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ROBUST AND ACCURATE MONITORING OF GUADALQUIVIR ESTUARY WATERS: A HIGH-RESOLUTION AND LOW-MAINTENANCE SYSTEM FOR WATER QUALITY AND HYDRODYNAMICS.

Francisco J. Gutiérrez[1], Gabriel Navarro[1], David Roque[1], Raúl García[1], José Luis Fernandez[2], Miguel Ángel Losada[3] y Javier Ruiz[1].

(1) Department of Ecology and Coastal Management, Instituto de Ciencias Marinas de Andalucía (I.C.M.A.N.), Consejo Superior de Investigaciones Científicas (C.S.I.C), 11.519, Puerto Real, Spain.

(2) Autoridad Portuaria de Sevilla (A.P.S.), 41.012, Sevilla, Spain.

(3) Group of Coasts and Harbours, Centro Andaluz de Medioambiente (C.E.A.M.A.), Universidad de Granada, 18.006, Granada, Spain.

Abstract – Since January 2008, The Guadalquivir Estuary has been equipped with a large amount of instrumentation performing an intensive collection of meteorological, hydrodynamic, hydrological and water-quality parameters. An important effort has been made in setting up a telemetry network to register most of those variables in near real time. All this instrumentation generates more than 70000 data per day. The final purpose of this deployment, and the circulation model being developed in parallel, is to generate a powerful tool for the integral analysis and management of the Estuary.

Keywords – real-time telemetry, water-quality, hydrology, hydrodynamics, meteorology.

I. INTRODUCTION

The results described in this document have been obtained under the framework of a contract between Autoridad Portuaria de Sevilla (A.P.S.), the institution in charge of Sevilla harbour, and Consejo Superior de Investigaciones Científicas (C.S.I.C.).

The main objective of the research conducted, led by Instituto de Ciencias Marinas de Andalucía (I.C.M.A.N.), is to diagnose and forecast the consequences of human actions on the dynamics of the Guadalquivir River estuary. In order to reach that goal, it has raised the necessity of generating a comprehensive collection of hydrodynamic and hydrological data since this database is an essential tool to validate the model that explains the global behaviour of the estuary. With the aim at promptly fulfilling this task, the Department of Ecology and Coastal Management of I.C.M.A.N.–C.S.I.C. has carried out the deployment of a telemetry network able to perform intensive real-time data collection of hydrological, hydrodynamic and meteorological variables. Furthermore, some other oceanographic instrumentation has been moored in the area of study: a thermistor chain and Acoustic Doppler Current Profiler (A.D.C.P.) with a tide-wave module, a single-point current meter and six temperature-pressure sensors for tide-regime characterisation (fig. 1).

II. MOORED INSTRUMENTATION

Thermistor Chain and Seafloor CTD

The thermistor chain registers sea temperature at 16 depths every 1 minute. The spatial resolution of the chain is 1 meter. The top thermistor is equipped with a pressure sensor monitoring the verticality of the chain. Attached to the concrete block, a moored CTD (RBR) monitors salinity, temperature and sea level every 10 minutes. This chain is located in the continental shelf, nearby The Guadalquivir River mouth.

A.D.C.P and Wave Module

This A.D.C.P. (AWAC-AST) performs 20-cell current vertical profiles and sea-level measurements every 10 minutes. The spatial resolution of the profiles is 1 meter. The Wave Module sample frequency is 2 Hz, the integration period is 60 seconds and it registers wave information every 10 minutes. Wave measurement is carried out every hour.

Tide gauge network

This network consists of 7 tide gauges deployed at the locations shown in figure 2. They have been configured to take sea-level measurements every 10 minutes.

III. REAL-TIME TELEMETRY NETWORK

Previous to the deployment of this network, the Department of Ecology and Coastal Management of I.C.M.A.N. – C.S.I.C. has carried out the design and construction of two prototypes able to perform intensive real-time telemetry of hydrological (temperature, salinity, dissolved oxygen, turbidity and chlorophyll fluorescence) and hydrodynamic (water column velocity profiles) variables. The technology developed for those prototypes has been used to equip the navigation buoys of the estuary, transforming them into environmental monitoring stations [1]. Figure 2 shows a sketch of the telemetry network deployed at the Guadalquivir Estuary.

Meteorology

This station, installed at the mouth of the estuary, is operative since April 2008 and supplies the network with the following real-time data: wind module and direction, 2π solar radiation, air temperature, relative humidity and atmospheric pressure. All these variables are sampled at 1 Hz and the actual integration period is 10 minutes.

Hydrodynamics

The Water Dynamics (WD) nodes of the network have been installed at the locations shown in figure 2. Every node is equipped with an ADCP (Nortek Aquapro, 1 MHz) providing 21-cell 3-D velocity profiles of the water column every 15 minutes. The upper 6 cells are monitored in real time as well as some other quality parameters: instrument pitch, roll and head pressure.

Water Quality

The Water Quality (WQ) nodes of the network have been installed at the locations shown in figure 2. Every node is equipped with a CTD (Seabird SBE16plus with three external sensors: a SBE43, for dissolved oxygen, and two Turner Design Cyclops, for turbidity and fluorescence) and a 4-pump module able to provide 4-depth vertical profiles of temperature, salinity, dissolved oxygen, turbidity and chlorophyll fluorescence every 30 minutes.

IV. I.T. INFRASTRUCTURE

In order to remotely control the nodes and store all the data generated by them, a data management and control server has been set up (figure 2). This server is behind a firewall to prevent the loss of sensitive information and it periodically publishes the scientific information gathered by the network into an external FTP server. The data retrieved from the moorings at maintenance are also published into that FTP server.

All the instrumentation infrastructure (moorings and telemetry stations) set up for this project generates more than 70,000 data per day. More than 18,000 of them are processed by the telemetry network in near real time.

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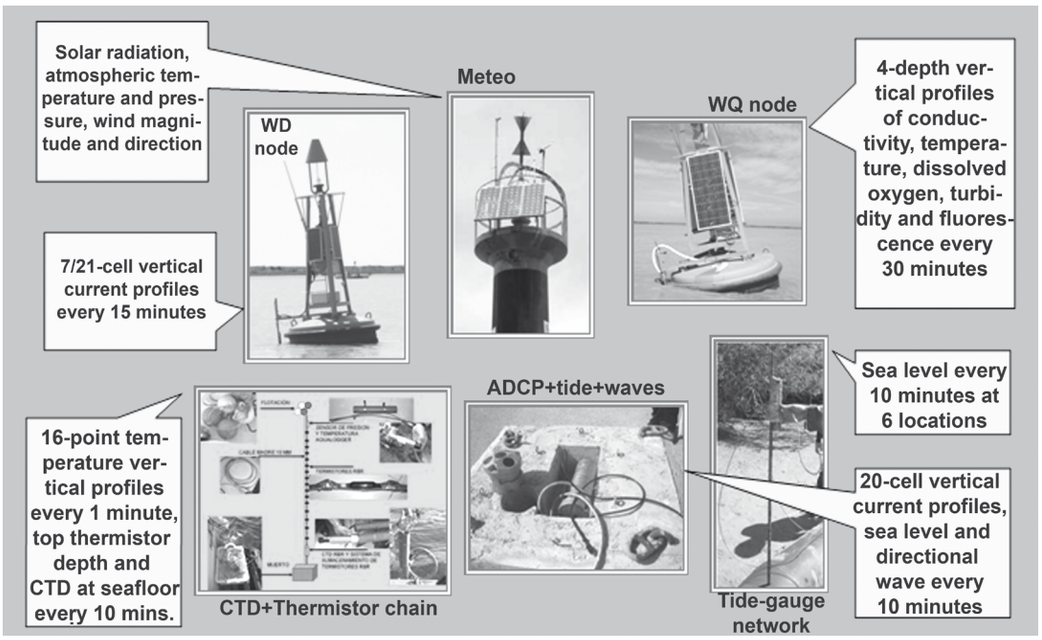

Fig. 1. Types of equipments deployed at Guadalquivir Estuary: variables and measurement rates.

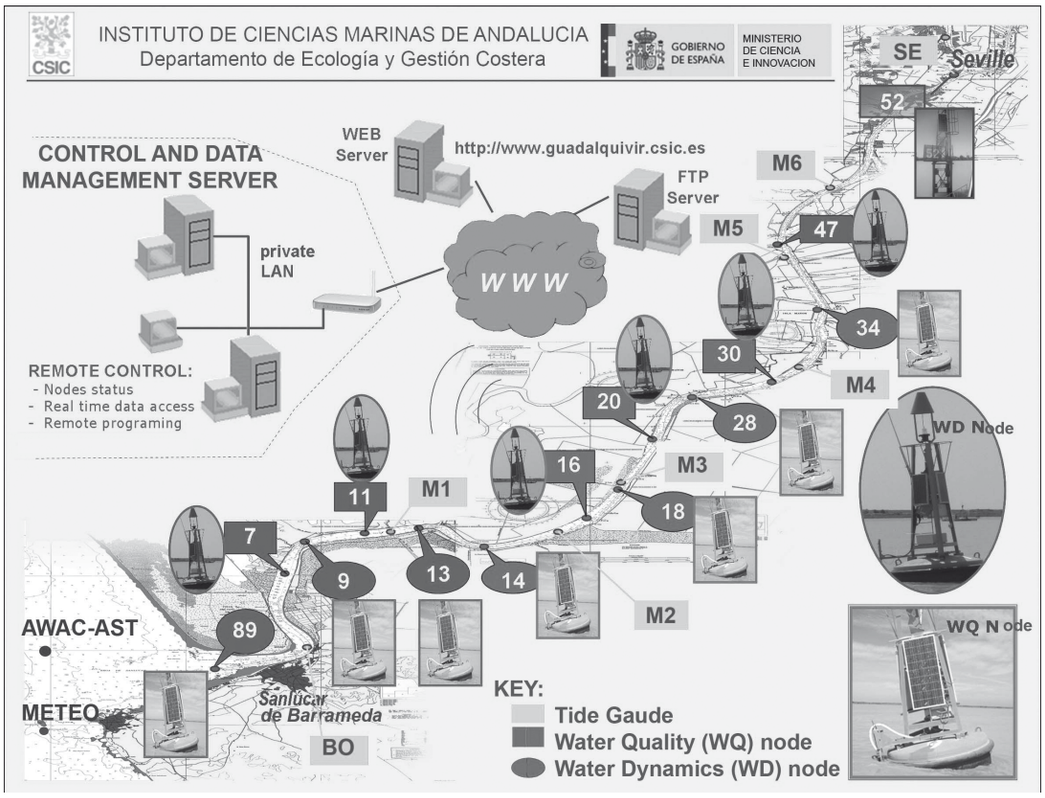

Fig. 2. Diagram of the whole technological infrastructure deployed at the Guadalquivir Estuary from January 2008.