1. Project Information

Proposal reference number[1]	23/1003407
Project Acronym (ID)[2]	MultiNuD2
Title of the project[3]	In-situ parallel nutrient sensor deployments
Host Research Infrastructure[4]	OBSEA
Starting date - End date[5]	2023-07-06 - 2023-11-21
Name of Principal Investigator[6] **Home Laboratory** **Address** **E-mail address** **Telephone**	Matthew Patey National Oceanography Centre, European Way, Southampton, SO14 3ZH mpatey@noc.ac.uk +44 (0)23 8059 6622

2. Project objectives[7] (250 words max.)

In this project, we aimed to deploy lab-on-chip phosphate, silicate and nitrate in-situ sensors at the OBSEA coastal Observatory. We would collect a suite of laboratory-quality nutrient measurements over an extended period to produce a nutrient dataset with a temporal resolution that is unprecedented in the surface ocean. We have little experience of testing the nutrient sensors with the more challenging conditions of warm temperatures and low nutrient concentrations found in OBSEA, especially during the summer months.

While these prototype sensors had been deployed previously (e.g. in estuaries, rivers and cold (including polar) waters, the coastal waters of the observatory offer environmental conditions that offer new challenges to the nutrient sensors. Specifically, we wanted to test three aspects that limit the capacity to deploy in-situ sensors in long-term moorings: reagent stability, biofouling, and low-level performance.

[1] Reference number assigned to the proposal by the TA-Office.
[2] User-project identifier used in the proposal.
[3] Title of the approved proposal. The length cannot exceed 255 characters
[4] Name of the installation/infrastructure accessed with this project. If more than one installations/infrastructures are used by the same project, please list them in the box.
[5] Specify starting and end date of the project (including eventual preparatory phase before the access).
[6] Fill in with the full contact of the Principal Investigator (user group leader).
[7] Write the short-term, medium and long-term objectives of the project. Use no more than 250 words.

3. Main achievements and difficulties encountered (250 words max.)[8]

Main achievements:

- We have had a successful collaboration with our colleagues at OBSEA, who helped us to overcome the shipping problems previously encountered.
- The observatory proved to be an excellent location to test sensors and we hope to use their facilities in the future for tests of lab on chip and other technology.
- We did not manage the 6-month deployment originally envisioned. However, a short deployment during July and August was successful, with all three sensors working well, despite very warm conditions and nutrient concentrations at levels that are challenging even for established laboratory techniques.
- Significant biofouling of the sensors occurred during the short summer deployment (see photo below). But the inlet filters appeared to be good enough to protect the sensors and no clear biofouling signal (such as a diurnal cycle) could be detected in the data.

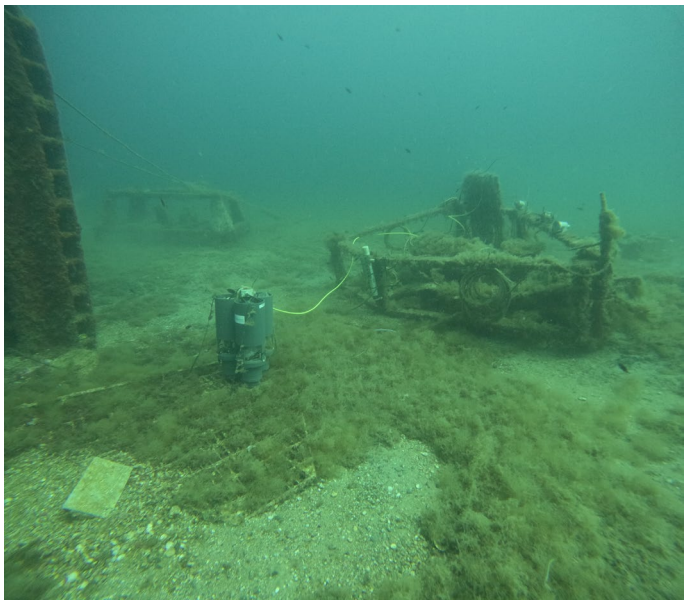


Figure 1. Nutrient sensors deployed at OBSEA in July 2023

Difficulties encountered:

- Due to transport delays the sensors were deployed in summer when the water temperatures are higher than 25C and sensors reagents do not normally last more than a few weeks. Future deployments and studies will include improvements of the longevity of the reagents.
- During summer, the water at OBSEA is very oligotrophic, this didn't allow us to record any value above detection limit for the N sensor. For Si and P sensors, values were below detection limit in 5% and 60% of the samples, respectively. In this case, we are sure that the

[8] Describe briefly the main achievements obtained and possible impacts, as well as possible difficulties encountered during the execution of the project. Use no more than 250 words.

sensors were working properly since they measured Kanso CRMs during the visit in July 23 and values agreed with those reported for the standard. For future deployments we will aim to cover other seasons such as early spring when higher values can be measured.

4. Dissemination of the results[9]

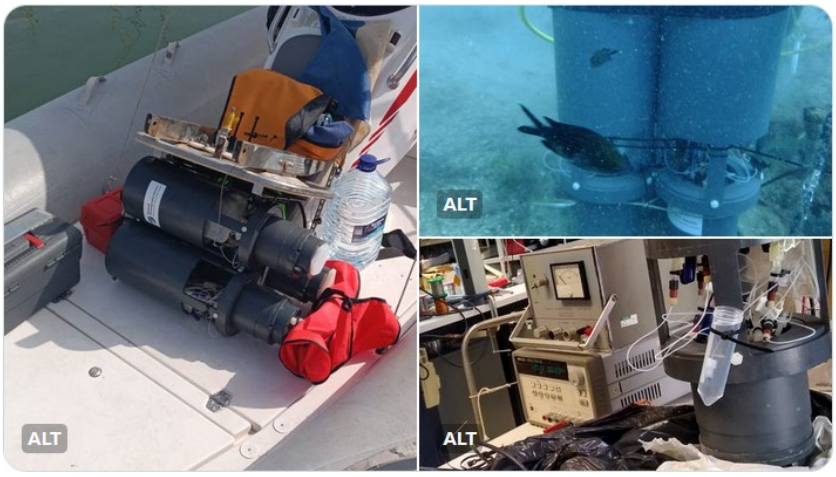
The data from the deployments will be deposited in the SEANOE repository (https://www.seanoe.org/) and will get a DOI.
NOC personnel visit to OBSEA in July 23 was publicised in our group Twitter channel, see link to the news:

- https://twitter.com/biogeosensing/status/1682043228554694665

[9] Describe any plan you have to disseminate and publish the results resulting from work carried out under the Transnational Access activity in JERICO -S3: scientific articles, books - or part of them -, patents, as well as reports and communication to scientific conferences, meetings and workshops. Highlight peer-reviewed publications. **Note that any publications resulting from work carried out under the JERICO -S3 TA activity must acknowledge the support of the European Commission – H2020 Framework Programme, JERICO -S3 under grant agreement No. 871153.**

NOC Ocean Technology and Engineering
@biogeosensing

This week we went to service some sensors that have been deployed at #OBSEA observatory as part of @JERICORI TNA project. They went again in the water today. Thanks to the great @OBSEAsarti team for all their help! #oceansensors #LOCsensors #nutrients @NOCnews @PatriLopzGarcia



4:02 PM · Jul 20, 2023 · **1,349** Views

View post engagements

1 6 8

NOC Ocean Technology and Engineering @biogeosensing · Jul 20
We would also like to thank colleagues from the Chemistry Department at @UPCVilanova for providing some reagents at a very short notice. This enabled one of the sensors keep on measuring.

1 5 87

NOC Ocean Technology and Engineering @biogeosensing · Jul 20
If you want to see out sensors in real time, take a look at the #OBSEA Camera
👉

youtube.com
OBSEA Camera
OBSEA Camera

4 56

5. Technical and Scientific preliminary Outcomes (2 pages max.)[10]

- OBSEA have physically integrated NOC sensors with the OBSEA platform and are able to operate the sensors remotely and retrieve data from them in near real time.
- Despite NOC personnel not being able to attend in person for much of the project, OBSEA personnel were trained remotely to operate the sensors.
- OBSEA personnel took water samples every time they visited the observatory which will be used to validate the sensor measurements. These samples will be measured in early 2024 following gold standard protocols.
- NOC personnel visited twice the facilities at OBSEA, first visit was between 17-19/07/23 and main objective was to service the sensors (repair P and Si sensors, prepare new reagents and measure some Kanso CRMs to check sensor performance). The second visit was between 20-21/11/23 and the main objectives were to prepare the sensors for shipping and collect data.
- Two deployments were carried out before the sensors failed:
    - The first deployment took place between 29/6/23 until 03/07/23, only the N sensor worked since P and Si sensors due to a problem with the reagent bags. Values for the NO3+NO2 were below detection limit of the sensor (80 nM).
    - The second deployment took place between 20/07/23 until 31/08/23. All 3 sensors worked well. Again, N sensor values were below LD, P sensor worked during the whole period, values were close to the detection limit of the sensor (0.06 µM average) see Figure 2. Si sensor worked only until the 12/08/23, we suspect that the reagents went bad due to the warm water temperatures, values were very low (0.4 µM average) see Figure 3.

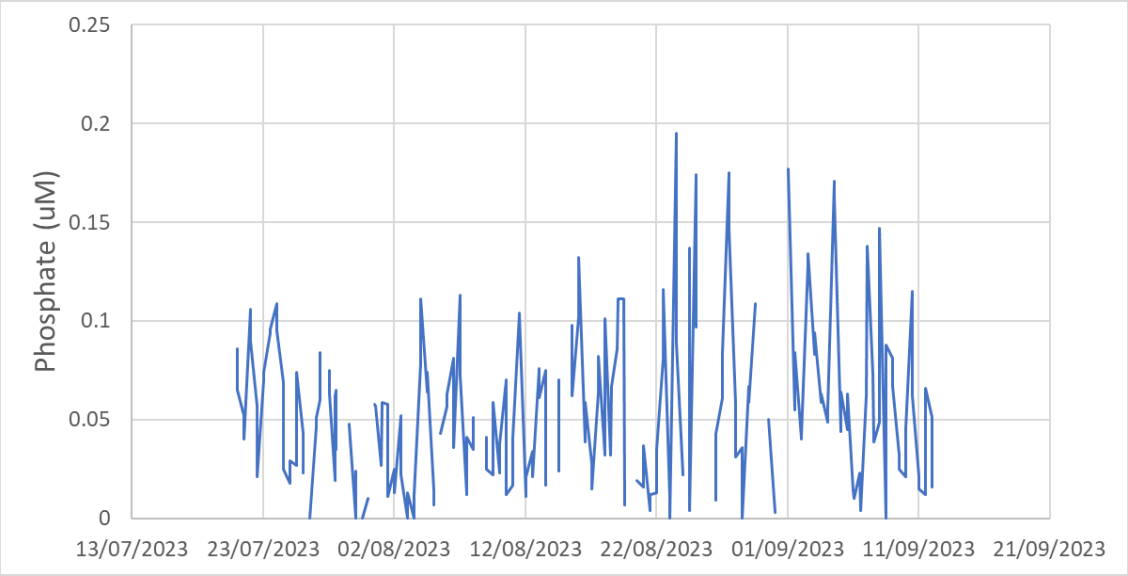


Figure 2. Concentration of dissolved phosphate in µmol/L, as measured by the LOC sensor at OBSEA between late July / early September 2023.

[10] Describe in detail results and main findings of your experiment at the present stage.

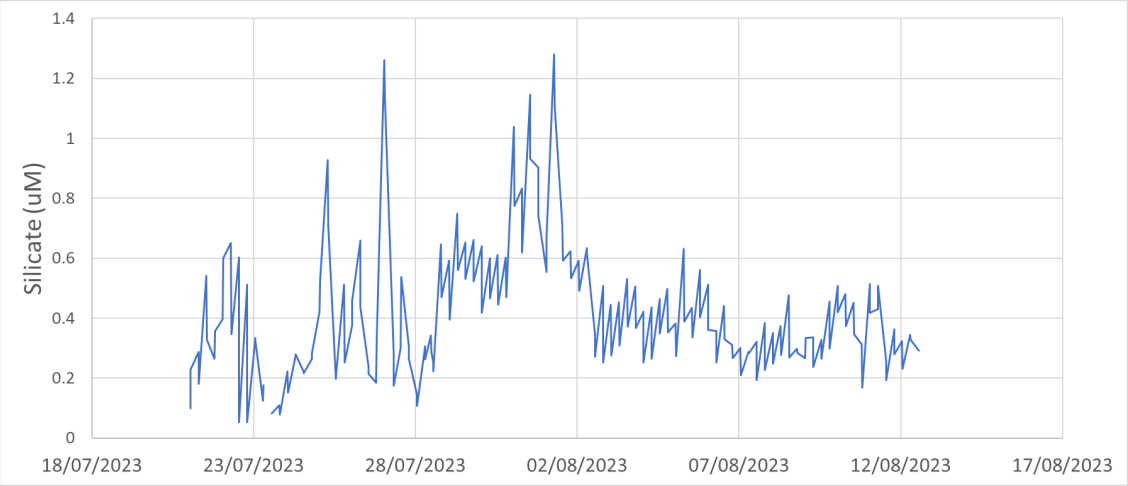


Figure 3. Concentration of dissolved silica in µmol/L, as measured by the LOC sensor at OBSEA during late July / early August 2023.

Southampton, 12/12/2023

Location and date

Signature of principal investigator