Remote Sensing for Integrated Water Resources Management: Approaches within the German-Vietnamese WISDOM Project

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Introduction

Integrated water resource management requires detailed knowledge about hydrologic,-, hydraulic-, ecologic, and socio-economic factors. It is the goal of the multi-disciplinary German-Vietnamese WISDOM project to set up an Information System, IS, for the integrated analyses of these factors in the Mekong Delta. Key data for the IS are amongst others remote sensing data products depicting information on landcover, landuse, flood extent or settlement in the Delta.

Radar remote sensing

Radar remote sensing data are well suited for tropical wetland ecosystem monitoring, because of the all-weather capability of Synthetic Aperture Radar (SAR) systems, and because of their sensitivity to biomass and the structure of flooded vegetation. In general, radar backscatter returns are lower over inundated canopy free areas.

The Terra SAR-X satellite delivers data in varying modes and resolutions (Table 1). Two StripMap images with 3m resolution in one of the projects's study areas - Tam Nong District - were acquired for October 2007 and January 2008, (rainy & dry season), (Figure 1).

Table 1: Terra SAR-X technical specifications

Height	5.0 m
Wet mass	1.230 kg
Orbit	514 km 98° Inclination sun-synchronous
Resolution	ScanSAR mode: 16 m @ 5 x 10 km Scene StripMap mode: 3m @ 30km swath Spotlight mode: 1 m @ 5 x 10 km Scene
Repetition rate	11 days
Life time	5 years

Water mask derivation

A common approach to derive water masks from SAR images is a threshold based image classifier. First, median filtering was applied to reduce radar speckle. Then a threshold was used to separate water- from non-water pixels in the image. Afterwards morphological image closing was performed. Finally, very small "islands" and "lakes" of defined size were removed. The resulting water masks are shown in Figure 2.

Change detection

A normalized difference index (NCI) image was calculated based on equation 1. Figure 3 shows a false colour composite of the resulting image and subsets thereof. Blue regions in the image represent regions with minor changes (main river estuaries and flooded rice paddies), while red regions display major changes (mainly flooded regions during the rainy season). The closer a pixel appears to red the more change it represents.

Discussion and Outlook

Currently, only limited information about the flood situation and severity can be extracted because the time period between both input images is long. With the Terra SAR-X satellite a repetition rate of 11 days is available, enabling regular scanning and multi-temporal derivation of water masks within this time interval.

Derived water masks will automatically (i) be ingested into the WISDOM information system and (ii) announced to the subsequent processors, e.g. flood modelling. They can directly be used for further geo-statistical analysis, e.g. by intersecting with landuse- or population datasets to quantitatively derive information on how many people or which type of crops are affected.

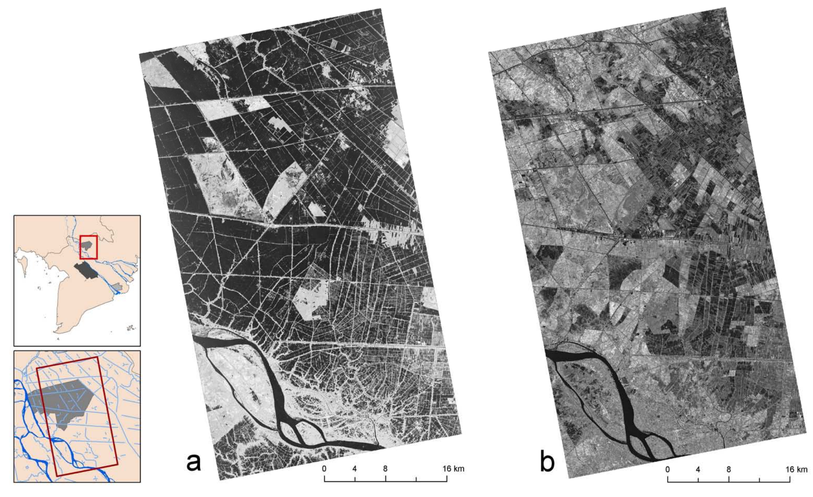

Figure 1: Terra SAR-X images from October 20th in 2007 (a) in the rainy season and January 5th in 2008 (b), dry season. Dark regions represent flooded areas, while light areas represent non-inundated areas, dams, roads, etc..

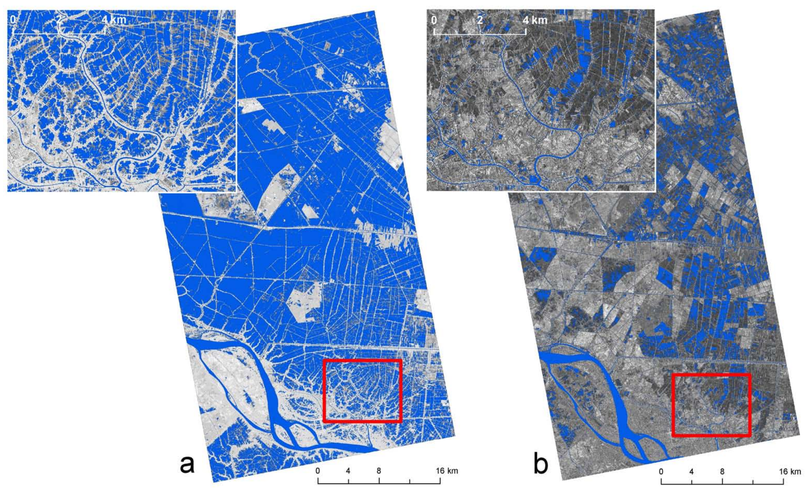

Figure 2: The SAR images from October 20th 2007 (a) and January 5th 2008 (b) superimposed with the derived water masks. The zoom images depict the high spatial detail of the sensor and the rate of change in both images

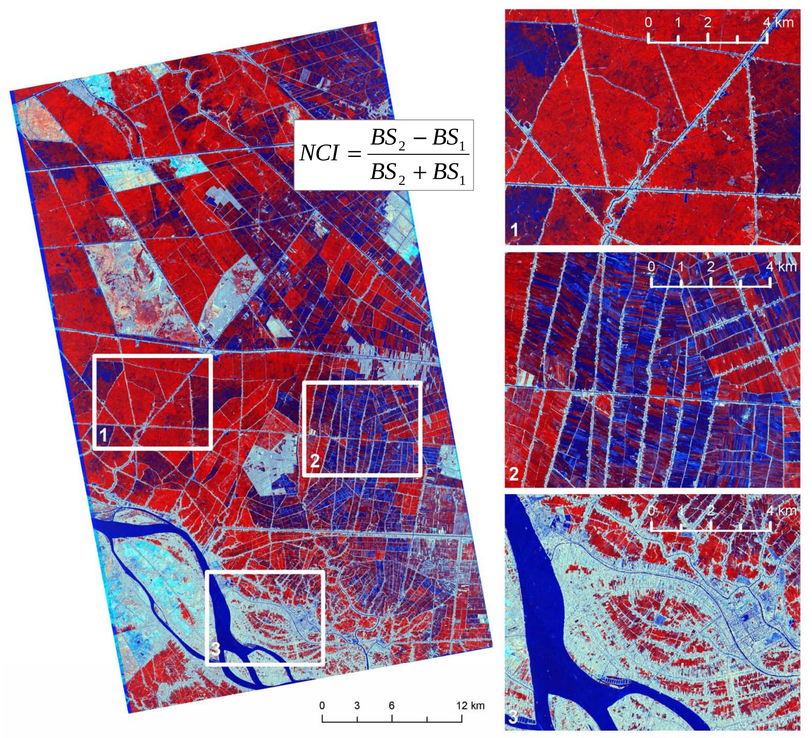

Figure 3: The changing inundation situation on the surface. False colour composite (red-green-blue: normalized change index image (NCI) -TSX October 2007-TSX January 2008). Colours towards to red indicate major changes, blue regions represent minor or no changes. Equation1: *BS1* and *BS2* = backscatter signals (pixel values) in the SAR images from Oct. 2007 and Jan. 2008, respectively. NCI ranges from -1 to 1 with zero values showing no change.

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