# Use of Proba-V Images in Southern Africa for Dynamic of Desertification Indicators

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***Abstract*—In southern Africa, land degradation and desertification affect the territory to a considerable extent. Given the lack of economic resources to reverse the problem in many countries within the region, prevention mechanisms can be key to address further land degradation and desertification. The use of Earth Observation Data for analyzing land degradation and desertification dynamics, in southern Africa is widely and consistently used. Under the Desert watch Extension project a consistent methodology to attain an Indicator of Susceptibility to Desertification was developed. In this paper we aim to implement the Indicator for Susceptibility to Desertification through Desert Watch Extension methodology, but employing new Earth Observation Data from the satellite mission of the Project On Board Vegetation-Proba-V. Our preliminary results validated the use of this new Earth Observation data set for the analysis of the spatial variability as well as temporal dynamics of drought, one of the key driving factors of land degradation and desertification in the region.**

***Keywords- the Southern Africa; desertification indicators; Proba-V; drought.***

## I. INTRODUCTION

This study aims to analyse the new dynamics of desertification and land degradation indicators in Southern Africa. The study area comprises Southern Mozambique, Southern Zimbabwe and the Northern part of South Africa. The research goal is to produce an Indicator for Susceptibility of Desertification (ISD) through remote sensing data, namely the Proba-V (Project On Board Autonomous Vegetation)[1]. The Proba-V is satellite mission from European Spatial Agency (ESA) and Centre National d' Etudes Spatiales (CNES) and is providing new Earth Observation Data since June 2013. This product has the same performance as the Satellite Pour l' Observation de la Terre – Vegetation (SPOT-VGT)[2]. Hence, it allows us to have series of data from 1998 to current days.

The semi-arid areas cover almost 16% of African continent´s surface and represent about 5.1 million km$^2$ [1]. Dryland degradation affects much of Africa, in general, and Southern Africa, in particular [2]. There are several studies that sought to discriminate between climate and human-induced dryland degradation in Southern Africa [3][4][5]. Among various factors, the cyclical occurrence of droughts at local level, as well as deforestation caused by farming and alike activities can increase the risk of desertification particularly in the semi-arid areas in Southern Africa [1]. The indicators about the susceptibility to desertification, particularly in the semi-arid areas in Southern Africa region, still requires further study. To what extent, through the use of the Proba-V-new remote sensing data - a steady and effective Indicator for Susceptibility of Desertification – ISD, can be obtained for Southern Africa? Our research goal is to employ the Proba-V satellite imagery and the DW-E methodology for obtaining an affective Indicator for Susceptibility to Desertification. We consider that using this new data could represent a crucial step for consolidating the understanding of the dynamics of desertification in Southern Africa.

## II. METHODOLOGY

In Southern Africa region, the driest months are July and August, whereas the rainiest months are December and January. Fundamentally, in the study area, two main seasons can be identified. One is cold and dry and another is hot and wet with about the same duration length of 6 months each. However, a decrease in precipitation can increase the likelihood of severe droughts.

In the preliminary stages of this study, in order to calibrate the ISD using the new Proba-V images, the correlation between the Normalized Difference Vegetation Index (NDVI), extracted from Landsat (Thematic Mapper[3], Enhanced Thematic Mapper plus[4] and Operational Land

[1] Proba Vegetation: small satellite for global vegetation http://proba-v.vgt.vito.be/

[2] Spot-Vegetation programme http://www.spot-vegetation.com/

[3] Landsat Thematic Mapper (TM) https://lta.cr.usgs.gov/TM

[4] Landsat Enhanced Thematic Mapper plus (TM) https://lta.cr.usgs.gov/LETMP

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Imager–Thermal Infrared Sensor[5]), SPOT-VGT and Proba-V images, was investigated by each land cover class. The Landsat images were pre-processed: radiometric and atmospheric correction, dark-object subtraction method and cloud and shadow mask and upscaling for Proba-V and SPOT-VGT spatial resolution. The images used in the calibration were taken from the month of September (the end of the dry season) for the years 2001, 2008 and 2014.

The dynamic of desertification indicators include: a) the number of days per year with precipitation below 1 millimeter (RL1) was computed from climate reanalysis of the data from The European Centre for Medium-Range Weather Forecasts (ECMWF), and it was the input for climatic component; and b) biophysical component, which is based on NDVI and soil brightness analysis, by land cover class. As work in progress, the models of desertification indicators had been determined using geostatistical methodologies (kriging, co-kriging, stochastic simulations ) with the biophysical and the climatic indicators [6][7][8][9][10][11][12]. This methodology coupled with field work (direct observation) will be pivotal to validate the findings as well as to ensure consistency.

## III. RESULTS AND DISCUSSION

The Proba-V and SPOT-VGT data products had shown a significant correlation with Landsat image, allowing us to follow through with the next step, which is the ISD.

Despite the decreasing in spatial resolution from 30m (Landsat) to 100m (and 300m) (Proba-V), the temporal resolution was increased from 2 images per month to 6 (and 3) per month. This is one of the major enhancements that the Proba-V satellite provided on Open Earth Observation Data.

Our results about climatic component (see Figure 1 and Figure 2), suggest that there could be a steady relationship between the spatial dynamic of drought and spatial variability of semi-arid areas over the region. Figure 1 represents the Static Component, which is the average of the number of days per year with precipitation below 1 millimeter (RL1). The highest values of the average of RL1 (red spots), seem to be spatially distributed according to desert areas and semi-arid areas over the region. Figure 2 represents the Dynamic Component, which is the slope of the variance of number of days per year with precipitation below 1 millimeter (RL1). The areas with high values (in red) experience the major variability in rainfall and these areas are distributed according to the semi-arid areas over the region. Overall, the climatic component analysis seems to show high levels of consistency with previous work on spatial dynamics of land degradation and desertification in Southern Africa [2]. We are working on soil component and we expect to obtain desertification indicator results with different spatial resolution (100m, 300m) using Proba-V images.

[5] Landsat 8 OLI (operational Land Imager) and TIRS (Thermal Infrared Sensor) https://lta.cr.usgs.gov/L8

In conclusion, the ISD in semi-arid areas, where the range of drought periods differed in magnitude in space and time, is significant for resources management and sustainable development strategy at national level.

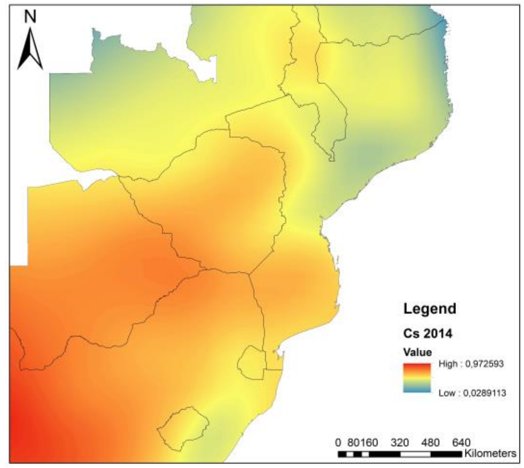


Figure 1. Climate Static Component

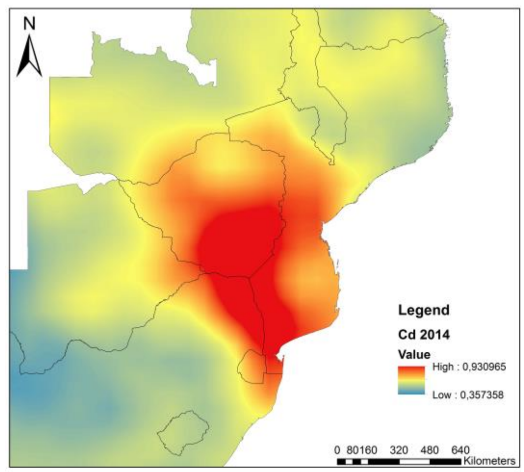


Figure 2. Climate Dynamic Component

## ACKNOWLEDGMENT

This research was supported by the European Spatial Agency, under the project “Development of Earth Observation (EO) indicator for the Dynamic of Desertification in Southern Africa”: Alcantara Study Reference No.: Ref: 144P12 and Contract Number: AO4147864/14/F/MOS.

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