Assessment of carbon, food, and water trade-offs towards emission targets in western Canada's endangered grasslands

Project Abstract

Humanity faces the triple challenge of stabilizing climate, safeguarding nature, and ensuring food security. Innovative approaches for climate- and nature-friendly land management and food production systems are urgently needed. The grasslands of Canadian Prairies (GCP) are among the most critical ecosystems that provide numerous ecosystem goods and services (EG&S), including carbon sink for climate regulation, forage production for wildlife and livestock grazing, and clean water for human consumption among others. Protection and restoration of GCP must be considered in Canada's climate change plans. Hydrological processes and terrestrial carbon fluxes are closely coupled. Physical and process-based Eco-hydro(geo)logical models (EHGM) are important tools for predicting the effects of these GCPs in regulating climate, preserving water, and providing food subject to climatic and land-use changes. This proposed I-STEAM research will contribute to a larger ongoing project (09/2018-02/2025) funded through CAIP Chair, NSERC DG, and Mitacs in collaboration with several industrial and governmental partners. This larger project involves several graduate and postdoctoral fellows, and it aims to investigate water-food-climate trade-offs across agricultural and grasslands of the Canadian Prairies. The goal of this I-STEAM project is to engage indigenous students to collaboratively study trade-offs between water, carbon, and food production in GCP. It will expose the I-STEAM student to a multidisciplinary project which brings together researchers from different disciplines and stakeholders from different sectors. Adequate supervision will be provided by Dr. Faramarzi (PI of the proposed project) and the primary PDF involved in the larger project to assist the I-STEAM student in learning about the state-of-the-art knowledge, advanced tools and data, and their role in managing water-food-climate challenges of our time. There will also be opportunities for a field trip in Alberta to familiarise the proposed student(s) with hydrological concepts, watershed-scale management, and grassland ecosystems including their various EG&S.

Anticipated Student Role and Developed Skills (max 200 words)

The student's primary roles are: (1) conduct a state-of-the art literature review about GCP and their role in providing EG&S; (2) learn about nature-based solutions in grassland ecosystems for regulating climate and sustaining food production and water quality; (3) learn about the concepts and applications of EHGMs; (4) in close collaboration with the primary PDF, apply newly acquired skills to assist with data analyses, mapping, and scenario analyses in threatened grassland ecosystems; and (5) help with the interpretation of the results and contribute to manuscript drafting. The student will be given the opportunity to present the research outcomes in the form of a presentation and/or poster. Faramarzi's lab has experience on suprevising undergraduate students (UG) for productive learning outcome, and some former UG contrbutions resulted in collaborative paper publication in top-ranked journals. In addition to the more technical skills, student will learn about the complex socio-ecohydrological processes that influence the strategies for watershed-scale management, including the potential trade-offs between water, carbon, and food. Due to the interdisciplinary nature of the project, the student will also benefit from exposure to a working

environment that engages different stakeholders (e.g., industry partners & land managers) and collaborating with faculty across different university departments.

Anticipated Student Involvement in the Project (max 200 words)

The student will work under supervision of Dr. Faramarzi and in direct collaboration with a PDF in her lab, who is currently leading the GCP's carbon modelling. This research is part of a much larger endeavor by Dr. Faramarzi's lab to study carbon-water-food trade-offs under a changing climate. This shared research framework will enable interaction with several postgraduate students working on various components of the larger project and facilitate a more holistic understanding of the water-food-environment and climate system.

Dr. Faramarzi's lab is specialized in modelling physical and biogeochemical processes involved in climate-land-water systems. The lab's predictive research capitalizes on a wide range of geospatial and time series data collected over at least multiple decades. Hence, short-term field measurements are not instrumental in the lab's research; instead, acquiring existing long-term data from various stakeholders is often required. However, we recognize the importance of field experience to (i) better understand the environmental processes underpinning the EHGMs and (ii) provide ecological context to the data used for model development. The student will therefore have an opportunity to visit the **Mattheis Research Ranch** in southern Alberta to learn about GCP including native grassland embedded within a matrix of tame pasture and annual cropland.

Anticipated Indigenous Community Benefits (max 200 words)

Healthy ecosystems, including grasslands, are fundamental to the well-being of Indigenous communities, who are disproportionately vulnerable to the effects of a changing climate. Globally, Indigenous Peoples are the primary custodians of intact ecosystems and biodiversity.
The implementation of nature-based solutions, superior ecosystem protection and restoration, would enormously benefit the Indigenous community in many situations. The I-STEAM student will acquire new knowledge and skills in ecosystem modelling, develop a deeper understanding of how natural and anthropogenic processes interact to influence ecosystem properties, and learn the principles of nature-based solutions in the context of grasslands of Canadian Prairies. The mutidiciplinary nature of the project and collaboration with both jounior and senior reseachers in- and outside of the campus will help student to develop confidence and leadership skillset. The offset protocols underpinning policy reward schemes for regenerative and sustainable land management are increasingly important in meeting national emission targets. Indigenous communities could benefit from such incentives, and the student's holistic knowledge on these topics could help make informed decisions and transfer knowledge.

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