

# The Electronic Monitoring System (EMS) as a minimum requirement for monitoring the extraction of an increasingly scarce raw material

*Reinhilde Van den Branden, Gregory De Schepper, Lieven Naudts*

*Royal Belgian Institute of Natural Sciences, Operational Directorate Natural Environment, Measuring Services Ostend, RBINS-OD Nature-MSO, 3de en 23ste Linieregimentsplein, B-8400 Ostend, E-mail: [zagri-ost@mumm.ac.be](mailto:zagri-ost@mumm.ac.be)*

## Introduction

This contribution outlines the Electronic Monitoring System (also referred to as EMS, black box or automatic registration system), its renewal in 2014, the obtained data results since its introduction as well as possible future improvements of the system.

### 1. History and evolution of the Electronic Monitoring Systems

Sand extraction in the Belgian part of the North Sea started in 1976. As a result of the Royal Decrees of 1996 and later, the EMS was introduced in 1996 and installed on dredging vessels to record and control the sand and gravel extraction activities in the Belgian part of the North Sea. Over the years, the legislation and agreements concerning EMS obligations improved which resulted in a complete EMS-dataset from June 2002 onwards. From 2006 onwards, extraction activities for the protection of the Belgian coast are also being monitored by this EMS.

Since 2014, the new EMS (the EMS 2.0) with remote data-transfer capabilities is being installed to replace the obsolete EMS 1.0 and to allow a more frequent follow-up of the correct functioning of the recording devices. The main advantages of the new system are: remote data transfer, remote configuration changes, automatic alert messages and local keyboard input for the obliged parameter 'declared load' (see Fig. 1). As a result of this renewal operation, the percentage of missing data could be further reduced to around 0% during the last 3 years.

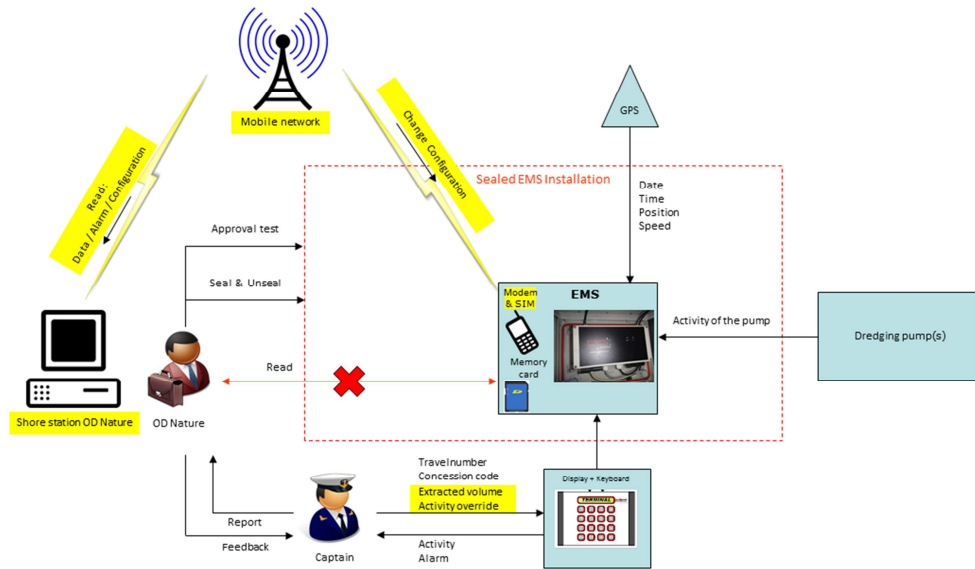


Figure 1: Schematic overview of the EMS 2.0 and the interaction with the system.  
The changes relative to the EMS 1.0 are marked in yellow.

## 2. Principle of the Electronic Monitoring Systems

The obligation to install an EMS, in accordance with specific technical requirements, on dredging vessels is bound to a concession to verify whether certain conditions of the concession are respected, i.e. permitted areas, minimum average speed during extraction and, if necessary, to verify the minimum distance between multiple extraction vessels. The presence of an EMS on the dredging vessels is additionally controlled by the Aerial surveillance team of RBINS-OD Nature-MUMM (SURV), which observes and reports the activities of dredging vessels.



Figure 2: Aerial surveillance: a. A dredging vessel extracting in sector 1a ; b. Fully loaded dredging vessel returning from sector 1a



Figure 3: An installed EMS 2.0 system and its sensors

The closed and sealed system automatically records, among others, the following parameters: identification of the vessel, the code of concessionary, the date and the time, the geographical position, the speed, the status of dredging pump(s) and finally the dredging activity.

The recorded and processed EMS data provides one of the main sources for the continuous monitoring of sand and gravel activities in the Belgian part of the North Sea. Other sources include data derived from the registers and from regular bathymetric, hydrodynamic and sediment transport surveys performed with e.g. the RV Belgica. The processed EMS data also gives an indication for the volume that has been exploited and allows to follow-up the evolution in space and time of the extracted volumes.

The EMS has the following benefits: low cost, easy to install and maintain with reliable performance, data falsifications is almost impossible. The compatibility with the demands of the ICES WGEXT working group and OSPAR makes the correct reporting of the analyzed electronic monitoring data (geospatial data on extraction locations through shape files) straightforward. In addition, the recent upgrade to the EMS 2.0 (2014) greatly reduces the chance of data loss and also allows for a better follow-up of the system's functioning as well as faster and more regular data processing intervals. Ad-hoc data processing on request is also possible and has proved its value already.

### 3. Data processing procedures

The EMS data records (both from the old and new systems) allow for an estimation of the sand extraction intensity, in particular the volume extracted by the dredging vessel per time frame by using either the declared load (available since 2014 based on the information entered by the crew) or the known fixed loading capacity (available since June 2002) (see Fig. 4). This enables the final data table to be used to represent the extracted volumes in space (grids of 100m x 100m) and time (overviews per year).

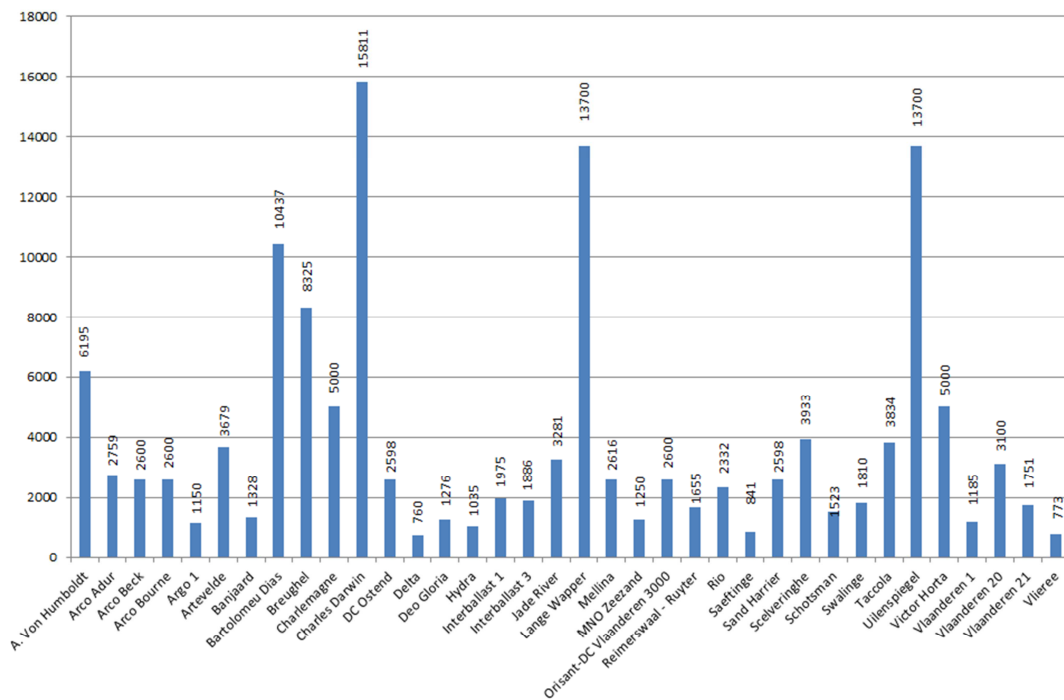


Figure 4: Overview of the used fixed loading capacity (m³) (specified by the concessionaire or calculated as average of the declared extracted volumes) of the vessels (ever) equipped with an EMS.

A comparison between the annual extracted volumes, on the one hand based on the vessels fixed loading capacity and the number of trips recorded and on the other hand on the reported volumes and the number of trips from the registers indicates an increasing difference between both (Roche et al., this volume). A detailed analysis and cross check of the EMS database with the ship registers is carried out to identify the causes. However, a determination of the extracted volumes was never a design requirement of the Electronic Monitoring System.

#### 4. EMS statistics

Based on all available EMS data and the above described method (making use of the vessels fixed loading capacity), the cumulative extracted volumes are presented as an annual overview in figure 5 (2003-2016) and as a geographical distribution (100 m x 100 m grids) in the figures 6 to 8 (2016-2014). For the geographical distribution of the EMS data for the period before 2014, reference is made to the conference proceedings of the previous study days of October 2014 and October 2011.

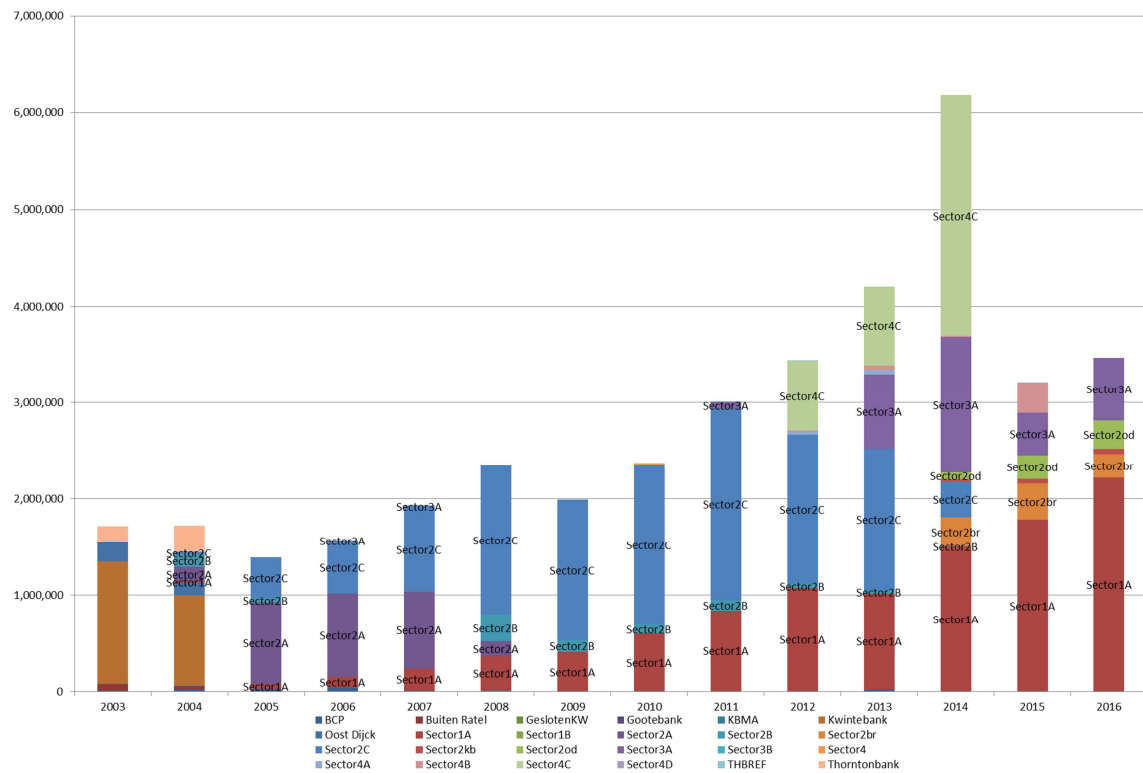


Figure 5: yearly extracted volumes (m³) versus sector

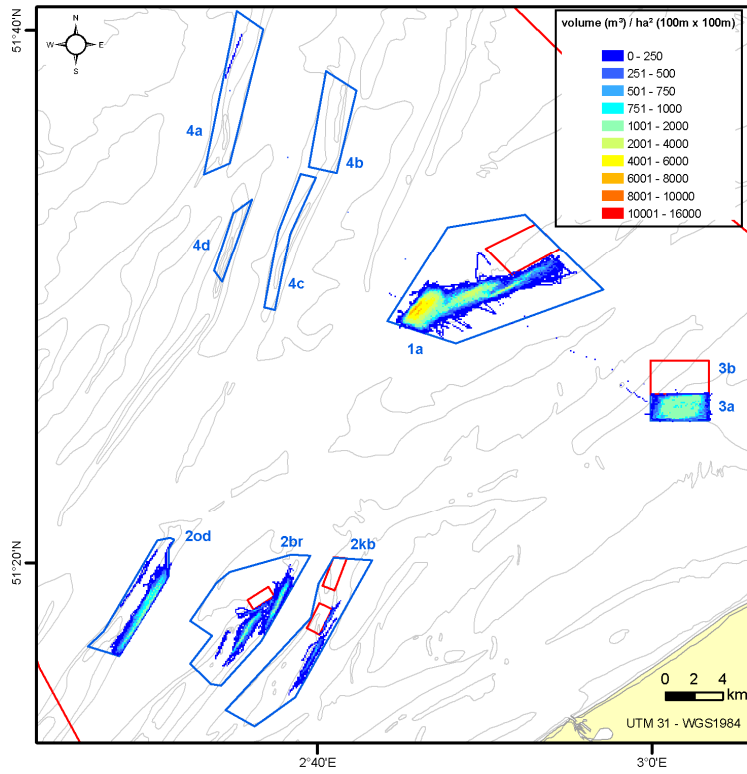


Figure 6: geographical distribution of the cumulative volumes (m³/ha²) for 2016

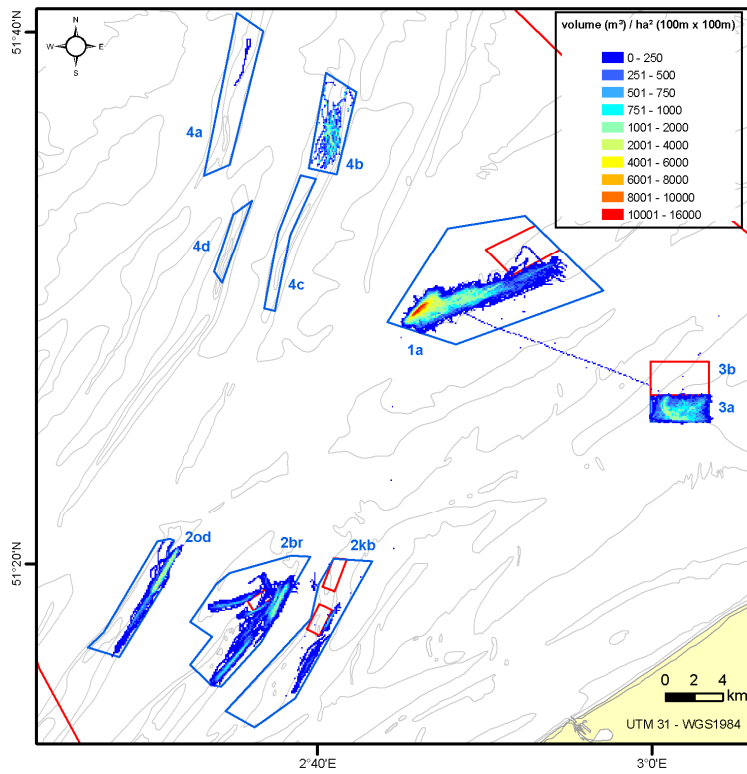


Figure 7: geographical distribution of the cumulative volumes (m³/ha²) for 2015

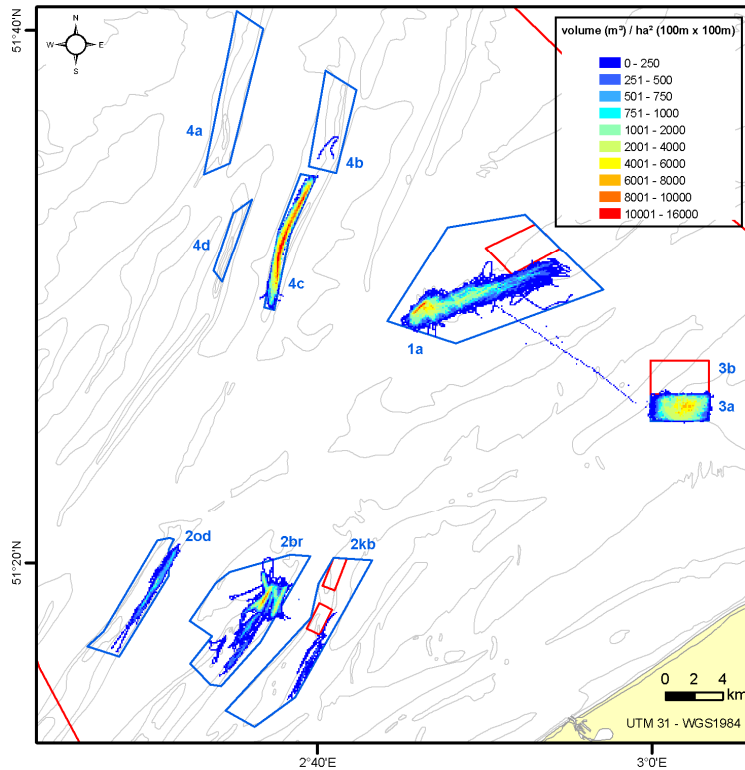


Figure 8: geographical distribution of the cumulative volumes ( $m^3/ha^2$ ) for 2014

## 5. Possibilities for improvement

The monitoring of the bathymetric evolution of the sand extraction areas, with e.g. RV Belgica, is performed with increased accuracy. This is the result of the introduction of new devices, i.e. on RV Belgica a multibeam echosounder system Kongsberg EM3002D as well as a new single beam echosounder system Kongsberg EA400 was installed in 2009 and a new Septentrio RTK GNSS receiver with heading option was installed in 2014. The evolution to be able to measure with higher accuracy and resolution will continue in the near future with newly available devices on the planned new Belgian research vessel. The new research vessel will be taken into service in the second half of 2020.

Based on the monitoring results, there is a linear correlation between the extracted volumes and the bathymetric evolution (Roche et al, 2014). However, when EMS data of one extraction activity is compared with bathymetric data (traces of one sand extraction journey), a position shift is determined (Roche et al., 2015). Improving EMS-data by entering a correction for the GNSS-antenna – dredge head offset could be considered in the future to compensate for this inaccuracy.

Another missing functionality in the current EMS-system is the lack of sensors to determine the effective load (through measurements of density, ship weight and hopper capacity). These measurements could allow a check on the declared load and would provide more certainty about the actual extracted volumes.

The above proposed improvements will definitely make the system more complex, more expensive and they would require regular calibrations. Moreover, automatic measurements of the hopper capacity are complex and not as accurate for sand loads (technical dossier BIS, 2006, Flemish government). For this kind of upgrade, a cost-benefit analysis is definitely needed. Due to the recent renewal of the EMS system, a new upgrade is currently not on the agenda.

## Conclusion

The regulations for the EMS obligation have made it possible over the last 15 years to make a reliable analysis of the extraction activities, both in space and time, based on the extracted volumes derived from EMS data. This dataset is used as one of the main sources for the continuous monitoring of sand and gravel activities in the Belgian part of the North Sea. The recent upgrade to the EMS 2.0 (2014) allows for a better follow-up and more regular data processing. Further improvements of the EMS system are complex and are not being planned for the moment.

## Acknowledgements

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