INTRODUCTION

Wetlands are at high risk for loss, due to inadequate legal protection, rapid population growth and climate change. Hydrology (i.e., flooding and soil moisture) controls the fate of wetlands, and varies with climate, population growth, and land use. This study was conducted to assess the capability of satelliteborne radar (C-band SAR) data to monitor the hydrology of wetlands.

Inundation

Contrary to our hypothesis, we found:

Comparison with leaf-on and leaf-off C-band ASAR data collected over the Roanoke River (below) to determine the impact of incidence angle on ability of SAR to monitor inundation below the forest canopy.

Hypothesis: the ability to detect inundation will decline

Contrary to our hypothesis, we found:

• Smaller incidence angle was least preferable
• Larger incidence angle data were better suited for inundation monitoring than expected

A wider variety of incidence angles and times of the year should be considered when monitoring inundation.

This should increase temporal resolution of future studies.

C-BAND RADAR MONITORING OF HYDROLOGY IN MID-ATLANTIC FORESTS: NEW INFORMATION FOR IMPROVED WATER QUALITY MANAGEMENT

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HYDROPATHET IN MID-ATLANTIC FORESTS

What controls hydrology in Mid-Atlantic Floodplains?

In situ data (e.g., inundation, soil moisture, basal area, tree height, and canopy closure) were collected coincident with ASAR images in 24 4-hectare forest plots located in backwater, levee, and upland areas adjacent to the Pasquotank River (lower left). These data were collected from spring of 2003 to winter of 2004. Stream discharge and climate data were gathered online. Statistical analyses were used to determine the relationship between inundation and stream discharge, temperature (a proxy for evapotranspiration), and precipitation.

> Inundation was strongly correlated with stream discharge, precipitation, and temperature.
> A 3-day period with 0.63 and 0.96 (average P = 0.76).
> A dirt road also influenced inundation (far right). After the connection between hydrology and climate was elucidated, we investigated the capability of C-band (SAR) to monitor hydrology.

MONITORING HYDROPATHET USING RADAR

Can C-Band SAR be used to monitor hydrology beneath the forest canopy in the mid-Atlantic U.S.?

Transmitted microwave energy (backscatter or b) is attenuated and reflected from different elements, resulting in the microwave energy detected by the sensor (below).

Variation in C-hh-backscatter, levee, and upland plots

> C-HH & C-VV m varies significantly between plot types (p < 0.0001).
> C-HH & C-VV backscatter & splash m and levee & upland m are significantly different (p < 0.05).
> C-HH significantly different (p = 0.05) between backscatter & levee.

Inundation

> C-HH: Leaf-off: -4dB; Leaf-on: -2.5dB change with inundation (upper-right).
> C-VV: Leaf-off: -1.5dB Leaf-on: -1dB change with inundation (lower-right).

Soil Moisture

> Large degree of collinearity between soil moisture & inundation.
> Variation between backscatter & upland sites.
> 1.5dB C-HH & 0.9 dB C-VV during leaf-on season with no flooding.

C-Band SAR can be used to distinguish different levels of flooding and soil moisture. C-HH can monitor even relatively small changes in flooding during leaf-off & leaf-on seasons and the potential of C-VV is promising during leaf-off season.

FORESTED WETLAND MAPPING

Can C-Band SAR be used to monitor forested wetland hydrology and map forested wetlands?

Maps were produced using multi-temporal SAR images and compared to field observations and U.S. Fish and Wildlife Service National Wetland Inventory (NWI) maps.

Multi-temporal SAR data were calibrated and georegistered, Band, and stacked to form one image file, before running a principal component analysis. Principal component 1 (PC1) was thresholded to produce the multi-class wetland map (hydrophytum) and PC1 was used with elevation data in a decision tree classifier to produce the binary forested wetland map.

CONCLUSIONS AND FUTURE DIRECTIONS

This study provides new technology to monitor forested wetland hydrology and changes to forested wetland hydrology, caused by climatic and anthropogenic forces.

Previous studies have shown that C-Band SAR can map inundation (5% versus 10%) in large forested wetland systems. This study was conducted at a finer scale with detailed measurements of inundation. It directly compared the abilities of C-HH & C-VV data to detect flooding and soil moisture throughout the year. Tested the ability of C-Band SAR to detect varying amounts of flooding (at relatively low levels), and used C-Band SAR to link levels of inundation to weather conditions in the Mid-Atlantic.

We are currently mapping forest hydrology in the Choptank River Watershed on the Eastern Shore of Maryland. Efforts are being made to streamline this process and enhance the applicability of this information to management issues, including water quality monitoring.

Although some water quality models, such as ANN4MP, are spatially explicit, they do not incorporate many of the parameters that can be derived with remotely sensed data. Maps of forest hydrology are expected to improve model estimates of water quality by identifying candidate locations where denitrification, and other chemical transformations that rely on aerobic conditions, may occur. We are working to incorporate forest hydrology models and other remotely sensed parameters into water quality models at multiple scales, ranging from local to National. Modeling the impact of watershed management, including the implementation of agricultural best management practices, with improved landscape information will help improve water quality in freshwater ecosystems, such as the Chesapeake Bay.

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