



Causality Analysis in the Water-Energy-Food Nexus in the Canadian Prairies

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As global water, energy, and food (WEF) demands are continuously increasing because of population growth, climate change, and the modernization of the human lifestyle, sustainable resource management is of prime importance. Societies have been struggling with the planning and management of WEF resources under changing population, climate, and ecosystem. Integrated resource management is essential to achieve optimal and sustainable WEF management as sector-centric (e.g. water-centric) management can lead to poor outcome. To that end, WEF nexus as a multi-centric approach has been introduced to emphasize interlinkages among WEF sectors. Such interlinkages need to be identified, quantified, and analyzed to facilitate sustainable WEF resources management.

This study aims to conduct a quantitative data analysis within the WEF nexus context to identify the interrelationships among WEF sectors and to understand how each sector interacts with other sectors in the Canadian Prairie provinces (Alberta, Saskatchewan, and Manitoba) individually, and as a whole over the period 1990-2020. Historical data used in this study are at annual temporal and provincial spatial resolution. A correlation-and-causality analysis has been conducted for different pairs of WEF sectors to measure the degree of relationships and to explore the cause-and-effects between each pair of sectors. The Multispatial Convergent Cross Mapping method, as a causal inference tool, has been used for identifying and assessing the causal relations. Determining the causal relationships among WEF sectors helps researchers identify critical components, of a large and complex system, for further investigation and modelling. It can also guide policy-makers for better allocation of resources.

Results showed that water has a stronger influence on food and energy than the other way around in the upstream province of Alberta. It was also found that food had more influence on energy than the other way around in the three prairie provinces. This study is a step forward toward a better understanding of the WEF nexus by using causal inference methods for tracking the strength of interactions to identify dominant sectors at both the provincial and regional scales. This can help build more parsimonious and efficient WEF nexus models for further simulation and scenario analysis.