HICO Data User's Proposal

Monitoring of Wetlands in the Nile Delta

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Abstract/project summary

The Nile Delta wetlands are among the most productive ecosystems in Egypt. These wetland systems directly support the economical and ecological values of the Nile Delta. The wetlands in the Nile Basin are facing several anthropogenic and natural threats. Human activities (urban, pollution and overfishing) are strengthened with climatic changes in reducing water quality leading to catastrophic wetland degradation.

Although, earth observation data (e.g., HICO) provide ecological information on water quality, they are limited with respect to information content, such as surface mapping and missing specific water quality parameters like conductivity, nutrients, oxygen. In-situ data, on the other hand, are collected regularly but are limited in, respectively, time resolution and spatial coverage. In order to address these shortcomings and add other valuable information, we will develop a framework to integrate HICO data and in-situ monitoring networks leading to a better exploitation of existing space capacity and know-how. HICO data will be converted to water quality indicators and integrated with in-situ measurements to produce new water quality maps with a broader range of parameters and decision supporting information.

1. Statement of work/project description

Objective

The proposed research aims at better understanding of wetlands water quality variation in the Bullurus lake, Nile Delta region, Egypt.

Our main objective is to develop a framework to integrate HICO water quality products with in-situ measurements to produce new maps of water quality and wetland ecological indicators with a broader range of parameters and decision supporting information.
The study will in particular address the following goals:

1. Resolving the subscale spatial variability of HICO- derived water quality parameters with respect to the matching in-situ measurements and other EO observations;
2. Developing a method to integrate HICO-products of water quality with in-situ measurements and existing ecological models of the study area;
3. Setting up a mentoring system based on EO-data and in-situ measurements to deliver quantifiable water quality variables and wetland ecological indicators of the wetland of the Nile Delta with focus on the Bullurus lake;

Study Area

The Northern Nile Delta Lakes are shallow, and have a rich aquatic life. Large parts of the lakes are overgrown with aquatic vegetation, speeding up the process of land reclamation. The open water area of the lakes rapidly declined during the last decades due to land reclamation, the formation of in-lake reed islands, and also due to the development of fish farms along the shores. The characteristics of the lakes changed considerably due to the construction of the High Aswan Dam. The main focus of this proposal will be on the Northern Nile Basin and specifically the Burullus lake. Burullus lake is a shallow brackish lagoons with a thick vegetation belt and numerous small islands. The lake is open to the sea through narrow canals with water depth varying from 0.7 to 7-2.4 m, in addition Burullus is a RAMSAR site.

Problem and Methodology

The wetlands in the Nile Delta are affected by anthropogenic and natural eutrophication, leading to undesirable increases in biomass of planktonic algae, turbidity, anoxia toxicity and poor ecosystem services. Several studies show that such aquatic ecosystems may reach to a tipping point, at which the water quality shifts abruptly from one state to another (e.g. Carpenter_etal_1999, Scheffer_etal_2001). Hence, a reliable, monitoring system that integrates multiple data sources is urgently needed for quantifying and predicting the ecological state of wetlands in the Nile Delta.
To achieve the goals of this proposal three tasks will be carried out, each leading to a set of deliverables. These tasks are: data acquisition, implementation and dissemination.

Task 1: data acquisition

Data are available from many sources (in-situ, EO products and model outcomes) we will explore and acquire these data from different organizations and data warehouses. Unfortunately the Medium Resolution Imaging Spectrometer (MERIS) on EnviSat has stopped sending data since April 8th 2012. Thus there an urgent need to establish a match-up data set for validation purposes between HICO and field data. Our data acquisition plan is as follows:

Task 3: Publication of scientific results

In this task we will finalize the project by delivering the final report of the activity and products produced as part of the research. In addition an executive summary of the final report will also be delivered, which highlights the objectives and the main results and their relevance for space data exploitation. Finally we will publish results in international journals and conference proceedings.
Deliverables:
Final Report, KO+12,
Executive Summary, KO+12,
Publication KO+18

Study Schedule

The research is planned to be undertaken over a 18 months period, starting in March 2013 as shown in table1.

ID	Type	Activity	Kick of meeting KO+1											
			1	2	3	4	5	6	7	8	9	10	11	12
1	Task1	EO data acquisition												
2		Field data acquisition												
3	Task 2	Atmospheric correction of EO data												
5		deriving water quality variables												
6		error assessment of EO products												
7	Task 2	Identification of hotspot												
9		Data down/up scaling												
12	Task 3	Final reporting												
13		Publishing in scientific journal												
15	meeting	HICO annual meeting												X

Table 1: schematic illustration of the time schedule of the planned execution of the project activities.

2. Biographical sketch and available facilities

By means of education, research and project services, the Faculty of Geo-Information Science and Earth Observation (ITC) of the University of Twente contributes to capacity building in developing countries and emerging economies. In doing so, considerable attention is paid to the development and the application of earth observation methods for solving water resources related problems. Such problems can range, among others, from determining the risks of extreme hydrological events, monitoring food and water security, to detecting environmental pollution. By using the most up-to-date geo-information techniques ITC provides tools that can support the processes of planning and decision making for sustainable development and the alleviation of poverty in developing countries and emerging economies.

3. Output and deliverables

1- In-situ field campaign is planned to be between April and May 2013 to capture the spring bloom. We will measure water quality variables and compliment them with spectral measurements of the light leaving the water surface and under water down welling attenuation coefficient (Kd, which are non-existing in this region);
2- Retrieve 10 years of MERIS data over the Northern Nile basin;
3- Establishing a match- data set between field and EO data.

Task 2: Research implementation

We will use EO data acquired by the HICO, which is by far the most outstanding space-borne sensor for inland and coastal areas. HICO sensor combines fine spatial resolution (~100 m) with spectral bands appropriate for water quality assessment. Five water quality maps will be derived from each HICO image, namely: chlorophyll-a concentration, abundance of colored dissolve matter, concentration of suspended particles, euphotic depth of photosynthetic available radiation (PAR) and identification of hot spot of cyanobacteria abundance.
We will deliver scientific data sets in the form of products resulted from each processing step. The processing chain of this task is as follow:
Atmospheric correction (AC) of HICO images: The available HICO products shall be processed to L1b by applying atmospheric correction model of Gao et al., (2000) coupled with the inland-turbid water processor of Salama and Shen (2010).
Deriving water quality parameters: Five water quality maps will be derived from each image acquired by HICO namely: chlorophyll-a concentration, colored dissolve matter, suspended particles, euphotic depth of photosynthetic available radiation (PAR) and phycocyanin (to identify hot spot). For this task, state of the art algorithms, quasi analytical algorithm QAA (Lee et al. 2002, Lee et al. 2010) and the GSM model (Maritorena 2002) modified by Salama et al for inland water (Salama et al. 2009) and HydroCE (Salama and Shen 2010) will be used. Water quality products from these models will be blended using weights estimated form the produced uncertainties for each water quality parameters.
Uncertainty assessment: We will produce five maps of uncertainty one for each derived parameter. The uncertainty measures are estimated from the retrieval models (QAA and GSM-Salama) and the validation results with available in-situ data using the models of Salama and stein (2009) and Salama et al., (2011 and 2012).
Identification of hotspot: Maps of phycocianin absorption (specific pigment of cyanobacteria), chlorophyll-a concentration and PAR euphotic depth will be combined in a simple index (a weighted sum) to identify hotspot of harmful algae bloom (HAB). The weights are determined form the data using principal component analysis (PCA). This method was developed at ITC for MERIS following the European Water Directive for the ROXO reservoir in Portugal and will be applied to HICO data.
Data integration (down/up scaling): We will employ scaling methods (e.g. Salama and Su 2010, 2011) that are applicable to matchup sets, and adapt them to blend HICO products with varying spatial resolutions. These models use the differences between two data at fine and coarse scales to estimate the subscale variability of water quality proxies of the coarse scale data. This information on the subscale variability of water quality may facilitate planning of EO product calibration and validation activities. It may also assist in resolving the critical scale of variability of the observed process in these wetlands and improve the assimilation of HICO water quality products with model predictions and in situ data.

Methodological results

The anticipated methodological results are:

1. A model to resolve the subscale spatial variability of HICO- derived water quality parameters with respect to the matching in-situ measurements and/or other EO observations;
2. Water quality variables and other ecological parameters blended from three models as applied to HICO;
3. A framework to integrate HICO-products of water quality with in-situ measurements and may be existing ecological models of the study area.

Improved knowledge

The results of this project will contribute to improve our understanding of:

1- The scale variability of wetland processes.

2- The trend of the ecologic state of the wetlands in the Northern Nile basin and how they are related to climatic change will also be probed;

3- The dynamic of ecological shifts (harm full algae bloom and Eutrophication) of the wetland in area, i.e. where and when the occurred, how they evolved and what the driving mechanism;

4- The expected future ecological responses of wetlands.

Deliverables

Final Report, KO+12,
Executive Summary, KO+12,
Publication KO+18, all developed codes and data product will make part of the publication and will be deliverd to HICO programe and data user and the open to

4. References

Carpenter, et al., (1999), Ecological Applications, 9: 751-771
Gao, et al., (2000), Applied Optics, 39: 887-896.
Scheffer, et al., (2001), Nature, 413: 591–596.
Lee, et al., (2005), Applied Optics, 41: 5755-5772.
Lee, et al., (2010), Applied Optics, 49: 369-381.
Maritorna, et al., (2002), Applied Optics 41: 2705-2714.
Salama, et al., (2012), Biogeosciences, 9: 2195-2201.
Salama, et al., (2011), Optics Express, 19: 16772-16783.
Salama, and Su, (2011) IEEE Transactions on Geoscience and Remote Sensing, 49: 2612-2622.
Salama, and Su, (2010), Sensors, 10: 7561-7575.
Salama, and Stein, (2009), Applied Optics, 48: 4947-4962.