes relevant to flash flood triggering in paired Balearic and Occitan catchments.

O2. Reconstruct past and project future land-use and land-cover trajectories (urbanisation, terrace abandonment, post-fire recovery) and quantify their hydrological signature.
O3. Implement, calibrate and inter-compare distributed hydrological and hydraulic modelling chains, combining the modelling frameworks developed at IMFT with the RiscBal operational forecasting chain.
O4. Assess EWS performance -lead time, probability of detection, false-alarm ratio- under coupled climate and land-use scenarios, including data-driven and hybrid physics–AI approaches.
O5. Translate the results into transferable warning thresholds and governance recommendations, co-designed with civil-protection and water authorities in the Balearic Islands and Occitanie.

Expected Results:

• A harmonised, quality-controlled hydrometeorological, land-cover and flood-impact database for paired Balearic and Occitan flash flood catchments.
• Quantified sensitivity of rainfall–runoff thresholds to climate and land-use change, with explicit uncertainty assessment.
• A benchmarked and transferable modelling chain coupling distributed hydrological modelling, hydraulic simulation and data-driven correction.
• A scenario-based framework for evaluating EWS performance under non-stationarity, ready for operational uptake by RiscBal and its French counterparts.
• Three to four articles in leading international journals, open datasets and code, and policy-oriented deliverables for regional authorities.
• A doctoral researcher trained across physical geography, hydrology, environmental fluid mechanics and risk governance, with a genuinely international and intersectoral profile.

Work plan

WP1 - Data assembly and event characterisation (M1-M12, UIB). Compilation of the RiscBal hydrometric and rainfall archive, AEMET and Météo-France products and flood-impact records; selection and instrumentation of paired study catchments in Mallorca and Occitanie.
WP2 - Climate and land-use scenarios (M6-M20, UIB with IMFT input). Analysis of sub-daily rainfall extremes and downscaled climate projections; reconstruction of land-use trajectories from remote sensing; construction of coupled climate-land-use scenarios.
WP3 - Hydrological and hydraulic modelling (M15-M30, IMFT, main secondment). Implementation, calibration and regionalisation of distributed hydrological and hydraulic models at IMFT under the supervision of Prof. Hélène Roux, including sensitivity analysis and hybrid physics–AI corrections.
WP4 - EWS performance assessment (M24-M40, UIB and IMFT). Scenario-based evaluation of warning thresholds, lead time and skill scores; definition of adaptive, non-stationary thresholds.
WP5 - Operational transfer and governance (M36-M46, non-academic secondment). Co-design of warning products with emergency-management and water-management practitioners; transferability and uptake analysis.
WP6 - Dissemination, open science and thesis writing (M1-M48). Publications, international conferences, open data and code, outreach activities and preparation of the doctoral thesis.
Co-supervision. Joan Estrany (UIB-RiscBal) leads the field monitoring, land-use, exposure and risk-governance dimensions; Hélène Roux (IMFT) leads the hydrological and hydraulic modelling and the model-evaluation dimensions. Joint supervision meetings will be held monthly online and at every

mobility milestone, complemented by an annual joint progress committee involving both doctoral schools.

References of both supervisors:

J. Estrany (UIB - RiscBal)

Estrany, J., Fortesa, J., Tomàs-Burguera, M., García-Comendador, J., et al. (2025). RiscBal, an innovation ecosystem co-created from physical geography research and public emergency management in a Mediterranean flood-prone region. Journal of Flood Risk Management, 18(4), e70159.

Estrany, J., Ruiz-Pérez, M., Mutzner, R., Fortesa, J., Nácher-Rodríguez, B., et al. (2020). Hydrogeomorphological analysis and modelling for a comprehensive understanding of flash-flood damage processes: the 9 October 2018 event in northeastern Mallorca. Natural Hazards and Earth System Sciences, 20(8), 2195–2220.

Fekete, A., Estrany, J., & Artacho Ramírez, M. Á. (2025). Cascading impact chains and recovery challenges of the 2024 Valencia catastrophic floods. Discover Sustainability, 6(1), 586.

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Luetzenburg, G., Bittner, M. J., Calsamiglia, A., Renschler, C. S., Estrany, J., et al. (2020). Climate and land use change effects on soil erosion in two small agricultural catchment systems (Fugnitz-Austria, Can Revull-Spain). Science of the Total Environment, 704, 135389.

H. Roux (Toulouse INP - IMFT)

Huynh, N.N.T., Garambois, P.-A., Renard, B., Colleoni, F., Monnier, J. & Roux, H. (2025). A distributed hybrid physics–AI framework for learning corrections of internal hydrological fluxes. Hydrology and Earth System Sciences. Hydrology and Earth System Sciences, 29 (15), 3589-3613.

Huynh, N.N.T., Garambois, P.-A., Colleoni, F., Renard, B., Roux, H. Demargne, J., Jay-Allemand, M & Javelle, P. (2024). Learning regionalization using accurate spatial cost gradients. Water Resources Research, 60(11).

Eeckman, J., Roux, H., Douinot, A., Bonan, B. & Albergel, C. (2021). A multi-sourced assessment of the spatio-temporal dynamic of soil saturation in the MARINE flash flood model. Hydrology and Earth System Sciences, 25, 1425-1446.

Douinot, A., Roux, H., Garambois, P.-A. & Dartus, D. (2018). Using a multi-hypothesis framework to improve the understanding of flow dynamics during flash floods. Hydrology and Earth System Sciences, 22(10), 5317-5340.

Roux, H., Amengual, A., Romualdo, R., Bladé, E. & Sanz-Ramos, M., 2020. Evaluation of two hydrometeorological ensemble strategies for flash flood forecasting over a catchment of the eastern Pyrenees. Natural Hazards and Earth System Sciences, 20, 425–450.

Required Skills and Competences :

We are looking for a curious, rigorous and field-motivated early-stage researcher with:

• a solid background in hydrology, physical geography, environmental or civil engineering, earth sciences or a closely related discipline;

• programming skills for scientific computing (Python and/or R; experience with Fortran, C or HPC environments is an asset);

• experience with GIS and remote sensing (QGIS/ArcGIS, Google Earth Engine, Sentinel and Landsat products);

• familiarity with hydrological or hydraulic modelling and with statistical or machine-learning methods applied to environmental data;

• willingness to take part in field campaigns and instrument maintenance in Mediterranean catchments, including during flood events;

• proficiency in English (minimum B2, written and spoken); knowledge of Catalan, Spanish or French is welcome but not required;

• ability to work in an international, interdisciplinary team and to interact with civil-protection and water-management practitioners. A valid driving licence is an asset for fieldwork.

Master's degree(s) required or equivalent(s):

Hydrology; water resources and water science and engineering; geography and physical geography; environmental sciences; earth sciences and geosciences; civil, environmental or agricultural engineering; fluid mechanics; meteorology and climate science; geomatics, GIS and remote sensing; natural hazards and risk management; applied mathematics or data science with an environmental specialisation. Equivalent qualifications giving access to doctoral studies in Spain and France will also be considered.

Co-supervision partnership framework

Co-supervision (2 supervisors): Yes - Prof. Joan Estrany (UIB-RiscBal, Spain) and Prof. Hélène Roux (Toulouse INP, IMFT, France).

Double degree PhD (France / Spain) where applicable and approved by the relevant institutions: Yes - an international co-tutelle agreement leading to a dual doctoral degree (UIB / Université de Toulouse) will be established, subject to signature by both doctoral schools.

Hosting institution: 36 months (University of the Balearic Islands, Palma, Spain).
Co-hosting institution secondment: 9 months (Institut de Mécanique des Fluides de Toulouse – IMFT, Université de Toulouse, France).
Non-academic secondment: 3 months. The non-academic host is still to be confirmed; suitable organisations include regional civil-protection and emergency-management authorities, water-resource and forest-service agencies, European operational flood-forecasting services and private providers of hydrometeorological monitoring and decision-support systems.
The two secondments add up to twelve months of mobility, scheduled around the modelling phase (WP3) and the operational transfer phase (WP5) of the work plan.

Work conditions

Duration: 48 months
Indicative start date: September 2027
Indicative gross salary: 2400€/ month approximately
If eligible (fellow with 1 or more dependent child), Family allowance: 50€/month

Trainings: project-specific training in distributed hydrological and hydraulic modelling and data assimilation at IMFT, in field hydrometry and sensor-network operation within the RiscBal monitoring network, and in civil-protection and emergency-management exercises during the non-academic secondment.

Mobility required : yes
Non-academic secondment : yes
Double degree / Cotutelle possible : yes
Doctoral tuition fees and Visa fees: fully covered by TERRA-MED program
Social security: Full employer contributions covered by the recruiting entity.

Host institution	Co-host institution

The University of the Balearic Islands (UIB) is a young, research-intensive public university set on a single green campus a few minutes from Palma, and one of the most productive Spanish universities in terms of research output per researcher. The candidate will join RiscBal, the Natural Risks and Emergencies Observatory of the Balearic Islands (riscbal.uib.eu), a research and innovation ecosystem co-created with the regional civil-protection and water authorities. RiscBal operates around 100 hydrometric and hydrometeorological stations with more than 24 years of continuous records, a real-time control centre, UAV and terrestrial laser-scanning equipment, water and sediment laboratories and permanent experimental catchments across Mallorca. Working here means doing science that is used: results feed directly into operational flood warning and emergency planning. Mallorca also offers an exceptional quality of life - a Mediterranean climate, the UNESCO World Heritage Serra de Tramuntana, sea and mountains within half an hour of the campus, and an international, multilingual academic community.	The Institut de Mécanique des Fluides de Toulouse (IMFT, UMR 5502 – Université de Toulouse / CNRS / Toulouse INP) is one of Europe's leading fluid-mechanics laboratories, with a long tradition in hydrology, eco-hydraulics and environmental flows. Within the H2O group, the candidate will have access to state-of-the-art distributed hydrological and hydraulic modelling platforms, high-performance computing resources, experimental facilities and a large, dynamic community of doctoral researchers. Toulouse is one of the largest student cities in France and a European hub for aerospace, earth observation and climate science (Météo-France, CNES, CNRM, Observatoire Midi-Pyrénées), providing direct access to complementary expertise and datasets. The city combines a rich cultural life with easy access to the Pyrenees and the Mediterranean coast.

Eligibility conditions

***Horizon Europe MSCA Mobility Rule*:** Researchers must not have resided or carried out their main activity (work, studies, etc.) in the country of the host organization (France or Spain depending on the employing institution) for more than 12 months in the 36 months immediately before the recruitment date – unless as part of a compulsory national service or a procedure for obtaining refugee status under the Geneva Convention.

***Horizon Europe MSCA Eligibility Criteria*:** Applicants must be eligible for enrolment in a doctoral programme at the employer institution and must not already hold a doctoral degree at the date of recruitment.
Applicants who do not fulfil the Mobility Rule and the Eligibility Criteria WILL NOT be considered for the research position.

***Language requirements*:** Applicants must demonstrate sufficient proficiency (B2) in English to successfully conduct doctoral research and participate in the TERRA-MED training programme.
For more information on this call for candidates see our website here and the guide for applicants here.

APPLY HERE BY Decembre 31st 2026

Administrative Contact TERRA-MED Programme Office (only for general administrative questions and redress demands. Any research-related question must be addressed to the supervisors by email, see second page) **Email**: terramed@euroregio-epm.eu