Sustainable Water Management Doctoral Programme (Water4All)

Title of the PhD Project	Using machine learning and remote sensing to investigate effects of climate change on hydrological extremes
Acronym	HYDEXCC
Research Fields of the Project	Climate change, hydrometeorology, hydrology, artificial intelligence
Keywords	WRF, WRF-Hydro, climate change, flood and drought, AI
Host Institution, Department and Campus Location	Middle East Technical University, Civil Engineering Department, Ankara
PhD Awarding Institution and Graduate Programme	Middle East Technical University, Engineering Faculty/Graduate School of Applied and Natural Sciences
Name and Affiliation of Main Supervisor	Prof. Dr. İsmail Yücel, Civil Engineering Department, Middle East Technical University
Name and Affiliation of Co-Supervisors	Prof. Dr. Orhan Gündüz, Environmental Engineering, Izmir Institute of Technology Prof. Dr. M. Tuğrul Yılmaz, Civil Engineering Department, Middle East Technical University
Research Environment and Infrastructure	PhD candidate will have access to the research infrastructure available at Middle East Technical University and Water Resources Laboratory. When a specific high computing system is needed, other national high computing system (e.g. Ulakbim) will also be contacted.
Scientific Context of the Project	Climatic changes exacerbates the duration, intensity and frequency of hydrologic extremes that adversely impact different socio-economic sectors (water, energy) worldwide. Under changing climate it is important to understand the effects of

	climate change on the characteristics of hydrological extreme events such as heavy rain, flood and drought. Artificial Inteligence (AI) together with remote sensing can help predict extreme climate. Combining AI with current scientific understanding based on physics-based projections from numerical weather prediction models yields some of the most promising results. Massive data sets from physics-based WRF simulations are analyzed by AI to find trends, and AI components are then added to the models to improve the predictions of physics-based model (WRF) extreme forecast simulations. Additionally, this work will include enhanced WRF extreme weather forecasts into a high-spatial-resolution WRF-Hydro model to estimate flood/drought discharges in hydrological catchments.
Brief Workplan	Detailed and up to date literature review in the use of AI together with numerical weather prediction models (WRF). Investigate appropriate AI or machine learning (ML) methods for hydrological extreme cases. Setup/configure and train the AI algorithm based on available WRF high resolution simulations and observations. Identify extreme weather conditions under climate change and setup WRF model for these events. Apply trained AI algorithm for extreme WRF simulations to obtain improved forecasts. Setup coupled WRF with WRF-Hydro for flood/drought discharge estimations.
Innovative Aspects of the Project	Blending AI and remote sensing data with numerical weather prediction models can improve the prediction of extreme weather in the era of climate change.

Training Opportunities of the Project	The project can provide opportunities for training in the hybrid utilization of AI and physics-based numerical weather prediction models for t-term extreme weather forecasts in important operational research centers.
Interdisciplinary Aspects	This research will gain benefit from interdisciplinary work of atmospheric science, computing science, and hydrology.
Intersectoral Mobility **☐ Short Visit** **☐ Secondment**	TBD
Intersectoral Mobility **☐ Short Visit** **☐ Secondment**	TBD
International Academic Secondment	TBD

Main Supervisor	
Brief CV	**Prof. Dr. İsmail YÜCEL** **E-mail:** iyucel@metu.edu.tr **Academic Degrees** Ph.D. Hydrology, The University of Arizona, USA 2001 M.Sc. Hydrology, The University of Arizona, USA 1996

	B.Sc. Meteorological Engineering, İstanbul Technical University, Türkiye 1993 **Professional Networks** Google Scholar: https://scholar.google.com/citations?user=RGHnl3YAAAAJ ResearchGate: https://www.researchgate.net/profile/Ismail-Yucel-2 Scopus: https://www.scopus.com/authid/detail.uri?authorId=57204345432 ORCID: https://orcid.org/0000-0001-9073-9324
Co-supervisors	
Brief CV	**Prof. Dr. Orhan GÜNDÜZ** **E-mail:** orhangunduz@iyte.edu.tr **Academic Degrees** Ph.D. Environmental Engineering, Georgia Institute of Technology, USA 2004 M.Sc. Civil Engineering, Georgia Institute of Technology, USA 2000 M.Sc. Environmental Engineering, Middle East Technical University, Türkiye 1997 B.Sc. Environmental Engineering, Middle East Technical University, Türkiye 1994 **Professional Networks** Google Scholar: https://scholar.google.com/citations?user=zmIGAlsAAAAJ&hl=en ResearchGate: https://www.researchgate.net/profile/Orhan-Gunduz Scopus: https://www.scopus.com/authid/detail.uri?authorId=9743239900 ORCID: https://orcid.org/0000-0001-6302-0277

Sustainable Water Management

Doctoral Programme (Water4All)

Brief CV	**Prof. Dr. M. Tuğrul YILMAZ** **E-mail:** tuyilmaz@metu.edu.tr **Academic Degrees** Ph.D. Earth System Sciences, George Mason University, USA 2011 M.Sc. Earth Systems, Vrije University Amsterdam, Türkiye 2005 B.Sc. Civil Engineering, Middle East Technical University, Türkiye 2003 **Professional Networks** Google Scholar: https://scholar.google.com/citations?user=ogpRhhIAAAAJ&hl=tr&oi=ao ResearchGate: https://www.researchgate.net/profile/M-Yilmaz-7 Scopus: https://www.scopus.com/authid/detail.uri?authorId=57191906140 ORCID: https://orcid.org/0000-0001-5094-1878