UBEST

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

Report 7

Field campaign UBEST7:

Ria Formosa - April 9-10, 2019

Partners

LABORATÓRIO NACIONAL DE ENGENHARIA CIVIL

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Abstract

This report describes the 7th field campaign of the project UBEST, intending to characterize the influence of a rainfall event, performed in the Ria Formosa on 9-10 April, 2019. This campaign was performed at four stations out of the seven stations sampled in the previous three campaigns. *In situ* measurements of temperature, salinity, pH and dissolved oxygen were carried out at each station and water samples collected to further determine the nutrients, chlorophyll *a* and total suspended solids concentrations.

The data acquired in this campaign will contribute to better understand the global functioning of the Ria Formosa after a period of rainfall 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, rainfall event, Ria Formosa, *in situ* measurements, water samples, physicochemical parameters

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1. Introduction

The project UBEST - Understanding the biogeochemical buffering capacity of estuaries relative to climate change and anthropogenic inputs (PTDC/AAG-MAA/6899/2014) aims at improving 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" in two Portuguese case studies: the Tagus estuary and the Ria Formosa, a coastal lagoon. The seasonal campaigns are one of the components of the Ria Formosa observatory and this report describes the last field campaign, campaign UBEST7 performed in 2019. The 7th campaign was performed between 9 and 10 April, 2019, after a period of rainfall that followed a long dry winter period, to contrast with the conditions recorded in the previous campaigns. In this last one, only four sites in the Ria Formosa were considered, assuming that it was there that the differences in the water characteristics could be magnified. *In situ* measurements and water collections were taken every two hours during one semidiurnal tidal cycle (~12.5 h), except at the reference station, the Faro-Olhão inlet, that was only sampled during the tidal peaks, i.e., at low-tide and high-tide.

The report is organized in 3 chapters. After the introduction in Chapter 1, the meteorological conditions, the location of the sampling stations and a general description of the field and laboratorial work performed are described in Chapter 2. A short evaluation of the field campaign is presented in Chapter 3.

2. Description of the field campaign

2.1 Meteorological and tidal conditions context

Meteorological conditions (precipitation, air temperature, humidity, atmospheric pressure and wind speed) that influenced the campaign period are presented in Table 2.1. These data were recorded in the Faro Airport Meteorological Station and Olhão Station and were provided by the Portuguese Institute for Sea and Atmosphere (IPMA).

Table 2.1. Mean (minimum and maximum) values of precipitation (mm), air temperature (ºC), humidity (%), minimum and maximum atmospheric pressure (hPa) and wind speed (m/s) acquired in Faro Airport Meteorological Station and Olhão Station (source: IPMA).

Location	Date	Precipitation (mm)	Air temperature (ºC)	Humidity (%)	Pressure (hPa)	Wind speed (m/s)
Faro Airport Station	April 5-8	23	13.9 (8.9-18.0)	76 (44-97)	1002-1019	6.3 (1.6-13.2)
	April 9	0.0	15.0 (11.7-18.7)	71 (54-86)	1018-1021	5.1 (1.6-10.1)
	April 10	0.0	14.5 (10.5-19.5)	73 (52-88)	1018-1021	4.2 (0.6-7.9)
Olhão Station	April 5-8	26.4	13.4 (8.1-18.3)	75 (42-92)	1001-1018	3.2 (0.0-6.9)
	April 9	0.0	14.1 (9.2-18.4)	74 (58-88)	1017-1020	2.3 (0.0-6.4)
	April 10	0.0	14.4 (8.2-19.7)	74 (58-89)	1017-1020	2.1 (0.0-3.9)

In the 4 days before to the last campaign about 25 mm of precipitation occurred (5-8 April 2019; Table 2.1), contrasting with the last three campaigns, led under dry and warm weather. The rainfall events, regardless not being considered extreme, was typical of a wet situation. The hourly variation of the precipitation during the 4 days before to the campaign and of the air temperature, humidity, atmospheric pressure and wind speed acquired in Faro and Olhão Meteorological Stations during the two consecutive days of the campaign are presented in Annex I. The precipitation in this period was higher on 5 and 7 of April, having occurred two events of heavy rain with values of about 5 mm/h. However, except those maximal values, in general, the rainfall intensity was 0.5-4 mm/h characteristic of moderate rain (following the scale indicated by IPMA). On the days of campaign, no rain was recorded. Regarding to the air temperature and humidity, the maximum values were obtained in the second day of the campaign, while the wind speed was more intense (maximum *ca.* 10 m/s) in the first day of the campaign than in the second one.

Regarding the tide, the prediction at Faro-Olhão for 9 and 10 April 2019, low tide was at 11:38 am and 12:18 am and the high tide was at 6:08 pm and 6:51 pm, respectively (source: http://www.hidrografico.pt/). These dates correspond to a tidal range of 2.3 and 2.1 meters, respectively, typical of spring tide.

2.2 Sampling stations

The sampling stations selected covered four sampling stations out from those seven characterized in the other seasonal campaigns. These encompass several water bodies (WB) of the Ria Formosa, as described by APA (Agência Portuguesa do Ambiente) (Figure 2.1).The selected stations were those where the highest variability in water characteristics was expected, from the results attained in the previous field campaigns. Three stations were located in the inner areas: station 1 – Bridge of Faro Beach, close to the western edge of Ria Formosa, representative of WB1; station 4 – Tavira under the influence of freshwater input that represents the Ria Formosa WB5; and station 5 – Cacela located in the eastern edge in the Ria Formosa-WB5. As a boundary station, representative of the outer area of Ria Formosa (WB3) and of the adjacent oceanic conditions, station 7 at the Faro-Olhão inlet was selected.

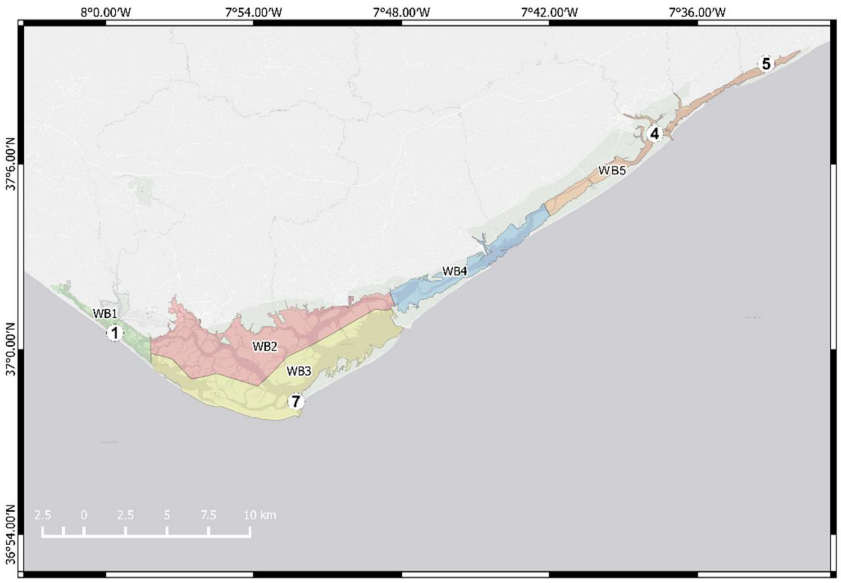

Figure 2.1. General overview of the study area and location of the sampling stations: 1 – Bridge of Faro Beach; 4 – Tavira, 5 – Cacela; 7 – Faro-Olhão inlet. In different colors are indicated the five water bodies (WB1 to WB5) established by APA Algarve.

The coordinates of the sampling stations and the sampling periods considered are indicated in Table 2.2.

Table 2.2. Coordinates of the sampling stations and sampling period.

Station	Latitude	Longitude	Period of sampling
1 – Bridge of Faro Beach	37.009001	-7.993699	April 9, 07:00 – 19:30
4 – Tavira	37.116308	-7.628722	April 10, 07:46 – 20:05
5 – Cacela	37.153973	-7.553397	April 10, 07:15 – 19:28
7 – Faro-Olhão inlet	36.971926	-7.871217	April 10, 12:15 and 17:40

2.3 Team

The team that participated in both the field campaign and laboratorial work is listed in Table 2.3.

Table 2.3. Team of the field campaign UBEST7.

Station/Laboratorial work	Name	Institution
1	Alexandra Rosa	UAlg Team member – CIMA
	Diana Silva	*1
	Luísa Bon de Sousa	*2
4	Alexandra Cravo	UAlg Team member – CIMA
	Alexandra Rosa	UAlg Team member – CIMA
	Gustavo Xufre	*1
	André Matos	*2
5	Alexandra Cravo	UAlg Team member – CIMA
	Alexandra Rosa	UAlg Team member – CIMA
	Gustavo Xufre	*1
	André Matos	*2
7	José Jacob	UAlg Team member – CIMA
	Alexandra Rosa	UAlg Team member – CIMA
	Miguel Amado	*1
Only laboratorial work	Cátia Correia	UAlg Team member – CIMA

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

2.4 Field work

The UBEST7 campaign was conducted on two consecutive days (9 and 10 April 2019). During the first day the station 1 (Figure 2.2) was sampled with the support of one personal car that allowed the transport of the team members and collaborators, as well as the material and equipment for the samples. In the second day, to sample the stations 4 and 5 (Figure 2.3 and Figure 2.4), the transportation of team, material and equipment was carried out using two personal cars from the team members. On the same day, the station 7, the boundary external station of the Ria Formosa (Figure 2.5), was also sampled, and the transportation of the team and material was gently provided by Animaris Ilha Deserta Company, by offering the boat transportation ticket.

In this campaign, *in situ* measurements of water temperature, salinity, pH and dissolved oxygen (concentration and saturation %) were taken using two multiparameter probes (YSI 6820 and YSI EXO 2). Before the campaign period, all the sensors of the multiparameter probes were calibrated with specific calibration solutions that were used to calibrate both multiparametric probes. Surface water samples were collected for further determination of chlorophyll *a* (2 L), nutrients and total suspended solids concentrations (1 L), using a sampling device coupling a 1 L beaker. At the stations 1, 4 and 5 *in situ* measurements and water samples were carried out every two hours along a complete semidiurnal tidal cycle (~12.5 h). At the station 7 only slack waters were sampled, at low-tide and high-tide peaks. At Tavira (the station with the highest potential to be influenced by river runoff), to verify if stratification

occurred in the water column, *in situ* measurements were also performed along the water column. The surface water samples, after collected, were transported to the laboratory in thermal containers to preserve their quality until further treatment.

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

Figure 2.3. Sampling station 4 – Tavira.

Figure 2.4. Sampling station 5 – Cacela.

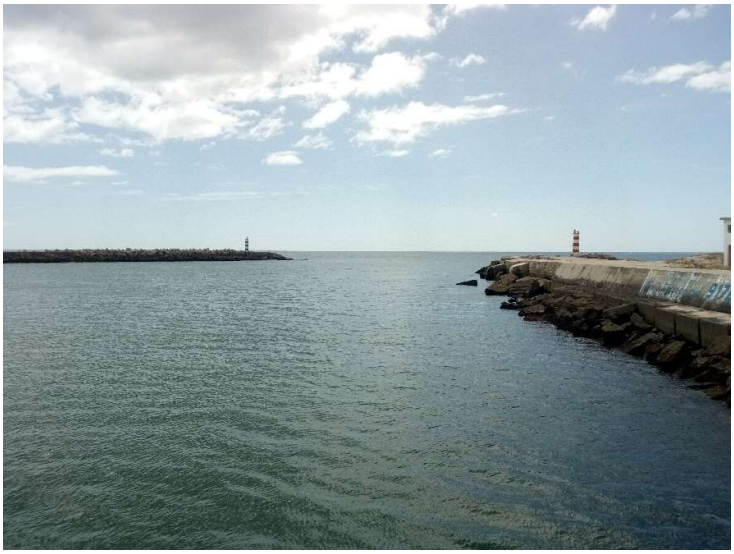

Figure 2.5. Sampling station 7 – Faro-Olhão inlet.

2.5 Laboratorial procedures

The water samples were processed in the laboratory 1.76 of CIMA - University of Algarve, with the support of the team members and the 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 2.6). The dissolved oxygen concentration measured *in situ* was also checked and calibrated against samples measured by the Winkler method.

Figure 2.6. 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 concentration of nutrients and chlorophyll *a* were determined based on spectrophotometric methods described by Grasshoff *et al*. (1983) and Lorenzen (1967), respectively. For the determination of the total suspended solids concentrations a gravimetric method was applied (APHA, 1992).

3. Evaluation of the field campaign

The purpose of the UBEST7 campaign performed in Ria Formosa coastal lagoon was to characterize the water quality variability after a rainfall event (around 25 mm of accumulated precipitation during 4 days before to the campaign period; Table 2.1). Although the rainfall events were not so intense as desired, the campaign was successfully accomplished, and the objectives achieved. Moreover, it is important to mention that the previous winter period was characterized as very dry.

The chemical analyses for the determination of nutrients, chlorophyll *a* and suspended solids were successfully performed. Water temperature ranged between 14 and 15ºC in all stations, except at Cacela and Bridge of Faro Beach, where highest values were recorded (max. 17.5 ºC), due to its shallowness and greater warming up during the day. Extreme dissolved oxygen values were also observed at station 5 (Cacela) (70-180%). Most of the salinity values were typical of oceanic waters (> 36), not reflecting a marked fingerprint of the rainfall event, since it stopped to rain one day before the campaign. The lowest value (35) was found at station 4 (Tavira) around low water, when the contribution of the Gilão River was maximum, as found in the last campaigns. Regarding to nutrients, the stronger signal from the rainfall influence was found for ammonium and nitrate, recording maximum concentrations during this campaign at sites 1 (Bridge of Faro Beach), 4 (Tavira) and 5 (Cacela). At site 4 (Tavira), silicate was also higher than the last campaigns, depicting a signal of the rainfall effect.

The maximum of chlorophyll *a* (1.7 µg/L) was registered at the eastern edge of Ria Formosa, at station 5 (Cacela), while at the other sites, concentrations were low (< 0.7 µg/L) typical of late winter conditions.

The UBEST7 campaign completes the planned field campaigns and together with the last three campaigns representative of spring, summer and autumn conditions, will contribute to better understand the spatial and temporal variability of the physicochemical parameters and further to validate the numerical hydrodynamic and biogeochemical models used to simulate futures scenarios of climatic changes and anthropogenic inputs.

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References

APHA (1992). *Standard Methods for Examination of Water and Wastewater*. 18th Edition. American Public Health Association. Washington DC.

Grasshoff K, Erkhardt M and Kremling K (1983). Methods of Seawater Analysis*. Verlag Chemie*, New York, 419 pp.

Lorenzen C (1967). Determination of chlorophyll and pheopigments: spectrophotometric equations. *Limnology and Oceanography*, 12(1961), 343–346.

ANNEX I – Meteorological conditions

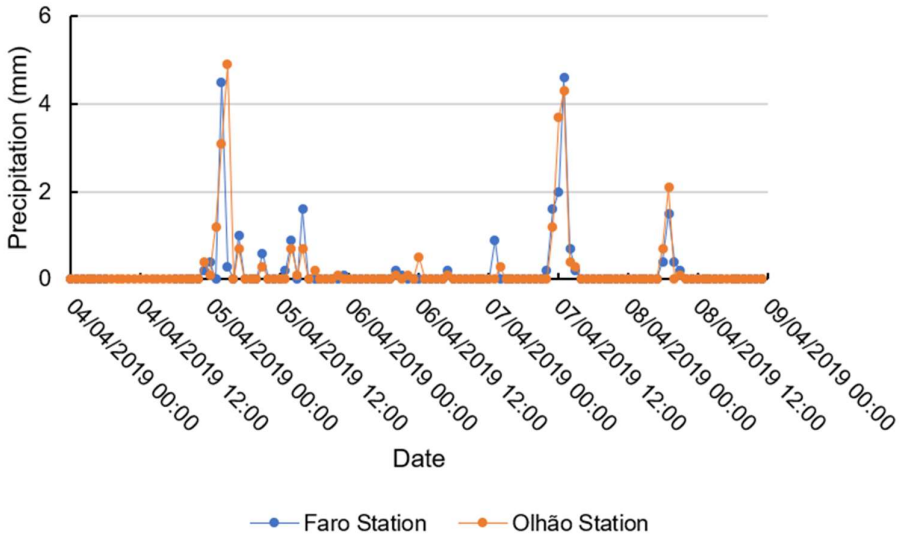

Figure A.I.1 – Hourly variation of precipitation (mm) between April 4 and 8, 2019 (source: IPMA).

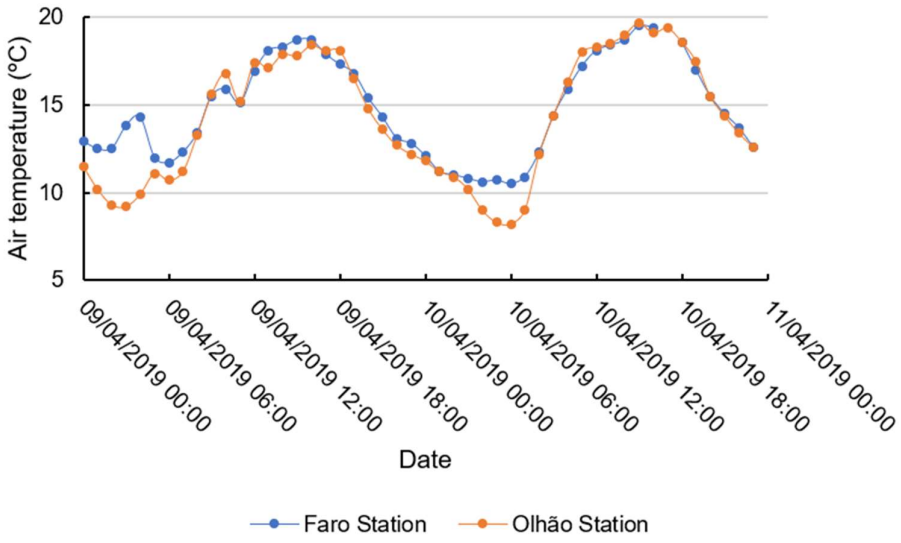

Figure A.I.2 – Hourly variation of air temperature (ºC) during April 9 and 10, 2019 (source: IPMA).

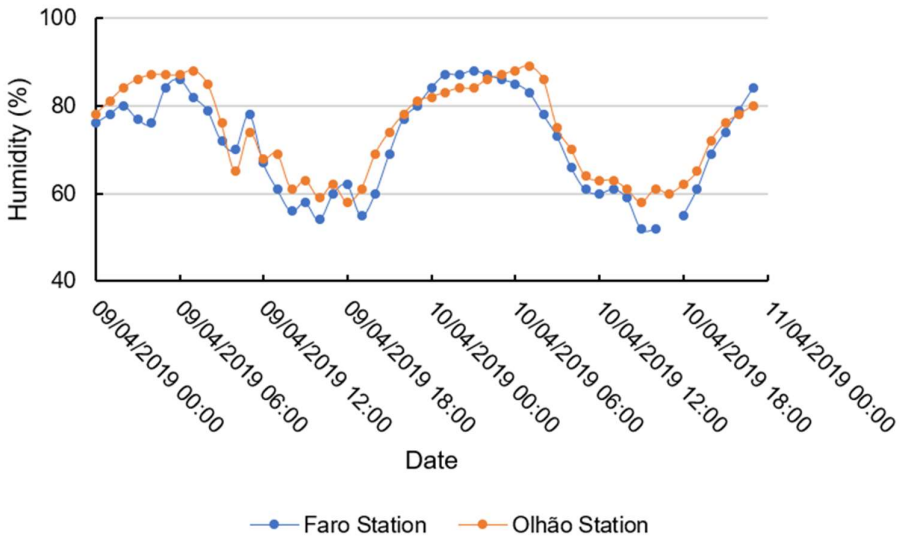

Figure A.I.3 – Hourly variation of humidity (%) during April 9 and 10, 2019 (source: IPMA).

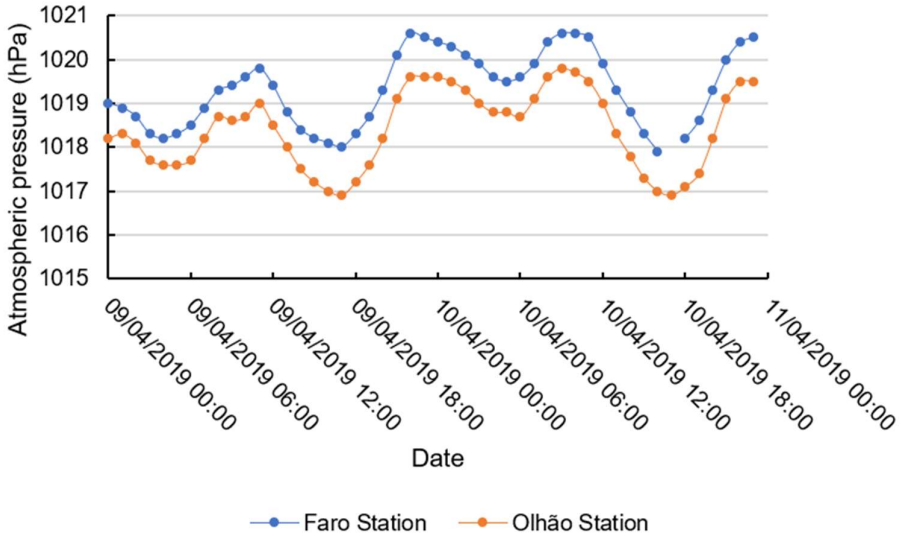

Figure A.I.4 – Hourly variation of atmospheric pressure (hPa) during April 9 and 10, 2019 (source: IPMA).

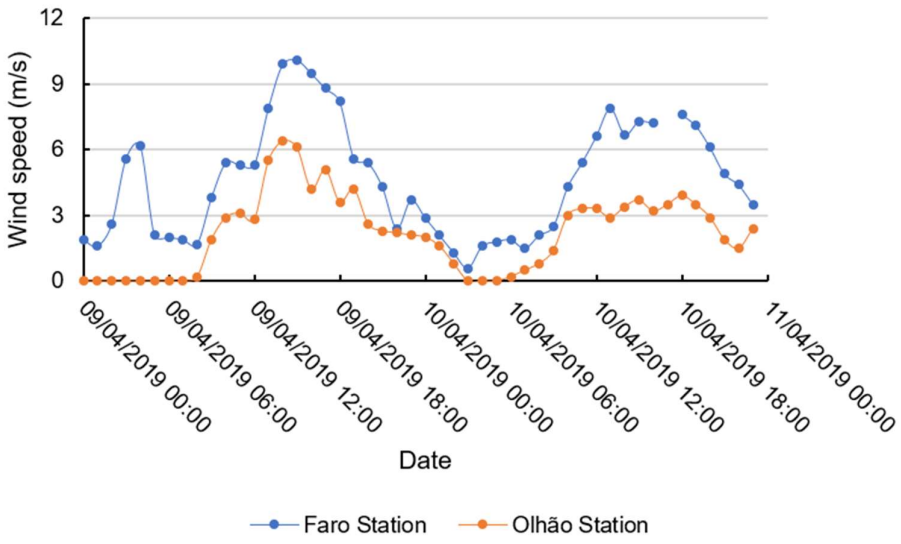

Figure A.I.5 – Hourly variation of wind speed (m/s) during April 9 and 10, 2019 (source: IPMA).