Hydrodynamics of the groundwater-fed Sian Ka’an Wetlands, Mexico, From InSAR and SAR Data - DTU Orbit (19/11/2019)

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The 5300 km² pristine Sian Ka’an wetland in Mexico is fed entirely by groundwater from the karst aquifer of the Yucatan Peninsula. The area is undeveloped and hence difficult to access. The inflow through underground rivers and karst structures is hard to observe resulting in difficulties to understand, quantify and predict the wetland dynamics. Remotely sensed Interferometric Synthetic Aperture Radar (InSAR) and Synthetic Aperture Radar (SAR) data offer new opportunities to get hydrodynamic information, which is useful for wetland management. InSAR data produces temporal phase-changes of the backscattered radar signal, which can be related to the water level changes in vegetated wetlands. SAR data reveals information of surface properties such as the degree of flooding through the amplitude of the backscattered signal. We used RADARSAT-1 InSAR and SAR data to form 36 interferograms and 13 flooding maps with 24 to 48 day intervals covering the time span of October 2006 to March 2008. The dataset has a high spatial resolution of ca. 20 to 60 m. Sian Ka’an consists of a mosaic of freshwater sloughs, canals, floodplains and brackish tidally-influenced areas. Throughout most of the year, water level changes in the wetland are almost uniform, resulting in a very low fringe signal in the InSAR-observations. However, during periods of maximum water levels in the wetland, steeper gradients of water level changes are observed in the wetland's sloughs, more than in the surrounding floodplains. The data reveal that two sloughs and a canal-shaped feature are main source areas feeding water into the wetland. The maximum relative water level changes observed in the wetland are 48 cm. Tide-induced water level changes appear to occur in 3 separate areas, with a maximum relative change of 24 cm, corresponding well with tidal predictions. The interferograms also reveal information about surface water flow directions and local-scale flow divides in the wetland, which are important for understanding the wetland hydrology. These flow directions and divides are supported by structures visible on Landsat imagery. Finally, the radar backscatter amplitude and its standard deviation reveal the spatio-temporal changes in the flooding extent of the wetland. Using this method we detected that the largest flooding extent (3020 km²) occurred in September 2007 after Hurricane Dean had passed through the area. In the case of no hurricanes, maximum extent of flooding occurs in November-December, 1-2 months after the end of the rainy season (2640 to 2980 km²). The smallest degree of flooding occurs in May (1350 km²) at the end of the dry season. This information along with relative water level change maps may be used for improved hydrological modelling of the wetland.

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