Flood mapping and forecasting

Synergy of SAR and optical satellite images with applications in the Zambezi Basin

Executive Summary

Study Team Members: M.Menenti[1], S.M. Alfieri[1], T.Bangira[2], A.v.Niekerk[2], Z.Vekerdy[3] , M.Painho[4]

Research Centre(s): [1]TU Delft, [2]Stellenbosch University,[3]University of Twente – ITC, [4]ISEGI - UNL

ESA Studymanager Dr. Benjamin Koetz

Alcantara StudyReferenceNo.: 14/P11
StudyType: Pilot
Contract Number:4000112465/14/F/MOS

Picture:

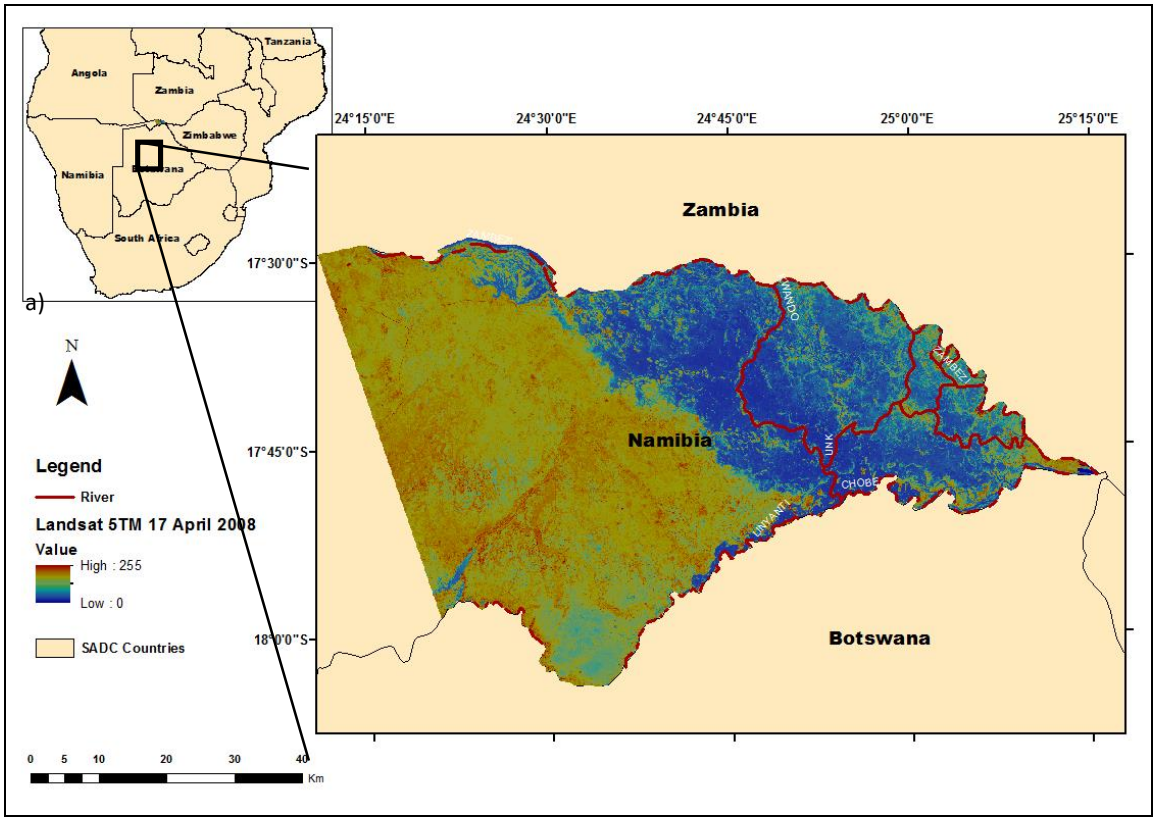

Figure 1. Geographic location of the Caprivi Basin in Southern Africa and its Eastern part

Motivation:
The study was motivated by the need to get a better, quantitative, understanding of the advantages and disadvantages of SAR and multispectral image data, taking into account the spatial and temporal at which such data are generally available and the characteristics of floodplains in Southern Africa.

Methodology:
Two approaches have been applied and evaluated. The data sets used in this study are listed in Table 1

Table 1 Overview of data evaluated in this study

Product	Spatial resolution	Temporal Resolution	Number of scenes			
			2008	2009	2010	2011
MERIS FR	300m	3 -5 days	49	42	38	46
SAR	30m	35 days	5	3	2	3
ASAR WS	150m	3-5 days	18	16	11	9
Landsat 5 TM	30m	16 days	7	4	3	2

Multispectral image data: The Normalized Difference Water Index (NDWI) proposed by McFeeters (1996) was applied to MERIS FR and to Landsat 5TM data acquired nearly simultaneously with flooding events in the Caprivi Basin (see Fig.1). A thresholding on NDWI index was initially applied but performance with MERIS FR was poor due to fragmentation of the water area and to emergent vegetation. A new spectral un-mixing method was developed and applied which uses both NDWI and NDVI.

SAR image data: three different methods were applied: a) backscatter thresholding; b) thresholding of mean backscatter and its standard deviation in a temporal sequence of SAR images; c) change detection. The thresholds were estimated by applying the Otsu (1979) method.

Results:

- A work-flow was developed to process each data set and to determine the extent of flooded area.

- Thresholds have been estimated for different subsets of the images using OTSU method and their temporal variability documented..

- Thresholding MERIS FR gave large overestimates of flooded area compared with Landsat 5 TM. Thresholding backscatter gave comparable estimates with ASAR WS and ASAR data, with slight underestimates with ASAR.

- A new spectral un-mixing method was developed and applied which combines NDWI and NDVI to deal with fragmentation of the water surface and emergent vegetation.

Publications:

BANGIRA, T., S.M. ALFIERI, M. MENENTI ,A.v. NIEKERK and Z. VEKERDY, . A spectral un-mixing method for flood mapping in heterogeneous areas: a case study on the Caprivi floodplain. Rem Sens. Special Issue: 20 p (to be submitted)

BANGIRA. T., S.M. ALFIERI, M.MENENTI,A. V. NIEKERK and Z. VEKERDY, 2016. Flood Mapping in Caprivi Basin, Namibia using High and Low Resolution SAR and Multispectral Data. LPS16 Oral presentation, Prague, 11 May 2016.

BANGIRA. T., S.M. ALFIERI, M.MENENTI,A. V. NIEKERK and Z. VEKERDY, 2016. Mapping flood extent with SAR and multispectral data in Caprivi flood plain (Namibia),Tiger workshop Addis Ababa, 01-02 February 2016.

BANGIRA. T., S.M. ALFIERI, M.MENENTI,A. V. NIEKERK and Z. VEKERDY, 2015. Flood mapping using SAR and multispectral remote sensing in the Caprivi Basin, ESA midterm presentation, WebEx meeting, TU Delft, 28 August 2015.

BANGIRA.T., M.MENENTI, A. V. NIEKERK, 2015. A Flood mapping using SAR and multispectral remote sensing in the Caprivi Basin . PhD Research Plan, Stellenbosch University, 16 June 2015.

Highlights:

Spectral un-mixing was done by applying robust statistics based nonnegative matrix factorization (RNMF) method. This method, due to the use of a cost function based on NDWI and NDVI, is robust against outliers. Results show that the proposed method based on RNMF can be used efficiently for multispectral un-mixing purposes.

This project and collaboration will continue until the completion of ms. Bangira PhD. at the Stellenbosch University under the joint supervision of prof. A.v.Niekerk and prof.M.Menenti.

Flood mapping and forecasting

Synergy of SAR and optical satellite images with applications in the Zambezi Basin

Questionnaire

Study team members: M.Menenti[1], S.M. Alfieri[1], T.Bangira[2], A.v.Niekerk[2],
Research centre(s): [1]TU Delft, [2]Stellenbosch University

Alcantara StudyReferenceNo.: 14/P11
StudyType: Pilot Study
Contract Number: 4000112465/14/F/MOS

	StronglyAgree	Agree	Neitheragree nor disagree	Disagree	Stronglydisagree	It does not apply/ Don't know
The topic behind this Alcantara project was interesting and relevant	x					
The study description clearly explained what was required		x				
The administrative effort required for this project was high (strongly agree), low (strongly disagree)			x			
The interaction with the ESA Technical Officer was important for the success of the project	x					
The interaction among all partners in this study was satisfactory		x				
After the Alcantara study we will continue this research	x					
After the Alcantara study we will continue our cooperation with the home institution of the external researcher	x					
During this Alcantara project we increased our knowledge about ESA and its programmes		x				
The research team would be willing to propose themes for new studies open to other groups (please specify below) (1)	x					
The project produced results that could be extrapolated to other regions (please specify below) (2)	x					
The project produced satisfactory results (SA) unexpected events affected results (SD – please specify below)		x				
The study budget was appropriate to carry out the work	x					
Othercomments						

(1) The study should be extended to cover.

(2) The study further demonstrated the