OPENING THE SATELLITE TOOLBOX

DATA UPDATES FOR COASTAL ZONES USING SATELLITE IMAGERY

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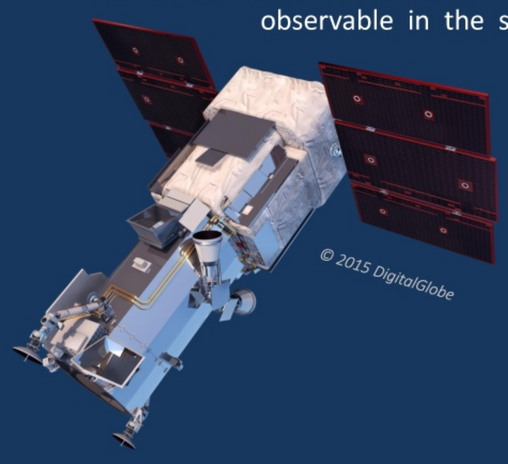
ABSTRACT

The coastal zone is a dynamic, multi-use environment subject to a wide range of pressures. Information layers such as bathymetry, seafloor habitats or geomorphology are necessary inputs to coastal zone management or engineering projects, but are often not available or outdated. Hence, there is recognized need for cost-effective survey and mapping tools for the coastal zone, particularly as these information layers may need to be regularly updated.

Satellite-derived geospatial information help to overcome some of these important data gaps, either as a stand-alone solution or as an integrated part of models, survey campaigns or reporting. The methods and benefits of integrating satellite-derived information for the shallow water zone into existing datasets are illustrated below. We used charting information together with most recent satellite analysis of shallow water bathymetry and coastline and compared with GEBCO 30 arc-second grid for the Persian Gulf. Especially for the coastal region, a significant overall increase in quality is observable in the satellite-derived bathymetry output. With its synoptic and repetitive coverage, satellite-based mapping and monitoring offers the ability to regularly update coastal zone seafloor information cost effectively, including over large areas.



SATELLITE DERIVED BATHYMETRY

There is a strong demand for rapidly accessible and cost effective information on shallow water bathymetric data; it underpins numerous applications in the coastal zone.

The retrieval of coastline and depth information from optical sensors was historically done with airborne photogrammetric stereo surveys. More recently, multispectral satellite imagery has been used to provide contiguous depth information through essentially two different approaches:

1. the empirical approach of relating brightness of light intensities to water depth through statistical relationships and
2. the physics-based approach of fully describing the light signal as a function of water depth, sea floor reflectance, water and atmospheric properties, as well as viewing and illumination geometries (amongst other factors).

The empirical approach is relatively simple to implement and is widely used (e.g. in the GEBCO cookbook), but its principal limitation is that up-to-date and high resolution in situ depth data are required for calibration. The physics-based approach is the current state of the art and technically sophisticated. The most obvious advantage of this approach is that it is location- and sensor-independent; no in situ data is required in order to retrieve water depth information from satellite imagery. Since this type of approach also allows for the highest level of accuracy, automation and standardization, EOMAP has evolved into the technology leader and largest producer of Satellite Derived Bathymetry for shallow water areas and holds an archive of bathymetric data covering the entire Arabian Gulf region down to a depth of approximately 15m and further regions globally. It is based on image data from 2014 and onwards and is constantly being updated and maintained as a 10/15m spatial resolution grid.

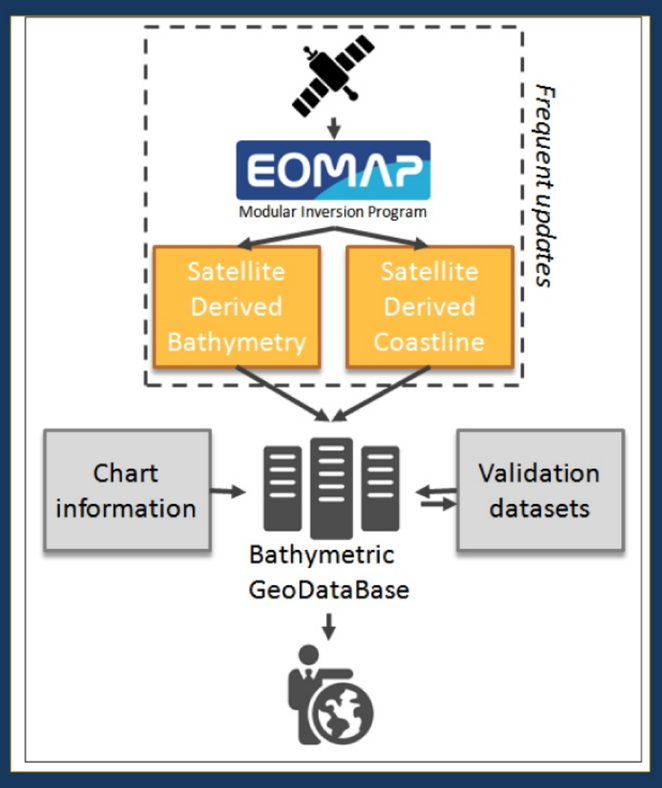


Figure 1: Schema of creating seamless and frequently updated bathymetric dataset.

INTEGRATION OF SATELLITE DERIVED INFORMATION INTO COASTAL MAPPING

Satellite-derived coastline and shallow water bathymetry information can either replace, update or integrate into existing datasets and maps. For the Persian Gulf, EOMAP has created a 75m resolution bathymetric grid which includes

(1) coastline data from high resolution satellite data from the Spring 2016,
(2) satellite derived bathymetry for depths down to 15m using moderate resolution satellite data from 2014 and onwards, and
(3) nautical chart information

To generate a spatial, seamless grid, the different data types were merged into a single dataset and interpolated using a deterministic interpolator which preserves the exact value of each single measurement. Prior to merging, the Satellite Derived Bathymetry information was validated, for selected regions, with most recently available acoustic and lidar datasets (Figure 4).

The seamless bathymetric grid (Figure 2) combines the benefits of up-to-date seafloor information on the shallow, more dynamic coastal zone as well as a full coverage of deep water bathymetry. This product performs noticeably better in the coastal when compared to the GEBCO 30arc-second data, for example (Figure 3 and 5).

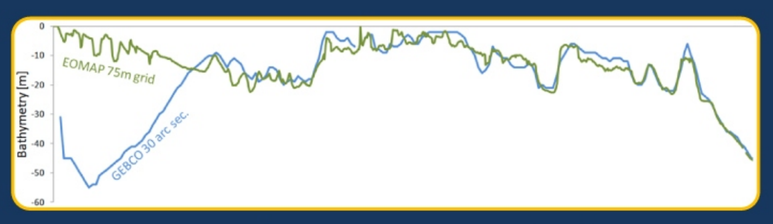


Figure 5: Transect of GEBCO-30arc second and EOMAP 75m grid.

PERSPECTIVE FOR FUTURE MAPPING AND MONITORING OF COASTAL ZONES

As outlined in this study, the integration of the satellite sensors into current mapping and survey plans enables (a) mapping large areas of the shallow water zone cost effectively, (2) keeping coastal zone environmental data updated on a regular frequency and (3) augmenting available datasets, directly leading to improved information content of GEBCO or national models.

These capabilities are set to continue benefiting from an growing number of satellite sensor programs in the operational and planning stages - from international, national and commercial entities - where some of these programs are being run on a free and open data policy. This positive outlook is further compounded by an acceleration of IT technology (e.g cloud computing), further algorithm break-through such as the physics-based approach and the increasing worldwide acceptance of these technologies and services.

EOMAP 75m grid

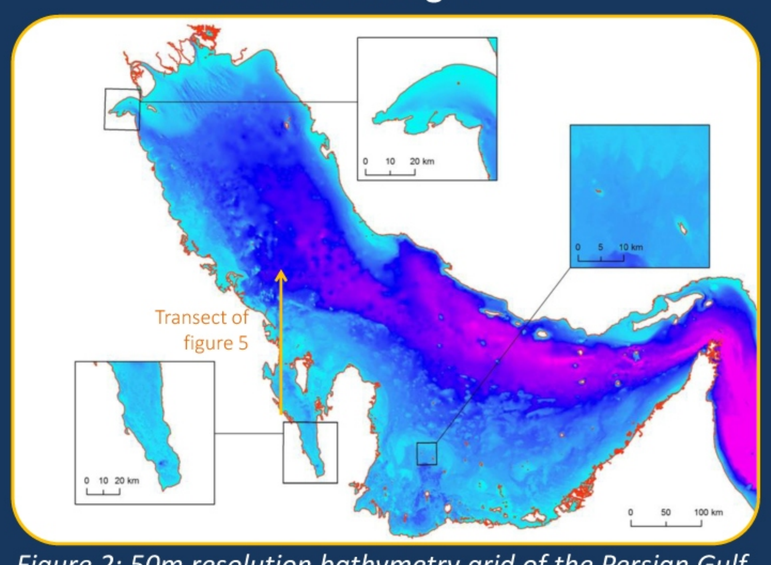


Figure 2: 50m resolution bathymetry grid of the Persian Gulf. Data are based on satellite derived bathymetry in the shallow water zone, most recent coastline derived from high resolution satellite imagery and chart data.

GEBCO 30 arc-second grid

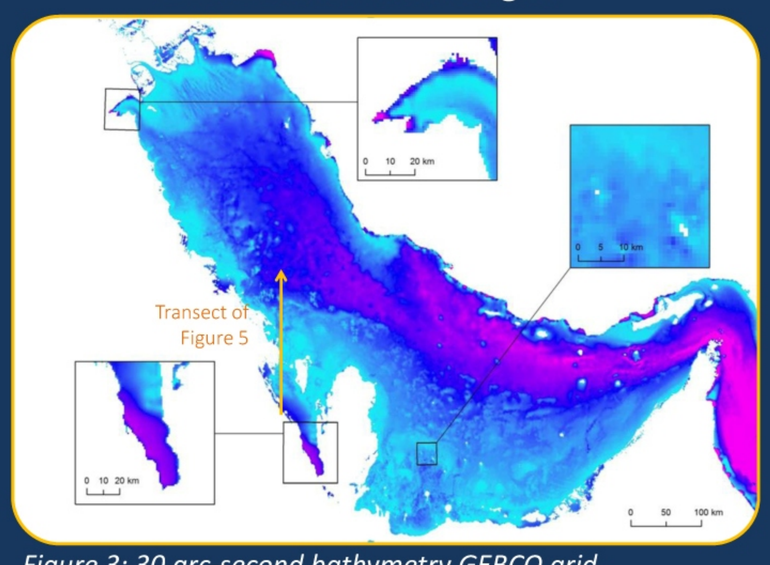


Figure 3: 30 arc-second bathymetry GEBCO grid.

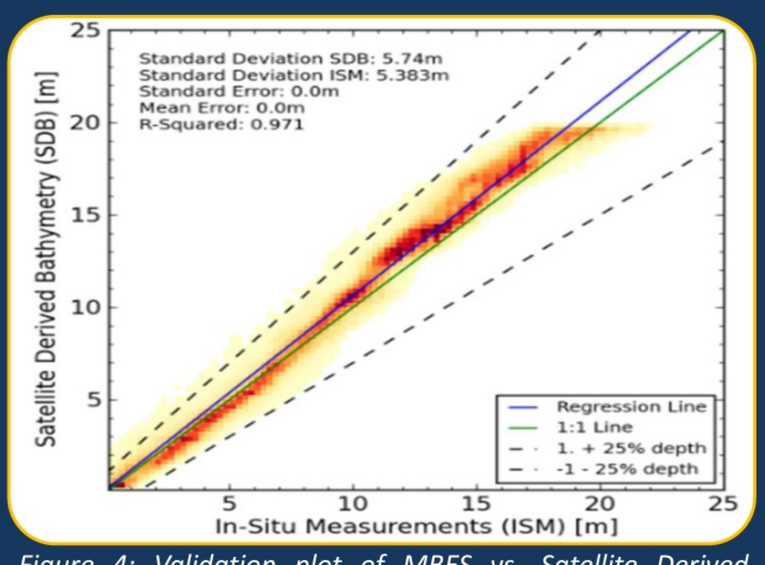


Figure 4: Validation plot of MBES vs. Satellite Derived Bathymetry