Photogrammetry, a descriptive tool for temperate subtidal rocky ecosystems. Better describe to better predict and manage.

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Introduction:

Study Context: The **Subtidal Rocky Ecosystems** (fig. 1):

- Very **diverse** and **productive Benthic** and **Demersal Communities**.
- A **complex** ecosystem **functioning** with multiple interactions between biotope, benthic community and demersal community.
- Many concomitant **natural** and **anthropogenic pressures**.
- Relatively **little studied** environments due to their difficulty of access.

Problem addressed: How to precisely study the **relationships** between the 3D architecture of the **substrate** (*e.g.* slope, aspect and complexity) and the associated **benthic communities**, still **badly understood** ?

Aim: Develop an innovative **methodology** based on the **photogrammetry** technique to **describe** the 3D complexity of the **substrate** and the structure of the associated **benthic communities**.

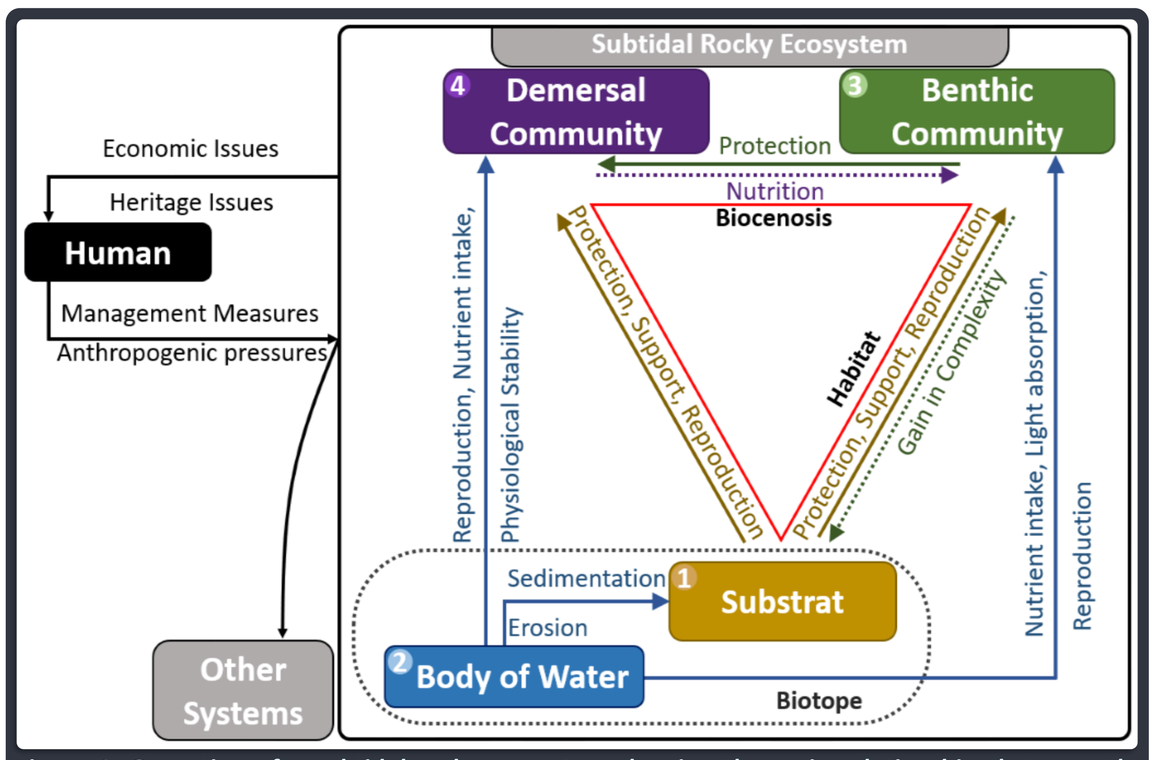
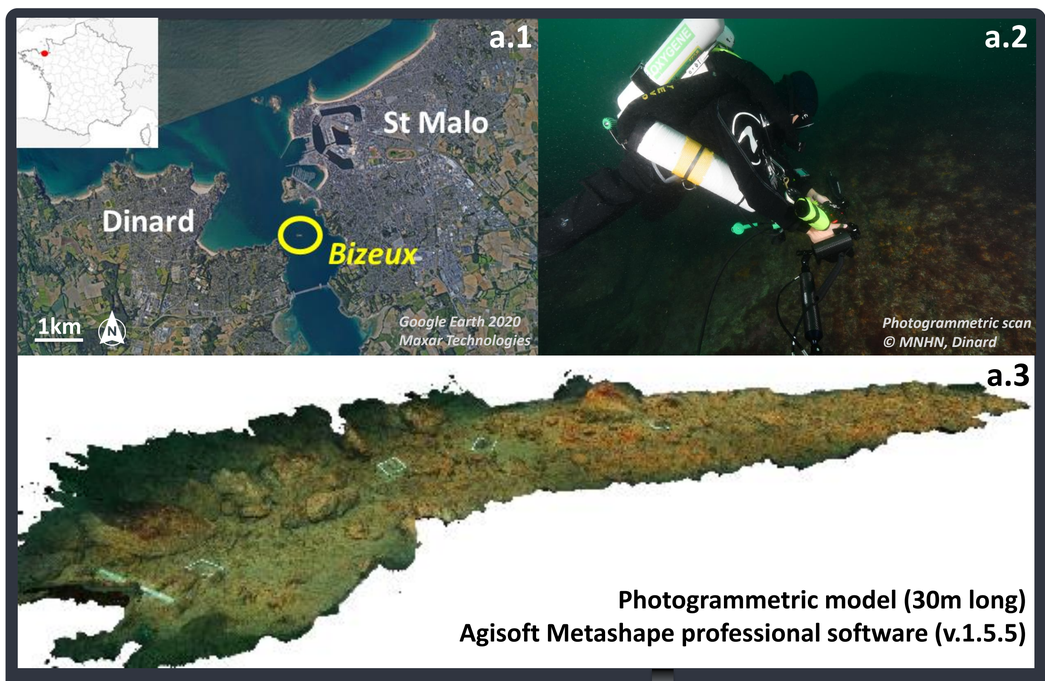


Figure 1: Operation of a subtidal rocky ecosystem showing the main relationships between the different compartments that make it up (1, 2, 3 and 4) as well as the peripheral issues.

Materials et Methods:



- The **photogrammetric model** (fig. 2.a.3) is built from **2 000 photographs** (fig. 2.a.2), on a **120 m²** transect of the **circalittoral** zone (*i.e.* rocky islet of Bizeux , fig. 2.a.1, at a depth of 13m corrected for 0 on the nautical charts).
- The **Digital Elevation Model (DEM)** exported from the 3D model (fig. 2.b.1) allows the calculation of new **geomorphological variables** (*i.e.* slope and aspect, ENVI software, fig. 2.c). In addition to the **Orthoimage** of the 3D model (RGB bands, fig. 2.b.2), this leads to a supervised **classification** of **biotope typologies** (ENVI software; fig. 2.d).
- The **projection of a random point pattern** (QGIS software, fig. 2.e.1), on the **photographic surveys** corresponding to each of the typological classes of the biotope (Metashape software, fig. 2.e.2), allows the **photo-identification** (fig. 2.e.3) in relation to the architecture of the biotope.

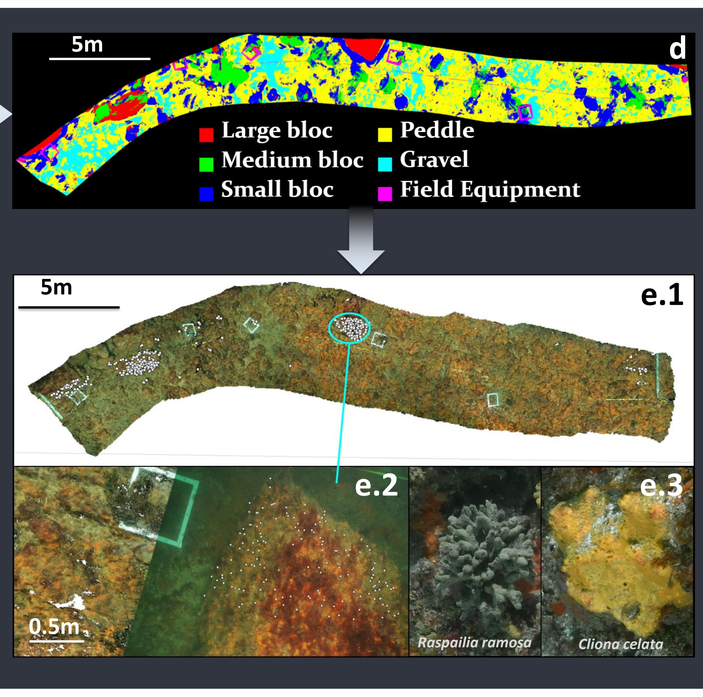


Figure 2: Methodological steps of the photogrammetric analysis for the description of the biotope and benthic communities. Case of the rocky islet of Bizeux (a.1) photographed in scuba (a.2) for the creation of the photogrammetric model (a.3). Export and analysis of the DEM (b.1) and the Orthoimage (b.2) for the calculation of a set of complementary geomorphological variables with different meshes (i.e. Slope and Aspect; c). Supervised classification of biotope typologies by maximum likelihood method (d). Sampling of benthic communities by projection of random points and stratified by typological class (i.e. Large Block; e.1), and photo-identification of the target organisms after going back to photographs (e.2 and 3).

Results, Discussion and Perspectives:

Advantages of the methodological concept:

- **High resolution** geomorphological and biocenotic **measurements**.
- **Intermediate** observation **scale** between the quadrat (m²) and the bay (km²).
- **Integration** to a larger scale (fig. 3).

Perspective:

- Analysis of the **accuracy** of **identification** of organisms.
- Relationship with **demersal communities**

Photogrammetric Model
Environmental Datas
→ Explicative/Predictive Model
→ Biomonitoring Tools
→ Monitoring of Environment Dynamics and Basis of Sustainable Management

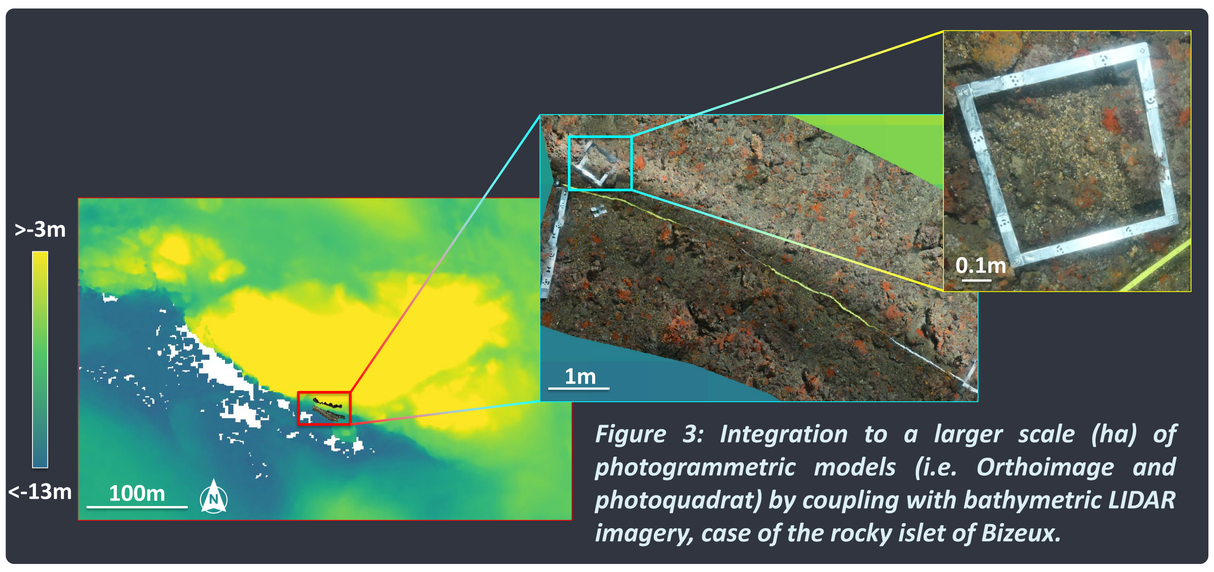


Figure 3: Integration to a larger scale (ha) of photogrammetric models (i.e. Orthoimage and photoquadrat) by coupling with bathymetric LIDAR imagery, case of the rocky islet of Bizeux.