Field Work

Baseline study prior to and after offshore exploitation activities

For baseline studies prior to industry operations and for environmental monitoring during and after operations we recommend to use a combination of stationary lander and mobile robots (crawlers) which are in use since 2010 .

A baseline study on benthic community structure, species richness is required prior to drilling, for comparison with post drilling assessments. Multivariate analysis of fauna at various survey points around the exploitation site are recommended. It is important to be able to predict the dispersal paths of material following release to the ocean. These predictions should be based on the results from the laboratory analyses and on the hydrodynamic conditions assessed at the site during the monitoring period before industry operations commences. Commonly, Acoustic Doppler Current Profilers (ADCPs) located on the stationary lander (central station) and on the mobile robot record current conditions for a period of time.

We recommend to deploy 1 -2 autonomous crawlers (equipped with sensors to determine flow characteristics, particle behavior, turbidity, fluorescence (chlorophyll), oxygen demand (benthic chamber or micro profiler), (3D) cameras for faunal analyses and 3D mapping of the seafloor. Regular time-lapse sampling of bio- and environmental data over a period of ≥1 year can then quantify biodiversity status and key species presence, if conducted at the appropriate spatial scales. A bioacoustics sensor is recommended for the central station to study the bentho-pelagic fauna including fish and mammals. These mobile robots perform transect analyses over several kilometers. On demand they can be supported by central stations (junction boxes) which allow to recharge the batteries and transfer the data onto an additional central data storage.

During exploitation

Scientific research projects such as ONC Canada or LoVe Norway have shown that 24/7 access to sensing equipment over cabled infrastructures is possible, even at several thousands of meters depth. Such scientific cabled observatories can be accessed remotely by researchers over the internet, often with users downloading high volumes of data in seconds, analyzing HD video streams or controlling remote operated equipment and manipulators. We recommend to install such cabled infrastructure which allows authorities and operational centers to permanently monitor the environment and rapidly react to disturbances. Once installed the sensors and crawlers (ONC) can easily be recovered for maintenance and exchanged using regular ships, thus avoiding expensive ROV operations for recovery and redeployment (METAS).

The robots are either tele-operated or monitor the environment autonomously during transects from one junction box to the next, where they transfer the data and recharge the batteries.

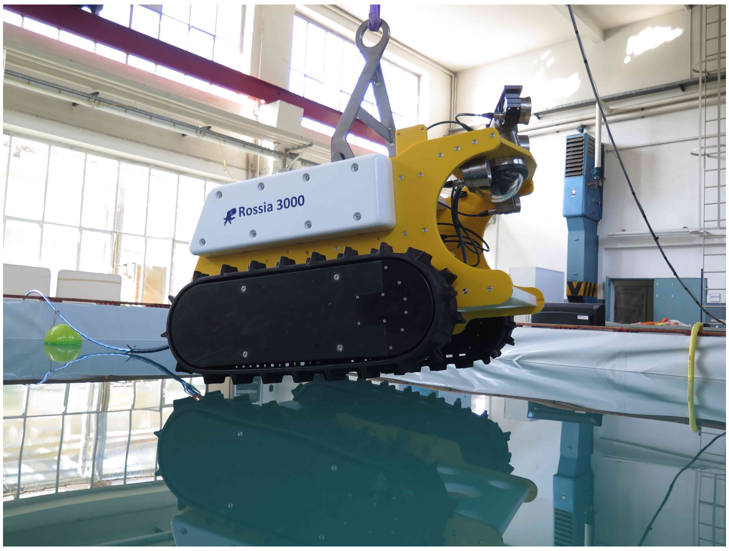
More especially, this approach allows multidisciplinary teams from different continents to investigate in parallel short- and long-term events and processes at the same time, interact with the sampling procedure by changing the observational missions, change the instrument/sensor deployments and data collection strategies, and interrogate a progressively large digital database. AUVs and docking station can be developed at a second stage of the project.

This technology can also easily be deployed at shallow water decommissioning sites in the North Sea, where existing/remaining infrastructure above sea surface can serve as communication and energy hub for tele-operations with crawlers equipped with specific analyzing technologies (Raman-spectroscopy, manipulators)

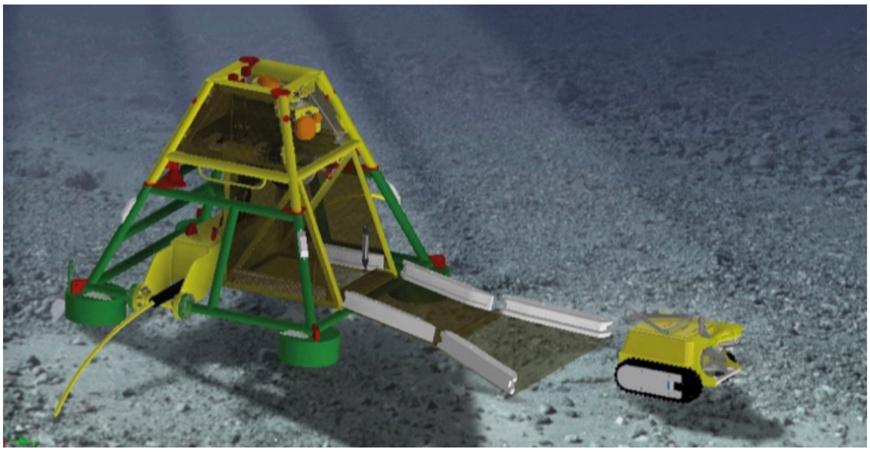
For nearshore areas the robot can be controlled via a surface buoy and WLAN. The robots are small enough to allow deployment from small vessels or even helicopters if needed. This technology can also be used to control crawlers for cable inspection, thus avoiding difficult ship-connected ROV operations under strong currents.

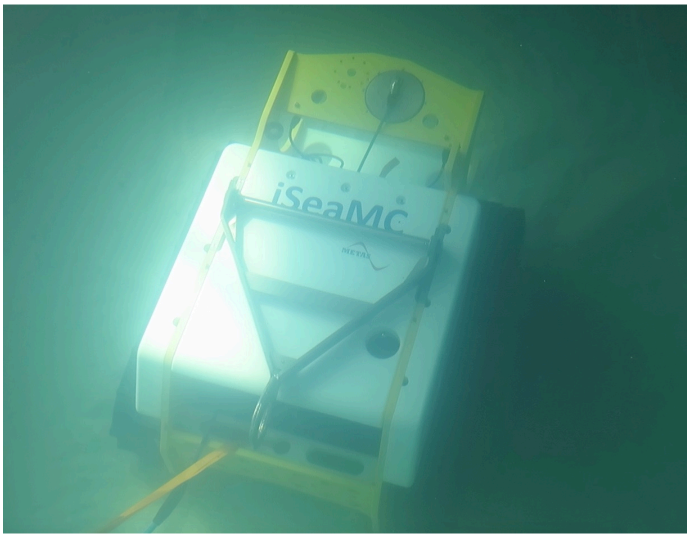
For each of the activities mentioned above the seafloor robots allow a cost- and energy efficient monitoring procedure in the range of 1 – 2 km, with the ability to extend operations to 10 or more kilometers when using autonomous operations and additional X-nets equipped with power to provide energy.

Crawler technology, operational at the Ocean Networks Canada cabled observatory since 2010 for 12 – 18 months deployments at 900 m water depths in Barkley Canyon

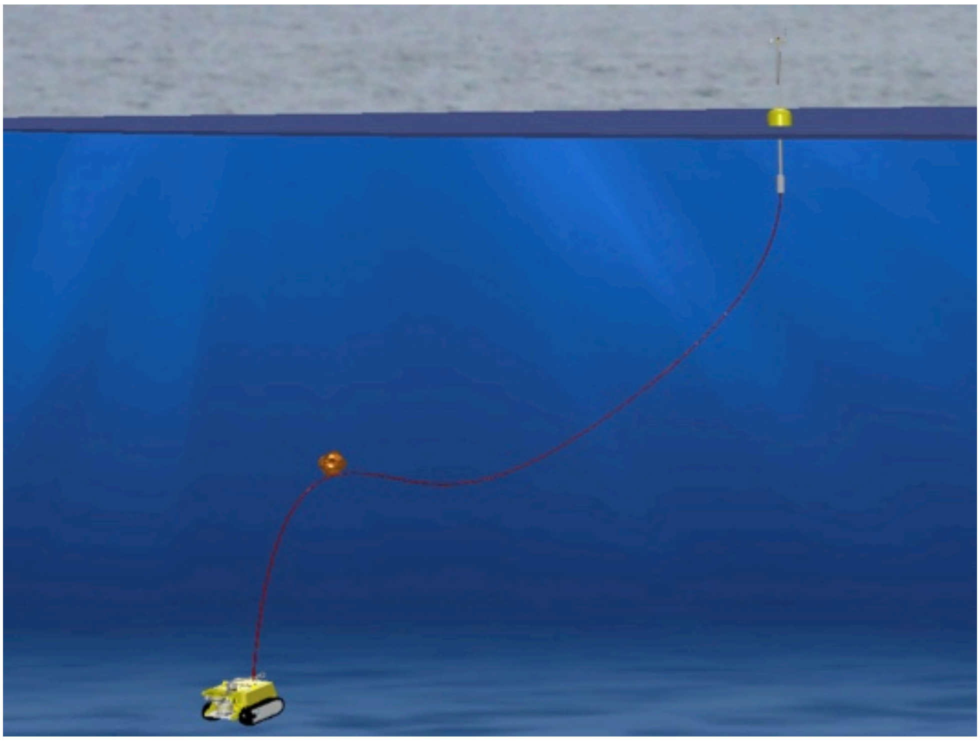


New crawler robots (Rossia Series) for tele-operated or autonomous operations from 10 – 5000 m water depths. Dimensions: 120 x 100 x 90 cm /L/W/H), 250 kg in air, 30 kg in water, 5 – 10 sensors, benthic chamber (operational in 2018).

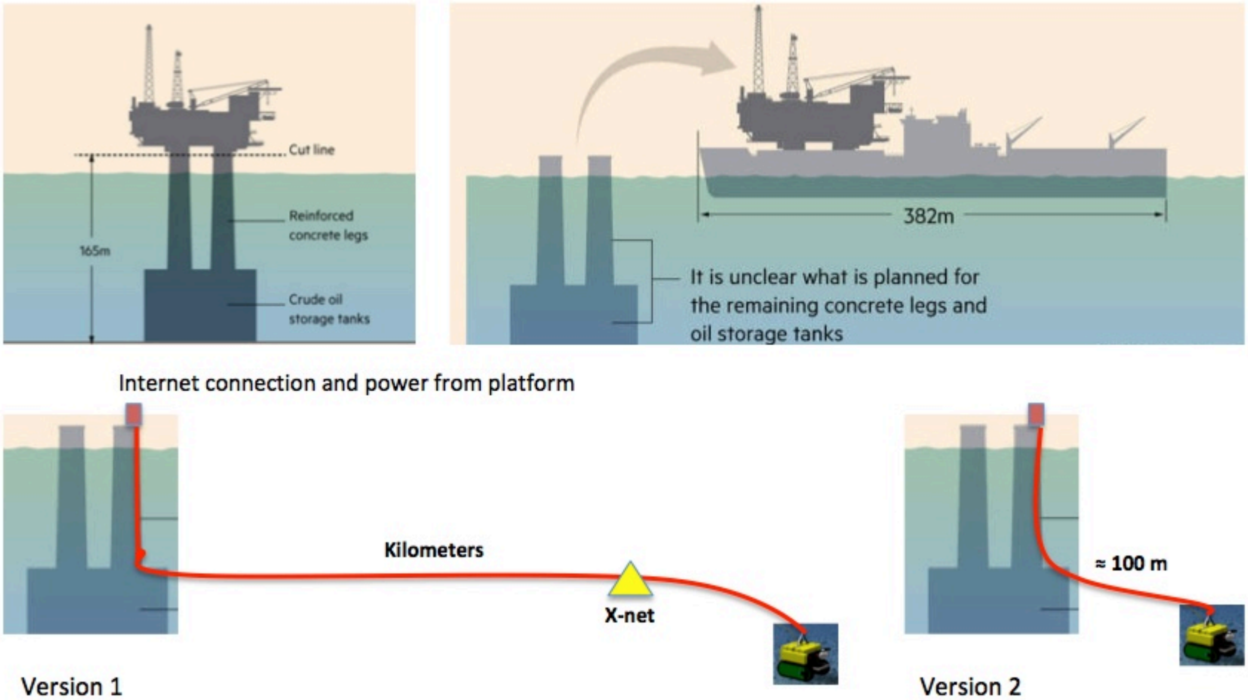




Cabled observatory with the METAS X-Net system with garage for a tele-operated or fully autonomous crawler from iSeaMC. The sensors installed in the X-Frame (yellow part) and crawler is serviced and maintained via a specially designed launch and retrieval tool (METAS), which does not need ROV operations (operational in 2020).

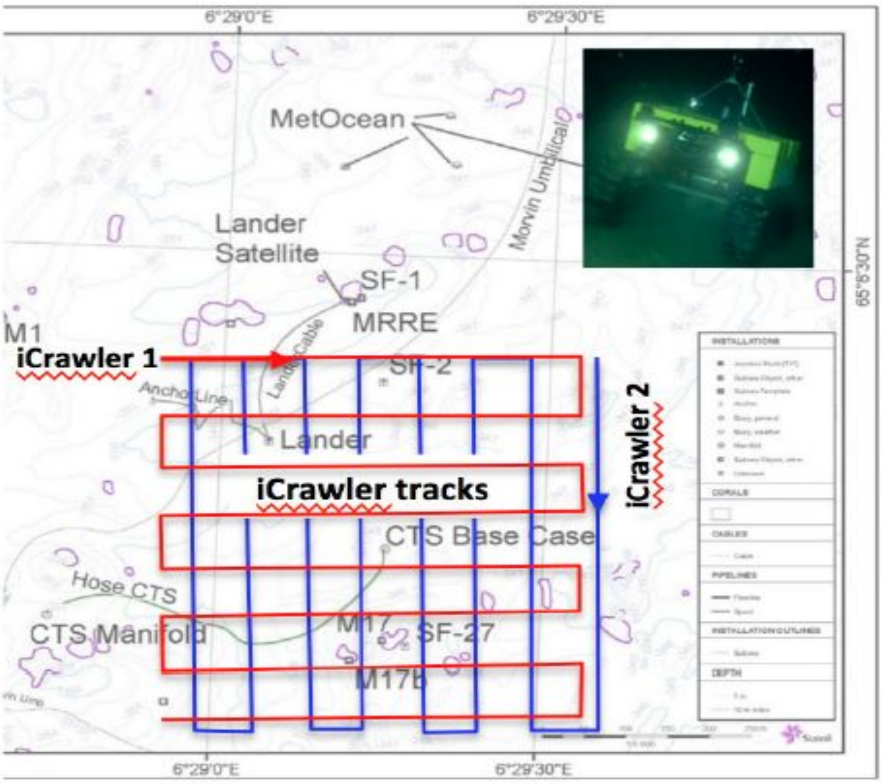


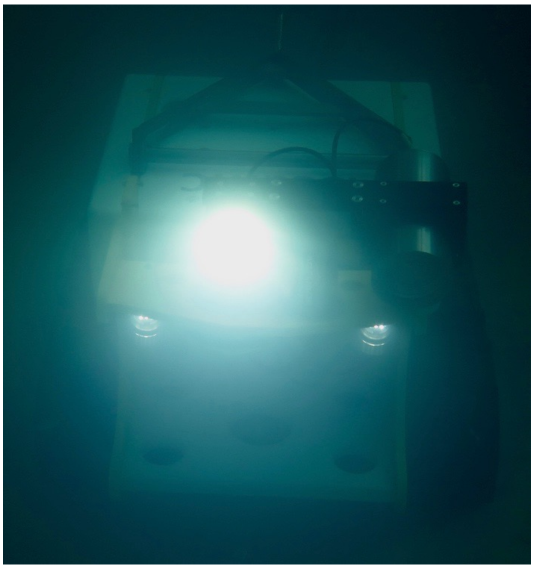
Crawler control via surface float for deployments in coastal areas from ships. The crawler can be deployed from a vessel of opportunity. Test cruise in November 2019. The WLAN connection can be extended to several kilometers in water depth down to 200 m.



Suggestion for environmental monitoring of decommissioning sites. Tele-operated crawlers are controlled via infrastructure which remained at the site during the decommissioning process. (Modified from Shell)

Example of future monitoring operations: A baseline study will be provided with one robot 1 – 0.5 years before drilling operations, followed by detailed monitoring during the 3-6 weeks drilling process and 1 mission after the end of drilling. During exploration, 1 – 3 robots can monitor the environment and can be regularly maintained via ROVs.





Example for autonomous operations (by 2020). The system can then also be used for environmental monitoring at deep sea mining sites (> 4 km water depth)