TA PROJECT REPORT

1. Project Information

Proposal reference number[1]	Ref.21_1631-JS3_CALL_1_REF_4024b_FISHES
Project Acronym (ID)[2]	FISHES (B)
Title of the project[3]	FISHES@SMARTBAY: Fibre-optic Intelligent Submarine High-Fidelity Environmental Sensing at SMARTBAY
Host Research Infrastructure[4]	SMARTBAY
Starting date - End date[5]	19/11/2021-3/12/21
Name of Principal Investigator[6] **Home Laboratory** **Address** **E-mail address** **Telephone**	Dr M. Belal National Oceanography Centre European Way, Southampton SO14 3ZH, UK mob@noc.ac.uk 0771962585

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

Key objective is to demonstrate our Distributed Acoustic Sensing (DAS) capability, i.e., ability to measure close to shot-noise broadband spatially resolved distributed measurements on the existing seafloor cable, in three different environmental conditions. This application covers access to one of three observatory access requests for this investigation. The tests conducted on the sea-floor cable will demonstrate monitoring-coverage of the multiparameter marine environmental variables space without affecting the fundamental electrical operability and connectivity purpose of the cable. The aim of this test would be to capture several marine processes, namely:

[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.

1. Wind/waves/currents: such events in shallower waters impact the seafloor and hence the cable more directly. Distributed strain profiling over well separated time events will help capture these signatures.
2. High-resolution temperature changes (~ 0.001 °C) enabling insight into differential thermal loading effects
3. Ambient marine noise (passive) variability
4. Tracking: aquatic mammals, structural health of the cable, scuba divers, vessel/ship traffic activity, water flow structure, e.g., surface generated turbulence due to wind forcing, etc.

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

We have successfully managed to pick anthropogenic activities both in the marine as well as terrestrial environments, e.g., vessel motion, road traffic etc. Additionally, we have also been successful in identifying contributions from dynamic changes in physical oceanographic features, e.g., wave changes due to surface winds etc, to the ambient noise variability observed over the duration of tests.
Whilst harsh weather enabled insights into the dynamics of the physical oceanographic features (surface wind related wave characteristics etc.), it contributed to significant background noise which compromises the SNR (Signal to Noise Ratio), especially when tracking anthropogenic activity across different sections of the cable, which due to its variable orientation relative to the seabed, experiences varied dynamic loading from the consequently varied physical oceanographic effects.
The support extended from the staff/members at the facility in SMARTBAY was incredible. The recording of events during the test plan in accordance with the plan directives and execution of tests, yet again in line with the plan details was not only done professionally, but with apt scientific rigor.

4. Dissemination of the results[9]

Promotional Article for Trials at SmartBay: *The UK's National Oceanography Centre to trial Artificial Intelligence at the SmartBay Observatory through the JERICO-S3 project*. Date TBC

[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.

[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.**

Results from the experiment will be publish in high-impact journals

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

Several TBs of data has been generated which will be analysed in detail in time. However, early analysis reveals that anthropogenic activity, both marine and terrestrial (as shown in figure 1), is successfully identified together with other natural sources of noise, e.g., wave swells (as shown in figure 2) etc., whilst being agnostic to the cable type, orientation, and location.

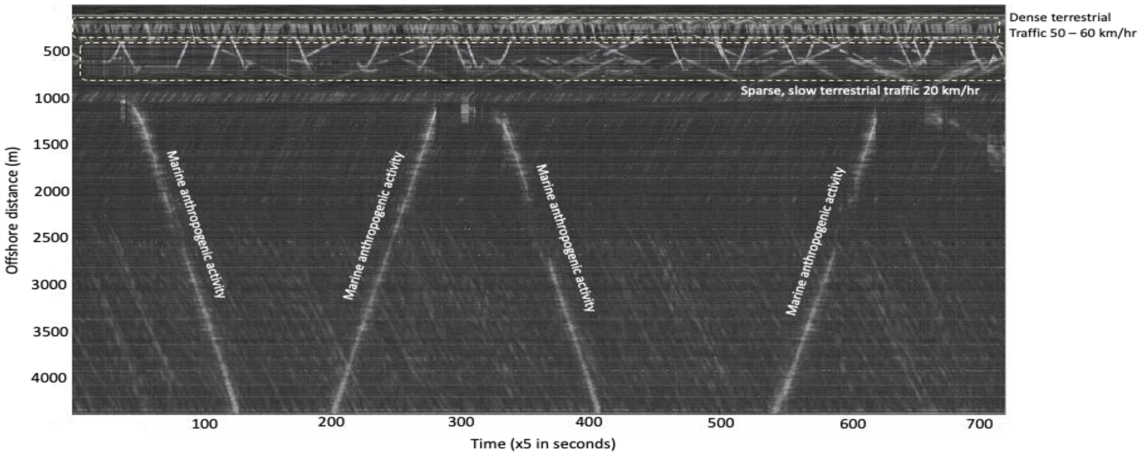

Figure 1: Shows marine and terrestrial anthropogenic activities captured as a function of offshore distance and time during interrogation of the seafloor cable at SMARTBAY

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

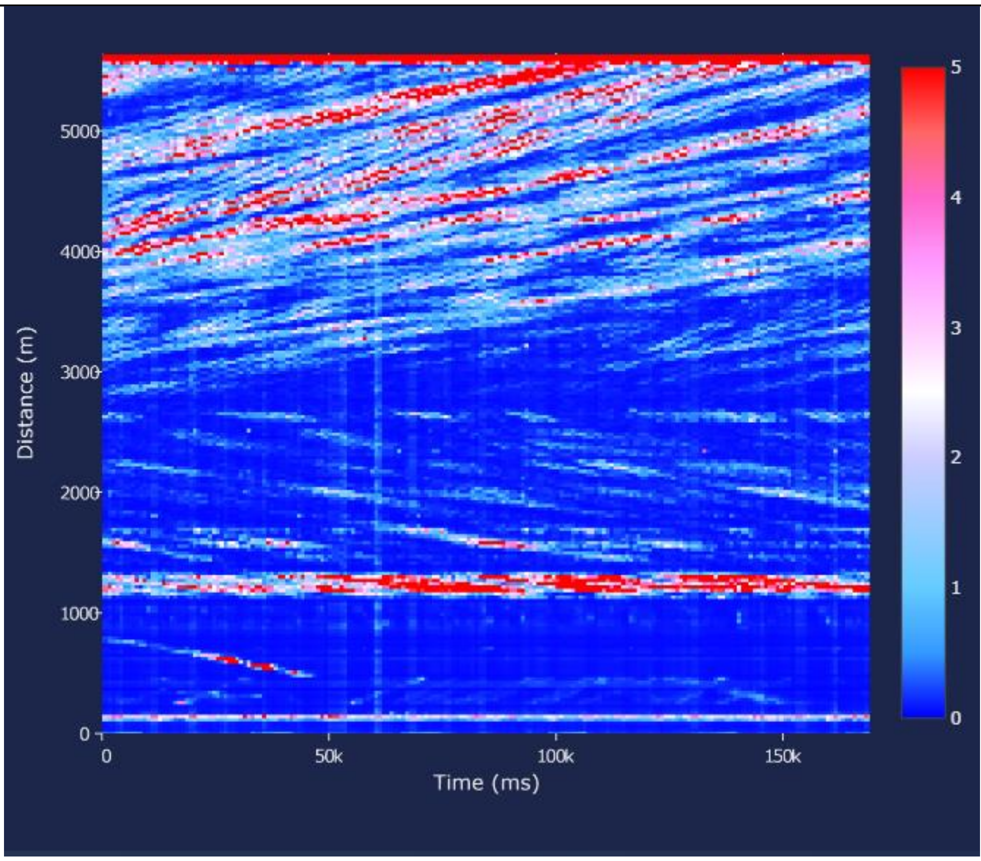

Figure 2: Shows the wave swells captured as high energy exhibits during interrogation of the seafloor cable. The change in directionality of the energy expressions from the wave swells beyond 2500 m offshore is attributed to the change in the cable direction beyond 2500 m offshore (cable makes a right angle turn after first 2500 m offshore)

The findings and their ongoing analysis bring us a step closer to realising some of the machine learning approaches which will enable localisation and tracking attributes to be realised.

Additionally, the variability in the weather pattern, had been found to contribute to the variability in the ambient marine noise content and distribution. This renders the prospects of disentangling several of its attributes through detailed statistical modelling, which is an ongoing investigation, that should ensue tremendous opportunities for enabling realisation of novel self-learning algorithms.

Southampton, 16/12/2021

Mohammad Belal

Location and date

Signature of principal investigator