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Deliverable Information	
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Deliverable title	Contribution to Joint Monitoring System Deployment and Operation
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Contents

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Introduction

In the present report we present the technical specifications of the purchased, within HERMES framework, oceanographic station, all preliminary study to select the deployment site, the documents submitted to national authority to obtain the required deployment license and the actions undertaken to deploy the system and ensure the oceanographic data collection, storage, initial processing and data transfer to land-based station (ORION server) for further processing. The station will be deployed in the Larnaca bay, next to the famous "Zenobia" shipwreck, at a depth of 40-42 m on /9/2019 by the technical staff of the equipment supplier (OSIL), the subcontractor, the Larnaca Napa Cruise Ltd vessel and divers. The first set of oceanographic observations will collected by the station and will be analyzed and post processed by ORION. The HERMES oceanographic buoy network was presented in the annual meeting of the Mediterranean Operational Network for the Global Ocean Observing System (MONGOOS) in Genova on 6/12/2018. Moreover, the data provided by the HERMES buoy network of the partner DUTH are visualized on line via the HERMES web GIS system developed within the frame of the HERMES project.

1. The HERMES Oceanographic Station

1.1. System description and Technical Specifications

Within the framework of HERMES project, a bottom-mounted upward facing AWAC 600 KHz Acoustic Current Doppler Profiler (ADCP) will be deployed in the Larnaca bay next to the "Zenobia" shipwreck, at a depth of 40-42 m, in order to provide oceanographic data (waves and currents at various depth cells) in real-time mode. The system includes on-line cable of 60 m length, an oceanographic buoy of 1.2 m diameter with 2 moorings of one ton weight each, the ADCP, the seabed mounding for the ADCP, a data logger and communication system and a power system.

The station has the capacity to record the full profile of water column currents (speed and direction) at given depth cells, the sea level change, the wave parameters (significant wave height, wave period and propagation direction), the sea temperature at the depth of the ADCP deployment and to estimate the concentration of suspended particulate matter (SPM) within the water column.

Data will be collected, stored and initially processed for QA/QC in the internal memory of the system. At a certain time of the day these data area eventually will be transferred to a land-based station in near-real-time mode.

The station (hardware) is accompanied with an advanced software allowing the communication of user to the oceanographic station, the data retrieval, and the processes of storage, manipulation, analysis and visualization of the current, wave and SPM data.

The following technical specifications have been met during the procurement:

- ✓ The oceanographic station is capable to record the sea level change (due to tide and storm surge), the waves, the currents, and estimate the concentrations of suspended particulate matter at specific cells throughout the water column. The system is capable to transfer collected data at real time mode and it is comprised by the following elements:
    - an ADCP echosounder with four acoustic beams emitting/receiving sound at the specific frequency of 600 KHz, bottom-mounted upward-facing will be deployed at a depth of 40-42 m at the pilot study site of Larnaca bay, next to the "Zenobia" shipwreck, for the monitoring of:

a) the three-dimensional current profiles (u, v and w-velocity components) at distinctive depth layers (cells) with thickness o f 2.5 m, throughout the whole water column above the ADCP;
b) the wave characteristics (significant wave height, wave period, wave direction of propagation) at the sea surface;
c) the change in sea level due to tides and storm surges;
d) the sea temperature at the depth of the ADCP deployment; and
e) the concentration of suspended particulate matter concentration estimate (in mg/l) at distinctive layers (cells) with thickness of 2.5 m, throughout the whole water column above the ADCP.

- a bottom ADCP mounted frame serving as the base to mount the instrument at sea bottom
- safe anchoring at sea bottom for the instrument
- a surface buoy of 1.2 m diameter, equipped with solar panels for the appropriate energy supply of the system
- two safe anchoring of 1 ton weight each at sea bottom for the surface buoy
- a 60 m high strength cable to ensure data transfer from the ADCP bottom-mounted instrument to the surface datalogger positioned in the surface buoy, and
- a datalogger for data storage equipped with a telecommunication data transfer system (GPRS modem) for the real-time data transfer to a land-based PC.

Additional technical specifications involve:

- The echosounder system is further equipped with an internal battery to ensure maximum possible energy autonomy of the monitoring system,
- The echosounder has two analogue input channels allowing the future additional sensor installation,
- The echosounder is equipped with an internal memory of 4GB, to ensure data storage in case of standalone use,
- The echosounder is equipped with an internal compass and pitch and roll sensors to report deviations of system's positioning from horizontality,
- The estimate of SPM concentration (in mg/l) is derived from processing the acoustic backscatter intensity (ABI) data recorded by the echosounder,
- The cable for data transfer is appropriate for long-underwater operations,
- The echosounder complies with all international standards (EN 61000-6-4) as declared by relevant accompanying documents and has a guarantee for one year of full operational use by the manufacturer.
- The supplied hardware and software is capable to compute internally at real time mode the typical directional wave parameters, as H_{max}, $H_{1/10}$, T_{mean}, and wave propagation direction.
- The system is capable to operate as bottom-mounted at higher depths recording the typical directional wave parameters, as H_{max}, $H_{1/10}$, T_{mean}, and wave propagation direction.
- The telecommunication system (modem) for data transfer ensures the safe and easy transfer of data using the GPRS technology, allowing the real-time processing and visualization of data at the land-based station.
- The surface buoy has a height of at least 1.2 m above sea surface and weights over 150 kg. The system is clearly visible by nearby vessels. The system is equipped with all navigation safety systems. The buoy is made by highly resistant plastic to solar radiation.
- The surface buoy has the appropriate safe and waterproof space to accommodate any electrical/electronic devices, batteries, dataloggers and telecommunication modems.
- The datalogger complies to international standards as IEC61326:2002, is equipped with an internal memory of 4MB, and has overall low energy requirements (e.g., operation at sleep mode of 0.7 mA), and protection from transitional hyper-voltages, electrostatic incidents and electromagnetic interventions.

- The recording and storage system has the capacity to allow a min sampling rate of 60 Hz, has several serial communication ports and communicates through the protocols HTML, POP3, SMTP, Telnet, NTCIP, NTP, HTTP, FTP.
- It has been ensured that all communication protocols between the echosounder and the datalogger and any other element of the system are absolutely compatible and operational.
- The datalogger system and the energy supply system has a guarantee of good operation for at least two years.

✓ The supplier of the equipment (OSIL) is responsible for delivering the oceanographic monitoring station ready for operation at the indicated position at sea, until the final deployment and operation of the system providing real-time transfer of data at the ORION server.

1.1.a. The bottom-mounted ADCP

The selected system for the measurement of current profile, waves, sea surface level change and the estimation of SPM concentration profile is the Nortek's AWAC 600 KHz, deployed with an Oceanographic buoy. The AWAC is the most well-respected, sophisticated and frequently used acoustic Doppler profiler and directional wave gauge. Using Acoustic Surface Tracking (AST), the AWAC has the capacity to make high quality wave measurements when deployed at a maximum depth of 50 m below surface. The sensor will be mounted in a frame on the sea bottom, where will be protected from complications at the surface such as harsh weather, vandalism, and ship traffic. While safely located at the bottom it is operated in online or in standalone mode. The raw data are stored to the internal data logger and power comes from an internal battery pack.

Figure 1: The AWAC 600 KHz ADCP system purchased and deployed at 40 m by ORION.

The AWAC 600 KHz measures water column current profiles using acoustic Doppler technology. The AWAC uses the three slanted beams to measure the current profile over a range determined by the acoustic frequency. Large transducers transmit narrow acoustic beams and provide accurate data. The AWAC alternates between wave data collection and current profiling. If the wave data collection is longer than the interval between current profiles, the AWAC will skip a current profile to ensure the continuous wave Data.

1.1.b. Technical Specifications of the ADCP

The requested oceanographic parameters of the ADCP fulfill the following specifications and standards:

Table 1. Oceanographic parameters recorded by the ADCP.		
Parameters		
1. Horizontal Velocity (u, v)	Measurement Range	±10 m/s
	Measurement Accuracy	±0.5 cm/s
2. Vertical Velocity (w)	Measurement Range	±5 m/s
	Measurement Accuracy	±0.005 cm/s
3. Sea Level	Measurement Range	0 – 50 m
	Measurement Accuracy	~ 0.5% of full scale
4. Wave	Sampling rate	2 Hz with capacity to record up to 2048 data per sampling
5. Wave Height	Measurement Range	Up to 15 m
	Measurement Accuracy	~ 1 cm
6. Wave Period	Measurement Range	0.5 to 50 s
7. Direction of wave propagation	Measurement Range	0-360°
	Measurement Accuracy	2°
	Measurement Resolution	per 0.1°

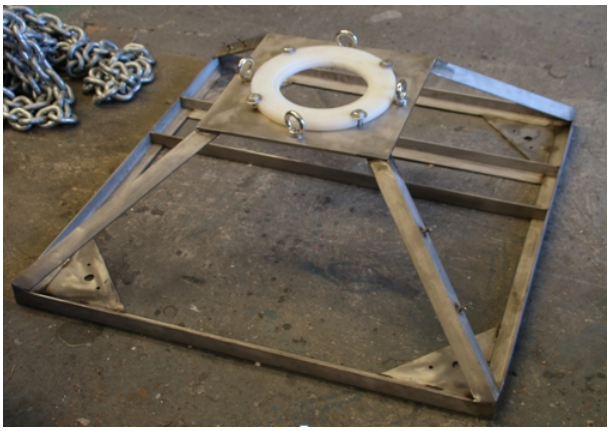

Figure 2: The AWAC 600 KHz ADCP system positioned on the mounted sea bottom frame to ensure horizontality and upwards facing.

1.1.c. Technical Specifications of the Buoy

The navigation buoy is manufactured from a single piece rotationally mounded float collar filled with closed cell foam for unparalleled floatation properties. Equally capable of being deployed in ports, harbors, rivers & inland waterways.

The technical specifications of the navigation buoy are the following:

Table 2. Technical specifications of the navigation buoy.

Dimensions	
Diameter (mm)	1,20
Overall height (mm)	1,940
Overall weight (kg) LIT with charging system	120
Overall weight (kg) UNLIT	96
Focal Plane (mm)	1,790
Max mooring weight (kg)	220
Min mooring weight (kg)	120
Waterline above datum (mm)	250
Chain size (mm)	16/19
Sinker weight in water (kg)	500

Figure 3: The navigation buoy of the ORION oceanographic station provided by OSIL.

The buoy has a specially protected, water-proofed plastic shell to place the datalogger and the communication system of the oceanographic station.

1.1.d. Technical Specifications of the Datalogger and Communications

The datalogger is the Campbell CR800 series equipped with GPRS modem. The CR800 is smaller and designed for applications in which fewer sensors are measured. These dataloggers differ in their keyboard display, as they include an on-board keyboard display to communicate with the user.

The CR800 consits of measurement electronics encased in a plastic shell and an integrated wiring panel. Low power consumption allows the CR800 to operate for extended periods of battery recharged with a solar panel – eliminating the need for AC power. The CR800 suspends execution when primary power drops below 9.6 V.

The technical specifications of the datalogger are shown below:

Table 3. Technical specifications of the datalogger.

Dimensions	
Max Scan Rate	100 Hz
Analog Inputs	6 single-ended
Pulse Counters	2
Switched Axcitation Channels	2 voltage
Digital Ports	4
Memory – Operating System	2 MB
Memory – CPU Usage, Program and Data Storage	4 MB

Figure 4: The datalogger of the ORION oceanographic station.

Figure 5: The configuration of datalogger, external battery and communications at the plastic shell of the navigation buoy.

1.1.e. Technical Specifications of the Software

The licensed software accompanying the above described system should be able to collect, process and analyze data transferred from the oceanographic station (waves, sea level, currents and SPM concentration profiles) at real time mode.

The web-based version of this software is accessible by any remote computer through the internet allowing the management and visualization of collected data. This web-software allows:

- The creation of diagrams and comparative diagrams between one or more sets of data (sea level, significant wave height, wave period, direction of wave propagation, u, v, w-currents),
- The creation and maintenance of database containing all recorded and cleaned datasets,
- The direct receipt and storage of measurements as recorded by the oceanographic system through the GPRS cell phone network,
- The capacity to receive and process data from more than one oceanographic station (system expansion in future),
- The presentation and visualization of historic data recorded from the oceanographic station(s),

- The management and visualization of data by authorized users,
- The transformation of data to any other data format (as CSV, Ascii data files),
- The capacity to alert the administrator in the case of extreme values, errors and malfunctions of the system, through SMS and e-mails,
- The visualization of alerts and alarms of each parameter in a graphical form.

1.2. System Licensing and Deployment

ORION submitted a technical report (in Greek) and a series of documents to the Cyprus Port Authority competent to approve and authorize the deployment of the oceanographic station in the Larnaca bay next to the "Zenobia" shipwreck.

Deployment was scheduled on 11/9/2019 at the Larnaca bay next to "Zenobia" shipwreck at a location at the 40-42 m depth, Figure 6.
The system was preconfigured by ORION to collect sea currents at layers of 2.5 m thick, with a sampling interval of 1 hr for currents and 3 hrs for wave characteristics.

The station's buoy was anchored with two anchors of 1 ton weight each positioned parallel to the wave crests approaching the area, to ensure that it will retain its position during extreme storms. Each anchoring involved 4 cement blocks with iron armature weighting 250 kg each, connected with chain (Figure 7). The ADCP echosounder will be deployed at the middle of the two anchoring (Figure 8).

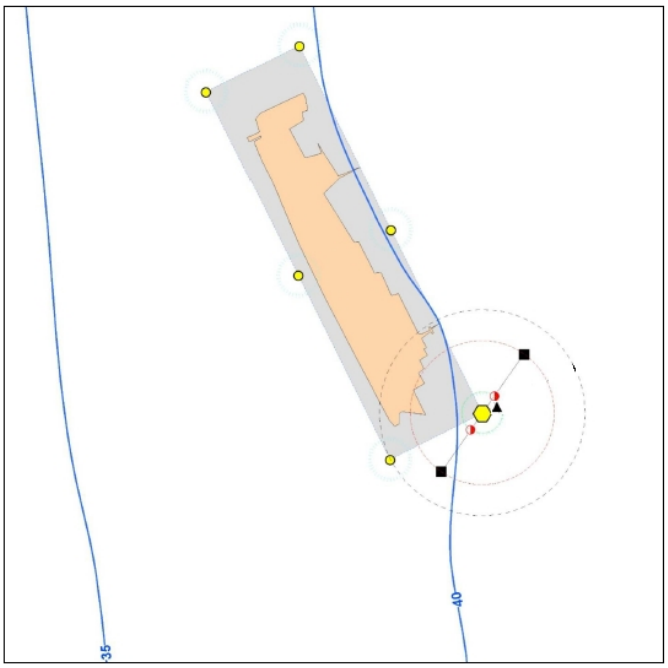

Figure 6: Left: The location of the "Zenobia" shipwreck in the Larnaca bay. **Right**: The location of the HERMES buoy (yellow polygon), the deployed 2 anchors of the Hermes buoy (back rectangular), the deployed base of the ADCP ((back treacle), the "Zenobia" shipwreck and the isobaths of 35 and 40 m depth.

Figure 7: The constructed cement iron armored 4 anchoring of the oceanographic station at Larnaca bay next to "Zenobia" shipwreck.

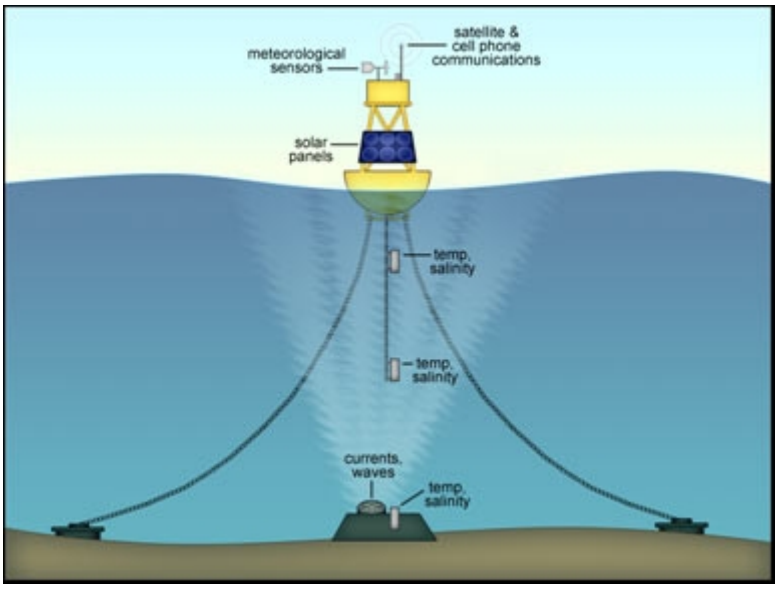

Figure 8: Schematic of the scheduled deployment of the HERMES buoy, the anchoring and the ADCP in the Larnaca bay, next to "Zenobia" shipwreck".

Figure 9: The buoy of the ORION oceanographic station at Larnaca bay next to “Zenobia” shipwreck.

Figure 10: The bottom mounted upward-facing ADCP at its deployed depth of 40-42 m depth in the Larnaca bay.

2. Analysis of Collected Dataset

3. Conclusions

4. Appendix

Τεχνικό Υπόμνημα: Βέλτιστη θέση εγκατάστασης Σταθμού Παρατηρήσεων στο ναυαγίου "Ζηνοβία", in the frame of the HERMES project, January 2019 (in Greeks).