CIVIL AND ENVIRONMENTAL ENGINEERING

DIATI – Water Use and NetZero Agriculture

Funded By	Dipartimento DIATI
Supervisor	TUNINETTI MARTA - marta.tuninetti@polito.it
Contact	TUNINETTI MARTA - marta.tuninetti@polito.it BERTAGNI MATTEO BERNARD - matteo.bertagni@polito.it
Context of the research activity	The agricultural sector accounts for approximately 90% of global water use and 70% of global water withdrawals, and contributes nearly 20% of annual global greenhouse gas emissions. Increasing crop water use efficiency while reducing its climate impact is essential for preserving water resources and limiting global temperature rise. While adopting greener fertilizers and renewable energy sources can mitigate part of agriculture's carbon footprint , the persistent emissions of methane and nitrous oxide from soil and livestock necessitate offsets through carbon removal strategies to achieve net-zero targets. Enhanced Weathering (EW) is a promising solution to achieve net zero agriculture. It involves applying crushed silicate rocks to soils, sequestering CO_2 as they dissolve. Besides its carbon sequestration potential (roughly 300 kg of CO_2 per ton of rock dissolved), EW offers substantial co-benefits, such as enhanced crop yields due to micronutrient supply and increased soil pH, similar to the effect of liming. For EW to be effective, sufficient water availability and enhanced hydrological soil flow are essential. By combining a state-of-the-art agro-hydrological and biogeochemical model for EW with regional and global datasets on hydroclimatic conditions, crop characteristics, and soil moisture, the research will identify optimal conditions for EW implementation in the Italian context and extend findings to a global scale.
Objectives	This Ph.D. research project aims to optimize the synergy between water use in agriculture and EW to maximize its effectiveness in carbon sequestration. The Ph.D student will develop the research activity according to this methodological pathway: (i) developing comprehensive scenarios for EW applications in agriculture, leveraging a state-of-the-art agro-hydrological and biogeochemical model, simulating the interactions between water use, soil health, and carbon sequestration. EW. Ii) Model advancements through integration of emergent EW field data. Iii) (iii) Analyses of hydroclimatic conditions using regional and global datasets to optimize EW implementation and agricultural production, (iv) Addition to the modelling framework of the various crop characteristics and their response to enhanced weathering treatments, thus understanding which crops benefit the most from EW to inform practical applications.

Skills and competencies for the development of the activity	A quantitative expertise based on analytical or numerical (e.g., Matlab, Python) skills is required. Basic knowledge in the field of hydrology, biogeochemistry, climate change, and agriculture. A good knowledge of the English language is mandatory.