Session 82

Innovations in the use of digital tools and the media for communication, outreach and education in support of coral reef protection

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Santa Cruz Cabrália reefs, Bahia Brazil: using digital tools and printed media to raise conservation awareness in K-12 education

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Abstract The coastal reefs of Santa Cruz Cabrália are intensely visited, but still poorly studied. In this context, Coral Vivo carried out physical mapping and partnered with the K-12 Terezinha Scaramussa State School in an environmental education activity, where students interviewed elder fishermen, many their own relatives, to learn the names of different areas on the reefs. These names were about to be lost, as traditional fishing loses importance. Moreover, students named areas that were not mentioned by the fishermen. Place names were identified over a WorldView-2 satellite image, which has a 1.85 m pixel for the 6 bands of the visible electromagnetic spectrum fused to 0.46 m resolution pixels of the pan-chromatic band. Imagery was geo-referenced in detail, and the public easily recognized sites. A bathymetry survey was conducted along an 800 km course, consisting of 175 parallel lines 4.5 km long, spaced 100 m apart. The 3,253,013 recorded sounding points, spaced roughly every 0.6 m, were corrected for tidal variations and interpolated into a digital bathymetry model that provided important information about the relief of the seabed, showing reef morphologies and depth. As a result, a printed poster depicting names, imagery, and relief, with 3-D views featuring depths represented by a color scale was created and distributed to public schools of Southern Bahia's coastal towns (also available at http://coralvivo.org.br/wp-content/uploads/arquivos/2198file-3.pdf)

Keywords: bathymetry, conservation, K-12 education, satellite imagery.

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Introduction

Brazilian coasts, which host the only coral reefs of the South Atlantic, have reefs in relative good condition that are poorly studied (Maida and Ferreira, 1996, Barbosa et al, 2012, Seoane et al, 2012). Southern Bahia is home to the largest and most biodiverse reef systems in Brazil (Castro and Pires, 2001) and the coastal reefs of Santa Cruz Cabrália are intensely visited but lack scientific information.

Coral Vivo ("Living Coral", a research and educational NGO) carried out physical mapping in partnership with the Department of Geology of the Federal University of Rio de Janeiro, from July 2014 to April 2015, which was met with great curiosity by the local population. An environmental education activity, dubbed "What place is this?", was carried in partnership with the K-12 Terezinha Scaramussa State School with the aim of promoting increased conservation awareness. The activity was planned to help preserve local culture, as reef names were about to be forgotten as the local economy transitions from multi-place traditional fishing to single-spot tourism.

Materials and methods

Santa Cruz Cabrália reefs consists of a shore-parallel 15 km long, 60 km² conservation unit called Parque Municipal Marinho da Coroa Alta and are located about 9 km northeast of the town in South Bahia, Northeast Brazil (Fig. 1). Coroa Alta and Araripe are the main reefs, but only the former is routinely explored by the community for tourism. Access to the 5 km offshore reefs is by boat, usually one of the 9 that run tours. Up to 500 people visit the reefs in a typical high-season day, which is from December to March, in the austral summer.

Identification of reefs was carried over a high resolution WorldView II scene. This satellite image has a 1.85 m pixel for the 6 bands of the visible electromagnetic spectrum which were fused to 0.46 m resolution pixels of the pan-chromatic band (Updike and Comp 2010). The scene was acquired April 04th, 2013 13:12:17 UTC, at high-tide (1.7 m above mean sea-level), and geo-referenced in detail, using the WGS-84 datum and a UTM zone 24S projection. A RGB-321 combination of bands maximizes water penetration by employing the green, blue and violet ("coastal blue") wavelengths.

The Echosounder-based bathymetric surveys consisted of 175 acoustic transects perpendicular to the coastline in order to record higher terrain variability. Thus, their interpolation reconstructs the bottom surface in the direction of the lowest variability. Moreover, separation between transects is a function of the desired horizontal accuracy of the bathymetric surface and seabed variability, bottom morphology, the shallowness of reef areas, time and cost logistics are also factors to consider. Low-cost techniques are already in use for shallow coastal areas based both on scientific echosounders (e.g. Sánchez-Carnero et al, 2012) and increasingly on commercially available GPS-echosounder units (Hatanaka et al, 2007; Heyman et al, 2007). Although less precise, the later obtain results that are quite useful in the case of MPA management plans (Seoane et al, 2006, 2012).

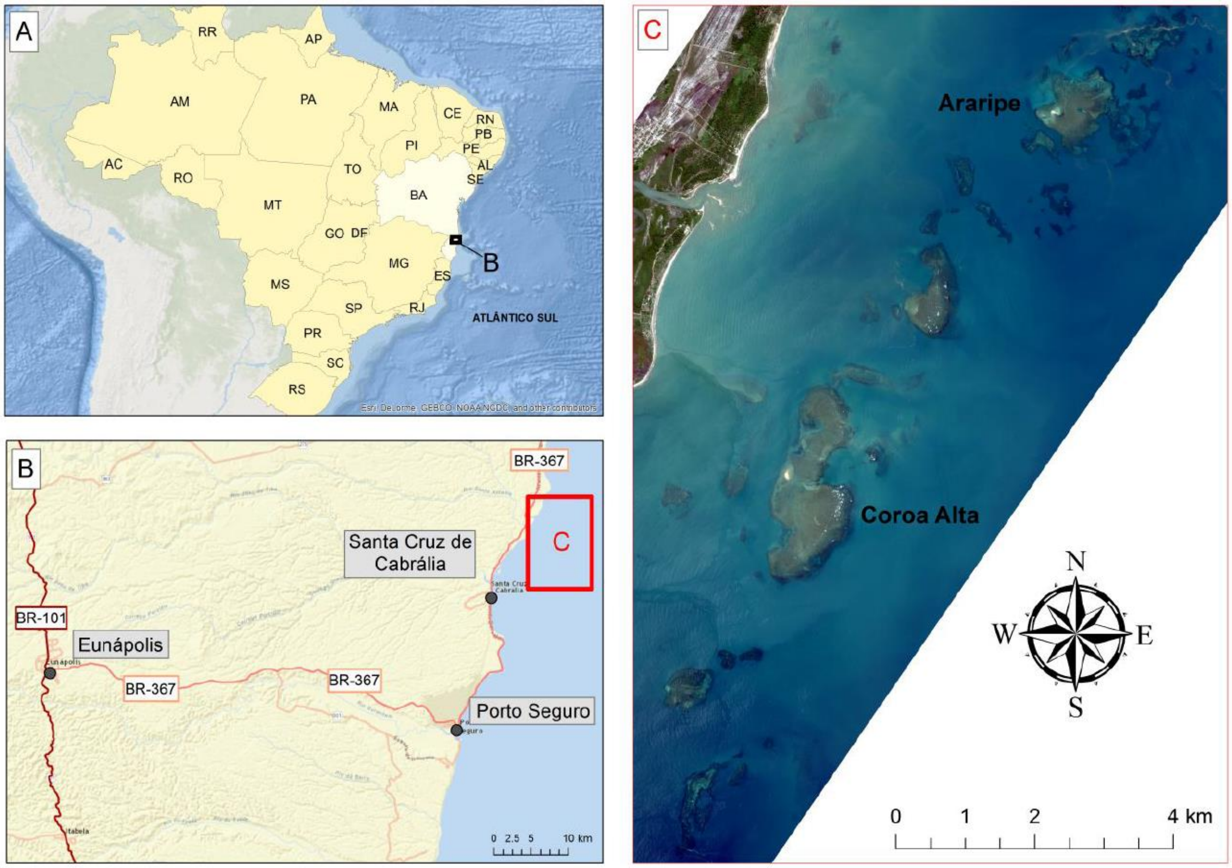

Fig. 1 Location and main access to Parque Municipal Marinho da Coroa Alta (PMMCA). A: Location in southern Bahia; B: Main access route, through the town of Santa Cruz de Cabrália; C- PMMCA reefs. (From Araújo et al, 2015. Data sources: IBGE 2013, ESRI basemap, 2014 Wordview II Imagery from Digital Globe)

Survey equipment consisted of a Simrad NSS-7 chartplotter mounted permanently on *Iamany*, a 7 m-long, twin-fiberglass-hull, twin-engine boat, which only dips 35cm below the waterline, an essential feature for safe navigation over the reefs. The echosounder has an integrated 12-channel GPS with an external antenna. The sounder head was equipped with the standard dual frequency (50 and 200 kHz) transducers, and survey frequency was set at 50 kHz. The unit produces cone-shaped pulses of sound, and the return time (calibrated for temperature and salinity) of the echo produced by the first surface encountered is used to calculate depth. The chartplotter recorded latitude, longitude, and depth points which were downloaded to a computer (Araújo et al, 2015).

Cross-shelf, East-West lines were spaced 100m apart with one-second readings along lines. The survey took over 30 days averaging 4-6 hours of navigation around the highest tide (ranging from 1.3 to 2.0 m above mean sea-level). Survey dates were carefully chosen to coincide with the highest tides, a strategy that was essential for a safe navigation above the reefs, which are exposed at low tides. Sand cays were avoided, and boat speed was kept below 7 km/h (Araújo et al, 2015).

Data were downloaded to a computer, parsed, and then loaded into a spreadsheet. Individual transect data were combined into a single file, which was then filtered to remove invalid points using sort functions within Excel. The points that did not have both a depth and position were removed, as well as points that repeated previously reported depths more than twice consecutively. Points with depths shallower than the minimum or deeper than the maximum survey depth were also removed. Transducer depth was accounted for, and a tide variation correction, based on data from the nearest tide gauge, located in Ilheus, BA (DHN, 2016) was also implemented. The area is subjected to mesotidal variations (<1.8m), and tide variation was typically less than 0.5 m for the survey by design (Araújo et al, 2015).

Over 3 million points were obtained along an 800 km course, consisting of 175 parallel lines 4.5 km long, spaced 100 m apart, for a density of roughly every 0.6 m along the lines. These were interpolated by morphologically homogeneous reef sectors, using a Radial Basis Function algorithm of ArcGIS's Statistical Analyst into a mosaic Digital Bathymetry Model (DBM) illustrating depth (Fig. 2). DBM byproducts include shaded reliefs and bathymetric contour lines that indicate the relief of the seabed and reef morphologies, as well.

Classes received a printed satellite image at the 1:15.000 scale overlaid with the newly acquired bathymetric contours, and students took turns interviewing elder fishermen from the community, mostly their own relatives, to learn the names of different areas on the reefs. Place names were identified through individual student-conducted interviews and were selected by simple majority if duplicity occurred, which was very rare. Students then proceeded to name reef areas not mentioned in the interviews.

The school-led interview process recognized 57 reef features and places, and an additional 03 places were considered relevant enough by the students to deserve receiving names. The main contributors, all local fishermen and elders of the community, received due credit in the final printed poster (Table 1). Response to the activity involved heavy participation by the majority of students, and the official-release of the poster *Recifes de Santa Cruz Cabrália* ("Santa Cruz Cabrália Reefs") occurred at the Santa Cruz Cabrália townhall on October 19th, 2015. (Fig. 3, see also http://coralvivo.org.br/noticias/coral-vivo-lanca-poster-recifes-de-santa-cruz-Cabralia-bahia).

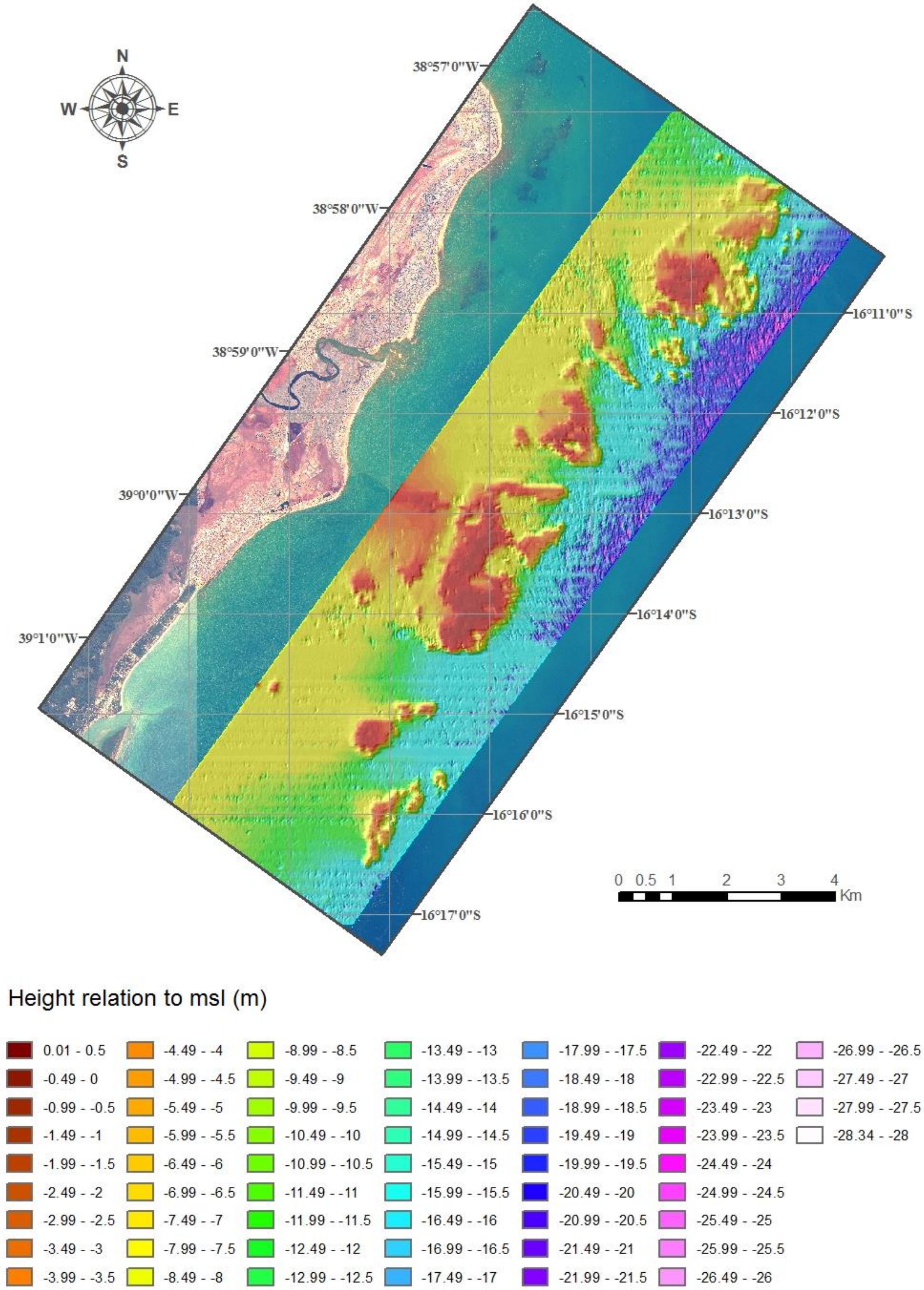

Fig. 2 Mosaiced Radial Basis Function interpolation-generated Digital Bathymetry Model of the morphologically homogeneous reef sectors. A semi-transparent, calculated hillshade with the light source positioned at Az 300/50 is draped over the DBM

Adeildo da Conceição Lacerda “Dé”
Benedito “Gique”
Claudio “Xepa”
Fábio Santana Costa “Galego”
Joval Borges Costa
Maciel Folly Silva
Marwin Lourenço
Nando Bezerra “Seu Nando”
Nelson “Guaiú”
Osvaldo Borges de Alcântara
Romildo Lacerda de Alcântara
Rosildo Lacerda de Alcântara
Sidênio Santos Alcântara “Sid”

Table 1: Main contributors to the school-led interview process, all local fishermen and elders of the community, credited as authors of the poster

Fig. 3 Official release of the poster *Recifes de Santa Cruz Cabrália* at the Santa Cruz Cabrália townhall, October 19th, 2015. Major contributors receive a framed poster from the Coral-Vivo team (in blue/green Coral-Vivo shirts) and local schoolteachers (in white Coral-Vivo shirts). Local council people stand at the back

Discussion

The printed poster *Recifes de Santa Cruz Cabrália* (Fig. 4) depicts names, imagery, and relief was distributed to the local authorities, fishermen, tourist operators and public schools of Southern Bahia’s coastal towns, and is also available at http://coralvivo.org.br/wp-content/uploads/arquivos/2198file-3.pdf.

During the planning of the physical survey, a reef formation shaped like a heart was observed. Previously unreported, likely due to its location at deeper waters (~ 20 m), it was named by the students *Coração de Santa Cruz* (“Heart of the Holy Cross”), after the interviews confirmed it wasn’t noticed before. The region is known as *Alagadas* (“Drowned”), and two other sectors were named *Cantinho do Amor* (“Love Corner”) and *Baixa do Coração* (“Low of the Heart”). The reef has steep walls which are rare in the area, where *Montastraea cavernosa* is abundant and covered by a pink-colored coralline algae.

Overall, the activities had great participation by both school teachers, students, and the elders of the community, who were very proud to show their geographical knowledge to the youngsters. A bridge was established between young and old, the villagers’ fishing past and present-day tourism activities. Young people were particularly curious about the technologies involved, and these were presented during science classes suited for each age group. Additional educational activities with school groups

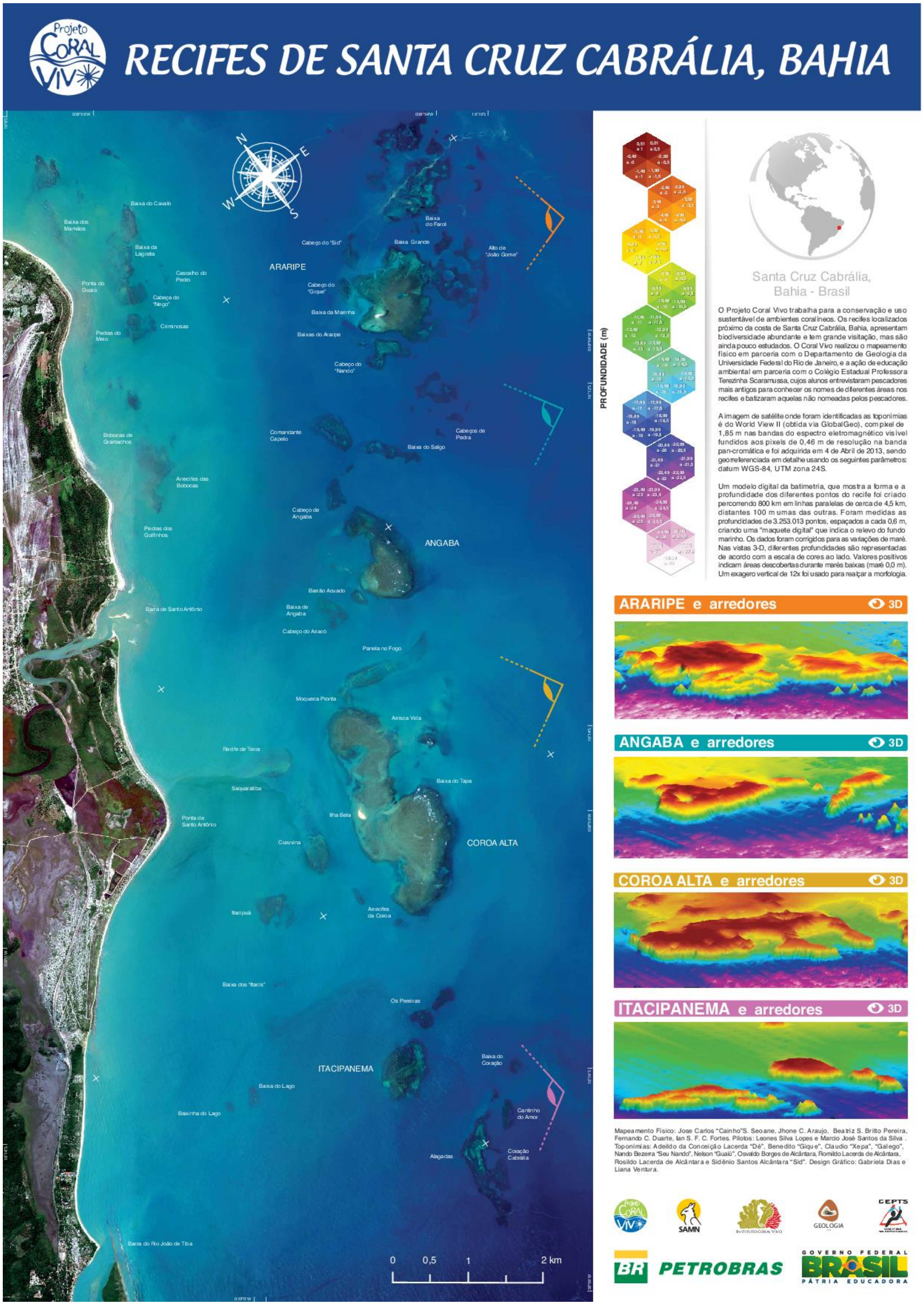

Fig. 4 Poster titled "Recifes de Santa Cruz Cabrália" , with names, imagery, and 3-D views of the relief. Available at http://coralvivo.org.br/wp-content/uploads/arquivos/2198file-3.pdf

included visits to the coral tanks and labs, including the mesocosm experiment (Duarte et al, 2015) at the Coral Vivo facilities located at the Arrail d'Ajuda Eco Parque, in nearby Porto Seguro, Bahia.

The technologies involved in the poster making (namely satellite imagery processing and GPS-guided, small vessel echosounder bathymetric surveys) are about a tenth of the cost of traditional bathymetric surveys, and can be readily applied in other reef areas around the globe. Educational activities with K-12 students will allow a new generation of natural scientists to flourish.

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