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MONITORING BENTHIC HABITATS AND BIODIVERSITY AT THE TIDAL ENERGY SITE OF PAIMPOL-BREHAT (BRITTANY, FRANCE)

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ABSTRACT

Marine tidal energy technology is still in its infancy in France and potential environmental impacts on the seabed are virtually unknown. The first French pilot project is currently launched close to Paimpol and the Bréhat Island (Brittany). Environmental monitoring has started in 2012 to assess the baseline of benthic compartment before deployment and the grid-connections of the 4 turbines. The Paimpol-Bréhat tidal site is located on a hard rocky bottom where conventional benthic survey techniques are unsuitable. This paper describes the methodology used to assess the initial state of benthic communities on the turbines and cable deployment area and presents the first results of the mapping and monitoring of the targeted benthic ecosystem.

INTRODUCTION

Harvesting tidal kinetic energy is still at an early-stage of development in France. French Government has launched in September 2013 a call for expression of interest dedicated to this marine renewable technology and has selected two sites for future commercial tidal arrays: the Raz Blanchard and the Fromveur strait. Off the northern coast of Brittany (close to Paimpol and the Bréhat Island), the first tidal pilot-scale project is currently realized by EDF-EN company with four OpenHydro turbines (each 16 m in diameter and 0.5 MW) to be deployed at 35 m depth. So far, a single pilot turbine has been tested at sea during winter 2011-2012 and since December 2013. 15 km of subsea power cable has been installed in June 2012 to connect the tidal site in the future. Most of the cable (12 km) is not buried due to the predominance of hard bottom in this area. At the same site, the France Energies Marines research institute has created an observatory to monitor potential environmental changes linked to tidal energy exploitation. Environmental impacts of tidal energy are poorly known [1, 2, 3], even if they are often said very limited by involved industries. Potential changes have to be assessed for each compartment of targeted marine ecosystems, including benthic communities. The Paimpol-Bréhat tidal site is situated in a large Natura 2000 (Special Area of Conservation) and OSPAR protected area which may host fragile reef habitats (with e.g., *Eunicella verrucosa*, *Pentapora fascialis*) in its deeper part, according to an ongoing program of marine habitats census. Turbine deployment area is also located within a crustacean's no-take zone. Thus, thorough environmental baseline studies are urgently needed to document the potential impact of the installation and operation of tidal turbines and subsea electric cable on the benthic habitats and communities. For this purpose, a private-public collaborative research project has been initiated in 2012 to map and monitor benthic communities in the tidal turbine deployment area, for which virtually no data existed so far.

METHODOLOGY

Since classical soft-bottom benthic monitoring techniques were not appropriate at the study site, we used a drop-down High Definition (HD) video approach during a scientific cruise in March 2012 to describe the initial stage of benthic assemblages at the turbine installation site, along the unburied part

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of the electric subsea cable route and at corresponding reference sites. A total of 57 videos profiles were recorded using a HD video camera (Sony HD CX6) mounted on a weighted frame equipped with two lasers, a light and an altimeter. The suspended video frame was successively dropped and lifted for a few seconds, while the research vessel was in neutral but still moving with the current. The video profiles were thus positioned following a random sampling design (Figure 1). Instantaneous high resolution pictures were taken each time the frame hit the bottom (representing a total of 1455 snapshots) allowing the identification of benthic epifauna. Some megafauna taxa were also recorded when the video frame is flying about 1 m above the bottom.

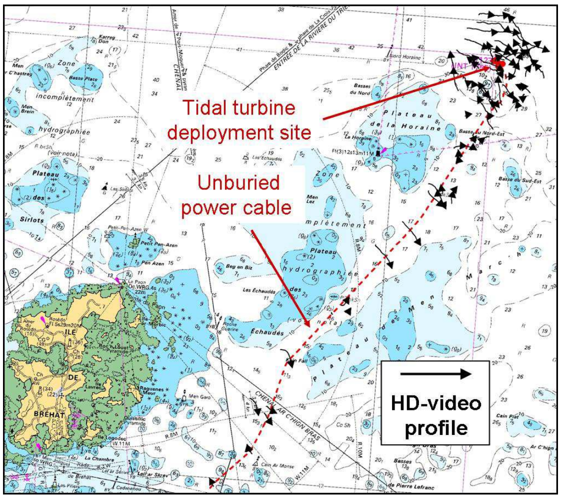

Figure 1: Location of the Paimpol-Bréhat tidal site and the 2012 and 2013 video profiles

An additional set of 24 videos profiles were acquired during a following scientific cruise in March 2013, both in the turbine deployment area and on the cable route. In areas where scuba diving was possible (depth < 25 m), benthic fauna was collected in order to validate identifications based on HD video data.

Only the 2012 video data have been treated to date. Benthic species were listed by reading video recording with the "VLC media player 2.0.4" software. The occurrence of dominating species and communities (faciès) were mapped using the software "Adélie-Video-3-bêta" (developed by Ifremer) coupled to a Geographic Information System interface. Environmental parameters like small-scale bathymetry, nature of the seafloor and current velocities were acquired by the EDF-EN company, either by direct observations and measurements or by modelling.

The monitoring of the biocolonization of the 12 km-long unburied cable casing (protection cast iron structures) has started in March 2013 through dive HD photo and video surveys at 3 different stations (A, B, C) located on the cable route at less than 30 m depth. In the same way, the monitoring of the biocolonization on concrete mattresses (stabilizing structures) has started in September 2013 after their installation during summer 2013.

OBSERVATIONS

During the 2012 survey (i.e. before the deployment of pilot turbines and the installation of the cable), 105 taxa we identified, including 91 invertebrate taxa and 14 benthic flora taxa. The benthic community was dominated by hard-bottom epifauna characteristic for the circalittoral zone, including ascidians, bryozoans, cnidarians, sponges and encrusting algae (Figure 2). Conspicuous mats of unidentified yellow and red social ascidians were present on most of the video profiles. Several identified species were of ecological interest [4], either because they were abundant at the tidal site while being considered to be rare in this region (e.g., the bryozoans *Flustra foliacea*, the cnidarians *Sagartia elegans*, *Sertularia argentea* and Tubulariidae sp.), or because they play important ecological roles as 'engineer species' (e.g. *Laminaria* macroalgae).

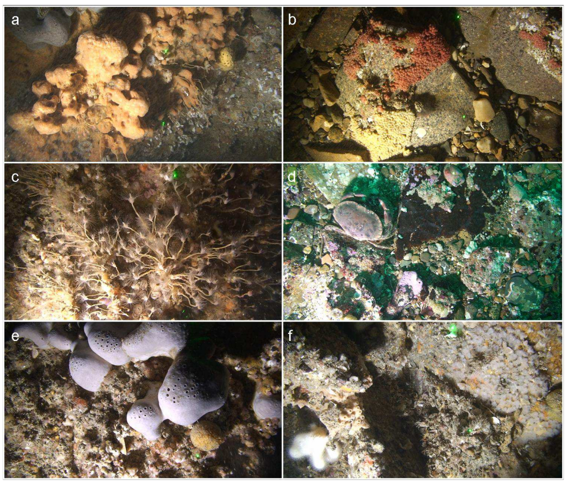

Figure 2: Outlouk of the hard-bottom benthic diversity observed at the Paimpol-Bréhat tidal site

This approach allowed getting a detailed map of a large proportion of benthic species and assemblages present at the tidal deployment area. Most of the identified benthic assemblages have also been recorded in the monitored area of the SeaGen tidal project [5]. Work is still in progress to identify species or taxa that could serve as indicators of potential ecological changes caused by the operation of tidal test-site, e.g. taxa specific to extremely tide-swept biotopes (e.g., Tubulariidae sp.).

The monitoring of the artificial reef effect of the protection of the unburied cable should be followed (at least annually) in the long term, during the exploitation phase of the tidal site. Preliminary results showed that benthic colonisation is mainly composed with cirripeds, hydrozoans and ascidians. At least 2 introduced species (the ascidian *Styela clava* and the gastropod *Crepidula fornicata*) occur on the cable protection structures with significant abundances. Regarding the benthic colonisation on cable-stabilizing concrete mattresses, preliminary results showed that very few species have fixed on the structures after 6 months. However, a few individuals of young *C. fornicata* are already present. A large crustacean (young individual of *Cancer pagurus*) has been observed on one of the 2 investigated mattresses, suggesting that such artificial structure may act as potential new habitat for large vagile benthic fauna.

CONCLUSIONS

Drop-down HD-video allowed to get a first large-scale overview of the benthic biodiversity present at the tidal test site of Paimpol-Bréhat. As suggested by previous acoustic survey, the seabed was mainly composed with rocky bottom, large blocks and pebbles. Benthic biodiversity was rich in terms of both species richness and assemblages (facies) diversity. These original data constitute a suitable baseline for the next impact assessment of the exploitation phase. Since potential impacts on benthos will probably occur in the near-field of turbine foundations, a towed flying HD-video system [6, 7] would be more efficient to monitor benthic assemblages a smaller space scale, around the turbines.

The benthic monitoring of the protection and stabilisation structures of the electric cable is going on a bi-annual frequency. The first conclusions will be available soon on the short-term changes of benthos on and in the close proximity of these artificial reefs.

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