Report on the design and implementation of the GIS

Activity 4.3 - Creation of an open access GIS
WP4 - Implementation of the Georeferenced Open Access Database

SUSHI DROP project (ID 10046731)

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Abstract

WP4 is focused to UUV mission planning, data acquisition and storage. This WP describes the procedures implemented to build a collection of data organized by biological and ecological interest in the form of thematic maps, 3D models, and geodatabases. The processed data can be visualized using open-source tools such as Geographic Information System (GIS) platforms to reach the public and all project stakeholders. In this report we describe the tools used and the workflow developed to bring the data acquired by the drone missions to the publication in formats suitable for GIS platforms.

Overview

In 1986 Professor Peter Burrough, one of the founding fathers of GIS, described its basic concept with the following phrase: "A powerful set of tools for storing and retrieving at will, transforming and displaying spatial data from the real world for a particular set of purposes."

Even today, this description is consistent with the possibilities offered by these software platforms. In fact, the available tools allow to synthesize relevant information related to the real world surveyed in the form of a discrete sequence of layers (Figure 1) in vector or raster format according to different needs.

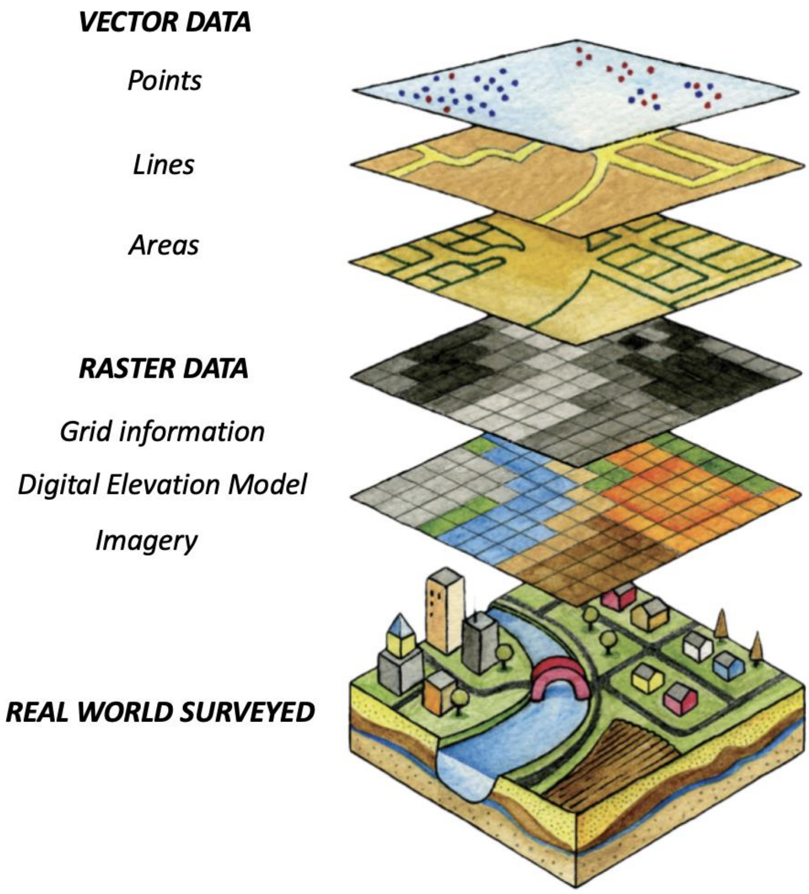

FIGURE 1 - GIS LAYERS CONCEPT: FROM REAL WORLD TO VECTOR AND RASTER LAYERS

Open Data and Open Source

One of the objectives of the SUSHI DROP project is to make public the processed data starting from the surveys of the missions carried out in the Adriatic Sea. The processed data are progressively made available to anyone to use without copyright restrictions, under the concept of open access to scientific data.

As referenced by Cooper in 2012 article "A call for disruptive innovation in science publishing with a new open data-sharing platform for the life sciences." (doi: 10.1038/npre.2012.7151.1) there are at least 10 benefits in producing scientific results as Open Data:

1. Negative data can be reported and shared
2. Preliminary data reporting can foster collaborations
3. Demonstration of feasability and preliminary data for grant applications with shrinking page limits
4. Students can publish their findings on small projects that enable them to establish themselves in scientific research
5. Novel findings can be established in a permanent and citable digital record
6. Findings from unfunded pilot projects can be reported
7. Free general public access to scientific findings
8. Copyright is retained by the creator of the work, the researcher, not the publisher
9. Fast (days) compared to the established peer review model (months)
10. Venue for early crowd-funding of small project

Within this context, the SUSHI DROP project has processed the acquired data, mainly using Open Source software, publishing them in formats defined by the Open Geospatial Consortium (OGC), an international consortium of more than 500 businesses, government agencies, research organizations, and universities driven to make geospatial (location) information and services FAIR (Findable, Accessible, Interoperable, Reusable).

Below are some of the main data formats managed by OGC, highlighting in bold those most relevant to the data processed and distributed by the SUSHI DROP project.

- 3D Tiles
- 3dP
- ARML2.0
- Cat: ebRIM App Profile
- Catalogue Service
- CDB
- CityGML
- Coordinate Transformation
- EO-GeoJSON
- Filter Encoding
- GML in JPEG 2000
- GeoAPI
- **GeoPackage**
- GeoSciML
- GeoSPARQL
- **Geography Markup Language**
- GeoRSS
- GeoXACML
- Geospatial User Feedback
- **GeoTiff**

- GroundwaterML
- HDF5
- i3s
- IndoorGML
- **KML**
- LandInfra/InfraGML
- LAS
- Location Services (OpenLS)
- Moving Features
- NetCDF
- Observations and Measurements
- OGC API - Features
- Open GeoSMS
- OpenMI
- OpenSearch for EO
- OpenSearch Geo
- Ordering Services Framework for EO Products
- OWS Context
- OWS Security
- PipelineML
- PubSub
- PUCK
- SWE Common Data Model
- SWE Service Model
- Sensor Model Language
- Sensor Observation Service
- Sensor Planning Service
- SensorThings
- Semantic Sensor Network
- Simple Features
- Simple Features CORBA
- Simple Features OLE/COM
- Simple Features SQL
- Styled Layer Descriptor
- Symbology Encoding
- Table Joining Service
- Time Ontology in OWL
- TimeseriesML (tsml)
- Two Dimensional Tile Matrix Set
- WaterML
- Web Coverage Processing Service
- Web Coverage Service
- Web Feature Service
- Web Map Context
- Web Map Service
- Web Map Tile Service
- Web Processing Service
- Web Service Common
- WKT CRS

In particular, for GIS software, QGIS in its latest Long Term Release (LTR) version was chosen for its unique features. "QGIS is a user friendly Open Source Geographic Information System (GIS) licensed under the GNU General Public License. QGIS is an official project of the Open Source Geospatial Foundation (OSGeo). It runs on Linux, Unix, Mac OSX, Windows and Android and supports numerous vector, raster, and database formats and functionalities." (qgis.org).

From UUV survey to GIS

One of the main challenges of the SUSHI-DROP project was the development of adequate procedure and software implementations to design and manage UUV missions and to process the huge amount of data collected during surveying operations.

In this context, a key initial step concerns the study of the positioning of the UUV during the mission and the estimation of its updated position during the execution of the subaqueous transects. This, as described in previous reports, is made possible by a combination of inertial and acoustic sensors thanks to which it is possible to estimate with good accuracy the geographical coordinates of Blucy and its altitude with respect to the seabed and vertical distance from the water surface. All information is processed in order to subsequently georeference each underwater survey (Figure 2).

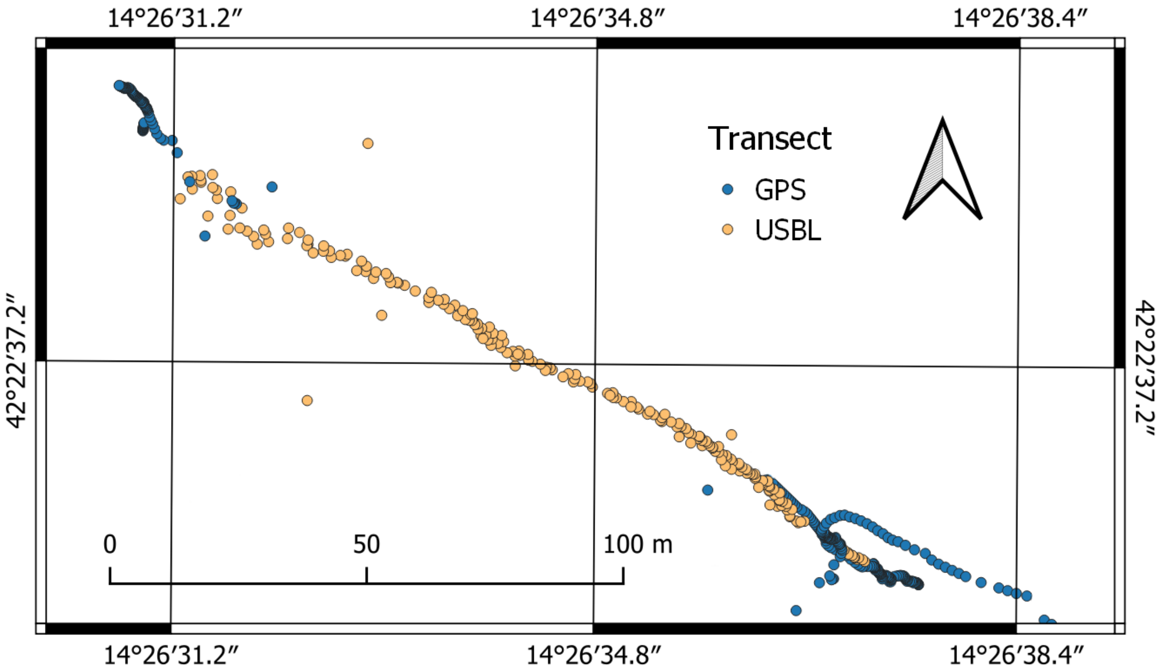

FIGURE 2 - UNDERWATER TRANSECT PROCESSED FROM BLUCY SURVEY (IN YELLOW)

In this example of a transect performed by the UUV, partially above sea water and partially submerged, shows the effectiveness of the positioning sensors after rigorous calibration. The sequence starts from the southeast with the drone on the surface positioned by the on-board GNSS receiver shown by the points highlighted on the map with blue color. When the drone submerges, it can no longer receive the satellite signal and relative positioning is activated via USBL respectively to the surface research vessel, shown on the map with yellow points. The drone performs the optical and acoustic survey remaining submerged and at the end of the transect, when it re-emerges in the north-west part of the image, we have a substantial coincidence of positioning, excluding some outliers, which shows a reduced drift of positioning and allows us an accurate georeferencing of the acquired data.

After the elaborations carried out on the data collected during the project missions, using SFM techniques or MBES processing, the output is uploaded on a special Web system hosted at the institutional domain of the University of Bologna at the address https://site.unibo.it/sushidrop (Figure 3)

FIGURE 3 - HOMEPAGE OF SUSHI DROP WEBSITE AT UNIVERSITY OF BOLOGNA

In a specific section of the website are organized the data acquired during the missions, visualized on a WebGIS system realized with Leaflet, an Open Source library in JavaScript language, using an open data basemap via OpenStreetMap (Figure 4).

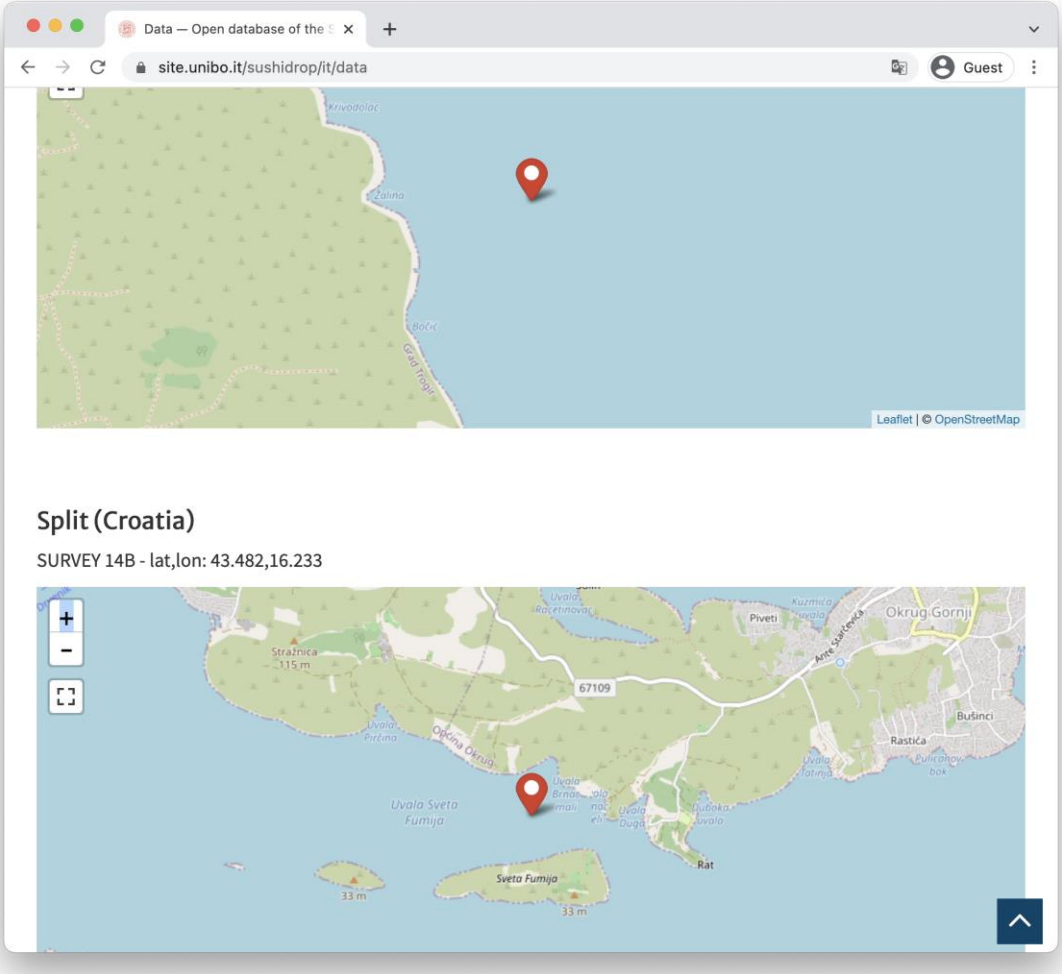

FIGURE 4 - EXAMPLE OF WEBGIS FOR SUSHI DROP SURVEYS

The data is then organized in a Database and served with a Geographic Information System that can be used remotely or locally installed in the workstation of the final user. The Open Access Database is currently on-line repository at Open Science Framework (OSF), a free and open platform to support research and enable collaboration.

Abbreviations

The following abbreviations are used in this deliverable:

DEM	Digital Elevation Model
GIS	Geographic Information System
GNSS	Global Navigation Satellite System
INS	Inertial Navigation System
MBES	Multibeam Echosounder
OGC	Open Geospatial Consortium
OSF	Open Science Framework
SFM	Structure from Motion
USBL	Ultra-Short Baseline
UUV	Unmanned Underwater Vehicle

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