
Exploring our marine geological resources in the fifth dimension: About 3D voxels, 4D impact models and uncertainty

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Mineral and geological resources can be considered to be non-renewable on time scales relevant for decision makers. Once exhausted by humans, they are not replenished rapidly enough by nature, meaning that truly sustainable management of these invaluable and sought-after resources is not possible. Comprehensive knowledge on the distribution, composition and dynamics of geological resources therefore is critical for developing long-term strategies for resource use. For the Belgian and southern Dutch parts of the North Sea, such strategies will be worked out in the project TILES (Belgian Science Policy, 2014-2017). Particularly, TILES has the ambition of:

- (1) Developing a decision support system (DSS) for resource use. This DSS contains tools that link 3D geological models, knowledge and concepts, providing information on present-day resource quantities and distribution, to numerical models of extraction-related environmental impact through time. Together they quantify natural and man-made boundary conditions and changes to define exploitation thresholds that safeguard sustainability on a multi-decadal time scale.
- (2) Providing long-term adaptive management strategies that have generic value and can be used for all non-hydrocarbon geological resources in the marine environment.
- (3) Proposing legally binding measures to optimize and maximize long-term exploitation of aggregate resources within sustainable environmental limits. These proposed measures feed into policy and associated monitoring plans that are periodically evaluated and adapted (e.g. EU Marine Spatial Planning and EU Marine Strategy Framework Directive).

Extensive analyses of data- and interpolation-related uncertainties, and of the propagation of these uncertainties in data products such as maps and GIS layers, form the backbone of the DSS. This is a necessary step in producing data products with confidence limits, and critical to detecting ‘true’ seabed changes in environmental monitoring. Using a dedicated subsurface viewer, a suite of data products will be viewable online. They can be extracted on demand from an underlying voxel (3D pixel) model. Each voxel will be assigned with values for geological, environmental and decision-related parameters, including uncertainty. The flexible 3D interaction and querying, enabled by TILES, will be invaluable for professionals, but also for the public at large and for students in particular. It will herald a new age in assessing cross-border impacts of marine exploitation activities.