Hidrography and water quality parameters in the medium Tagus River, Spain

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Introduction

The Tagus river is the longer river in the Iberian peninsula and is regulated by many dams. Consequently, the original fluctuations and lotic condition has been altered and replaced by a more lentic environment.
Environmental and hydrological parameter were measured in the middle-upper Tagus river (Spain) from February to December 2010 at 21 sampling stations to analyse the current river status.
Hydrodynamic simulation packages require water velocity data. We have performed some processed on the ADCP's raw data in order to optimize and better illustrate the velocity fields in the river.

Study Site

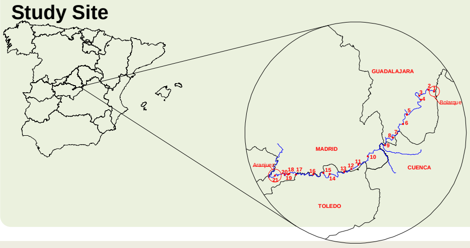


Fig. 1. Map of study area. Sampling stations (upstream to downstream) in the Tagus river:
1- Salto de Bolarque, 2- Puente de Sayatón, 3- Presa de Zorita, 4- Zorita de los Canes, 5- Central Eléctrica Almoguera, 6- Piscifactoría de Illana, 7- Presa Estremera, 8- Salto eléctrico, **9- Salto de Valderribas, 10- Fuentidueña del Tajo**, 11- Azud Buenamesón, 12- Villamanrique, 13- Azud de Villaverde, 14- Central Eléctrica Valdajos, 15- Puente de Villarrubia, 16- Azud de la Aldehuela, 17- Casa del Soto, 18- Azud Embocador, 19- Casa de la Monta, 20- La Pavera, 21- Rancho Grande.

Material and Methods

Samples for water quality were taken at 21 locations between the Bolarque Dam (p.-1) and the confluence with the River Jarama in Aranjuez (p.-21) (Fig. 1). This river section was about 150 Km long with altitude ranging form 480 to 642 m. The studied area is regulated by 13 dams and weirs formed a chain of impoundments. Temperature, salinity, pH, turbidity and optical dissolved oxygen were recorded in situ with an YSI 6600 V2-4 multiparametric probe. Nutrients (nitrate, nitrite, ammonia and phosphate) together with chloride, calcium, magnesium, sulfate, sodium, and bicarbonate were determined in the lab within 24 hours after sampling (Ionic Cromatography).
Measurements for hydrological parameter - water velocity profiles, depth and discharge - were obtained by an ADCP broadband Sontek/YSI RiverSurveyor M9 (Fig. 2). 95 cross section (transects) between stations p.-9 and p.-10 (12 km) were taken.

Fig. 2. Examples of temporary cableway with a tethered ADCP boat used to obtain water velocity profiles, depth and discharge.

Bathymetry

Flow, stage and bathymetry were measured between stations p.-9 and p.-10. Bathymetric x, y and z data were recorded with the RiverSurveyor M9 (equipped with an ecosounder) and a Differential Global Positioning System (DGPS) mounted on a boat.

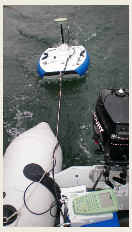


Fig.4. Bathymetry data collection using depth sounder Sontek/YSI RiverSurveyor M9 and GPS differential 1200 Leica.

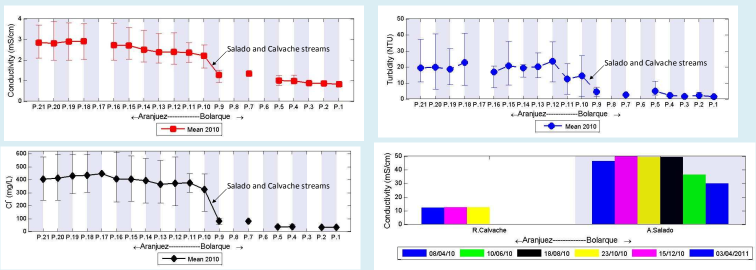
Cross sections

Fig. 3. Location of the cross sections taken of selected area of the Tagus river between the station p.-9 and p.-10. This section is divide in two subsection: 1) from Station p.-9 to Chorros de Estremera Hydroelectric dam and 2) from Chorros de Estremera Hydroelectric dam to station p.-10.

Results

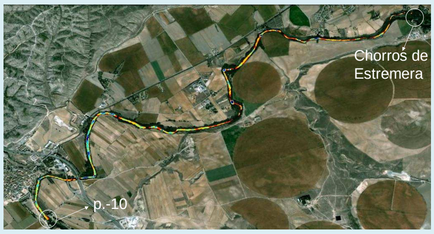
Environmental parameters

The environmental parameters measured in the whole selected area (from station p.-1 to p.-21, Fig.1) are shown in Figure 5 (a to d). In this figure dots mean average level for all samples taken along the year 2010. Upper bar over each point means maximum value achieved, lower bar means minimum measured level.
An increase in conductivity and turbidity at station p.-10 is observed. Two saline streams (the Salado and Calvache streams) flow into the Tagus river between station p.-9 and p.-10 pouring high concentrations of sodium chloride and sodium sulfate.
Fig 5. Environmental factors along the selected area.



Bathymetry

Figure 6 shows the bathymetry of the area. In the right part of the figure one can see the impor-tance of pools (e.g. Chorros de Estremera hydroelectric dam) against shallow waters domi-nating downstream (bottom part of the figure) with many rifles



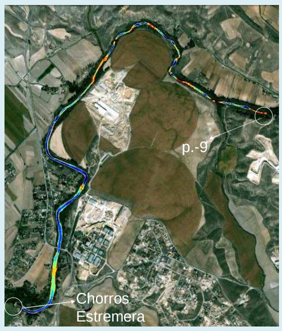
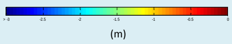


Fig 6. shows the z values of the interpolated grid using the Delaunay triangulation method.



Water Velocity Cross Section

Fig.7. shows some of the water velocity cross sections and total discharge. Gray area in graphs means bottom geometry. Black area means the non-measured area by the ADCP at the top, bottom, and both banks. The total discharge is computed as a sum of the measured portions of the cross section and the estimation of the non-measured portions. This estimation is computed by extrapolation of the cross section at the top, bottom, and both banks. Top and bottom non-measured areas use either a constant or one-sixth power-law method extrapolation to estimate the unmeasured discharge.

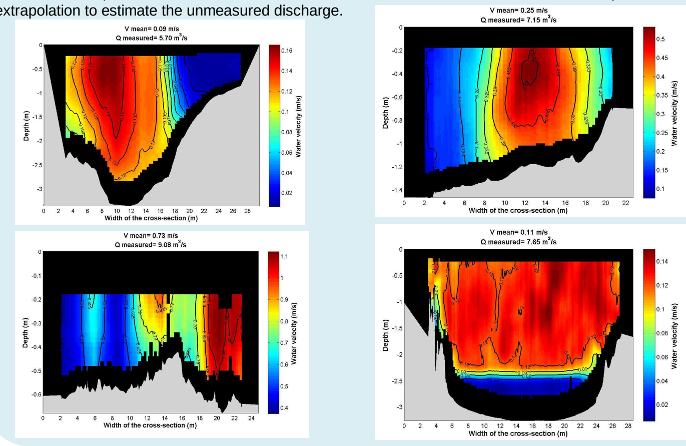
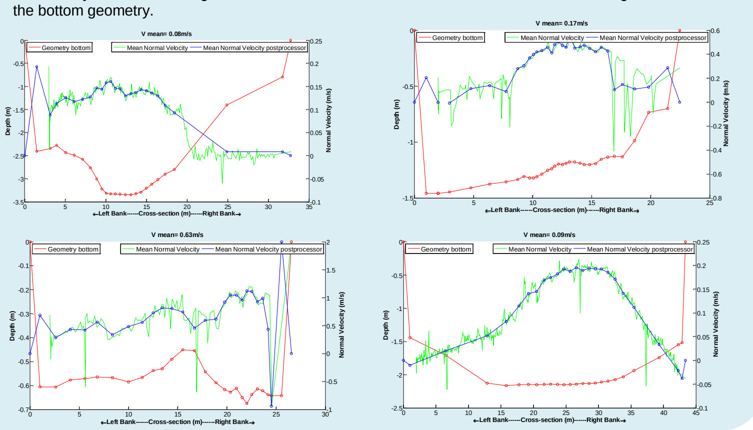


Fig.8. Representation of the mean normal velocity at a determined cross section is compared with the mean velocity profiles between 5 and 10% total discharge. This process allows a better visualization of the velocity fields and can be used as input in advanced hydrodynamic modelling simulations packages like PHABSIM, River2D and IBER for instance. Green line is the observed average normal velocity for each profile (in a cross section). Blue line is the mean normal velocity computed as the average of the velocity profiles consecutive in such a way that the discharge value do not reach more than 5 to 10% of the total discharge. Red line means the bottom geometry.



Discussion

The environmental and hydrological parameter measured are good indicator of the current physical and chemical state of the river. These parameters are required to late studies of the ecological status of the river.
The bathymetry and velocity profiles (in its three components x, y and z) are required to run 2 or 3-D advanced hydrodynamic models. The postprocess of the mean velocity profiles captured by ADCP are required to use representative data as input in these models.
The study of the ecological status of the river requires to know in detail its spatial heterogeneity that can be only simulated with these advanced models.