REMOTE SENSING MODELLING AND MONITORING OF WATER QUALITY WITHIN THE SEVILLE (SPAIN) AREA DAMS

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ABSTRACT/RESUME

Monitoring and modelling the bio-geochemical state of continental water bodies should be based on remote sensing data. The proposed project looks at the modelling and spatial-temporal assessment of water quality within the Seville area dams through the use of the hyperspectral and multi-angular capabilities of the CHRIS sensor in the water configuration (Mode 2).

1. INTRODUCTION

The deterioration of the ecological status of continental waters (dams, lakes) has become an urgent and growing problem in the last years. Numerous natural and human induced factors contribute to the increase in the concentrations of optically active substances in the water bodies as well as the rise of water turbidity and water temperature. This processes can lead to algal bloom events, anoxia and even to a dramatic deterioration of water quality parameters.

As a consequence, the bio-optical properties and the amounts of the constituents (phytoplankton, detritus, mineral particles and yellow substance) of the water can be modified in short spatial and temporal scales whose investigations are of interest to those responsible for the management of the water-bodies specially for reservoirs of drinking water. Water quality investigations are routinely carried out taking in situ water samples and running laboratory analysis periodically with the consideration of water safety and quality. However these procedures are time consuming and provide only point water quality data, being unable to depict the synoptic water quality parameters for the entire reservoir. It is essential to set up an efficient and convenient water quality monitoring model that can predict the spatial and temporal distribution of different water quality parameters. An economical approach to monitoring and modelling the bio-geochemical state of such water bodies should be based on remote sensing data.

This project must be understood within the general context of policy and decision-making for the protection of continental waters and its main aim is the development of new methodologies of remote sensing for the monitoring and assessment of water resources. More specifically, it looks at the modelling and spatial-temporal assessment of water quality within the Seville area dams (including Aracena, Zufre, La Minilla, Cala and Gergal) in co-ordination with the main bodies responsible for the regulation and monitoring of the above mentioned dams, namely the Guadalquivir Water Authority (Confederación Hidrográfica del Guadalquivir) and Seville Water Supply Public Corporation (Empresa Municipal de Abastecimiento y Saneamiento de Aguas de Seville - EMASESA) with remote sensing methods.

2. STUDY SITE

The hydrographic network of the Guadalquivir River Basin has the lowest water quality in the Andalusian region, eutrophization being a general process in all its the water reservoirs. The study area includes a system of 4 dams connected by the Ribera de Huelva River. Gergal Dam is the smallest and the head of the system while Aracena Dam is the biggest (Table 1).

Table 1

	Aracena	Zufre	Minilla	Gergal
Bas.Surf.(Km^2)	408	850	1054	1755
Surface (Has)	954	968	182	250
Volume (Hm^3)	128	175	57,8	35
R.V. (Hm^3)	38	45	15	15
W.Vol. (Hm^3)	109.18	170.76	36.12	14.26

During the year 2004, the Minilla and Gergal dams (the closest to the Water Supply System) corresponds~~s~~ to tempered holomictics and monomictics with a general pattern of an alternating phase of stratification beginning in April and a mixing phase starting in October. Water investigations at the Gergal Reservoir are conducted using boats and point sampling. During 2004 a first maximum of cryptophytes and diatoms has been registered at the beginning of spring with other two cyanobacteris (Aphanizomenon) blooms at the beginning and end of summer time.

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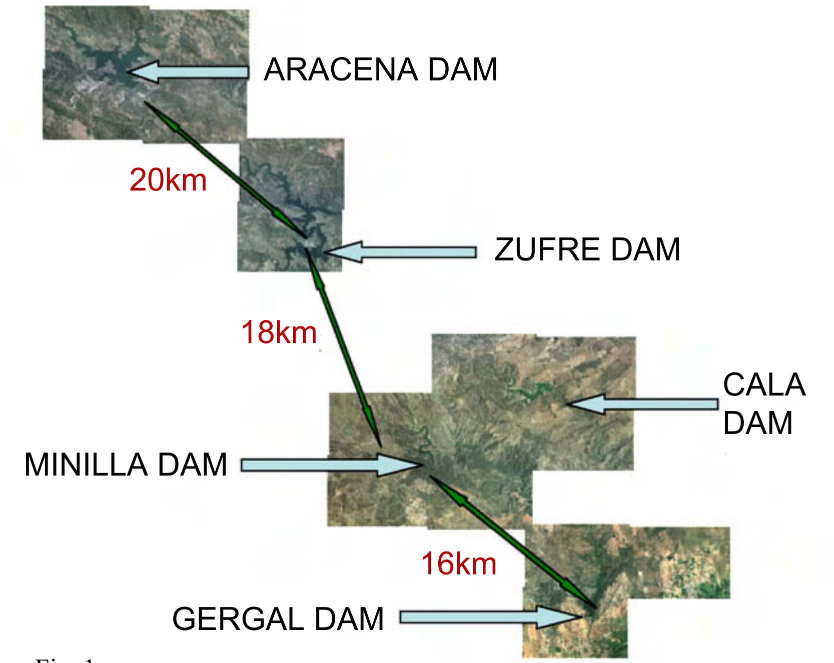

Fig. 1

3. DATA COLLECTION

The methodology includes the in situ measurement of spectral and physic-chemical parameters in GPS geo-referenced points of the water body synchronized with satellite pass. To cover the spatial variability of water quality parameters in each dam, a grid of sampling points has been designed. The number of GPS referenced points will be of 15-20 stations in Gergal and Minilla Dams, and 20-30 in Aracena (Fig. 2), Cala and Zufre.

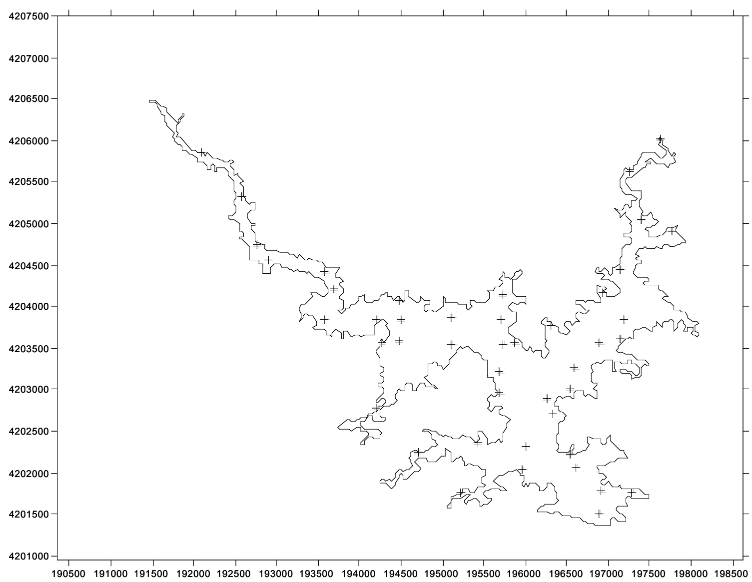

Fig. 2

According to the limnological behaviour of Gergal Dam the best dates to characterize the phases of stratification and mixing of the water columns will be on December, April, July and September.

3.1. Spectroradiometric and in situ measurement

Reflectance measurements will be carried out with an Ocean Optics dual spectrometer with a 3.5º fore-optic from 350 to 1100 nm with a 0.5 nominal band-with Spectralon target reflectance. Four separate scans of each sample target will be carried out.

Spectral measurement of above water remote sensing reflectance down-welling and up-welling radiance profiles, simultaneous measurement of Secchi Disk, Chlorophyll, Phycocianin, Turbidity (FTU) and CDOM with a CTD system will be completed with water and biological sampling

3.2. Laboratory analysis

Water laboratory includes analysis of chlorophyll-a, phycocianin, turbidity, absorption and scattering spectra of suspension solids and pigments, water dissolved substances absorption, particles size distribution, mineralogical analysis as well as algal microscopy.

Pigment concentration will follow standard procedures according to [1]. Fixed volume of water will be filtered through pre-combusted glass fibre filters (WhatmanGF/C). Chl a and phaeopigments will be measured following extraction in methanol [2,3]. Total suspension solids will be measured by gravimetric procedures on a pre-weighed membrane filter (Millipore 0.45 μm pore size).

Absorption and backscattering spectra of pigments, suspended solids and CDOM are main parameters in remote sensing bio-optical modelling of water bodies [4-7]. The spectral measurements will be carried according to the modified FTF procedure [8-11] CDOM absorption spectra will be measured on filtered water samples [12-13].

4. RS MODELLING

Among the various sensors currently available for environmental monitoring, Landsat Thematic Mapper (TM) data have been previously used to study water quality issues in the study area [14,15]. Spectral and spatial limitations of this multispectral sensor to carry out bio-optical modelling can be avoided with data gathered from the hyperspectral CHRIS-Proba sensor. The development of space-temporal prediction models within the Seville area dams, through the use of the hyperspectral and multi-angular capabilities of the CHRIS sensor in the water configuration (Mode 2) is the main aim of this project.

CHRIS (Compact High Resolution Imaging Spectrometer) sensor allows acquisition of high spatial resolution images (19m pixel size) in 18 (vis-NIR) spectral bands that make it very fitted for continental water studies. Moreover different angular images of the same spot can avoid sun glint effects.

Atmospheric and geometric corrections of CHRIS images will be necessary to the temporal modelling of the water reservoirs. Empirical modelling of the main bio-geochemical variables (Chl a, SS and CDOM) in each dam will allow the estimation and the prediction of eutrophization events. More elaborated models that integrate inherent and apparent optical water properties will be also developed.

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