Mapping wetland water dynamics using Synthetic Aperture Radar and multi-temporal Shannon Entropy

* Valentin PONCOS¹, Andrew WELCH²

1. Kepler Space Inc., 72 Walden dr, Ottawa, Canada, K2K 3L5, poncos@kepler-space.com
2. JWRL Geomatics, 128 Creekside Drive, RR 2, Woodlawn, Ontario, Canada, K0A 3M0, andy@jwrl.ca

* Corresponding Author

ABSTRACT

The dynamic of wetland water represents a complex and sometimes unknown process. The difficult access in these areas, coupled with the impossibility of detecting water under vegetation using optical systems (regardless of resolution) mounted on-board airplanes or UAV systems, led to the use of Synthetic Aperture Radar (SAR). SAR systems are capable of penetrate vegetation and are also very sensible to water content. The mechanism that makes possible the measurement of water dynamics is the double-bounce mechanism. Microwaves penetrate the vegetation, bounce from the water surface under the vegetation canopy, then from the vegetation stems, and return to the SAR antenna. The interferometric phase of this double-bounce mechanism will contain the path between the two phases centres of the bounce points, one at the water level and another one on the vegetation stem. The stems tend to be fixed, whereas the water levels can change rapidly; thus, a change in the double-bounce interferometric phase will be related mostly to water level changes.

Objective: to characterize wetland water dynamics (extent variation under the vegetation canopy, flow directions and gradients, water level changes).

Methodology: SAR amplitude was used to detect bright pixels dominated by double-bounce from flooded vegetation. Persistent Scatterers Interferometry (PSInSAR) was used to detect and mask bright pixels containing persistent scatterers from infrastructure and bare-rocks that could be confused with flooded vegetation.

Multi-temporal analysis was used to map temporal patterns. A number of estimators optimized to detect changes (such as amplitude, polarimetric and phase-based Shannon Entropy) were implemented and applied to a large area of interest in the Peace Athabasca Delta.

Results: Maps of water flow direction and gradients, together with inflow/outflow points and flooding/spill-out areas at the contact between the wetland and the high ground were produced. Temporal analysis was used to map the long-term flood plain by integrating local, short-term flood events.