

Application of Geographic Object-Based Image Analysis to seabed imagery: the way forward?

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1 What is Geographic Object-Based Image Analysis (GEOBIA)?

Hay and Castilla (2008) define GEOBIA as follows:

- A sub-discipline of Geographic Information Science
- Devoted to developing **automated** methods
- Aiming at partitioning remote-sensing imagery into meaningful **image objects (Segmentation)**
- Assessing the characteristics of image objects through spatial, spectral and temporal scales (**Classification**)
- Generating new **geographic information** in GIS-ready format.

GEOBIA is especially powerful when features on the ground are much larger than the pixels in the image of that part of the seabed, thus a seabed feature might be represented by several image pixels. In this so-called H-resolution case, pixel-based image analysis approaches become increasingly inefficient as they struggle to derive meaningful signatures from seabed objects with high within-class spectral variability.

2 How does GEOBIA work?

Object-based image analysis, including GEOBIA, consists of two basic steps:

- **Segmentation** of the image into image objects
- **Classification** of image objects

Segmentation is the process of complete partitioning of a remote-sensing image into non-overlapping image objects (Schiewe, 2002) on the basis of homogeneity (Blaschke et al., 2014).

An image object is a discrete region of a digital image that is internally coherent and different from its surroundings. (Castilla and Hay, 2008).

Classification may be carried out in different ways: In the knowledge-based approach, the analyst’s understanding of the imagery is used to formulate systematic rules that are applied to the imagery during the classification process. In the sample-based approach, observations are fed into data-driven machine learning algorithms (e.g. classification trees). Both approaches can be combined.

3 GEOBIA workflow

Input



Segmentation



Classification

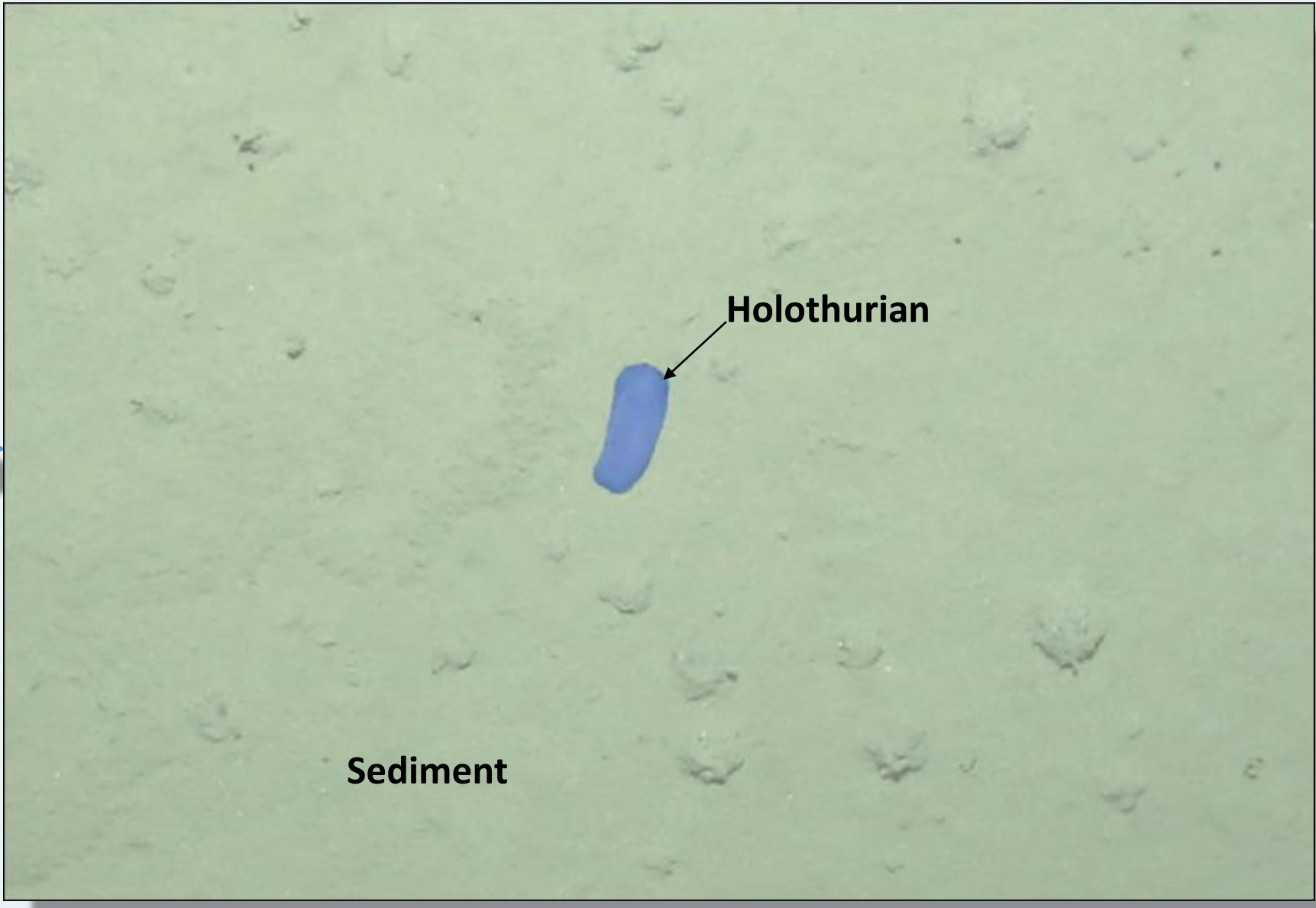


Figure 1. General GEOBIA workflow: Imagery serves as input data (left) and will be segmented into homogeneous regions within the image (‘image objects’). Features that can be used for classification might relate to spectral properties, texture, shape, extent, relations to neighbouring objects among others.

4 Case study: intertidal habitats

- Application of GEOBIA to very-high resolution (3 cm) imagery (near-infrared, red, green, blue) and terrain data from structure-from-motion, collected with an unmanned aerial vehicle.
- Mapping of intertidal habitats: saltmarsh, seagrass (sparse, dense), water and sediment
- High accuracy >90% (sensitivity, specificity, balanced accuracy) across all classes
- Transferable to underwater photo-mosaics?

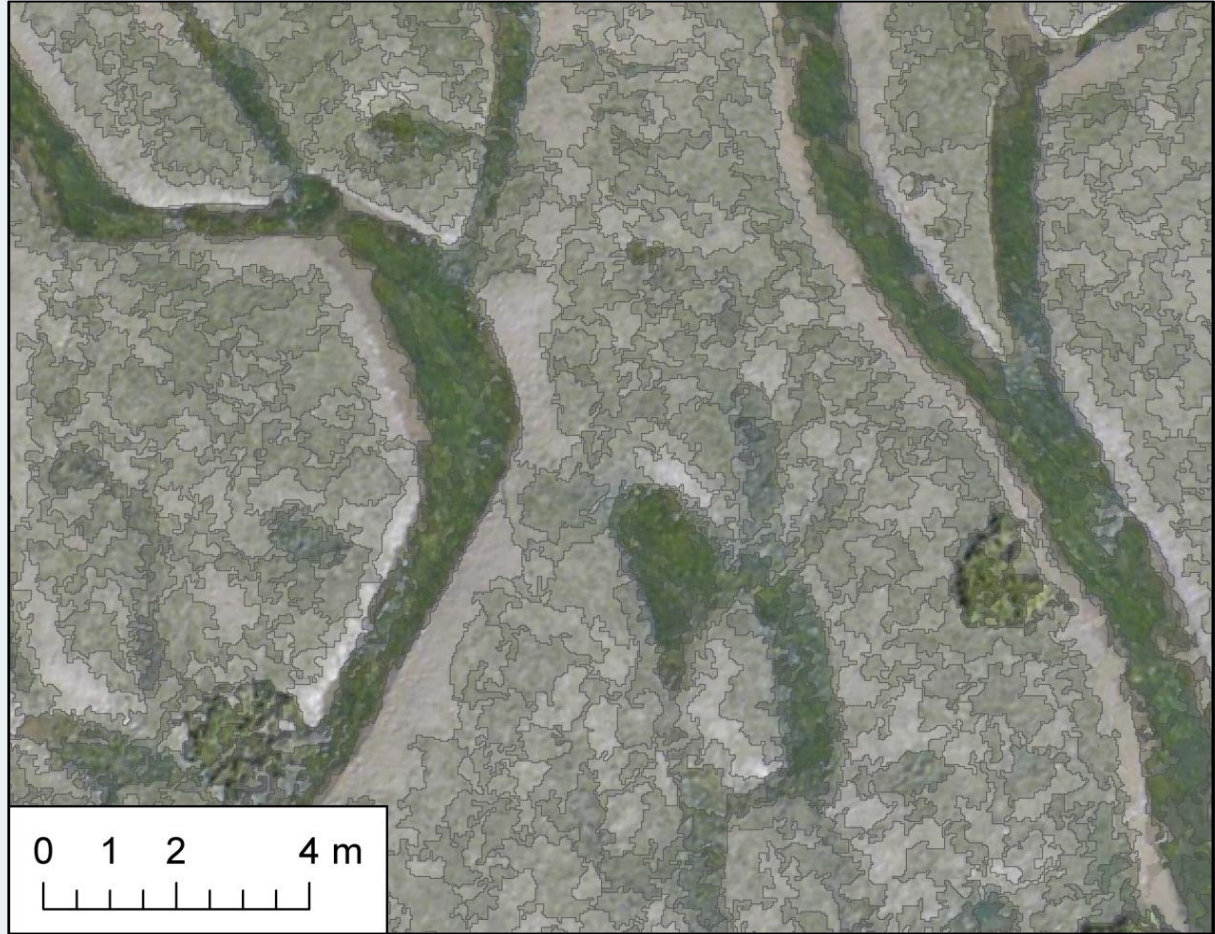


Figure 2. Result of segmentation using the RGB bands showing image objects formed around identifiable patches of sediment, saltmarsh vegetation and varying levels of seagrass coverage.

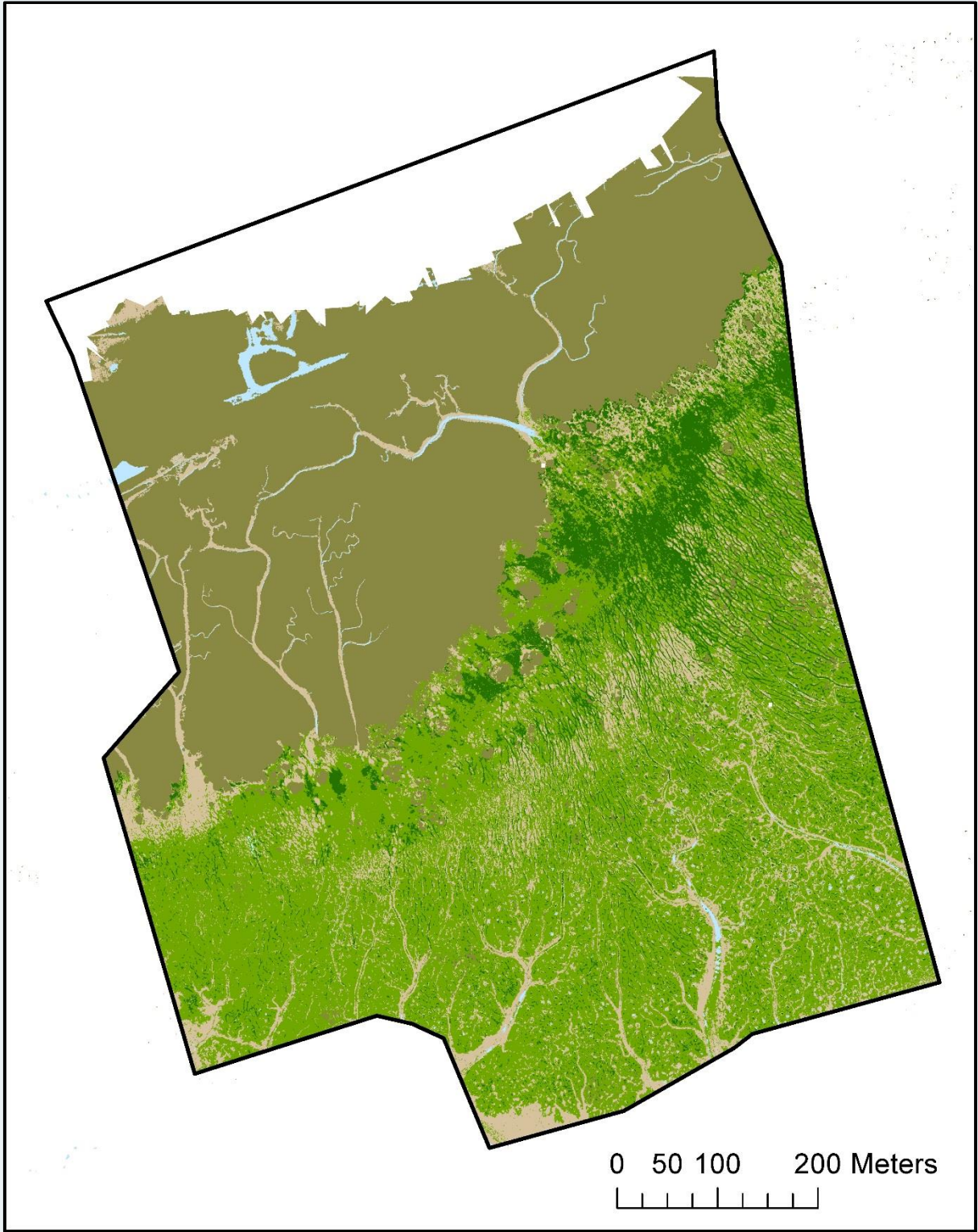


Figure 3. Final habitat map showing distribution of saltmarsh (olive), sediment (beige), water (light blue), sparse seagrass (light green) and dense seagrass (dark green).

5 Case study: Ferromanganese nodules

- Classification of seabed imagery to detect ferromanganese nodules
- Nodules appear dark, but illumination varies across image. Simple thresholding might lead to suboptimal results.
- Application of an object-based approach allows to utilise additional features. In this case, a customised relational feature was used. This feature is calculated as the difference in the intensity of the red channel between the target and neighbouring objects.
- Nodules were detected by applying the customised relational feature and a threshold for the intensity of the red channel.
- Nodules can be counted and area of the seabed they cover estimated.
- Transferable to other images?

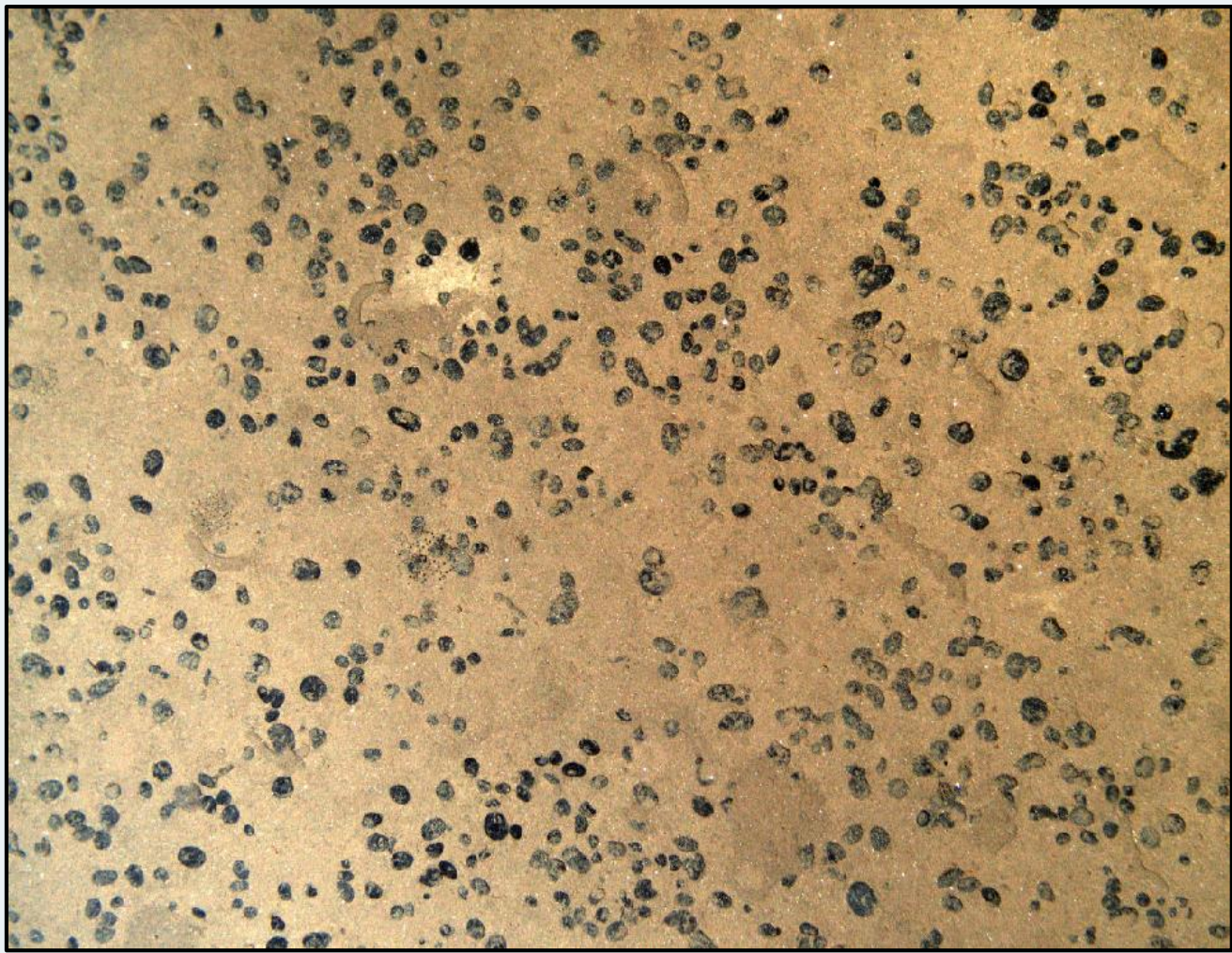


Figure 4. Example of a seabed image showing ferromanganese nodules (LeBas and North, 2015).

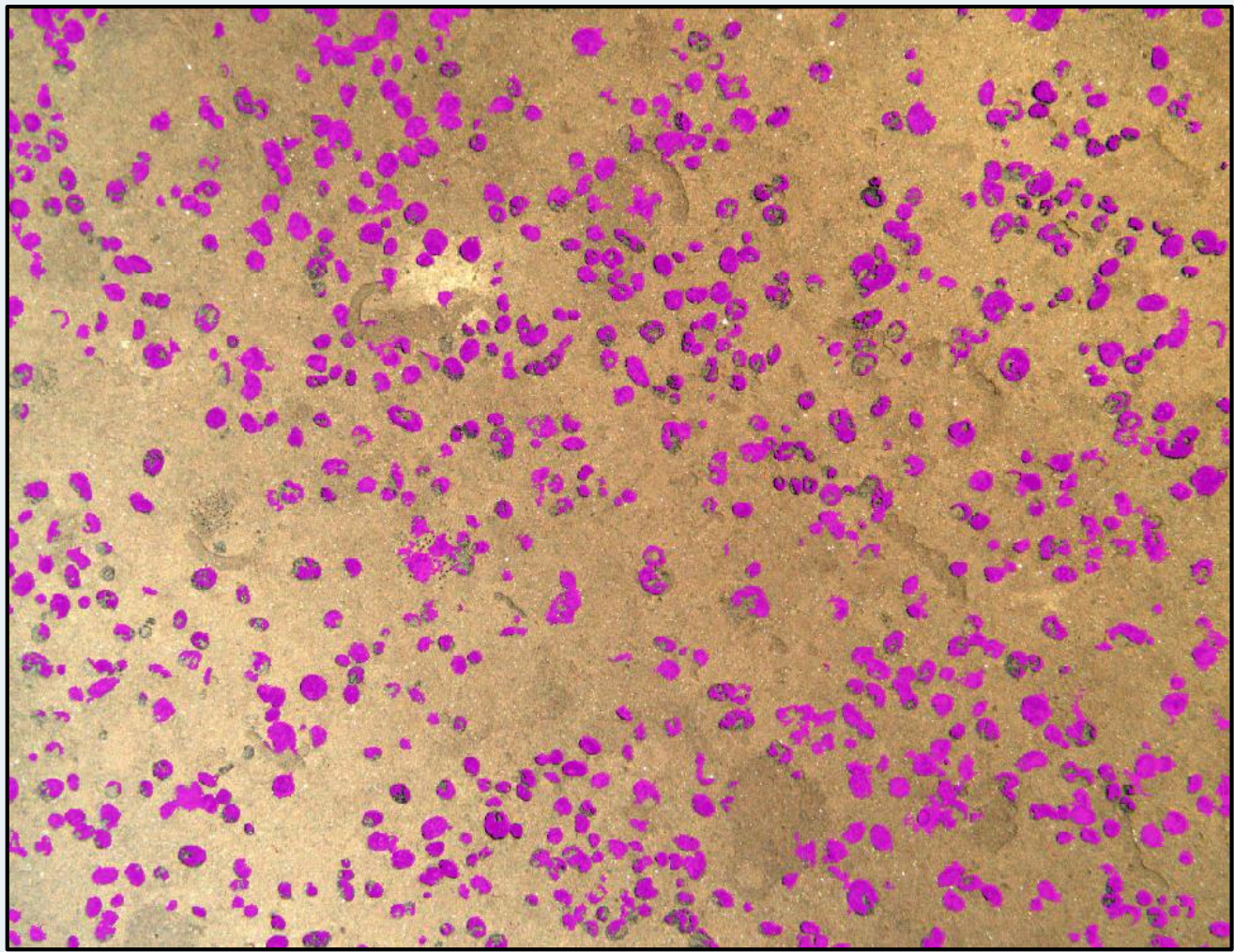


Figure 5. Results of the classification showing nodules highlighted in magenta. They cover an area of ca 14.4%.

6 Conclusions

- GEOBIA is now widely applied in terrestrial remote sensing and land cover mapping
- Offers a framework for (semi-)automated image analysis
- Especially suited to H-resolution case images
- Offers a wealth of additional features beyond pixel values that can be utilised for image classification
- Image objects can be readily integrated into a vector GIS

Now that seabed stills imagery is collected in large quantities and photo-mosaics can be built from seabed surveys with autonomous underwater and remotely operated vehicles, it might be timely to investigate what GEOBIA could offer when analysing large image data-sets in a robust and repeatable fashion. It is hoped that this poster might stimulate a discussion on the potential of GEOBIA approaches for mapping and extraction of information from seabed imagery.

Acknowledgements

Thanks to Anna Downie (Cefas) for provision of case study on intertidal habitat mapping. Tim LeBas (National Oceanography Centre) and Timm Schoening (GEOMAR) provided seabed imagery. This work was funded by the Cefas Research and Development Fund.

References

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