CIVIL AND ENVIRONMENTAL ENGINEERING

DIATI - Enhanced Weathering for Net-Zero Agriculture: Optimizing Water Use

Funded By	Dipartimento DIATI
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Context of the research activity	With the agricultural sector contributing more than 20% of annual global greenhouse gas emissions, reducing its climate impact is essential for 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) represents one of the most promising solutions. Borsa finanziata nell'ambito del progetto "Dipartimenti di Eccellenza 2023-2027 (l. 232/2016, art. 1, - commi 314 - 337)" - Dipartimento di Ingegneria dell'Ambiente, del Territorio e delle Infrastrutture (DIATI) del Politecnico di Torino, finanziato dal Ministero dell'Università e della Ricerca.
Objectives	EW involves applying crushed silicate rocks to soils, sequestering CO2 as they dissolve. Besides its carbon sequestration potential (roughly 300 kg of CO2 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. Given that the agricultural sector accounts for approximately 90% of global water use and 70% of global water withdrawals, leveraging this substantial water consumption could significantly enhance carbon removal outcomes. This Ph.D. research project aims to optimize the synergy between water use in agriculture and EW to maximize its effectiveness. By combining a state-of-the-art ecohydrological 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. The Ph.D student will develop the research activity according to this methodological pathway: (i) developing a comprehensive model integrating a state-of-the-art ecohydrological and biogeochemical model tailored for Enhanced Weathering. This model will simulate the interactions between water use, soil health, and carbon sequestration, (ii) analyzing hydroclimatic conditions using

	regional and global datasets to analyze hydroclimatic conditions relevant to EW implementation and agricultural production, (iii) adding to the modelling framework 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	We are looking for a highly motivated candidate with: Strong quantitative skills; A background in environmental engineering or physics with major in hydrology and/or biogeochemistry; Fluency in English; A passion for climate change mitigation; Proficiency in computing and software tools represents an important complementary skill set.