Understanding the biogeochemical buffering capacity of estuaries relative to climate change and anthropogenic inputs

Report 4

Field campaign UBEST2:

Ria Formosa - September 14-15, 2017

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Abstract

This report characterizes the second field campaign of the project UBEST, representative of summer conditions, performed in the Ria Formosa on September 14-15, 2017. This campaign was accomplished in the same seven stations sampled in the spring campaign (UBEST1), which cover the entire coastal lagoon. *In situ* measurements of temperature, salinity, pH and dissolved oxygen were carried out in each station and water samples collected to further determine the concentration of nutrients, chlorophyll *a* and total suspended solids.

The achieved data contribute to better understand the global functioning of the Ria Formosa under a seasonal approach that will serve to anticipate its susceptibility to future scenarios of anthropogenic inputs and climate change, using numerical hydrodynamic and biogeochemical models.

Keywords: Field campaign, summer conditions, Ria Formosa, *in situ* measurements, water samples, physicochemical parameters

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1. Introduction

This report provides a characterization of the second field campaign of the project UBEST - Understanding the biogeochemical buffering capacity of estuaries relative to climate change and anthropogenic inputs (PTDC/AAG-MAA/6899/2014). This project aims to improve the global understanding of the biogeochemical buffering capacity of estuaries and its susceptibility to future scenarios of anthropogenic inputs and climate change, to effectively support the short and long-term management of these systems. UBEST scientific goals will be achieved by the deployment of "observatories" and to promote the generalization of the conclusions, two distinct Portuguese case studies were selected: the Tagus estuary and the Ria Formosa, a coastal lagoon. These case studies were selected due to their ecological and economic importance both locally and regionally and, simultaneously, due to their very distinct physical and morphological characteristics.

The second field campaign, campaign UBEST2, was performed in the Ria Formosa between September 14 and September 15, 2017, to be representative of summer conditions. This field campaign covered the entire area of the Ria Formosa and included *in situ* measurements and water samples collection every two hours during one semidiurnal tidal cycle (~12.5 h).

The report is organized in 2 chapters besides the present Introduction. The location of the sampling stations and a general description of the field and laboratorial work performed are presented in Chapter 2. Chapter 3 presents a short evaluation of the field campaign.

2. Description of the field campaign

2.1 Sampling stations

A field survey was carried out in September, including seven stations to comprise the different water bodies (WB) of the Ria Formosa, as described by APA (Agência Portuguesa do Ambiente) and at the same stations selected in the first campaign (**Error! Reference source not found.**). Five stations were located in the main channels, although at inner areas: station 1 – Bridge of Faro Beach representative of Ria Formosa WB1; station 2 – Cais do Combustível that represents the Ria Formosa WB2; station 3 – Fuzeta representative of Ria Formosa WB4; station 4 – Tavira under the influence of freshwater input that represents the Ria Formosa WB5; and station 5 – Cacela also located in the Ria Formosa WB5. Stations 6 at the Olhão channel and 7 at the Faro-Olhão inlet are representative of the outer area of Ria Formosa (WB3). The last one will also be used to characterize the adjacent oceanic conditions.

Figure 2.1. General overview of the study area and location of the sampling stations: 1 – Bridge of Faro Beach; 2 - Cais do Combustível; 3 – Fuzeta; 4 – Tavira, 5 – Cacela; 6 – Olhão channel; 7 – Faro-Olhão inlet. The stars correspond to the location of 4 pressure transducers: Bruce's Yard (PT1); Cais do Combustível (PT2); Deserta Island (PT3); and Quatro Águas de Tavira (PT4).

The coordinates of the sampling stations and the sampling periods considered are indicated in Table 2.1.

Table 2.1. Coordinates of the sampling stations and sampling period.

Station	Latitude	Longitude	Period of sampling
1 – Bridge of Faro Beach	37.009001	-7.993699	September 14, 07:00 – 21:30
2 – Cais do Combustível	37.002754	-7.921186	September 14, 07:30 – 20:40
3 – Fuzeta	37.050767	-7.742030	September 14, 07:00 – 20:00
4 – Tavira	37.116308	-7.628722	September 14, 07:00 – 20:00
5 – Cacela	37.153973	-7.553397	September 14, 07:00 – 20:00
6 – Olhão channel	36.998081	-7.841326	September 15, 07:00 – 19:50
7 – Faro-Olhão inlet	36.971926	-7.871217	September 15, 07:40 – 20:25
PT1 – Bruce's Yard	37.021122	-7.945661	September 12 – 21
PT2 – Cais do Combustível	37.002755	-7.921182	September 11 – October 3
PT3 – Deserta Island	36.965858	-7.871014	September 11 – 18
PT4 – Quatro Águas de Tavira	37.115725	-7.629700	September 8 – 22

2.2 Team

The team that participated both in the field campaign and laboratorial work is listed in **Error! Reference source not found.**.

Table 2.2. Team of the field campaign UBEST2.

Station/Laboratorial work	Name	Institution
1 and 2	Alexandra Rosa	UAlg Team member – CIMA
	Ana Rita Viegas	*1
	André Matos	*2
	Diana Silva	*1
	Gustavo Xufre	*1
3	José Jacob	UAlg Team member – CIMA
	Danny Brito	UAlg – student and technician
	Gonçalo Sousa	*1
	Ana Teresa Viegas	*1
	João Cunha	*1
	Bruno Silva	*1
4	Alexandra Cravo	UAlg Team member – CIMA
	João Zêzere	*1

Station/Laboratorial work	Name	Institution
5	Miguel Amado	*1
	Cátia Correia	*2
	Luana Castilho	*2
	Miguel Amado	*1
	Laura Pacho	*1
	Jokin Echezarreta Pérez	*1
6 and 7	José Jacob	UAlg Team member – CIMA
	Alexandra Rosa	UAlg Team member – CIMA
	Danny Brito	UAlg – student and technician
	Luísa Bon de Sousa	UAlg Team member – CIMA
	André Matos	*2
	Catarina Coelho	*1
	Cátia Correia	*2
	Diana Silva	*1
	João Cunha	*1
	João Zêzere	*1
	Micaela Justo	*1
Only laboratorial work	Filomena Rita	UAlg team member – technician

*1 –Volunteer collaborator – UAlg student;
*2 –Volunteer collaborator – Former UAlg student.

2.3 Field work

The UBEST2 campaign was conducted on two consecutive days (September 14 and 15). During the first day the stations 1, 2, 3, 4 and 5 (Figure 2.2, Figure 2.3, Figure 2.4, Figure 2.5 and Figure 2.6) were sampled with the support of one car from the University of Algarve, one rented car and several personal cars that allowed the transport of the team members and collaborators, and the sampling material and equipment. In the second day, to survey the stations 6 and 7 (Figure 2.7 and Figure 2.8), the outer station of the Ria Formosa, a boat with a skipper was rented all day (from 6:30 to 22:00) and the transportation of team, material and equipment was accomplished using one car from the University of Algarve and personal cars from the team members.

In this campaign, *in situ* measurements of water temperature, salinity, pH and dissolved oxygen (concentration and saturation %) were measured using the same multiparameter probes used in the field campaign UBEST1, two from UAlg and two from LNEC. Previously to the field campaign, all the sensors of the four YSI multiparameter probes were calibrated using the same calibration solutions. Water samples were collected for further determination of chlorophyll *a* (2 L), nutrients and total suspended solids concentrations (1 L), using a 5 L Niskin bottle and/or a sampling cup. At each station, measurements and water samples were carried out every two hours along a complete semidiurnal tidal cycle (~12.5 h), at surface for those station where the water column is shallow (< 3 m) and where stratification of the water column was not recorded during the first campaign (UBEST1). At Tavira (station 4), due to the potential influence of freshwater input, and at Olhão channel (station 6), to identify if water stratification occurred during summer conditions, *in situ* measurements were

performed along the water column, every 1 m and samples of water were also collected at both the surface and the bottom levels four times along the day: in the first sampling hour (around sunrise), in low tide, in high tide and by the end of the sampling period. After water collection, the samples were placed in thermal containers to preserve their quality until further processing in the laboratory.

Figure 2.2. Sampling station 1 – Bridge of Faro Beach.

Figure 2.3. Sampling station 2 – Cais do Combustível located in the Port of Faro.

Figure 2.4. Sampling station 3 – Fuzeta.

Figure 2.5. Sampling station 4 – Tavira.

Figure 2.6. Sampling station 5 – Cacela.

Figure 2.7. Sampling station 6 – Olhão channel.

Figure 2.8. Sampling station 7 – Faro-Olhão inlet.

To study the physical conditions and circulation patterns within the Ria Formosa lagoon, the variation of the sea level was also measured by four pressure transducers (two Level TROLL, one Infinity and one DIVER) located in different sites (Figure 2.1).

2.4   Laboratorial procedures

The water samples collected at the seven stations were processed laboratorially at the University of Algarve, with the support of the team members and several volunteer collaborators. The water samples were filtered with specific filters for suspended solids (0.45 μm porosity, cellulose acetate, Gellman) and chlorophyll *a* (0.7 μm porosity, GF/F, Whatman) determination (Figure 2.9). The dissolved oxygen concentration was also determined based on the Winkler method to confirm the data measured *in situ*.
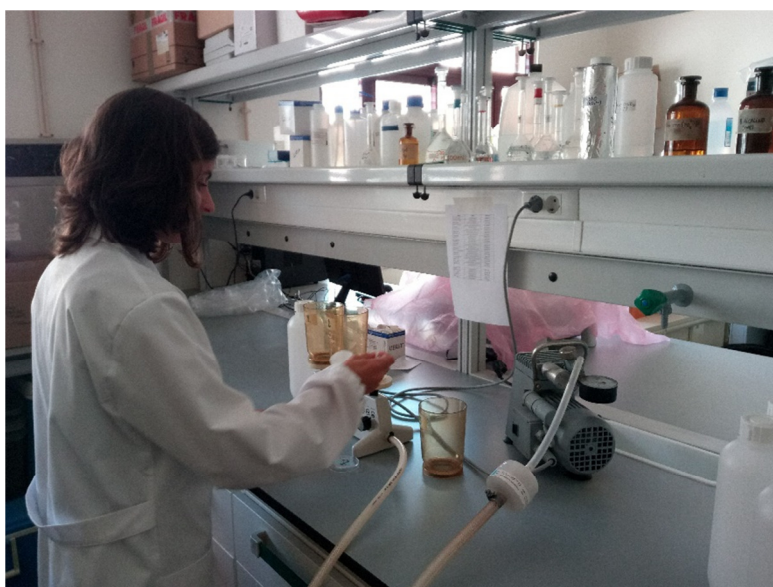
Figure 2.9. Laboratorial analyses for chlorophyll *a* concentration.

The filtered water samples through Gelman filters (0.45 μm porosity) were used for the determination of nutrients concentration (nitrate, nitrite, ammonium, phosphate and silicate). The concentrations of nutrients and chlorophyll *a* were based in spectrophotometric methods described by Lorenzen (1967) and Grasshoff *et al*. (1983), respectively. For the determination of the total suspended solids concentrations a gravimetric method was applied (APHA, 1992).

3. Evaluation of the field campaign

The experience acquired in the first campaign improved the planning of UBEST2 campaign. Regardless the decrease of the team members, this campaign was successfully accomplished, and the objectives attained.

The chemical analyses for the determination of nutrients and chlorophyll *a* were done successfully and the variation of the sea level acquired with the pressure transducers was also processed. *In situ* measurements and the concentrations of nutrients under summer conditions allowed to confirm that at the stations where measurements were taken at the bottom level or in vertical profiles, the water column were vertically homogeneous, without apparent stratification in terms of temperature, salinity, pH and dissolved oxygen. Temperature and salinity at stations 1 to 5 were higher than at stations 6 and 7. Concerning the dissolved oxygen, extreme values were recorded at Cacela (~40-150%), with minimum at the beginning of the day and the maximum during the afternoon, around low water. These data show that the eastern edge of Ria Formosa, where the water column is very shallow, and the bottom partially covered by vegetation, the biological processes were more intense than at the rest of the sampled stations. Globally, the nutrient and chlorophyll *a* concentrations were low, except at Cacela (station 5) and Bridge of Faro Beach (station 1).

The data acquired in this campaign will serve to understand the spatial and temporal variability of the physicochemical parameters selected in summer conditions and further to validate the numerical hydrodynamic and biogeochemical models.

Acknowledgments

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