THE BLUE GROWTH FARM PROJECT: FIELD TESTING AND DEMONSTRATION OF A NOVEL MULTI-PURPOSE PLATFORM

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KEY POINTS

- *"The Blue Growth Farm" project introduces a new multi-purpose floating platform concept*
- *A 1:15 experiment was carried out at sea in 2021 at NOEL laboratory of Reggio Calabria*
- *Huge amount of data were collected and managed via an in-house software platform*
- *Surveillance and security system (SSS) was replicated in scale and demonstrated.*
- *Connection-disconnection manoeuvres of a novel umbilical connector were successfully demonstrated.*

1. INTRODUCTION

The Blue Growth Farm (BGF) H2020 EU project (GA n. 774426, 1st June 2018 – 31st March 2022) proposes an efficient, cost-competitive, and environmentally friendly multi-purpose floating offshore platform concept. It is based on a modular floating structure, moored to the seabed, where automated aquaculture and renewable wind-wave energy production systems are integrated and engineered for profitable applications in the open sea (*Lagasco et al.*, 2019). This paper presents some results of an experimental activity performed in real environment (at sea) in the Natural Ocean Engineering Laboratory, NOEL (Reggio Calabria, Italy) on an aero/hydro outdoor prototype of the platform (scale 1:15). The activity is described in more detail in a companion paper (*Santoro et al.*, 2022).

Section 2 reports a brief description and some examples of the data set recorded. In Section 3, the description of the software used to manage and store the data is given. Section 4 describes the demonstration activities carried out during the campaign. Concluding remarks are finally given in Section 5.

2. EXPERIMENTAL ACTIVITY AT NOEL LABORATORY

As described in the companion paper (*Santoro et al.*, 2022), more than one hundred sensors have been installed and the recorded measurements obtained from March 2021 to January 2022 have been pre-processed and stored to be further processed and analysed. An overview of the data collected is reported in Table 1. The high number of 10-min records available for each variable of interest compensates for the impossibility to control the input, allowing to perform input-output dynamic identification in the frequency and time domains, as well as statistical analyses. Due to the long duration of the experiment and to the aggressiveness of the sea environment, interruptions and malfunctioning were observed for the installed sensors, resulting in reductions in the number of usable records available for each variable with respect to the total values reported in the table. However, this issue was overcome thanks to the redundancy of sensors and to the real-time monitoring of data, which allowed continuous maintenance of the measuring system. Data pre-processing was useful for filtering, estimation of data statistics, spectra and synthetic indicators of platform behaviour (e.g. month reports) and real-time monitoring. Some examples of the pre-processed data are reported in Figure 1.

Measurement	Data collected	Number of records
Undisturbed wind	Wind velocity Wind direction	26729 (10-min)
Undisturbed waves at variable water depth	Wave surface elevation + tide (d_1) Wave surface elevation + tide (d_2)	23062 (10-min)

(d_1 = 1.9m; d_2 = 3.7m; d_3 = 20.9m)	Wave surface elevation +tide (d_3) Wave head of pressure +tide (d_1)	13101 (10-min)
Undisturbed current profile	Current velocity profile Current direction profile	23 (overall 2063 hours)
6-DOF platform motions + SHM	x, y, z accelerations in a point roll, pitch angles yaw angle Strains in 4 sections	19799 (10-min) + 5047 (10-min)
Mooring loads	Loads at the 4 fairleads Load within a mooring line	24926 (10-min) 12703 (10-min)
Moonpool waves	Relative surface wave elevation in 7 points Relative wave head of pressure in 17 points	15998 (10-min) 24926 (10-min)
Wave field around the platform	Relative wave head of pressure in 16 points	24926 (10-min)
WECs dynamics	Air pressure in 8 chambers Water pressure in 22 points, distributed in 8 chambers	9955 (10-min)
Wave loads + overtopping	Pressures in 15 points on the breakwater	24926 (10-min)
Wind turbine	tower and nacelle acceleration blade flapwise bending moment bending moment and torsion along the tower rotor position and velocity yaw position blade pitch angle wind speed and direction	184 (record duration variable within 10-60 minutes)

Table 1. Synthetic overview of data acquired during the experimental campaign. Reference duration for each record is of 10 minutes.

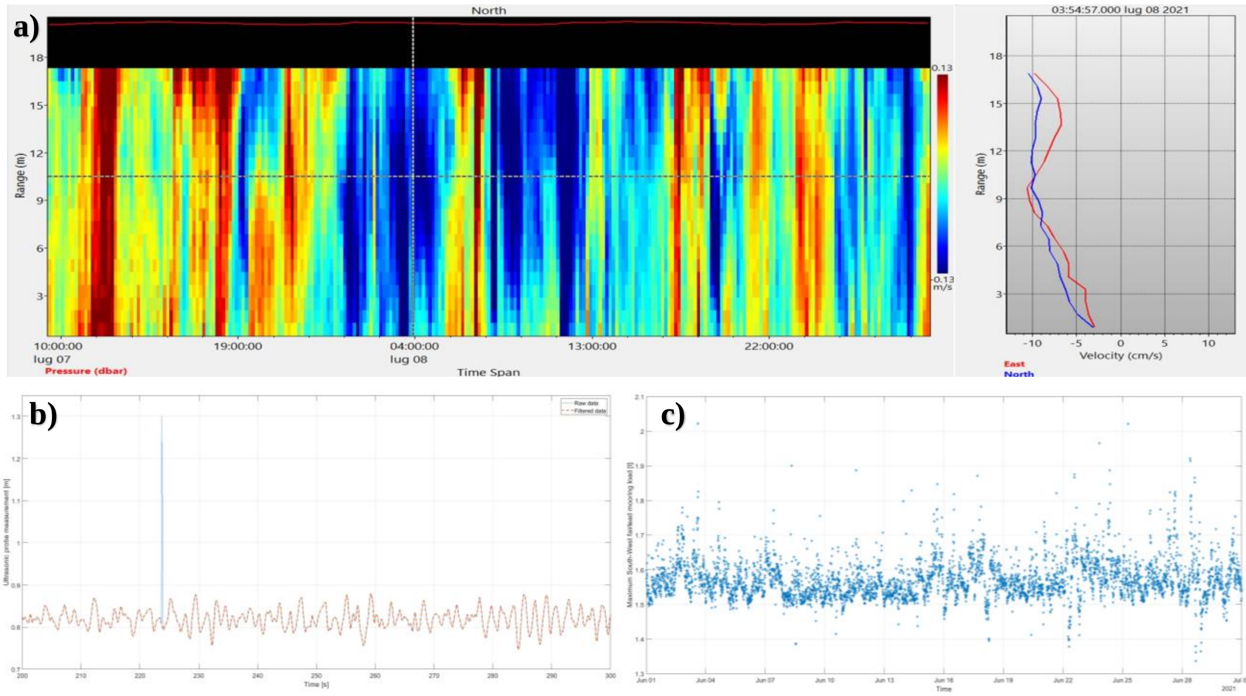

Figure 1. Examples of the pre-processed data: a) current profile measurements; b) relative surface wave elevation in the moonpool (blue line = raw data, orange dashed line = filtered record); c) monthly records of the maximum load in a mooring line.

3. THE BGF_AQUARES SOFTWARE PLATFORM

The SW platform named “BGF_AQUARES” has been designed to facilitate data gathering and visualisation capability from different sources and to control the platform status, as well as alert in case some measured value exceeds the provided threshold. Raw and pre-processed sensor data are stored in the cloud in different formats: real-time data and statistical data grouped every 10 minutes. The Graphical User Interface (GUI) of the software, installed on a dedicated workstation of the NOEL laboratory, was composed of a set of views (Figure 2), each one dedicated to show a specific set of data/information. In particular:

- structure (platform);
- metocean data;
- hydrodynamics information;
- WECs;
- wind turbine;
- electric supply and dispatch.

A “system type” tag has been assigned to every measurement in the database, so to be grouped in the appropriate view. The collected sensors data have been then aggregated and used as input for the Machine Learning Analysis tool, developed within the project activities and aimed to identify trends in the structural and naval responses and to ensure that deviation from the ordinary is properly highlighted and dealt with.

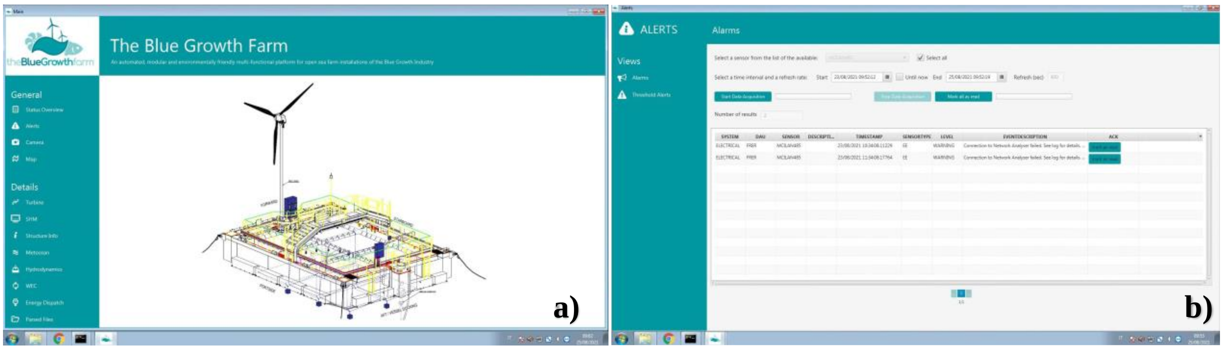

Figure 2. BGF_AQUARES Graphical User Interface: a) main view; b) alarms view.

4. DEMONSTRATION ACTIVITIES

During the experimental campaign, two demonstrations activities have been planned and successfully performed, i.e. 1) the test of device-to-cable connection of the umbilical cable and the connector and 2) the test of the surveillance and security system.

4.1. Surveillance and Security System

The aero/hydro outdoor prototype “Aurora” has been equipped with a camera made up of both optical and thermal sensors to test the Surveillance and Security System (SSS) aiming at overseeing the physical integrity of the platform and of the people involved in its maintenance. The monitoring system is based on the AIS (Automatic Identification System), composed by a transponder and a receiver. The system has several functions, mainly: tracks identification (AIS), vessel movement prediction, targets alarms/warnings management, route planning and monitoring. To test the capabilities of the system, a tentative of approach to the “Aurora” platform has been simulated using an inflatable boat, as shown in Figure 3.

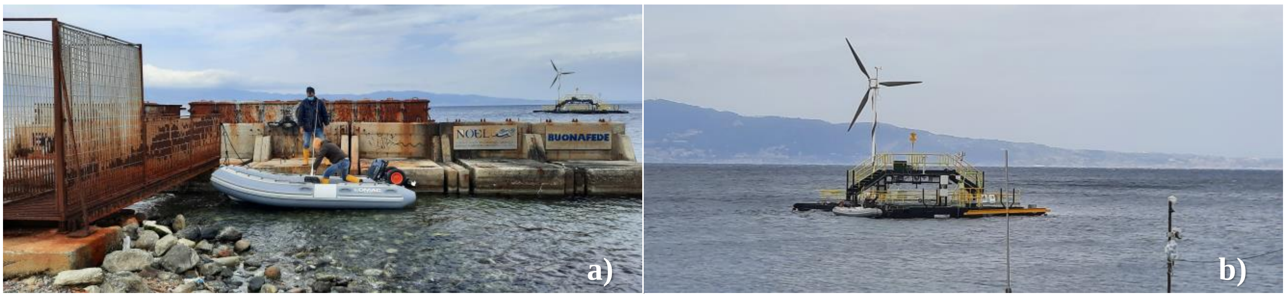

Figure 3. Surveillance and Security System test: a) installation of the AIS transponder on-board, b) inflatable boat approaching the platform.

4.2. Umbilical cable and connector

The feasibility of the handling and connection manoeuvres between the dynamic cable and the platform has been tested in real environment, in order to collect useful info for the full-scale application, especially in terms of operations and of sealing of the innovative connector, patented by the project partner Ditrel Industrial. One watertight housing has been welded to the lowest part of the centre aft caisson of the prototype and the dynamic cable has been fitted with the watertight male connector. The activity (Figure 4), successfully performed, aimed at: checking cable & connector behaviour during the experimental campaign, carrying out connection and disconnection trials, assessing cable & connector resistance to the real environment.

Figure 4. Umbilical cable and connector test: a), b) connection manoeuvre; c), d), e) disconnection manoeuvre.

5. Conclusions

An innovative experimental campaign has been organized and performed at the Natural Ocean Engineering Laboratory of Reggio Calabria aiming at collecting data on the scale model of the multipurpose platform BGF. The dataset acquired is composed by a large number of records, which at first analysis has shown to be consistent and suggest the feasibility of floating structures composed by different subsystems. The demonstration activities has been successfully performed, allowing the acquisition of useful information both on security and surveillance system and operation manoeuvre at sea. Further analyses on data collected during the campaign are needed to provide final conclusions on the platform dynamics and the subsystems interaction.

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