Research Programme

38° cycle – Academic Years 2022/2023 – 2024/2025

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PhD SDC
SUSTAINABLE DEVELOPMENT
AND CLIMATE CHANGE

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Scholarship code

CU1.24

Curriculum: 1. Earth System and Environment

Addressing integrated and environmentally sustainable water resources Management (ISWRM) In the Mediterranean area

Reference Person: Bonaccorso Brunella (bbonaccorso@unime.it)

Host University/Institute: University of Messina

Research Keywords:	Water resources management Climate and land use changes Environmental sustainability
Reference ERCs:	PE10_17 Hydrology, hydrogeology, engineering and environmental geology, water and soil pollution PE8_3 Civil engineering, architecture, offshore construction, lightweight construction, geotechnics SH7_8 Land use and planning
Reference SDGs:	GOAL 6: Clean Water and Sanitation, GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

The Mediterranean region is experiencing a broad range of threats to water security related to the reduction of water resources availability mainly driven by water overexploitation and pollution and land degradation, due to the rising urbanization, mass tourism and intensive farming. Excessive abstraction of water (e.G., pumping from rivers and groundwater withdrawal) is already altering natural flows, affecting downstream uses, and triggering a sequence of negative environmental impacts. On the other hand, improper land use (e.G., poor cultivation methods, deforestation, and overgrazing) is increasing soil erosion, sedimentation of reservoirs and irrigation canals, and damaging water supply infrastructures. Furthermore, climate change is expected to exacerbate the existing water scarcity issue in the region, leading to unprecedented challenges and risks, especially in arid and semi-arid regions. To address such emerging threats, effective implementation of integrated and environmentally sustainable use of surface water and groundwater resources at the river basin level, also including land use management as an integral part of sustainable water management, is of primary importance in the Mediterranean area. To this end, this research project aims at developing a holistic and dynamic approach integrating biophysical models, current and future scenarios of climate and water demand, as well as land use, to identify optimal water resources management options under different conditions in a representative water supply system in the Mediterranean region. In particular, the Ph.D.

Candidate will develop and implement a dynamic modeling framework for simulating the impact of climate and land use change, and related land and water management practices, on water resources and ecosystem services in a selected case study. The requirement for environmental flows to maintain ecosystems, such as wetland and in-stream environments, will be also considered in the modeling framework to redefine sustainable rules of competition for water and land use between the economic sectors and the environment. As a result, the modeling framework will provide all the required climate information and updated patterns of surface water availability and groundwater recharge, thus helping decision makers to adapt water use and regulation of natural and artificial water bodies, as well as land/agricultural practices, to changing climate and socio-economic conditions, always complying with environmental needs.

Research team and environment

The research activity will be carried out at the Department of Engineering, University of Messina. Within the Research Group of Water Engineering and Hydrology coordinated by Prof. Giuseppe T. Aronica. The Group includes an Associate Professor and other members (Ph.D. Students, Post-Docs, and Research Assistants) and covers research topics related to water resources management, stochastic hydrology applied to the analysis of extreme hydrometeorological events, drought and flood risk management, hydrological and hydraulic river basin modeling, among others. The Research Group collaborates with several other research groups in Italy (University of Palermo, University of Catania, IUSS Pavia, Polytechnic Milan, University of Naples, and others) and abroad (University of Exeter, University of Thessaloniki, University of Bristol, Middlesex University, University of Sarajevo and others).

Suggested skills for this research topic

The Ph.D. Candidate should have a background in civil/environmental engineering, earth and environmental sciences, or related disciplines. A solid background in mathematics, statistics and data analysis is recommended. In addition, programming skills (e.G., MATLAB, R project, Python), GIS knowledge, and experience in re-analysis, climate model and remote sensing data retrieval and elaboration will be positively evaluated. A willingness for international mobility is also recommended, as well as an attitude to work in a collaborative environment, with an interdisciplinary approach.

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Scholarship code

CU2.02

Curriculum: 2. Socio-Economic Risk and Impacts

Developing innovative approaches for cascading effects to improve flood risk management actions with a specific interest on the functional vulnerability of critical infrastructures.

Reference Person: Aronica Giuseppe Tito (giuseppetito.aronica@unime.it)

Host University/Institute: University of Messina

Research Keywords:	Resilience and risk impact
	Critical infrastructures
	Sustainable engineering
Reference ERCs:	PE8_3
	SH7_6
	PE8_11
Reference SDGs:	GOAL 11: Sustainable Cities and Communities, GOAL 13: Climate Action

Description of the research topic

Risk analysis is central to Civil Protection activities and is the core element of risk management. Specific "Risk Management Plans" are needed to ready Civil Protection structures for tackling and managing an emergency. These identify the objectives that must be followed and achieved for the organisation of a desirable response by the Civil Protection when the event occurs.

The development of risk reduction strategies includes all aspects of risk management, from prevention to recovery. Civil Protection has a central role in ensuring a resilient approach for disaster risk reduction

The project aims at studying innovative approaches for the development of integrated flood risk scenarios taking into consideration critical specific issues of areas at risk and the consequences of high frequency/low damage events that affect them. High frequency floods still involve and require mitigation actions on the part of civil protection and citizens before floodwaters inundate the land and directly affect assets that can benefit from enhanced protocol development based on realistic scenarios.

In particular, the main idea is to develop a supporting decision tool for the comparative analysis of disaster reduction strategies in flood risk management, with a specific interest in

studying the functional vulnerability of critical infrastructures in order to preserve their efficiency during and after hazardous events.

This project will contribute to risk prevention addressing two challenging goals: firstly deriving consistent risk scenarios at the micro-scale, for frequent events, focusing on strategic infrastructures vulnerability; secondly defining effective strategies for managing emergencies, focusing on the individuation of areas at risk of isolation, best routes to reach populations, recovery areas, good practices to avoid the presence of citizens and cars in flooded areas.

The project also aims to support Civil Protection actions of risk reduction in at-risk territories during and after emergencies, keeping at-risk citizens safe, through both flood water avoidance and minimising disruption. Flood events cause both direct and indirect impacts, referring to the losses or disruption caused by the direct contact with flood water or due to the secondary effects.

For example. Transport infrastructures, can suffer structural (direct) damages after a flood event and, consequently, lead to an isolation of flooded and also not flooded areas (indirect effect). The efficiency of urban infrastructure is maintained if their disruption does not cause injuries and their functional role is substituted by other infrastructures following alternative routes. Identifying strategic buildings for citizen people recovery, defining the transferability transitability and partial transitability damage states and providing the alternative routes in both eventualities - including considerations on people behaviour, human resources and costs of alternative actions – is an important contribution to mitigate events' consequences by maintaining efficient infrastructures during and after disasters. Event management protocols benefiting from such considerations.

The main activity of the PhD student will be at the Water Engineering Research Group at the University of Messina, which will be integrated with two training periods, one abroad (6 months) at University of Bristol (one of the main European centres on the topic of the thesis) for an improvement of knowledge to flood resilience for the transport infrastructure and one at the Department of Civil Protection of the Sicily Region to improve the aspects related to disaster reduction strategies during and after hazardous events.

Research team and environment

TThe research activity wilt take place at the Department of Engineering, University of Messina. Within the Research Group of Water Engineering and Hydrology coordinated by Prof. Giuseppe T. Aronica. The Group includes an Associate Professor and other members (PhD students, Post-Docs, Research Assistants) and cover research topics related to flood risk management and flood defense design, flood propagation modelling, hydrological and hydraulic modelling of flash floods and debris flows, flood vulnerability and damage evaluation, pluvial flooding, sustainable urban drainage systems. Flood early warning, stochastic hydrology applied to the analysis of extreme hydrometeorological events. The research activities are supported by several national and International grants in the field of

flood risk assessment and mitigation, damage evaluation, development of disaster risk reduction strategies. The Research Group collaborates with several other research groups in Italy (University of Palermo,IUSS Pavia, Polytechnic Milan, University of Naples, and others) and abroad (University of Exeter, University of Thessaloniki, University of Bristol, Middlesex University, University of Sarajevo and others).

Suggested skills for this research topic

The ideal candidate shuold have a background in civil and environmental engineering studies, in particular in the field of urban and riverine flooding, flood vulnerability and damage evaluation.

Familiarity with programming languages such as Matlab, R, Fortran, will be positively considered, as experiences in statistics, data analysis and socio-economic modelling will be an added value. Fluency in English, both written and spoken is recommended. Finally, the candidate shuold be strongly motivated to work in a collaborative environment, with an interdisciplinary approach. A wllingness for international mobility is required