POLITECNICO DI MILANO

PhD in INGEGNERIA AMBIENTALE E DELLE INFRASTRUTTURE / ENVIRONMENTAL AND INFRASTRUCTURE ENGINEERING - 39th cycle

Research Area n. 1 - Water Science and Engineering

PNRR 118 PA Research Field: MODELLING AND MONITORING DROUGHTS AS COMPOUND CLIMATE-RELATED EVENTS

Monthly net income of PhDscholarship (max 36 months)
€ 1195.5 In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	**Droughts** are usually thought of as long-lasting and slow-acting climate phenomena caused by a lack of precipitation and change of other factors over a period of months or years. However, recent drought events across many regions around the world have shown rapid intensification (over a daily or weekly time scale) with sudden occurrence, which can lead to huge losses into a wide array of environmental and societal sectors. For this, the term “flash droughts” has been coined in the scientific literature. For “flash droughts” Otkin et al. [*2018*] have proposed to refer to those droughts having a rate of intensification much more rapid than normal. Note that though a deficit in precipitation is a basic requirement for drought to develop, the speed with which it develops, and its ultimate severity are also influenced by other environmental anomalies, like temperature. For example, when precipitation deficits occur alongside other extreme weather anomalies that enhance evaporative demand, such as high temperatures, low humidity, they can work together to quickly deplete soil moisture reserves owing to increased evapotranspiration (ET). Persistence of such conditions for days to weeks can force a transition from energy-limited ET to water-limited ET, leading to the emergence of a flash drought.

	emergence of a flash drought. Thus, drought events depend on different drivers (precipitation, temperature, etc) and for this can be viewed and treated as compound climate-related events. In this view, the PhD student will contribute to renew competences and instruments of public administration to support the analysis and forecast of drought events with the final goal of improving its knowledge towards the compound mechanisms of droughts.
Methods and techniques that will be developed and used to carry out the research	During this project, the PhD student will learn/make practice/develop **statistical methods for the analysis of compound events** (including copulas, EVT, ML techniques, and AI techniques) and their application to the study of droughts. The methods and techniques will be applied to the study area of **Po river basin District**. This district is an important economic area, producing about 40% of the national Gross Domestic Product: water uses involve strategic activities, such as agriculture, livestock, energy production, inland navigation, and industry. Drought events have occurred more frequently in the Po River Basin District since 2003, requiring improvements in the system of drought monitoring and management. Then some analyses will be extended at Europe scale. The objectives of the PhD student are: 1) develop **statistical indices** for the evaluation **of compoundiness** of the drivers in drought events; 2) assess the **occurrence of droughts** as multivariate objects; 3) assess the **mechanisms of compound droughts** in **some key events** (like the 2003 event or the 2022 event) using using process-based hydrological modelling; 4) **develop R codes** for drought statistical analyses. The research will be conducted in collaboration with the Po River Basin District Authority.
Educational objectives	The PhD project will provide to the candidate: methodological competences at both theoretical and

	applied levels in stochastic hydrology, and modeling of compound climate-related events; capabilities to interact with people o diverse background; problem setting and solving capabilities.
Job opportunities	Academy Environmental Protection Agencies Civil protection authorities River basin authorities
Composition of the research group	1 Full Professors 0 Associated Professors 3 Assistant Professors 0 PhD Students
Name of the research directors	Carlo De Michele

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Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	597.75 €
By number of months	6

National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	Po River Basin Authority - https://www.adbpo.it/ (Reference person: Paolo Leoni)
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	University of Geneve
By number of months abroad	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
Educational activities (purchase of study books and material, funding for participation to courses, summer schools, workshops and conferences): approximately 1630,00 euros per PhD candidate

per year, on average.

Teaching assistantship (availability of funding in recognition of support to teaching activities by the PhD student): there are various forms of financial aid for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities, within the limits allowed by the regulations.

Computer availability and desk availability: individual assignment for the entire career.