MINISTERO DELLE INFRASTRUTTURE
SERVIZIO INFORMATIVO DEL MAGISTRATO ALLE ACQUE DI VENEZIA - SEZIONE ANTINQUINAMENTO

Real-time water quality monitoring network in the lagoon of Venice (Italy): fouling problems

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1. Introduction

The Sezione Antinquinamento del Magistrato alle Acque di Venezia (Anti-Pollution Department of The Venice Water Authority, SAMA) is taking a series of measures to counteract the degradation of the lagoon, including dredging of contaminated sediments, clean-up of contaminated sites inside the lagoon, pollution prevention from the industrial discharges, wetlands reconstruction. In order to control the status of the ecosystem and to verify both the short and long term effects of such initiatives, the Venice Water Authority has set up a real-time monitoring network of the water quality parameters of the lagoon (WQPs).

In this poster we would show some problems concerned these activities: data collected by automated instruments may be not reliable in certain circumstances, because of bio-fouling.

Fig. 2 - Frontal view of a station, Ve-5 located in Trezze

Fig. 1 - Location of the stations

2. Monitoring networks

The monitoring system is composed by 10 stations placed in different part of the lagoon, in order to cover the most significant areas of the lagoon: the area surrounding the city of Venice; the part of the lagoon directly influenced by the industrial area of Porto Marghera; the area of the southern lagoon close to the city of Chioggia, an important economical center for fishing activities; various areas close to the outlet of the main rivers which flow into the lagoon; reference unperturbed areas (*Fig. 1*). Each station consists of a housing, completely made by plastic material, without metallic part, in order to avoid any possible interference in the case of trace metal measurements (*Fig.2*). All the stations are equipped with Ocean Seven 316 multi-parameter probes (Idronaut, Milan, Italy, *Fig. 3*) measuring the following water parameters: depth of the water column, temperature, pH, salinity, dissolved oxygen, redox potential, turbidity and chlorophyll a (*Fig. 4*, *Tab.1*). All the stations are self-operating, the power being supplied by solar panels, and able to transmit the collected data to a remote station, located in the SAMA laboratory, by using a GSM system. The different operations of the probes are controlled by a particular device, named BUOY controller. The probes are calibrated in the laboratory by using certified reference materials and standards. Every one or two weeks, according to the period of the year, or when anomalous data are measured, the operating probe is substituted with a new one. By this way, it is possible to perform continuous measurements of all the parameters with limited risks of drifts of the signals and unreliable data due to the fouling of the sensors. Each station is also equipped with static sampling systems for the collection of both ,wet and dry atmospheric deposition, which are periodically analyzed for the evaluation of the pollution load due to inorganic (metals) and organic (POPs) pollution due to atmospheric fall-out.

Fig. 3 - The probe Ocean Seven 316, Idronaut

Pressure	(dbar)
Temperature	(C°)
Conductivity	(mS/cm)
Dissolved Oxygen	(ppm)
Reference	
pH	(pH)
Redox	(mV)
Fluorescence	(µg/L)
Turbidity	(FTU)

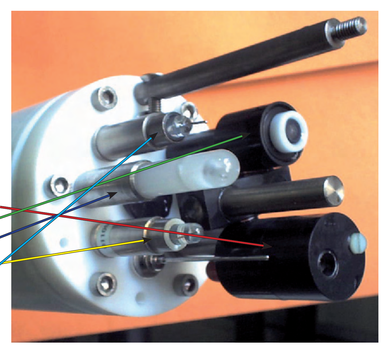

Fig. 4 - Sensors of the probe

	Range		Accuracy		Resolution		Time constant	
Pressure	0 1000	dbar	0.05%	full scale	0.03	%	50	sec
Temperature	-5 +35	°C	0.02	°C	0.0007	°C	50	sec
Conductibility	0 60	mS/cm	0.02	mS/cm	0.001	mS/cm	50	sec
Oxygen dissolve	0 25	ppm	0.1	ppm	0.0	ppm	3	s (in air)
	0 250	% sat.	1%	sat.	0.10%	sat.	3	s
pH	0 14	pH	0.01	pH	0.001	pH	3	s
Redox	-1200 1100	mV	1	mV	0.1	mV	3	s
Auxiliary inputs	0 5000	mV	0.5	mV	0.05%	mV	50	sec(max analogue input)

Tab. 1 - Range scale and accuracy of the sensors

3. Fouling affects the Standard Oceanographic Sensors

Data collected by automated instruments may be not reliable in certain circumstances, for instance, as a consequence of improper instrumental calibrations, various kinds of abrupt failure, and more gradual impairment of the sensors. This last source of error may often be due to dirt or bio-fouling, which can attach to the probes, typically when the monitoring network is placed in natural systems characterized by high biological productivity or turbidity, as in shallow-water estuaries, lagoons, ponds or lakes. Biofuling is a new problem to standard oceanographic instrumentations that usually work in clean water conditions, like open sea one. Moreover, most of oceanographic monitoring activities, like CTD profiles, requires no more than 3-4 hours to be carried out. In the continuous monitoring program of the Venice lagoon, instead, the probes are supposed to be operative for a long time (several weeks or a month) in a very productive environment: it makes the sampling much more difficult especially during spring and summer. In these period the reliability of the data can rapidly decay after 5-15 days. In *figure 5* it is possible to see an example of a not working probe due to biofouling (*Fig. 5*).

Fig. 5 - Dirty probes because of the biofauling activity

The most significant consequences are:

Conductivity: The high production and the biological activities of benthic organisms can affect the measures covering the sensor.

Oxygen: The sensor works in pressure compensation conditions. So, suspended sediment can easily disturb the signal.

pH-Redox reference: The gel of the reference contains a solution of KCl. The more the sensor works in water, the more the Na present in water can contaminate the gel, substituting the K.

Turbidity and Chlorophyll: Both these sensors are optical and the biofouling affect the lecture window.

Pressure: Because the water is shallow and the atmospheric signal have the same magnitude order than the water pressure, this sensor needs an atmospheric compensation.

All the sensor, furthermore, have an additional stress due to very high corrosion conditions.

Some consequences of these problems are shown in *figure 6*.

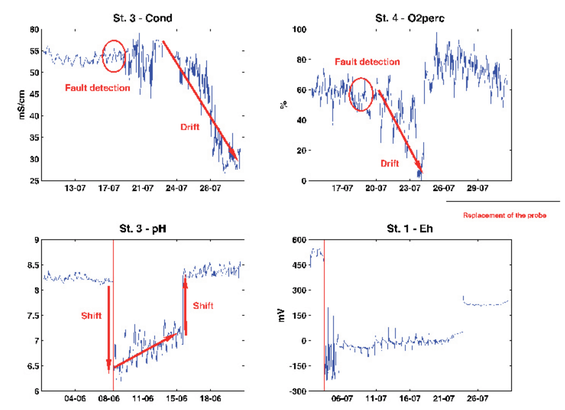

Fig. 6 - Exemple of data

4. Solutions

At the moment, we just found few solutions working in a very strait collaboration with Idronaut. As regards as the Oxygen sensor, in order to adapt the probe to these extreme conditions, they have developed new sensor with specific particularities, without pressure compensation. As regards as pH-Redox reference, SAMA is testing a new reference sensor based on NaCl instead of KCl to avoid the exchange between K and Na.

SAMA is developing a data quality system software in order to distinguish between water condition changes and sensor problems.

5. Conclusion and Future Work

The standard sensors for open oceanography need continuous attentions and very often require serious design modifications.

The real-time monitoring system of the Magistrato alle Acque is producing an enormous number of environmental data, which can be useful for the local and international scientific community interested in the study of the Venice lagoon ecosystem.

Furthermore, it is a strong convincement of the Magistrato alle Acque that the environmental information from this network must be divulgated at the local community, which have the right to know the status of the ecosystem where they are living. For this aim, the Magistrato alle Acque is developing a graphical software which allows, through chromatic animation implemented on a geographical basis, an effective and easy to understand real-time representation of the status and the evolution of the Venice Lagoon ecosystem.

6. Acknowledgements

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