WATER QUALITY MAPPING IN TÉRRABA SIÈRPE WETLAND, COSTA RICA, USING DESIS AND SENTINEL 2 DATA

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1.1 Introduction

The project "Application of multispectral and hyperspectral Earth Observation data to investigate water quality in relation to agricultural activities within the Térraba Sièrpe Wetland in Costa Rica - MONEO-WET)" corresponds to an initiative focused on investigating the applicability of remote sensing data in tropical systems. The main topic of this project is the use of EO data to assess the impacts and dynamics of agricultural activities on the sensitive RAMSAR wetland ecosystem Térraba Sièrpe at the mouth of the Térraba and Sièrpe rivers.
The impact of agricultural activities on this wetland and its influence on water quality will be studied in more detail in this project. One goal of this project is to develop a first EO database and define analytical methods for water quality studies in the Térraba Sièrpe wetland and beyond. The results will provide a deeper insight into the processes of the entire wetland ecosystem and may help to detect harmful damage to the fragile environment caused by agricultural activities. The long-term goal is sustainable land use management that is exemplary for many other tropical wetlands in Latin America.

1.2 Study area

Térraba Sièrpe Wetland National Park in Costa Rica is part of the RAMSAR convention sites and is considered as one of the most biodiverse mangrove swamp in the world in terms of biodiversity. It covers a total of 27,066 hectares of protected mangrove forest, is periodically flooded by the tides and has a good supply of mud rich in organic material (FAO, 2012). The growing agricultural areas in the immediate vicinity of the wetland not only threaten the ecosystem, but also damage the biodiversity in the long term. Scientists from Germany and Costa Rica are working together to collect data with established (e.g. Sentinel 2) and new Earth Observation sensors (e.g. ISS/ DESIS) (CEOS, 2018) to assess water quality parameters and link these parameters to agricultural land use in the surrounding area. The common goal of the project is to evaluate the applicability of Sentinel-2 and DESIS hyperspectral satellite imagery for water quality studies in relation to plant cover in the vicinity of the Térraba-Sièrpe Wetland National Park in Costa Rica.

Field campaigns were carried out in November 2018, March and November 2019 and March 2021 during dry season. The sampling sites for in-situ measurements were taken in the three main meanders of the Sièrpe and Térraba River within the wetland. At each sampling site, the spectral signature of the river was recorded using an Ocean Optics Sensor System (OOSS). The WASI-2D inversion method (Gege, 2004, 2006, 2014), a semi-analytical model, was parameterised with default specific inherent optical properties (SIOPs), but in future SIOPs of the Térraba Sièrpe Wetland System determined through water sample analysis will be used.

1.3 Preliminary results

Some of the Sentinel-2 overpasses were coincident with available field data, however DESIS images could not be obtained during field campaigns, thus only a qualitative evaluation is presented. WASI-2D (Gege, 2014) was applied to time series of L2A Sentinel2 and DESIS images from February to April 2019 during the dry season. Although cloud cover in the tropics is a major challenge, the influence of thin clouds could be corrected and the concentrations of suspended matter (TSM) and yellow matter (CDOM absorption) could be derived quantitatively (see Figure 1). The map of chlorophyll-a shows plausible spatial distributions and concentrations in some parts of the image (Umaña, 2015), but in many areas (especially in the ocean) the concentrations are below the detection limit. The Sentinel 2-based turbidity estimates and comparisons with DESIS images showed them to be in good agreement (see Figure 2). Preliminary results indicate that under favourable observational and environmental conditions, the quality of DESIS and Sentinel2 data are suitable for mapping highly variable water constituents in tropical environments. Their quantitative determination by satellite is therefore an important contribution of this project to the ecological assessment of the waters and the surrounding environment of the study area.

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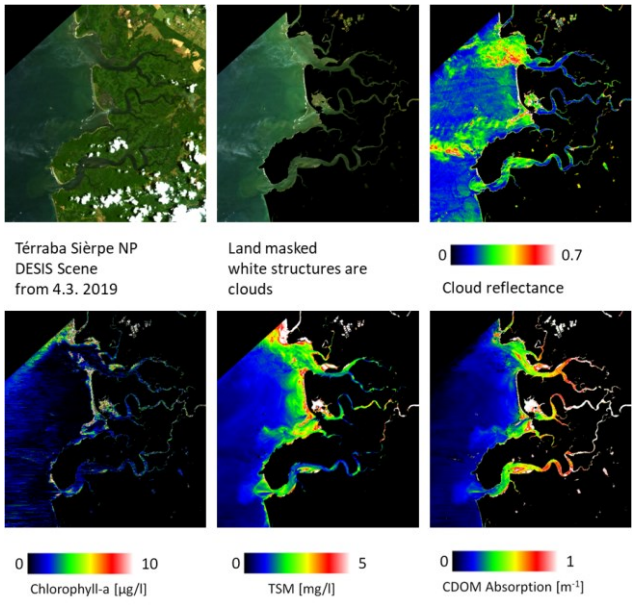

Figure 1. First analyses of a DESIS imagery from 4.3.2019. The thematic maps show the reflectance of clouds as well as the concentrations of chlorophyll-a, suspended matter (TSM) and yellow matter (CDOM absorption).

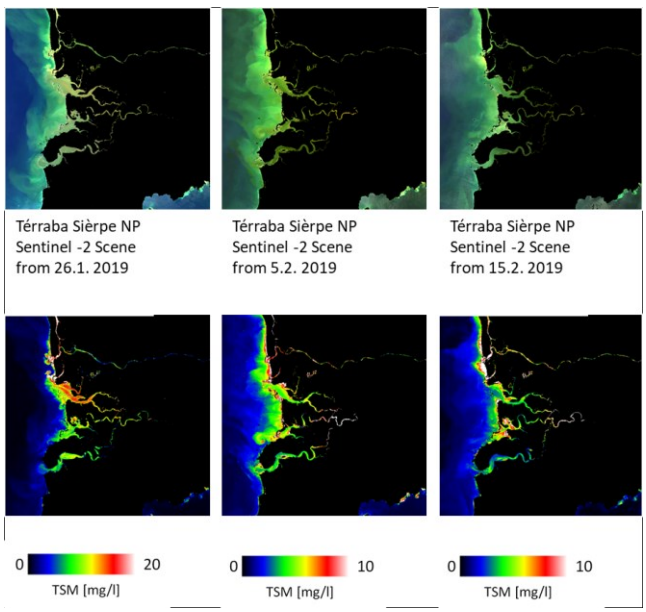

Figure 2. A time series analysis of Sentinel-2 data show the dynamics in the test area (1.), as example the suspended sediment concentrations as shown (2.) on 26.1.2019, 5.2.2019 and 15.2.2019.

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