MSPGI: A Geoportal Feasibility Study

Planning Authority MSP Geoportal MSP Implementation Initiative

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SIMWESTMED

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Glossary

AJAX	Asynchronous JavaScript and XML
CDb	Common Database
COTS	Commercial Off-The-Shelf applications
ELA	Enterprise Licencing Agreement
ERDF	European Regional Development Fund
ESF	European Social Fund
EU	European Union
GEO	Global Earth Observation
GI	Geographic Information
GIS	Geographic Information Systems
ICT	Information and Communications Technology
PA	Planning Authority
QA	Quality Assurance
QC	Quality Control
RDBMS	Relational Database Management Systems
SIntegraM	Spatial Data Integration for the Maltese Islands ERDF Project
SOA	Service Oriented Architecture
SpatialTRAIN	Spatial Data SIntegraM sister ESF Project

Introduction

Directive 2014/89/EU calls for Member States to apply Maritime Spatial Planning (MSP) in their marine waters. In applying this framework, Member States are required to adopt a process to analyse and organise human activities to achieve ecological, economic and social objectives. The preparation of a MSP plan is the key deliverable expected from Member States and in doing so are expected to organise the use of the best available data, and decide how to organise the sharing of information necessary for MSP plans. The availability of information for stakeholders can also contribute towards effective co-ordination at a national level particularly in regulating different maritime sectors.

The SIMWESTMED project (EASME/EMFF/2015/1.2.1.3/02/SI2.742101) component 1.3.3 was developed specifically to consider the data requirements for MSP. As project partners and MSP Competent Authority for Malta, the Planning Authority has sought to contribute to this component and in doing so, identified that the current state of play does not permit effective and efficient data sharing. This observation was confirmed further during the processes to prepare the Country Fiche report required for the Basin Scale Analysis, and the Case Study #4 of the same project.

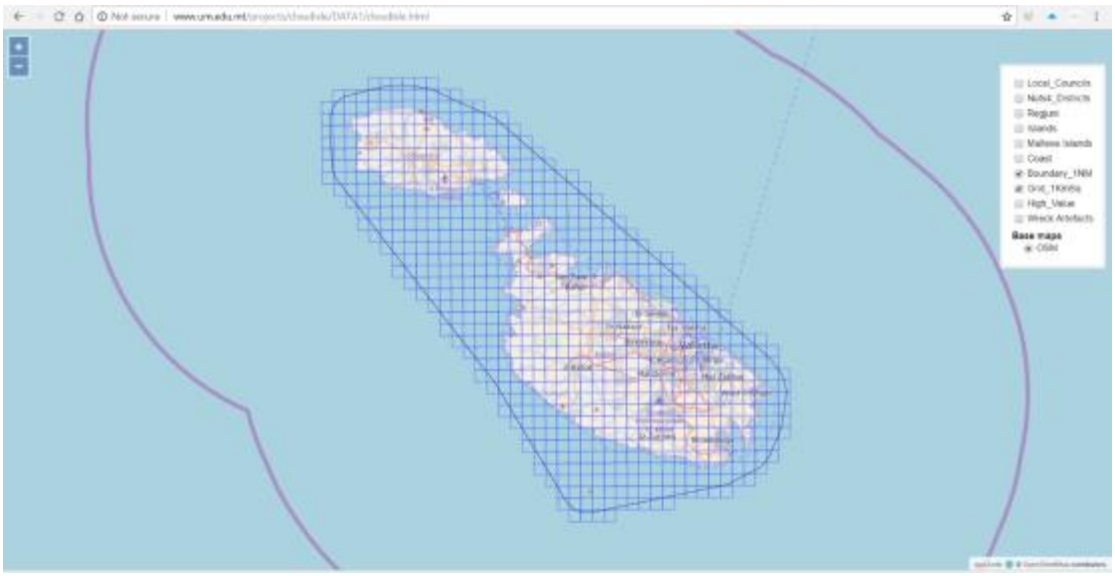
As part of the SIMWESTMED project, a review of the Country Fiche submitted for the Basin Scale Analysis (project component C.1.1.1) and the identification of data requirements, a data trawling exercise was conducted as identified in Appendix III in conjunction with a metadata review.

The process emanating from such an exercise identified various issues that highlighted the need to investigate the scope for an MSP Geoportal, which issues concerned the following:

i) No central data repository for Marine Spatial Data was identified
ii) Data was distributed within different agencies and different units within the entities
iii) No formal dataflows were identified
iv) MoUs were ad hoc and not known to other parties
v) No system integration reports were available
vi) Validation of datasets was non existent
vii) The data covering MSP was fragmented across the various datasets
viii) Some information existed solely in hardcopy or in publication (journal/book) format
ix) Map projections were not always clear
x) Metadata was either inexistent or not fully completed
xi) Data was available in various formats
xii) A web service existed within the PA but had limitations on the extent of the marine zones as it was mainly restricted to the terrestrial areas
xiii) A GIS Strategy was made available in 2018 and the geoportal aspect had yet to be realised

xiv) The SIntegraM project dissemination tool tender was still in the process of being awarded, which tool is aimed at gathering and disseminating in a shareable and integrated structure. The concept behind such a process is to identify the key datasets and to make them available to government and public consumption through a geoportal. This builds on the Cloudisle initiative that was created to disseminate LiDAR information for both terrestrial and bathymetric areas. This WebGL system is targeted to deliver the base 3D data for use in spatial planning and also disseminated data up to one nautical mile from the baseline coast (as indicated in Figure 1 below).

Figure 1 Screenshot of Cloudisle data grid



Source: http://www.um.edu.mt/projects/cloudisle/DATA1/cloudisle.html

To this effect the Planning Authority considered an additional unilateral effort within the scope of the SIMWESTMED project to investigate the matter further and evaluate options it could consider to fulfil this particular requirement from the MSP Directive (Article 10). The proposal for an MSP Data Portal can be considered as a component of a wider reform of the Planning Authority geomatics functionality, which pertains to the backend support and functionality of the GI creation process as covered at one end by the Geomatics and IR functions, whilst the other web-related GI expertise is set within the ICT GI Technologies Unit. The latter function is set up separately from the Geomatics Unit and develops the internal and external GI web interfaces.

This document presents a proposal for the setting up of a Marine-related Geoportal supporting the implementation of the MSP Directive which may serve as the basis for the implementation of the operational functionalities required for the integration of the marine-related spatial datasets, the facilitation of inter-agency data dissemination as well as creating a web tool that helps users to understand the wider catchments that spread beyond the terrestrial domain within which the current web portals reside.

The resultant approach showed that there are two options available: one that a new system is created, one that replicates the PA's Geoportal, or one that would add on a section to the current Geoportal, where the latter was deemed the most feasible.

Scope

The document targets the concept of web-GI as a main dissemination function and posits measures to enhance the current positive functional aspects whilst indicating change within a strategic approach.

The scope of this document is to review the current web spatial information systems (web-GIS) approach to the Planning Authority's functionality focusing on the marine data availability for stakeholders' and public consumption.

A number of tasks were required to fulfil the scope of this document, including:

- a review of technologies and software that could enhance web-GI;
- A desk-based study on operational documentation to ascertain data management, dissemination modes and lacunae, inclusive of INSPIRE;
- Identifying a workable system;
- Drafting of lineage documentation on the process, creation of walkthroughs;
- Development of a series of informative walkthroughs illustrating the data creation process and potential analytical studies that could be carried out to ensure data integration and a wider cross-discipline data analysis leading to information and knowledge;
- Drafting of a training manual for PA staff to maintain the system.

The tasks required significant input in terms of time in view of the limited resources available. Various methodologies were attempted to review the best-practice process.

The deliverables are integrated within this document and the detailed Appendices as indicated below:

- Appendix I - Outline GeoPortal Implementation Plan
- Appendix II - PA Marine and GI Teams
- Appendix III - Assessing the data availability and review
- Appendix IV - Training Manual for GI WebMaps using QGIS
- Appendix V - Training Manual for Creation of File Geodatabase in Arcmap 10.5
- Appendix VI - Training Manual for Creation of an ArcMap Web Service
- Appendix VII - INSPIRE Input Form xls: Spatial data template
- Appendix VIII - INSPIRE Input Form xls: Non-Spatial data template
- Appendix IX - Appleseed and Open-Portals paper

Disclaimer

This report covers the structures, GI requirements for the setting up of an MSP Geoportal through the perspective of past, current and potential Geoportal spatial remits and can be changed as deemed necessary through changes to the systems approach or any other entity or nation-wide remit that GI is morphing through. Whilst proposing a functional structure and remit, the document may require changes and further review by the PA's ongoing change process in terms of Geoportal creation, structuring and dissemination.

A Portal for the Marine Spaces

Synopsis

Spatial entities depend on data to design, create, develop and provide services to the community. In a scenario where a large majority of this data is location-based, computer systems that can manage location-based information provide a unique functional and executive advantage.

There is an understanding and acceptance within the PA and other marine-related agencies that a Geographic Information System (GIS) and its inherent systems that enable the creation of dissemination tools, such as web portals, are now a proven information technology that is essential to delivering a broad spectrum of the PA's services involving location-based information.

Marine data exists in various formats, datasets and structures which in some instances have been widely used for policy-making purposes and in others have been created for an isolated ad hoc project. However, datasets have not been brought together into a coherent and single point of reference, one that can either be structured through a geodatabase or through the eventual web portal.

What essentially remains is a road map to guide the organisation to a successful implementation of the MSP-related webportal. This document represents that road map in the form a review of the current portals and existing systems, as well as potential systems that may be employed in order to enable the PA or any other interested agency in creating a web-portal for the marine spatial information.

The Planning Authority's current GeoServer

Background

A web-Geographic Information System (web-GIS) is defined as the online dissemination tool of "an information system that is used to input, store, retrieve, manipulate, analyse and output geographically referenced data (location-based), in order to support decision making for planning and management of land use, natural resources, environment, transportation, urban facilities, and other administrative records."

The PA has used GIS for mapping within its various departments and even had one of the first webmaps on the island that had morphed from an html-based system, through a fat-server/thin-client structure through a proprietary system to a fully-enabled web-GI.

Refer to the publication outlining the web-GI development process as detailed in Appendix IX:

Formosa S., (2014). If Appleseed had an open portal: Making sense of data, SEIS and integrated systems for the Maltese Islands, in B., Murgante, S., Misra, A.M., Rocha, C, Torre, J.G., Rocha, M.I., Falcao, D., Taniar, B.O., Apduhan, and O., Gervasi, (Eds.). Computational Science and its Applications – ICCSA 2014 Lecture Notes in Computer Science, 2014, LNCS 8580, 709-722, DOI: 10.1007/978-3-319-09129-7_51, Springer, Heidelberg, ISBN: 978-3-319-09128-0 (Peer-Reviewed)

Statement of Study Problem

The PA's web-GIS is an information asset and valuable decision support tool for providing efficient government service to the community and which can be extended to a wider audience at an international scale. The PA has a veritable treasure-trove of online information that is disseminated to the public. It is inherently important that the same datasets as the marine layers are distributed and where restrictions due to national security are involved, the relevant access and security levels are put in place.

This section will focus the organisation's efforts on the understanding of the pivots that the PA web-GIS and how it can be upgraded such that:

- It reviews the current geoserver;
- It identifies the issues that are hindering or offering an obstacle to the implementation of the marine-related data layers;
- Reviews similar sites;
- Discusses a way forward;
- Drafts a series of walkthroughs that help the entity or any other stakeholder to build their own geodatasbase and to create a webserver should such wish to; and
- To draft the relevant INSPIRE-related metadata documentation for use.

Current state of play

Currently, the Planning Authority uses the GeoServer as the first point of reference to start assessing building applications. One fundamental role of the authority is to evaluate development proposals in accordance with approved planning policies and existing constraints which include location of protected areas and development criteria to ensure the applications fall within the requested parameters before a planning permit is granted. For this purpose, the Geoserver acts as the first visual aid to confirm that the proposed area for development falls within all requested criteria. The existing Geoserver supports the decision making process of the Authority and provides information for prospective project proponents.

At the same time Malta being a small island surrounded by a relatively larger maritime space urges matters to assess marine development applications in an efficient and professional matter particularly in view of the environmental objectives that influence the scope of maritime development. A recent study to develop a conceptual model of a Spatial data infrastructure covering Malta's marine space taking into consideration the needs of Marine Spatial Planning (MSP), the Marine Strategy Framework Directive (MSFD) and the Water Framework Directive (WFD), was presented by Hili (2014). The relevant outcome of that study, concerning MSP, provides further insight to the scope of this document.

The European Commission's DG MARE website provides the key benefits for having an MSP portal ready available to people to access which include:

- *Reduction of conflicts* between sectors and create synergies between different activities;
- *Encouragement of investment* by creating predictability, transparency and clearer rules;
- *Enhanced cross-border cooperation* between EU countries to develop energy grids, shipping lanes, pipelines, submarine cables and other activities, but also to develop coherent networks of protected areas;
- *Protection of the environment* through early identification of impact and opportunities for multiple uses of space.
  (https://ec.europa.eu/maritimeaffairs/policy/maritime_spatial_planning_en)

The PA has one GeoServer with a data set that is available to the public and a more detailed data set is provided through an internal Geo Server. In both instances there are limitations when it comes to addressing marine waters, mainly because efforts in recent years have focused on improving the data portal to increase efficiency in relation to development proposals on land where the greatest pressures are.

Issues and required improvements

(a) Projection

Limitations with the current Geoserver exist that do not enable efficient use of available marine data. First and foremost, data layers on existing marine uses and environmental information is not incorporated within the system and secondly, existing data layers with information on all the development proposals submitted for a planning permit though incorporated with the other data layers is difficult to access. These two factors hinder efficient processes in both plan and policy making and assessment of development proposals.

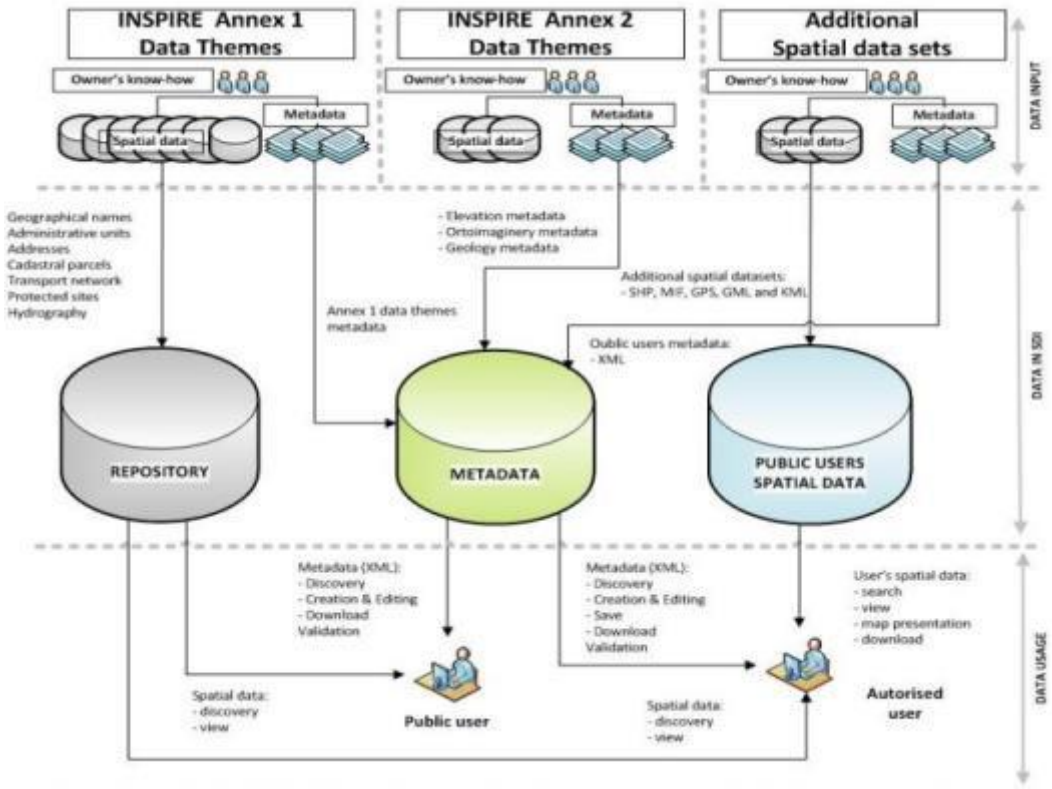
The internal GeoServer lacks the necessary tools to identify and analyse marine applications. The Planning Authority currently uses a "Non-Earth" projection adopted in the early 1990`s. Having a Non-Earth (stripped coordinate system) does not allow the free dissemination and injection of Web Map Services (WMS) (OGC n.d). WMS is one of the primary concerns that influence data sharing at both national and international levels. Since the current basemap does not hold a valid coordinate system no data concerning neighboring countries can be visible and overlapped for ease of information.

The primary need is a conversion of current data to a well known coordinate system, such as WGS84. This will ensure homogenous sharing of information and also more accurate data collection from external devices.

(b) Data quality and availability

An issue to cater for homogeneity is to make the data INSPIRE compliant, in accordance with the provision of Directive 2007/2/EC. The existing layers with marine data are not all compliant. Furthermore the Geoserver does not provide a download service for retrieval of this information. Figure 1 illustrates the optimum scenario which needs to be targeted in any effort to create a functional Geoportal for MSP.

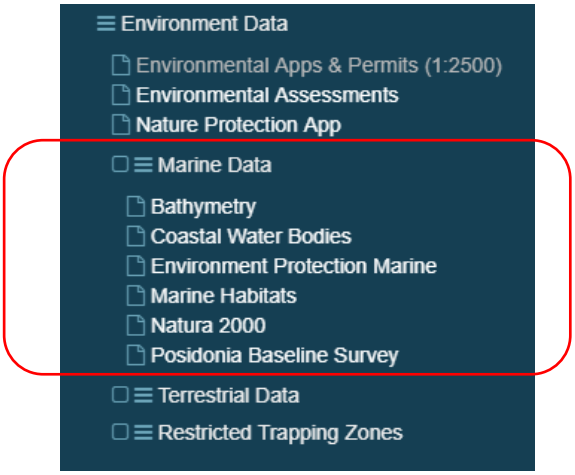
Figure 2 INSPIRE Directive Annexes and Data Dissemination services



At present, most of the information on the quality of the marine environment is provided by the Environment Resource Authority (ERA) which is the Competent Authority for the implementation of the major environment Directives at sea, including the Habitats Directive, Birds Directive, Marine Strategy Framework Directive and Water Framework Directive. Hili (2014) analysed the process of gathering of information for the MSFD and Water Framework Directive with a view of developing a common data management system to service both functions. Should such a data management system be adopted by ERA it could support proposals for an MSP portal by providing the relevant information required to facilitate both the process of plan making and monitoring within MSP and the assessment of proposed development applications at sea.

Currently, the GeoServer holds environmental data dating from 2016 up until the environment protection and spatial planning functions were under the responsibility of one authority. Following the regulatory and institutional changes, any updates to the environmental data sets have not been included within the current Geoportal. This affects timely action with regards to administrative efforts for policy development and planning permit evaluations. Figure 3 shows the table of content for the environmental information currently available on the portal. It is to be noted that no data from environmental monitoring is included.

Figure 3 Table of content of Environmental data

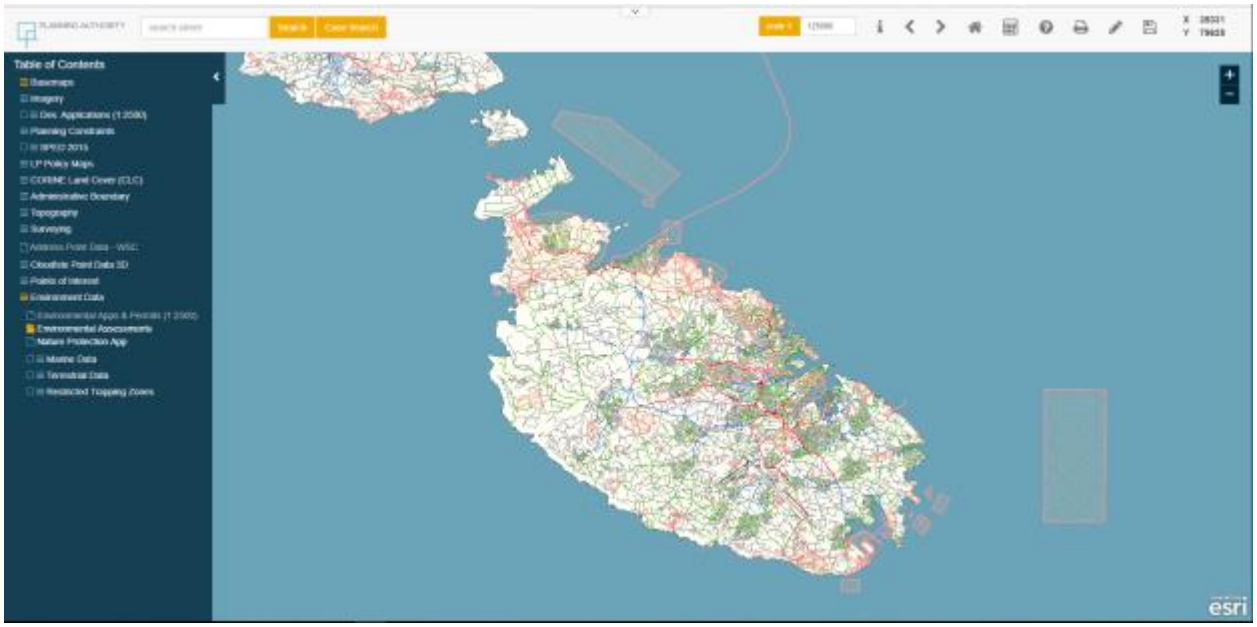


(c) Development permit applications at sea

The third major issue is the amalgamation of the Marine application together with Land applications. Currently, the Planning Authority does not differentiate Marine applications from Land Applications. Due to the size of the islands and large number of Land based applications, the development applications tab is only visible when zoomed at 1:2500 thus not allowing viewing of development applications such as fish farm pens, underwater cables etc. This is virtually impossible to carry out with a normal screen.

A possible option to overcome this issue is to separate planning applications at sea from those on land. Having the data split would mean being able to display Marine data at 1:125,000 and thus showing all marine applications around the island. An example of this is the data set on Environmental Assessments which are visible in 1:125,000 as shown in Figure 4. Being able to activate and view data at such a large extent provides the capability to distinguish applications like tuna pens or current works which are offshore. This in turn also provides the officer an opportunity to compare proposed projects with information on site history (any previous permits submitted and whether approved or not) and over impose other environment information at a large scale.

Figure 1 Environmental Assessments 1:125,000 viewing scale.



After such data is separated it can be converted to a full-blown WGS co-ordinate system and be visible at 1:250,000 to provide an opportunity to share information with other entities at both national and international levels. It can also facilitate plan making and decision making on various aspects concerning the use of maritime space and the regulation of activities therein.

Tools available on spatial data

Open source Servers

Geoserver

http://geoserver.org/

Geoserver is an open source server for sharing Geospatial data. It publishes data from most of the major spatial data sources using open standards and is a Java-based software server that allows users to view and edit geospatial data. Geoserver is also designed for interoperability.

Open Standards used are, Web Feature Service (WFS), Web Map Service (WMS), and Web Coverage Service (WCS). The Geoserver website provides user manual and tutorials, it also provides extension to provide additional functionality to the base Geoserver. This open source server can also display data on some of the more popular mapping applications such as Google Maps and Google Earth. In addition, GeoServer can connect with traditional GIS architectures such as ESRI ArcGIS.

Mapserver

http://mapserver.org/

Mapserver is yet another platform for publishing spatial data. Mapserver does not aspire to be a full GIS suit as is declared on the company website "MapServer is not a full-featured GIS system, nor does it aspire to be." Mapserver is sub-divided into 3 packages. MapServer Core, which is written in C and takes care of service publishing. MapCache, which takes care of tiling capabilities and finally TinyOWS which performs transactional requests to WFS for feature editing.

Proprietary GIS Servers

Boundless

https://boundlessgeo.com/boundless-server/
Boundless is divided in diverse suits to accommodate required needs. As a GIS server it offers publishing of Geospatial data as web services and to web-apps, desktop clients or mobile devices. With Boundless one is able to edit services directly through the OGC services. The company offers two servers, Standard for on-premises hosting and Enterprise for cloud-optimised hosting. Boundless is a highly scalable GIS server solution for large-scale enterprises.

Boundless server Enterprise offers the following opportunities:

(i) Reduced Costs: Scale at a lower cost without vendor lock-in and with 24x7 expert support that avoids costly in-house maintenance, with expert 24×7 support
(ii) Flexibility: where components run individually, together, or interoperate with proprietary software; ability to customise service
(iii) Interoperability: it can connect to existing databases; it publishes services in OGC or GeoServices REST formats

Esri ArcGIS Server

http://enterprise.arcgis.com/en/server/latest/get-started/windows/what-is-arcgis-for-server-.htm

ArcGis Server provides Geospatial data to anyone who has an internet connection. Mainly this server system provides webservices which provide the generated GIS information to tablets, smartphones, laptops, desktop workstations, and any other devices that can connect to web services.

ArcGis Servers is divided into three different editions: Basic, Standard and Advanced.

(i) Basic: this edition of ArcGIS GIS Server includes geodatabase management and the ability to publish (but not edit) feature services for map visualization and query. The geometry service is provided as well as the ability to publish geodata services. This edition cannot be

used as a hosting server. Refer to Appendix V for a description of the Geodatabase creation lineage.

(ii) Standard: with the Standard edition, the Basic edition is provided, plus all the GIS web service types offered by ArcGIS GIS Server. This service prepares the generated maps for web use, supports web-based editing using feature services, and to publish geoprocessing services from any tool included in ArcGIS Desktop Standard. The Schematics capability is included, with several other extensions available for purchase. Finally, maps, apps, and other geographic information can be shared with everyone in your organization through the ArcGIS Enterprise portal.

(iii) Advanced: with the Advanced edition, the service provides the Standard edition, plus the ability to publish geoprocessing services from any tool included in ArcGIS Desktop Advanced. Additional capabilities for geostatistical models and spatial analyst tools are also included with the Advanced edition. All other extensions are optionally available for purchase.

ArcGIS Server offers a large number of specific extensions for different business sectors as indicated in Table 1 below.

Table 1 ArcGIS specific extensions

Capability	ArcGIS GIS Server Standard	ArcGIS GIS Server Advanced
Serve schematics datasets	Included	Included
Share 3D services and embed 3D analysis tools	Not available for purchase	Included
Serve geo statistical models	Not available for purchase	Included
Share/embed Spatial Analyst tools and services	Not available for purchase	Included
ArcGIS Data Interoperability extension	Available for purchase	Available for purchase
ArcGIS Data Reviewer extension	Available for purchase	Available for purchase
ArcGIS for INSPIRE extension	Available for purchase	Available for purchase
ArcGIS for Maritime: Server extension	Available for purchase	Available for purchase
ArcGIS Network Analyst extension	Available for purchase	Included
ArcGIS Workflow Manager extension	Available for purchase	Available for purchase
Esri Defence Mapping extension	Not available for purchase	Available for purchase
Esri Production Mapping extension	Available for purchase	Available for purchase
Esri Roads and Highways extension	Available for purchase	Available for purchase
ArcGIS Pipeline Referencing extension	Available for purchase	Available for purchase

Esri's ArcGIS also offers the possibility to use ArcGISOnline which allows the publishing of GIS web services to an Esri-administered cloud environment. No installation is required but a login to Arcgis Online is needed.

There are two types of services than can be deployed:

(i) *Feature services* that expose the geometry, attributes, and symbol information for vector GIS features. They are appropriate for displaying, querying, and editing ad hoc generated data on top of web basemaps.
(ii) *Tiled map services* that expose a set of pre-generated map images (known as a map cache) that can be viewed as basemaps in a web mapping application. When an ad hoc service is published a request can be made to the server to create and store a cache of tiles which can be accessed by the service's URL.

Esri is focused on offering Web Services and tools to control such services, Esri can provide authoring, sharing and editing of spatial data online.

Open source Desktop Applications

QGIS - Quantum GIS
https://qgis.org/en/site/

QGIS is a professional GIS application that is built on top of Free and Open Source Software (FOSS). QGIS runs on Linux, Windows, Mac osx and Android. QGIS has a large active community and forums and provides the following services:

Data viewing:
- Spatially-enabled tables and views using PostGIS, SpatiaLite and MS SQL Spatial, Oracle Spatial, vector formats supported by the installed OGR library, including Esri shapefiles, MapInfo, SDTS, GML and many more. See section Working with Vector Data.
- Raster and imagery formats supported by the installed GDAL (Geospatial Data Abstraction Library) library, such as GeoTIFF, ERDAS IMG, ArcInfo ASCII GRID, JPEG, PNG and many more. See section Working with Raster Data.
- GRASS raster and vector data from GRASS databases (location/mapset). See section GRASS GIS Integration.
- Online spatial data served as OGC Web Services, including WMS, WMTS, WCS, WFS, and WFS-T. See section Working with OGC Data.

Map Compositions:
- QGIS browser
- On-the-fly reprojection
- DB Manager
- Map composer
- Overview panel
- Spatial bookmarks
- Annotation tools
- Identify/select features
- Edit/view/search attributes

- Data-defined feature labelling
- Data-defined vector and raster symbology tools
- Atlas map composition with graticule layers
- North arrow scale bar and copyright label for maps
- Support for saving and restoring projects

Creation, editing, export and managing of Spatial data

- Digitizing tools for OGR-supported formats and GRASS vector layers
- Ability to create and edit shapefiles and GRASS vector layers
- Georeferencer plugin to geocode images
- GPS tools to import and export GPX format, and convert other GPS formats to GPX or down/upload directly to a GPS unit (On Linux, usb: has been added to list of GPS devices.)
- Support for visualizing and editing OpenStreetMap data
- Ability to create spatial database tables from shapefiles with DB Manager plugin
- Improved handling of spatial database tables
- Tools for managing vector attribute tables
- Option to save screenshots as georeferenced images
- DXF-Export tool with enhanced capabilities to export styles and plugins to perform CAD-like functions

Extended functionality with additional Plugins

Core plugins include:

- Coordinate Capture (Capture mouse coordinates in different CRSs)
- DB Manager (Exchange, edit and view layers and tables from/to databases; execute SQL queries)
- Dxf2Shp Converter (Convert DXF files to shapefiles)
- eVIS (Visualize events)
- GDALTools (Integrate GDAL Tools into QGIS)
- Georeferencer GDAL (Add projection information to rasters using GDAL)
- GPS Tools (Load and import GPS data)
- GRASS (Integrate GRASS GIS)
- Heatmap (Generate raster heatmaps from point data)
- Interpolation Plugin (Interpolate based on vertices of a vector layer)
- Metasearch Catalogue Client
- Offline Editing (Allow offline editing and synchronizing with databases)
- Oracle Spatial GeoRaster
- Processing (formerly SEXTANTE)
- Raster Terrain Analysis (Analyze raster-based terrain)
- Road Graph Plugin (Analyze a shortest-path network)
- Spatial Query Plugin
- Topology Checker (Find topological errors in vector layers)
- Zonal Statistics Plugin (Calculate count, sum, and mean of a raster for each polygon of a vector layer)

- Exports a web version based on html-javascript output.

This application has already been tested in Malta. The University of Malta - PA Cloudisle initiative is based on such an output.

Mapwindow GIS
http://www.mapwindow.org/

MapWindow GIS is an open source project which is sub divided into 5 packages for various uses. MapWindow GIS uses an extensible plugin architecture, Active X controls and a C# developer library DotSpatial. MapWindow GIS offers Support and also documentation on their website.
The packages are subdivided as follows:

- MapWindow v4.x
  Free, ready-to-use spatial data viewer and geographic information system that can be modified and extended using plugins. MapWindow 4 is built on the MapWinGIS programmer tool (see below). The development of this application started in 1998 and has stopped in favor of MapWindow5 in 2015.
- MapWindow5
  MapWindow5 is rewritten from scratch, starting in early 2015. It has or will have all functionality of MapWindow v4 and is also extendable using plugins. New features of this version, not available in previous versions, are geo-database support, WMS support, repository browser, toolbox with restartable tasks and more.
- MapWinGIS
  MapWinGIS.ocx is used to provide GIS/mapping functionality to user-written Windows Forms based applications. Code can be written in Visual Basic 6, VB .NET or C# and can be commercial or open source. MapWinGIS is the mapping control used in MapWindow4 and MW5.
- HydroDesktop
  Free hydrologic data software for data discovery, download, visualization, editing, and integration with other modeling tools. Using the DotSpatial library.
- DotSpatial
  Free GIS programmer library and tools for C# and .NET based applications. The DotSpatial library is written in C# and can be used in commercial or open source projects.

CrimeStat
https://www.icpsr.umich.edu/CrimeStat/index.html

Crimestat is an open source software designed for Crime spatial analysis but can be adapted for Spatial statistics. It is free to download and is being used by many police departments around the country as well as by criminal justice and other researchers. Spatial Descriptions and Models are provided by the author website and can be found below.

Spatial Description

- Spatial distribution - statistics for describing the spatial distribution of incidents, such as the mean center, center of minimum distance, standard deviational ellipse, the convex hull, or directional mean.
- Spatial autocorrelation - statistics for describing the amount of spatial autocorrelation between zones, including general spatial autocorrelation indices - Moran's I , Geary's C, and the Getis-Ord General G, and correlograms that calculate spatial autocorrelation for different distance separations - the Moran, Geary, Getis-Ord correlograms. Several of these routines can simulate confidence intervals with a Monte Carlo simulation.
- Distance analysis I - statistics for describing properties of distances between incidents including nearest neighbor analysis, linear nearest neighbor analysis, and Ripley's K statistic. There is also a routine that assigns the primary points to the secondary points, either on the basis of nearest neighbor or point-in-polygon, and then sums the results by the secondary point values.
- Distance analysis II - calculates matrices representing the distance between points for the primary file, for the distance between the primary and secondary points, and for the distance between either the primary or secondary file and the grid.
- 'Hot spot' analysis I - routines for conducting 'hot spot' analysis including the mode, the fuzzy mode, hierarchical nearest neighbor clustering, and risk-adjusted nearest neighbor hierarchical clustering. The hierarchical nearest neighbor hot spots can be output as ellipses or convex hulls.
- 'Hot spot' analysis II - more routines for conducting hot spot analysis including the Spatial and Temporal Analysis of Crime (STAC), K-means clustering, Anselin's local Moran, and the Getis-Ord local G statistics. The STAC and K-means hot spots can be output as ellipses or convex hulls. All of these routines can simulate confidence intervals with a Monte Carlo simulation.

Spatial Modelling

- Interpolation I - a single-variable kernel density estimation routine for producing a surface or contour estimate of the density of incidents (e.g., burglaries) and a dual-variable kernel density estimation routine for comparing the density of incidents to the density of an underlying baseline (e.g., burglaries relative to the number of households).

- Interpolation II - a Head Bang routine for smoothing zonal data that can be applied to events (volumes), rates or can be used to create rates. In addition, there is an interpolated Head Bang routine for interpolating the smoothed Head Bang result to grid cells.

- Space-time analysis - a set of tools for analyzing clustering in time and in space. These include the Knox and Mantel indices, which look for the relationship between time and space, and the Correlated Walk Analysis module, which analyzes and predicts the behavior of a serial offender and a spatial-temporal moving average.

- Journey to crime analysis - a simple criminal justice method for estimating the likely location of a serial offender given the distribution of incidents and a model of travel distance. The routine allows the user to estimate a travel model with a calibration file and apply it to the serial events. It can be used to identify a likely location given the distribution of 'points' and assumptions about travel behavior. There is a routine for drawing lines between origins and destinations (crime trips).

- Bayesian journey to crime analysis - an advanced criminal justice method for estimating the likely location of a serial offender given the distribution of incidents, a model of travel distance, and an origin-destination matrix showing the relationship between where crimes were committed and where offenders lived. A diagnostics routine analyzes serial offenders for whom their residence is known and estimates which of several journey to crime estimates is most accurate. A selected method can be applied to identify a likely residence location of a single serial offender given the distribution of incidents, assumptions about travel behavior, and the origin of offenders who committed crimes in the same locations.

- Regression modeling - a module for analyzing a relationship between a dependent variable and one or more independent variables. The CrimeStat regression module includes both Ordinary Least Squares and Poisson-based regression models, estimated from Maximum Likelihood (MLE) or Markov Chain Monte Carlo (MCMC) algorithms. The current version includes six different models including OLS, Poisson with Linear Dispersion Correction, Poisson-Gamma and a Poisson-Gamma-Conditional Autoregressive (CAR) spatial regression model. The module can handle very large datasets through a Block Sampling approach. There is also a module for applying estimated coefficients to a new dataset to make predictions.

GEODA
https://spatial.uchicago.edu/geoda

GeoDa is a spatial data analyst tool provided by The Center For Spatial Data Science, the Univeristy of Chicago.

"It has one goal: To help researchers and analysts meet the data-to-value challenge. This challenge involves translating data into insights"

The program is designed for location specific incidents, building, firm, address level, aggregated areas, neighborhoods and districts. GeoDa differentiates from other packages because it focuses on explicitly spatial methods for these spatial data.

Geoda provides through spatial statistical tests that supplement map visualization, real-time exploration of data patterns, scatterplot matrix.

Proprietary Desktop Applications

Mapinfo Pro - GIS Desktop
https://www.pitneybowes.com/us/location-intelligence/geographic-information-systems/mapinfo-pro.html

Mapinfo is a powerful tool is designed to map and share maps, it easily combines data, analytics to produce intelligent mapping. It offers a very intuitive design and has a ribbon based interface. Mapinfo Visualize data in less time than ever and update themes, layers and legends instantly, it also offer compatability with today's most common PC data formats as well as relational and spatial databases.

Features and Capabilities as per their site description are presented in the table below.

Common PC files	Relational and spatial databases	Spatial data	Maps and imagery
Microsoft® Excel	Oracle®	AutoCAD® DXF/DWG	WMTS (background maps)
Access	Microsoft® SQL Server	SHP	WMS and WFS services
DBF	PostGIS	DGN	Aerial images
CSV and delimited ASCII text files	SQLite	GML	Satellite images
	ODBC compliant databases	KML	Scanned paper maps
		OGC GeoPackage	
			Microsoft® Bing maps
			Print, publish and share your maps with ease.
			Add legends and charts using our Wizards.
			Share, save or export data in commonly used formats.
			Take fast action from your insights.

Esri ArcGIS
http://www.esri.com/arcgis/about-arcgis

Esri has its own desktop suit. It mainly comprises of Arcmap, ArcCatalog, ArcGlobe, ArcScene and latest introduction ArcGis Pro. ArcGIS Pro, a new application available to ArcGIS Desktop users, provides tools to visualize, analyze, compile, and share your data, in both 2D and 3D environments.

Arcmap is the main desktop utility used to buildmaps, perform Analysis, Manage Spatial data, control service publishing, attach to GeoDatabases and much more. It`s main role is to assist in visualization but also the primary link to many tools and extension offered by Esri. An interesting tool, especially for the PA is the Statistics package.

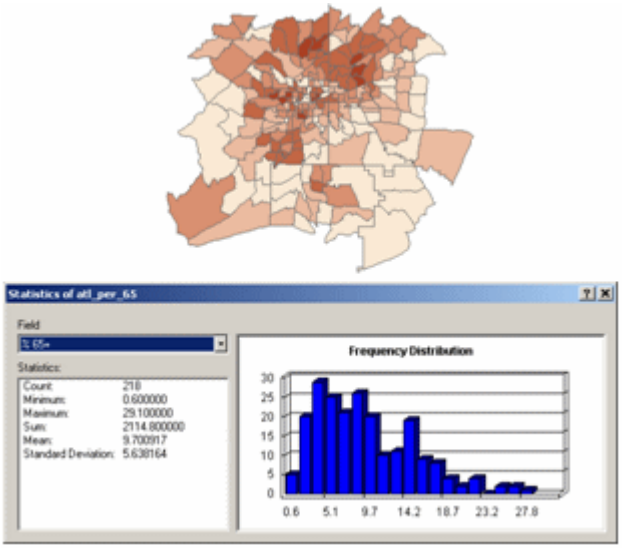
Capabilities of ArcGIS

ArcGIS offers a unique set of capabilities for applying location-based analysis to your business practices. Gain greater insights using contextual tools to analyze and visualize your data. Then share these insights and collaborate with others via apps, maps, and reports.

(a) Spatial Analytics

Spatial analytics is the heart and soul of ArcGIS. You use it to find the best location for your business, plan for smarter communities, and prepare or respond faster in crucial situations. The aim is to reproduce numerical information into a visualized map which is easier to interpret and to highlight the potential use of the Analysis. An example provided in Esri`s site is the use of the Statistic analysis for the distribution of senior citizens by census tract in a particular region, including the mean and standard deviation, as well as a histogram showing the distribution of values. (http://desktop.arcgis.com/en/arcmap/latest/analyze/commonly-used-tools/statistical-analysis.htm).

Figure 5 Standard Deviation and Histogram showing distribution of values.



The Statistical Analysis package offers various other tools such as the Summary Statistics tool was used to calculate the number of vacant parcels for a set of census tracts, including the total, the mean, and the standard deviation, it also includes charts and graph and a Q-Q plots.

ArcMap fully integrates itself with ArcGIS Server and allows to communicate for service publishing and also use various other tools. Arcmap allows to distribute WMS, WFS and Mapping services and also exports to various other formats other then Esri Shape files.

(b) Mapping & Visualization

Maps help you spot spatial patterns in your data so you can make better decisions and take action. Maps also break down barriers and facilitate collaboration. ArcGIS gives you the ability to create, use, and share maps on any device.

(c) 3D GIS

3D GIS brings real-world context to your maps and data. Instantly transform your data into smart 3D models and visualizations that help you analyze and solve problems and share ideas and concepts with your team and customers.

(d) Real-Time GIS

Real-time GIS empowers you with location monitoring of any type of sePAr or device — accelerating response times, optimizing safety, and improving operational awareness across all assets and activities, whether in motion or at rest.

(e) Imagery & Remote Sensing

ArcGIS gives you everything you need to manage, process, analyze, and share imagery. Not only do you get access to the world's largest imagery collection, you get tools like satellite, aerial, drone and full motion video.

(f) Data Collection & Management

With ArcGIS, you can easily collect, crowdsource, store, access, and share your data efficiently and securely. You can integrate data stored in your business systems and geo-enable any data from any source.

Technological Way Forward

WebGIS forms part of a rapidly morphing technological upheaval as witnessed from the move from HTML to ImageMap u GISclient to full WebGI. Some of these directions will play an important role in easing and facilitating the introduction of a WebGI as part of an enterprise GIS for thePA.

The different issues that must be integrated, as identified in the PA GI Strategy adopted in 2017 before such a WebGl can be created include:

(i) Improved Usability of GIS

The general trend of GIS development seems to indicate that it is becoming more usable and dispersed in organisations, both public and private sectors. Traditionally GIS started in individual departments and served specialised functions. GIS applications required highly trained staff to operate. In recent years with the growth and maturity of GIS, it has become easier to use, more intuitive, more analytical, and more embedded with a variety of technologies, thus has become much more usable to a broader set of disciplines as well as businesses processes.

(ii) Standardisation& Interoperability

Standardisation is the reason for the success of the Internet, the World Wide Web, e-Commerce, and the emerging wireless revolution. The reason is simple: our world is going through a communications revolution on top of a computing revolution. Communication means "transmitting or exchanging through a common system of symbols, signs or behaviour." Standardisation means agreeing on a common system (ArcNews Online).

(iii) Service Oriented Architecture

Although not specific to GIS, Service Oriented Architecture (SOA) is closely linked to much of the explosion of interoperability and web-based GIS applications. In computing, the term SOA expresses a business-driven approach to software architecture that supports integrating the business as a set of linked, repeatable business tasks, or "services". Services are self-contained, reusable software modules with well-defined interfaces and are independent of applications and the computing platforms on which they run. SOA helps users build composite applications, which are applications that draw upon functionality from multiple sources within and beyond the enterprise to support horizontal business processes. SOA helps businesses innovate by ensuring that IT systems can adapt quickly, easily and economically to support rapidly changing business needs. SOA is largely based on a set of Web services standards (e.g., using SOAP or REST) that have gained broad acceptance over the past several years. These standards have resulted in greater interoperability and avoidance of vendor lock-in. One can implement SOA using any service-based technology.

(iv) GIS on the Web

GIS will continue to become more web-based. Improvements in Internet speed, cost and availability have brought about innovations in Web site technologies, such as the use of Asynchronous JavaScript and XML (AJAX), image tiling for 3D visualisation, and continuous scrolling. Such technologies are improving the usability and response times of Internet sites and are an attempt to bring browsing more in line with the desktop experience.

(v) Mash-ups

A mash-up is a website or web application that uses content from more than one source to create a completely new service. Content used in mash-ups is typically sourced from a third party via a public interface or API. Mash-ups are revolutionizing web development and will influence the way maps can publish on the web, especially involving third party vendors, such as Google Maps.

(vi) GIS Data in Relational Database Management Systems (RDBMS)

Early GIS data was stored primarily in proprietary file formats. As the industry changes to more open systems, the relational database management system has emerged as the preferred way to store GIS information, primarily because of the open architecture standardisation, and ability to integrate with other databases.

(vii) Unprecedented Access to GIS Data

GIS data availability is rapidly growing for GIS data users. In the early years of GIS, data was available in proprietary formats and not easily shared between governments and businesses. With the proliferation of personal computers, use of the Internet and standardisation of GIS data formats, access to GIS data has become much easier and widespread. Many governments and private businesses post data on web sites for download and consumption, either for free or for a fee.

(viii)Mobile GIS

Wireless technologies combined with the previously discussed Web-enabled GIS are allowing spatial data to be moved into the field and used in many ways, such as feature finding (e.g., utilities), field editing of data, and routing.

(ix) Broad Public Acceptance & Knowledge

Although an acronym not widely known or used, GIS has been a driving force behind much of the mainstreaming of web-based mapping found today on the internet. Web sites like Map Quest and Google Maps deliver GIS functionality (limited), but largely without the average user knowing what GIS really is. This has been a big boost for the GIS community and has had positive side effect in that it has raised the public's awareness and acceptance of finding information via a mapping interface. And not only are map interfaces becoming more accepted for obtaining information, but collectively the public's skill level has been raised. Simple

functions like pan and zoom and the ability to navigate in a map-based environment are becoming part of the collective knowledge base of users, furthering to help boost GIS as a common accepted information tool.

Recommendations for an MSP Geoportal

Some key notes can be extracted from this desk study that would need to be presented for consideration when the Planning Authority as the MSP Competent Authority seeks to update its data management services for the creation of an MSP portalSuch keynotes be incorporated in the current/new Geoserver and not restricted to an independent portal:

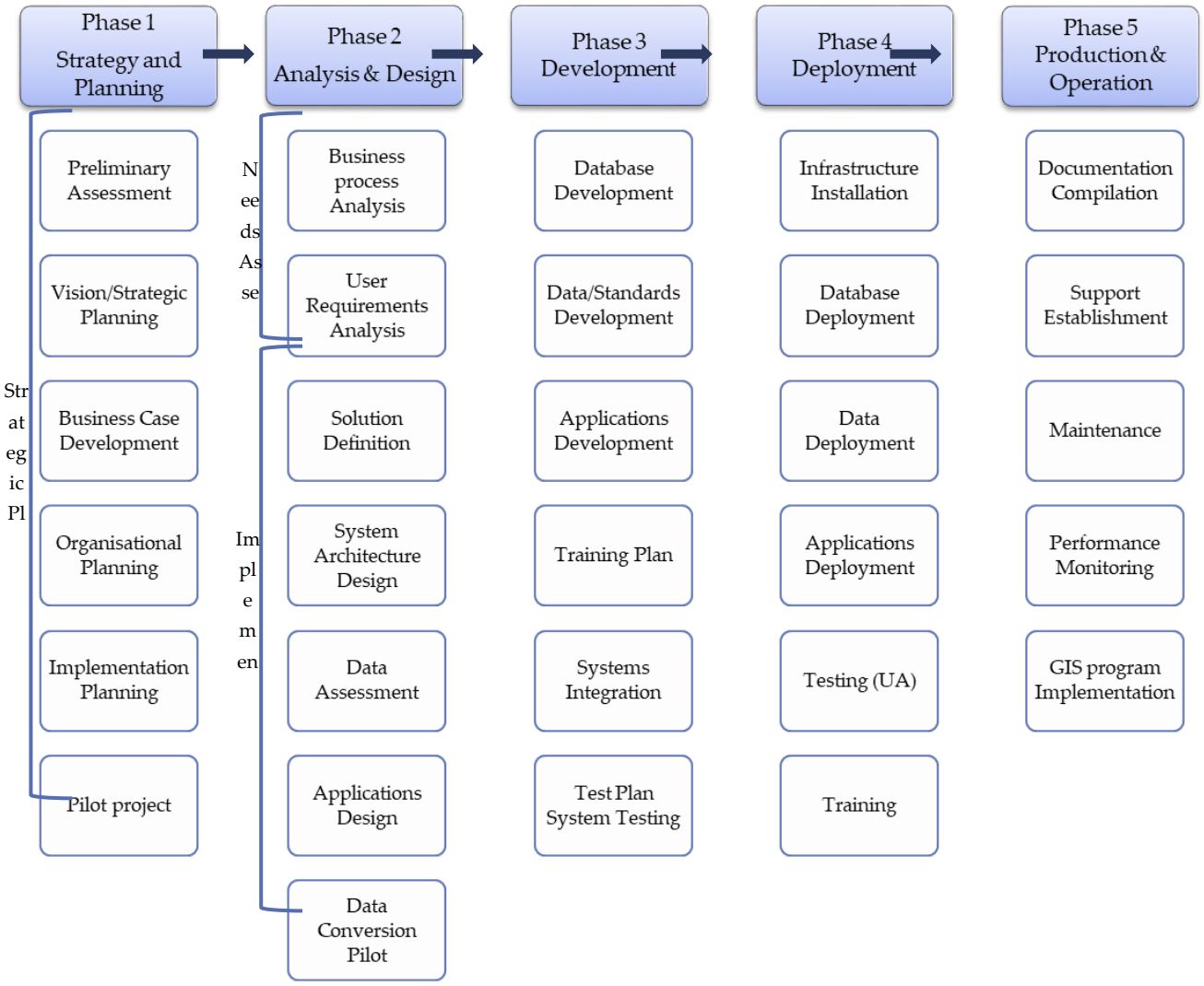
- Reproject data to well-known coordinates, such as WGS84
- Separate Marine development permit applications from Land Applications
- Display Marine data at a zoom level of 1:250,000
- Provide Dissemination, search and download service and per INSPIRE Directive
- Fill up metadata for Marine parcels to confirm with INSPIRE Directive

With the introduction of the above notes, the Geoportal will be able to cater for MSP data and further assist spatial planners to evaluate application but can also serve as an information portal for the general public. It is imperative that MSP data is disseminated to the public as this contributes to greater knowledge of how maritime activities are planned, organised and regulated.

Architecture & Application Choices

In terms of the options available for the creation of a website that would serve the PA for the Marine data, a number of considerations were taken up: the use of a web-mapping service. Web-based mapping has allowed for a significant advanced in the ability to deliver light-weight mapping functionality (thin client-fat server approach) to a large audience at a relatively low cost. Whilst the PA was one of the forerunners of such applications, there is yet a vast amount of activities that need to be partaken to in order to allow better web-mapping management.

The GeoPortal implementation Plan is outlined in Appendix A as it follows the proposed Plan identified in the GI Strategy document (2018) which identifies five different phases that include the strategy and planning, analysis and design, development, deployment and production and operation as identified in the Figure 6 below.


Phase 1
Strategy and Planning
Phase 2
Analysis & Design
Phase 3
Development
Phase 4
Deployment
Phase 5
Production & Operation
Strategic Pl
Needs Asse
Implemen
Preliminary Assessment
Vision/Strategic Planning
Business Case Development
Organisational Planning
Implementation Planning
Pilot project
Business process Analysis
User Requirements Analysis
Solution Definition
System Architecture Design
Data Assessment
Applications Design
Data Conversion Pilot
Database Development
Data/Standards Development
Applications Development
Training Plan
Systems Integration
Test Plan System Testing
Infrastructure Installation
Database Deployment
Data Deployment
Applications Deployment
Testing (UA)
Training
Documentation Compilation
Support Establishment
Maintenance
Performance Monitoring
GIS program Implementation

Employing this methodology will help identify the processes required to set up the Marine WebGL.

With web-based mapping:

- User software requirements are minimal. Users only need to have a web browser.
- Networking requirements are minimal. Users only need to have a standard Internet connection to use a web application.
- Application software and settings can be maintained on a central server and published out to users, thereby eliminating the need to install, configure, and maintain application software and settings on each user's computer.

The service would still need to be based on a back-end, either through stand alone or through a geodatabase structure that sits in the back-end.

Accompanying the centralised data model is the emergence of storing and managing GIS data a relational database management system (DBMS). While DBMS' are not new, GIS data has only recently started the migration towards being managed through a DBMS. This has been due to the complexity of geospatial data, the models used to build GIS data, and the legacy of the proprietary formats that most GIS data was built on in the last two decades. Additionally, effective integration of GIS data with other business systems requires that data be stored in a DBMS.

Appendix V and Appendix VI detail the processes required to create the geodatabase and the web-service respectively.

If the PA or stakeholders opt for a simple webmap that does not include multi-functionality, the document, through Appendix IV discusses the processes required through the use of an opensource tool, called QGIS.

WebGIS Best Option

This chapter provides a financial analysis of costs associated with implementing an enterprise GIS. As has been mentioned repeatedly in this plan, GIS is more than just the technology; therefore, this cost estimate looks at the total cost of GIS over a three year forecast period, including the software/hardware, planning, design, development, deployment, and maintenance and support of the system. This cost estimate is based on the best available information and has been reviewed by a consulting firm for verification and validation. Some costs, such as hardware and software are fairly straightforward to estimate, and others such as data conversion and application development are rough estimates. This is because the GIS Needs Assessment phase, which will focus on data requirements, is yet to be completed. Once the GIS Needs Assessment is completed, it will be possible to assess the magnitude of the conversion effort and then adjust the cost estimate accordingly, if necessary.

In the evaluation of the PA's WebGIS, costs are divided into two types:

(i) implementation and
(ii) maintenance, or program costs.

Implementation costs are those costs associated with designing, developing, and deploying the initial enterprise GIS, essentially costs during the first year. Maintenance costs are those associated with ongoing costs and maintenance. The table below identifies the categories within the implementation and maintenance costs. Note that some of the components are identified in each. Items already implemented or in progress are identified.

Following diverse reviews, the best option was deemed to create a MSP-dedicated site that 'sits' on the PA webserver and which can elicit and capture webservices from the other entities, irrespective of what they chose to use: whether a standalone system within the different stakeholders or a central system within PA which captures the webservices.

The best option should feature the following:

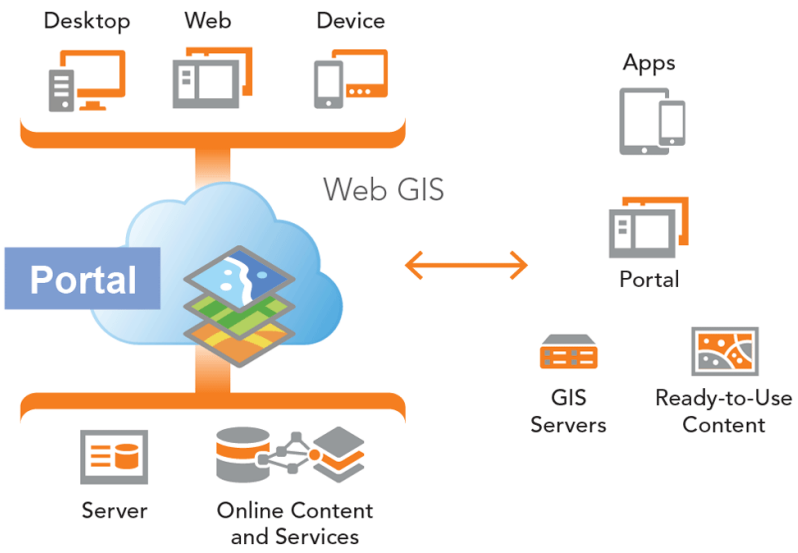
- the current SIMWESTMED-related data and the Marine-related data that is external to the MSP but which can be captured through a webservice scenario or even through a service offered by the PA;
- it show depict the current static maps (based on security and access to same);
- it should allow for the capture of stakeholders' webservices and other online data which conforms to capture service;
- in case of real-time data capture, the option to capture real or near-real time capture as was the case with SEIS. However a cost-analysis can be carried out as on what the data sources are, how they are received, which data sensors are submitting data and how such is captured, converted and displayed. It the process is governed by the stakeholders or international entities, then the protocols need to be assessed, reviewed and the technological issues highlighted.
- The system should allow for online analysis and basic statistical tool availability

- It should allow for scenario-building, though one needs to discuss this with the SIntegraM dissemination contractor to check whether the option is viable and how far can such be deployed.

Costs	
Hardware software maintenance/upgrades	Staffing – Already installed through systems set up at the PA. Would need further investment should a requirement be placed on the need to create a new system as against adding a new service to the current system as a separate Marine page.
Data maintenance	Data incoming from both internal PA units or from the stakeholders needs to comply with INSPIRE Directive requirements (Appendix VI and VIII). Data is to be in full WGS84 format to ensure compliance with the SIntegraM output, which ensures less dependency on other entities to convert from truncated ED50 to full ED)
Training/Education	Technology investments need to keep abreast with the PA webserver and relative training rendered. PA and stakeholders are to ensure that the geoportal includes walkthroughs and help screens that serve as training to both developers and the user base.
System Support	Application Development – expertise already within the PA on maintenance, however any new development would cost

The relative costs are based on user-friendliness for easy viewing and querying

While publishing the data, considering the awareness in the browser usage, the interfaces (web pages) can be designed in such a way that it appears familiar to the user. User-friendliness is ensured while viewing the GIS data. While accessing the GIS data from the central server through Internet/Intranet, the client needs only a web browser. There is no need of installing sophisticated GIS software or plugins at the user's end. GIS data can be easily queried through the Internet browser.To achieve these objectives, the PA must have the proper GIS infrastructure in place and the following architecture is being recommended:



http://www.esri.com/esri-news/arcuser/winter-2014/portal-for-arcgis-101

To implement such a setup as based on the current ArcGIS Server Enterprise edition and WebGIS structure at the PA, one needs to develop and implement the dissemination tool, either through an add-on to the current structure, a new service or inclusion in the SIntegraM dissemination service..

Estimated costs:

- Current PA webGIS addon 5,000 euros (excl. VAT)
- Dissemination tool including backend 65,000 euros (excl. VAT)
- SIntegraM tool 0 euros

Note: the costings above assume that the human resource factor is already absorbed by the PA through the Marine Team and ICT GI resources.

Risks

Most of the risk the PA will face will be in-house-based during development and management of the system. These include:

- *Data Conversion*

  Data conversion is usually the most expensive component of a web-GIS implementation, which risks were mitigated by the SIntegraM data conversion and Reprojection tool.

- *Department Conflicts/Scope Creep*

  In the enterprise GIS model, one comprehensive system will be designed to serve all departments. In such a model, there will inevitably be varying opinions and conflicts in how the system is designed. While this is typical in any multi-entityendeavour, during the web- GIS implementation it will be particularly important to manage the scope of work closely and develop change management procedures to ensure there are not excessive delays, excessive costs, or incidences of scope creep broadening the project beyond is original intent.

- *Complex Technology*

  While the front end of many GIS are becoming more simplified and easy to use for the casual user, it is important to realise the technology behind the GIS is becoming increasingly complex. The PAwill need to acknowledge that certain skill sets identified will be required to keep the system at a certain level of operation. If these skill sets are not available, then the benefits again are likely not to be obtained.

Conclusion

This desk study attempted to evaluate the potential for developing an MSP portal hosted by the Planning Authority, in addition to its existing Geoportal. It provides the technical argumentation to take forward a possible option that can be implemented by the organisation as an initial instrument to facilitate the effective implementation of the MSP Directive. This would constitute the first step towards improved co-operation and co-ordination at national level which would pave the way for future options at the trans-boundary level.

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Appendix I – Outline GeoPortal Implementation Plan

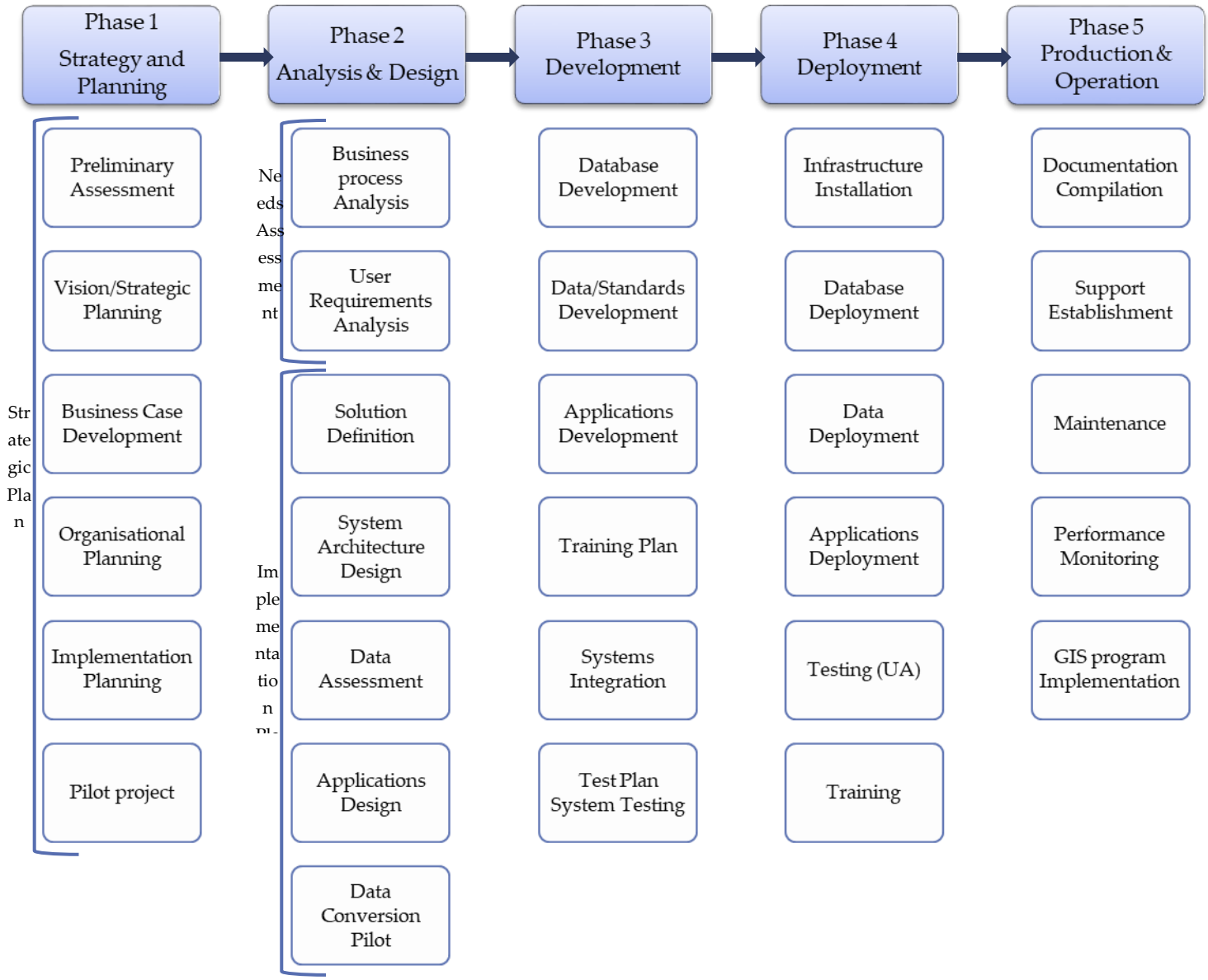
The Appendix lists the outline Plan that is being envisaged in order to implement the Marine GeoPortal.

The Plan has been built on the guidelines emanating from the PA GIS Strategy.

Formosa, S., Borg, B. (2018). GIPSI18: GI Planning Authority Strategy 2018: Geographic Information Systems (GIS) Three-year Strategic Plan FY2019-FY2022, Floriana, Malta, 17 April 2018

Work Plan Outline

This section contains the proposed work plan for theGeoPortal implementation. The work plan uses a five phase approach to design, development, deployment, and. Upon successful completion of this five phase process, Malta would have a dedicated marine-based system.



Phase 1 – Strategy and Planning

Phase 1 represents the strategic planning portion of the enterprise GIS implementation. This phase establishes the overall direction for the Web GIS for thePA, including a vision, goals and objectives, business case justification, financing plan, and a pilot project.

Phase 1 Activity Areas

1.1 GIS Scoping/Preliminary Assessment

This first activity area involves a preliminary assessment of the current environment.

Work Areas

1.1.1 Assess current environment (opportunities, constraints, challenges)
1.1.2 Research other similar authorities that have Marine Data
1.1.3 Research evolving trends and business needs
1.1.4 Evaluate architecture and application choices
1.1.5 Preliminary evaluation GIS integration capability with key business processes
1.1.6 Establish project organisational structure
1.1.7 Identify deployment timeline

1.2 Vision/Strategic Planning

Web-enabled systems require more planning, testing, than simple non-interactive solutions and will havePA-wide and extra-PAimplications; therefore, it is recommended that an oversight committee which can be composed of the SIMWESTMED project Group be established to help with planning efforts. It is anticipated that the committee will help serve as the main group of GI Web-Portal promoters. Activity in this section includes:

Work Areas

1.2.1 Development of GI Web-Portal goals and objectives
1.2.2 Identify key issues facing GI Web-Portal implementation, identify stakeholders responsible for decision-making these issues
1.2.3 Identify priorities for inclusion in GI Web-Portal (e.g., mission critical systems, high priority data)
1.2.4 Develop conceptual GIS Webmodel, demonstrate consistency with overall IT architecture and the current MapServer

1.3 Business Case Development

This activity involves documenting the cost/benefits associated with aGI Web-Portal. While not every cost and benefit can be accounted for, specific examples of current business process can be used as examples to show how the process will benefit under the Web model. As already identified in the PA Strategy and in the usefulness of the MapServer, there is a business case to expand the current Web-Portal to either add on a new set of datasets onto the server such a the expansion of the current server to cover marine areas, or as an alternative to create a new multi-entity webserver that will serve as a dedicated marine server.

Work Areas

1.3.1 Develop appropriate cost/benefit analysis
1.3.2 Document other intangible benefits ofGI Web-Portal (e.g., improved customer service)

1.4 Organisational Planning/Communication

A variety of organisational and resource related issues will need to be addressed to ensure webportal GIS implementation is congruent with the organisational structure, that its functions are understood by stakeholders. These include:

Work Areas

1.4.1 Define Marine Section and ICT GI Team organisational structure of GIS within the organisation
1.4.3 Establish roles &responsibilities of user groups
1.4.4 Create Communication Strategy for informing/sharing stakeholders and interested parties about status of GI Web-Portal

1.5 Strategic Plan

This activity involves assembling the main planning document for GI Web-Portal as well as budget and timeline for deployment.

Work Areas

1.5.1 Develop GI Web-Portal Technology 'Road Map' (implementation plan and timeline)
1.5.2 Develop GI Web-Portal implementation budget, resource requirements

1.6 Pilot Project

A pilot project, or 'early win', will be an important milestone in the Webimplementation by allowing an opportunity to show decision-makers and potential userswhere the project is heading with a real live tangible example and point out key benefits,value, and functionality of the web portal.

This function is demonstrated through the: initial webportal pages created through SIMWESTMED. The issues identified therein require a an established process of creating both a dedicated geoportal as per Appendix V and to follow the process established in Appendix VI detailing the process to create an online webmap.

Work Areas

Project Initiation

1.6.1 Identify initial pilot project parameters (i.e., goals/objectives)

Needs Assessment

1.6.3 Determine end user environment for pilot project, including public access component
1.6.4 Identify and document functional requirements of pilot project
1.6.5 Identify and document technology needs with candidate project, including procedures and requirements for deploying the web-based mapping application

Development

1.6.8 Acquire software/hardware environment for pilot
1.6.9 Integrate both solutions including new functionalities
1.6.10 Build and configure back-end environment
1.6.11 Develop reporting functionality
1.6.12 Configure pilot
1.6.13 Test pilot

Deployment

1.6.16 Create demonstration format/strategy and present to interested/identified parties, including a strategy of how the external website component will be presented to the public
1.6.17 Deploy pilot
1.6.18 Conduct presentations/demonstrations internally
1.6.19 Monitor usage/troubleshooting

Phase 2 – Analysis and Design

The Analysis and Design phase examines the activities that can benefit from the use of web-GIS by analysing business processes and workflows within the organisation and document how geographic information is part of that workflow. From this documentation, solutions are identified and overall system blueprint with a Web focus is created.

Needs Assessment (Activity Areas 2.1 and 2.2)

The adoption of technological innovations such as a web-GIS is not always a straightforward process.

The Needs Assessment activity itself serves as a learning tool where potential users in each participating department learn about web-GIS.

As part of this Needs Assessment, the PAwill have all of the information needed to plan and develop a GI Web-Portal, through looking at the workflow and processes within and between departments, responsibility for data creation, updates and maintenance will become apparent. The Needs Assessment informationwill be used as the basis for the Implementation Plan or blueprint for implementing the GIS.

Phase 2 Activity Areas

2.1 Business Process & Workflow Analysis

Business process analysis and modeling is an effective tool for defining the business activities associated with the use of GIS and when properly applied will greatly expand the organisational benefit of the GI Web-Portal. The business process and workflow analysis outlined here will result in providing documentation of the existing business process ("as-is") and with the GIS technology ("to-be").

Work Areas

2.1.1 Review of existing documents, systems, resources, and activities as they relate to GIS
2.1.6 Compile information
2.1.7 Create draft report
2.1.8 Conduct follow up interviews as necessary
2.1.9 Review & refine final report

2.2 User Requirements Analysis

Work Areas
2.2.1 Prepare Needs Assessment approach

2.3 Solution Definition

The Solution Definition step represents the compilation, review, and synthesis of Needs Assessment and workflow analysis to arrive at an overall solution. This is an important step as it represents the shift from the evaluation and analysis of user requirements to resolve and the formulation of ideas, concepts, explanations that will reach the desired solution.

Work Areas
2.3.1 Identify potential software suite solution
2.3.3 Determine additional application development needs
2.3.4 Determine overall application environment that will do the best job at collectively addressing the identified application/workflow functions

2.4 System Architecture Design

Via the Needs Assessment, the current system architecture will be known as well as what is needed to adequately support a proposed Web system. System Architecture Design will provide the foundation for building a productive operational environment for GI Web-Portal.

Work Areas
2.4.1 Review current system architecture
2.4.2 Develop overall System Architecture Design with upgrade recommendations, application specifications
2.4.3 Develop conceptual interface design
2.4.4 Develop proposed hardware/software Procurement Plan

2.5 Data Assessment

This work area will involve taking inventory of the current inventory environment and comparing it with the Needs Assessment findings to determine data gaps and issues. This work area also involves evaluating the condition of existing data and determining the appropriate steps to bring it into the planned GIS environment and also look at how the data will be managed once it is within the GI Web-Portal environment.

Work Areas
2.5.2 Develop overall map base model for classifying and grouping various data layers
2.5.3 Develop Data Conversion/Migration Plan and prioritisation scheme based on condition of data. Identify layers that are targeted for immediate upload into the GIS geodatabase.

2.5.4 Develop Data Management Plan to address updates, uploads, transfers, replication, replenishment, backups, archiving, etc.

2.6 Base GIS Database Design –Conceptual/Logical Data Model

Conceptual/logical database design is the first step in database design where the contents of the intended database are identified and described allowing for a comprehensive mental framework and organised structure to be revealed. The conceptual design captures the user's view of the data and will allow the opportunity to evaluate how all of the various aspects interact (relationships), while at the same time providing the opportunity to identify major issues early on. This step uses information developed during the Needs Assessment and typically places it a structured format in the form of an Entity-Relationship Diagrams (ERD) or UML (Unified Modeling Language) diagrams.

The ERD or UML diagrams show the relationships between database tables and identify primary keys and important attributes. The purpose of the ERD or UML is to specify all tables and relationships needed to support the GIS applications. The conceptual design process is iterative. It will identify items that are in existing databases that may need to be geocoded and included in the Web system. New attributes or entities will be discovered through interaction with staff and will require changes to the entities and their relationships.

Given the various states of spatial data within the organisation, information that is currently maintained in GIS format or is maintained by other entities, will not need to go through database design, but can proceed toward being integrated into the GIS database. Assuming the data meets the established standards (e.g., metadata standards, INSPIRE) and is fairly isolated from other data, the data can be moved into the GIS database. Other layers will need to go through database design stages. Refer to Appendices VIII and IX for the templates created as part of this project for spatial and non-spatial data.

Work Areas
2.6.1 Organise and prepare working groups/individuals for specific model(s)
2.6.2 Conduct meetings/interviews
2.6.3 Develop logical data model(s)
2.6.4 Develop preliminary metadata requirements
2.6.5 Review and validate w/ groups and update as necessary

2.7 Application Design

Based on the Needs Assessment and Solution Definition, and in conjunction with the goals/objectives and established topology of stakeholders of marine data, the application

environment can be identified. The GIS applications are those functions that GIS software performs, whether 'out-of the box' or through customisation, using programming languages that will make the software useful to end-users. This activity will result in conceptual descriptions of the software applications recommended for development within Phase 3 Development.

This step should also include recommendations on priority application development given that not all application development will be covered in the initial core implementation.

Work Areas

2.7.1 Develop Application Design document with priority application development recommendations
2.7.2 Review and comment
2.7.3 Prepare final document

2.8 Data Conversion Pilot

Given the complexity of the web-GIS data conversion process, a data conversion pilot project will be initiated. This will allow all participants to work through the entire conversion process and evaluate weakness/strengths/ and learn how to improve the remaining sets of data. These are identified in the initial processes reviewed in Appendix III as part of the process of analysing the current marine data.

In addition, the SIntegraM Reprojection software tool should enable the completion of this conversion process.

Work Areas

2.8.1 Identify candidate layers that can be used from the SIMWESTMED project
2.8.2 Develop scope of work
2.8.3 Implement scope of work
2.8.4 Review and refine process to improve further data conversion efforts

Phase 3 – Development

The Development phase is analogous to the construction phase of building a house. Design documents, or 'blueprints', from Phase 2 are used to begin actual database development, data conversion, and application development of the elements of the GI Web-Portal.

Phase 3 Activity Areas

3.1 GIS Database Development –Physical Data Model

The physical model is built from the conceptual/logical model and is the process of implementing the data model schema within the geodatabase.

Work Areas

3.1.1 Develop physical database model(s)
3.1.2 Perform data conversion and migration based on Data Conversion/Migration Plan
3.1.3 Initiate database set-up and administration

3.2 Data/Standards Development

The PAwill be using data and sharing data from a variety of sources, both internal and external. This data may be stored in different formats, have varying levels of accuracy, use different map symbols, be produced on different schedules, be provided in different media, etc. Although there are technological ways to deal with some of these variables, standards and procedures are necessary to ensure thePA's data investment is protected and continues into the future. Standards and procedures serve as a corporate umbrella to promote data integrity and consistency. One of the more important standards will be metadata for individual data layers. These should be developed as the data layers are being created.

Work Areas

3.2.1 Create prioritised outline/list of standards and procedures to be developed as per Appendices VII and VIII as based on INSPIRE Directive
3.2.2 Develop standards and procedures
3.2.3 Review and test standards/procedures with stakeholders
3.2.4 Develop single source location for easy access to standards and procedures

3.3 Priority Applications Development

ThePAs GI Web-Portal application development will be based on business requirements. Under this approach, business functions and user needs identified through the Needs Assessment

drive the applications that are developed to support these specific functions and users. This insures that the system developed will be useful and will be used. Additionally, application development is the process by which the functional requirements of specific users are translated into software tools that support those functions. This requires that the functional requirements be transformed into detailed design specifications for application programmers.

Work Areas

3.3.1 Develop detailed design specifications for priority applications as recommended in the Application Design document. Specifications will include, but not limited to:

- Narrative description of what the application will do
- What business function the application will support
- A list of data inputs and outputs
- A list of menus and tools with descriptions of associated functionality
- Hardware and software requirements
- Diagrams illustrating screen layouts and data models
- Objective performance criteria that can be used to determine when the application is "complete."

3.3.2 Develop application prototype suitable for presenting, reviewing, test-run

3.3.3 Verify alignment of applications with the functional requirements specified in the Needs Assessment.

3.3.5 Incorporate additional modifications to application and refine accordingly

3.4 Training Plan

Training is considered a "critical success factor" in the implementation of GI Web-Portal. It is important to develop a process for developing a training environment within the context of the existing structure, the topology of user groups, and tied to the goal of establishing a sufficient knowledge base within the organisation.

The Training Plan needs to encompass all personnel levels from within the organisation and from the Marine stakeholders, from end users, to help desk personnel, to system and database administrators, and representatives from all levels of management, including decision-makers of GIS. The goal of this Training Plan is establish a blueprint to develop a 'critical mass' of knowledge, awareness and skills at the PA so that the GIS site is successful.

Work Areas

3.4.1 Identify users that need to be trained

3.4.2 Identify the requirements that users will need to complete their work

3.4.3 Develop objectives and timelines for specific training phases

3.4.4 Evaluate relevant training options

3.4.5 Develop training program for each of the identified users

3.4.6 Develop single source location for easy access to training and knowledge base information.
3.4.7 Implement training necessary to complete components of Testing Plan

3.5 Systems Integration

GIS systems integration includes the work necessary to integrate spatial and non-spatial data from disparate technologies, applications, and business units for use in GIS. TheMarine GIS will be integrating with key business systems such as asset management system. This step involves determining the process of integration with each of the different systems and will allow the ability to uncover potential integration issues and resolve them prior to the Deployment Phase.

Work Areas
3.5.1 Develop systems integration document.

3.6 Testing

Adequate testing will ensure GI Web-Portal is delivered with the correct functionality and behaviour as originally planned and designed.

Work Areas
3.6.1 Develop approach, scope, procedures, and acceptance criteria in Test Plan.
3.6.2 Conduct testing.
3.6.3 Debrief on testing, recommended actions/changes.

Phase 4 - Deployment

Deployment represents the phase in which the GI Web-Portal will be physically installed and rolled out. Deployment will involve hardware, software applications, web-based applications, databases, the network, and personnel, and therefore needs to be closely coordinated to ensure an orderly deployment. To the extent possible a phased deployment should be coordinated so as to not create a situation of a 'single switch' event and run the risk of multiple problems emerging at once.

Up to this point in the GIS development process, the GIS hardware and software will have been acquired and data conversion completed (or a substantial portion has been finished) both from PA investment and SIntegraM investment. Different components of the hardware and software will also have been purchased. It is now necessary to put all the pieces together, test them to make sure they work as expected, and to initiate all procedures necessary to use the GIS.

Phase 4 Activity Areas

4.1 Infrastructure Installation

Work Areas
4.1.1 Develop infrastructure Deployment Schedule, including communication plan
4.1.2 Initiate infrastructure deployment

4.2 Database Deployment

Work Areas
4.2.1 Develop Database Deployment Schedule
4.2.2 Initiate Database Deployment

4.3 Data Deployment

Work Areas
4.3.1 Develop Data Deployment Schedule
4.3.2 Initiate data deployment

4.4 Priority Application(s) Deployment

Work Areas
4.4.1 Develop Priority Application(s) Deployment Schedule

4.4.2 Initiate priority application deployment

4.5 Testing

Work Areas
4.5.1 Using Testing Plan developed in Phase 3, conduct testing as planned.

4.6 Training

Work Areas
4.6.1 Using Training Plan, conduct additional as planned. Note: training may occur prior to specific deployments

Phase 5 – Production and Operation

The production and Operation phase will lead to a successful maintenance, monitoring, support and service program for the GI Web-Portal.

Phase 5 Activity Areas

5.1 Documentation Compilation

Work Areas
5.1.1 Assemble and inventory all identified required project documents
5.1.2 Complete remaining documentation.
5.1.3 Create single source resource location with easy access for relevant documents.

5.2 Support Established

Work Areas
5.2.1 As identified in Training Plan, initiate GIS support program for identified user groups.

5.3 Maintenance

Work Areas
5.3.1 Establish hardware/software maintenance program and lifecycle schedule.

5.4 Performance Monitoring

Once the system has been deployed, it will be important to determine what's working right, what could work better, and what additional capability needs to be developed.

Work Areas
5.4.1 Conduct post-project assessment workshop with project participants
5.4.2 Review and compile report with recommendations
5.4.3 Develop plan for continue performance monitoring.
5.4.4 Determine measures for performance optimisation.

5.5 Web-GIS Program Development/Implementation

This document(s) will address establishing the overall program and associated work planfor theweb-GIS Program implementation.

Work Areas

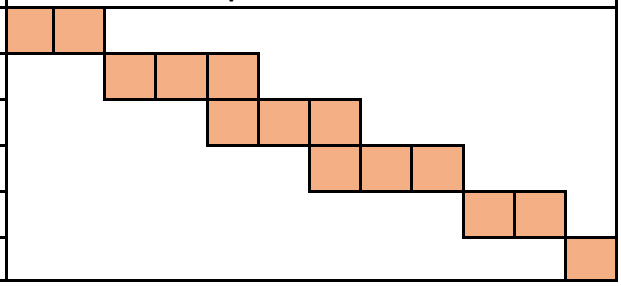
5.5.1 Initial deployment and operational testing report.

5.5.2 Final system delivery, user training, and workflow migration complete

Best Practice: Deployment process is repeated incrementally on a periodic schedule to leverage technology change

Schedule

The initial implementation of thePA's Marine GeoPortalis expected to take approximately 12 months. The schedule below shows the timeline of the future proposed 5 phases of the project. The timeline details the potential steps that can be taken up, though the timeline can be shrunk considerable should the focus be entirely on the system creation particularly by one dedicated member of staff.

	Task	Operational Year
1	Planning	
2	Analysis & Design	
3	Development	
4	Deployment	
5	Production and Operation	
6	Continued Application Development	

Appendix II – PA Marine and GI Teams

1. **Marine Experts**
    - Use of GIS is available and knowledge on how to use maps and maintain the current data layers and create new ones. On the spatial analytics, some more knowledge on the different tools as identified in the earlier chapters would help expand the potentialities of such a system
    - Data content - not owners of all the datasets and will need MoUs to amend such data unless the guardian entity will provide updated data on an ongoing basis through in-house changes and subsequent submission to the PA marine Team or through a direct upload to the web portal.

    - Issues that may hinder the process relate to:
        - Changes in data capture and projection-decision procedure
        - Changes in database structures from source data or PA
        - Creation of front ends that might not allow for the non-terrestrial zones
        - Changes in roles and responsibilities of the different parties

2. **ICT GI Team**
    - Creation and maintenance of the geoportal
    - Creation of related datasets for geoportal consumption
    - Maintenance of the system
    - Uploading of the datasets
    - GI Issues - Integration of data and continuity and control.
    - Procedurally - require metadata structure for GI, ex timestamps
    - INSPIRE-related data structures
    - SIntegraM dissemination tools
    - Security management for portal

Appendix III – Training Manual for GI WebMaps using QGIS

Lineage Documents

Process used in creating the GI layers for online dissemination

Project: Use of QGIS to create an online webmap

User: Saviour Formosa

Date: April 2018

Source File Name: First draft Document

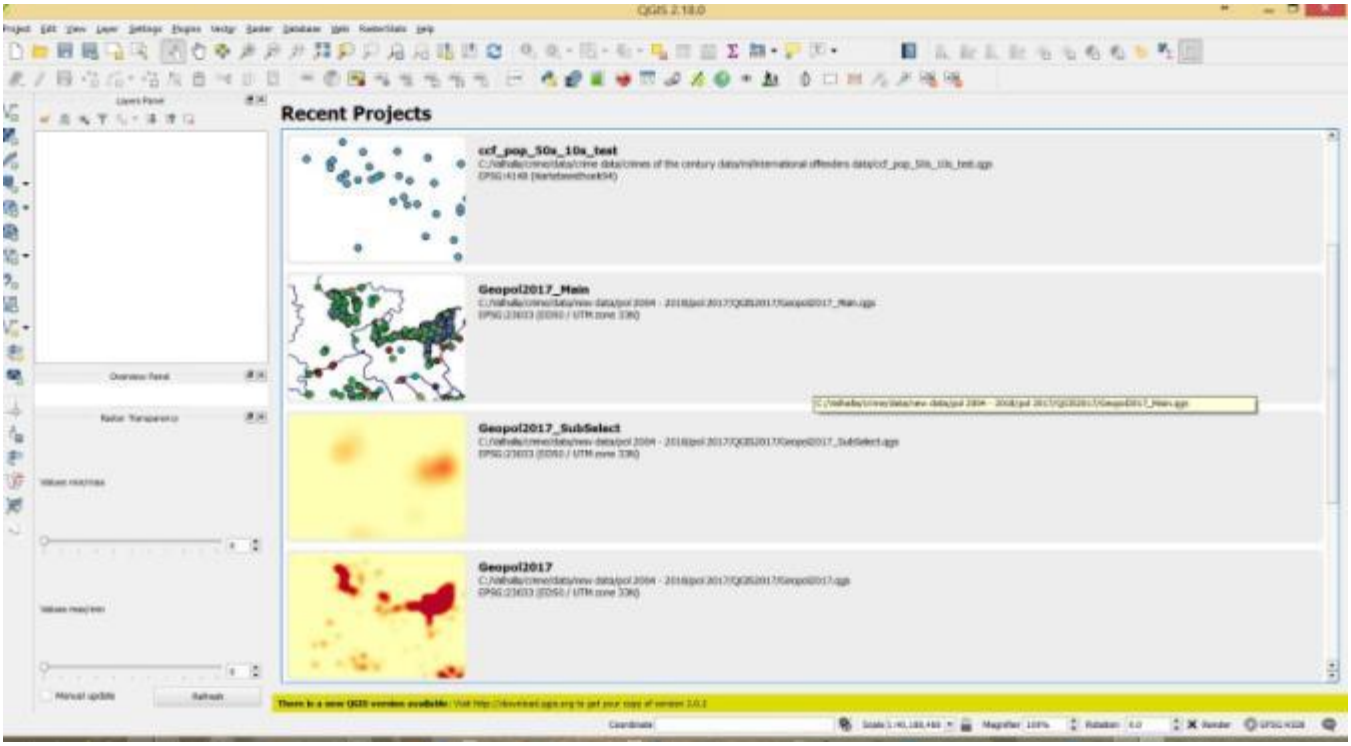
Destination Directory: C:\Temp

Project Description: QGIS to webmap publishing

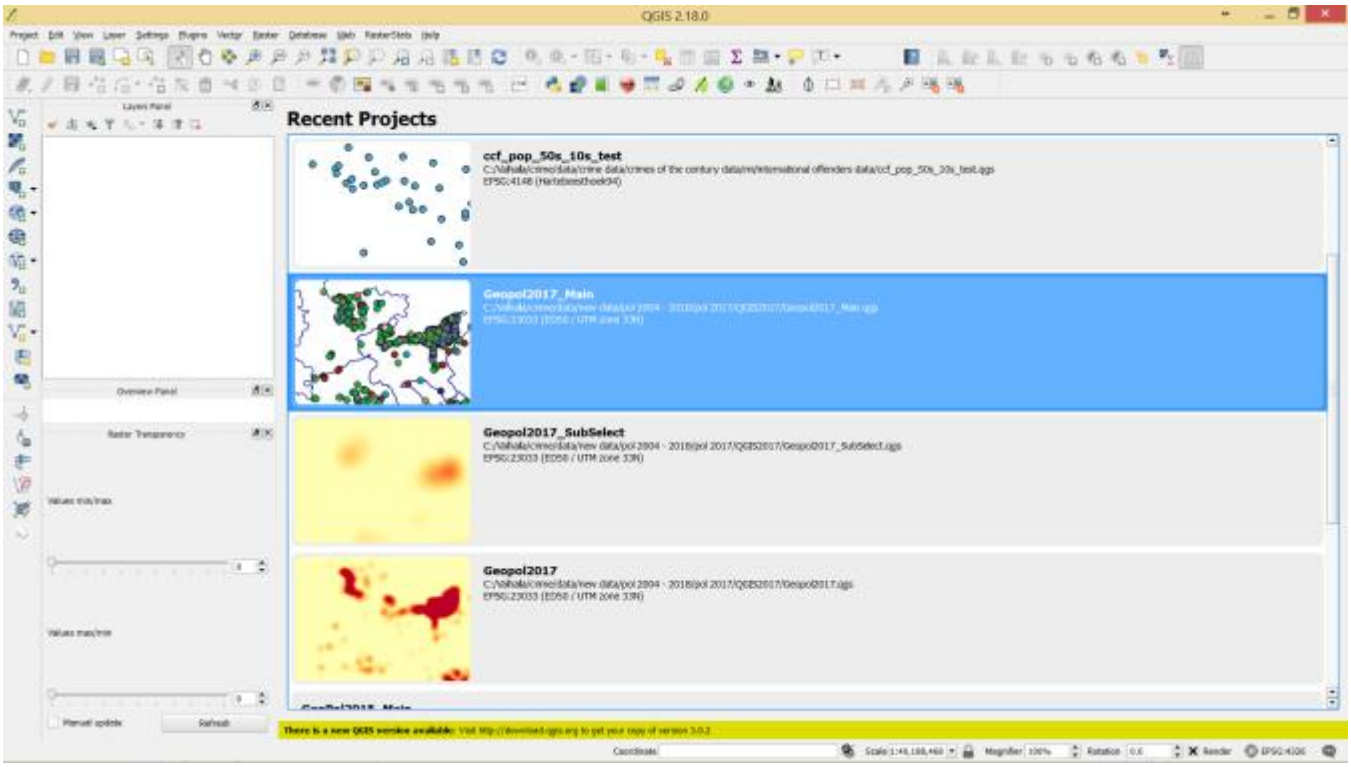
Document Verified By:

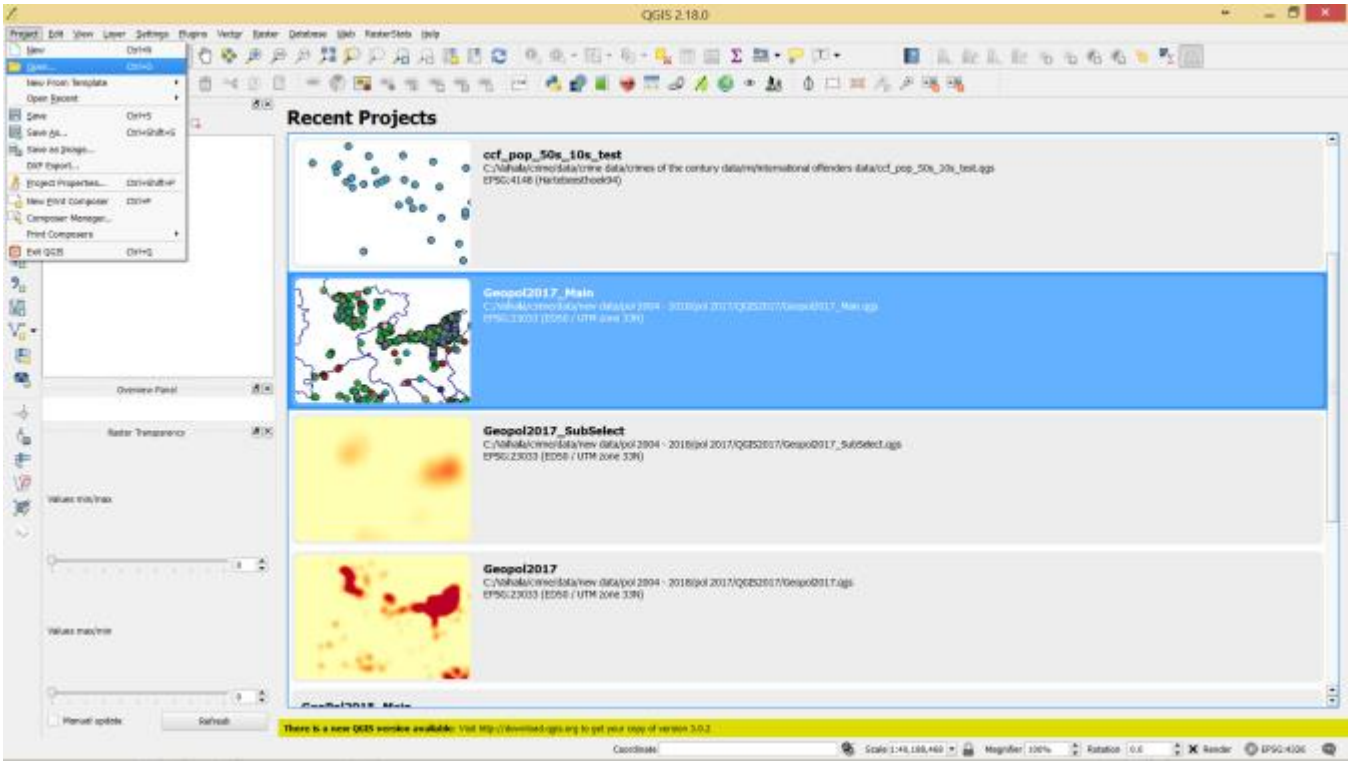
Abbreviations used: QGIS – Quantum GIS

Figure 1

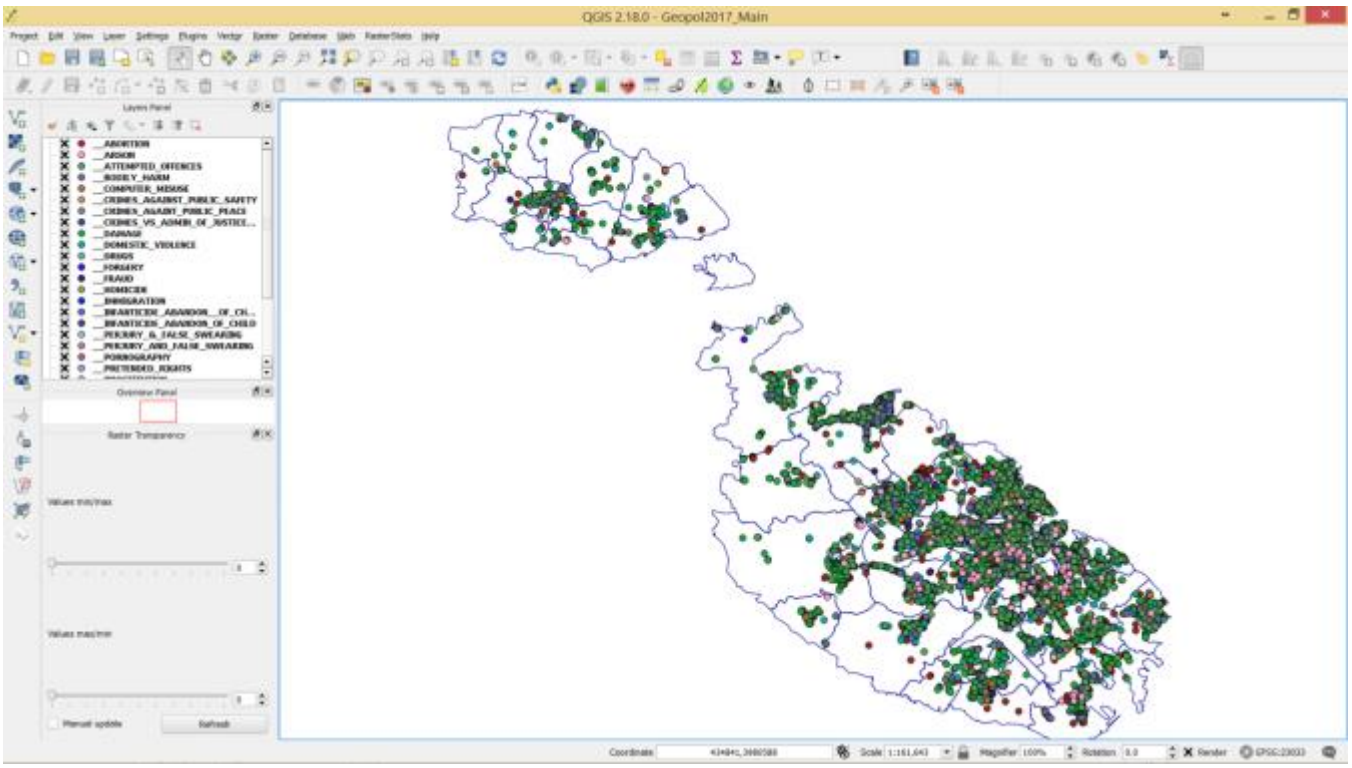


Load a project

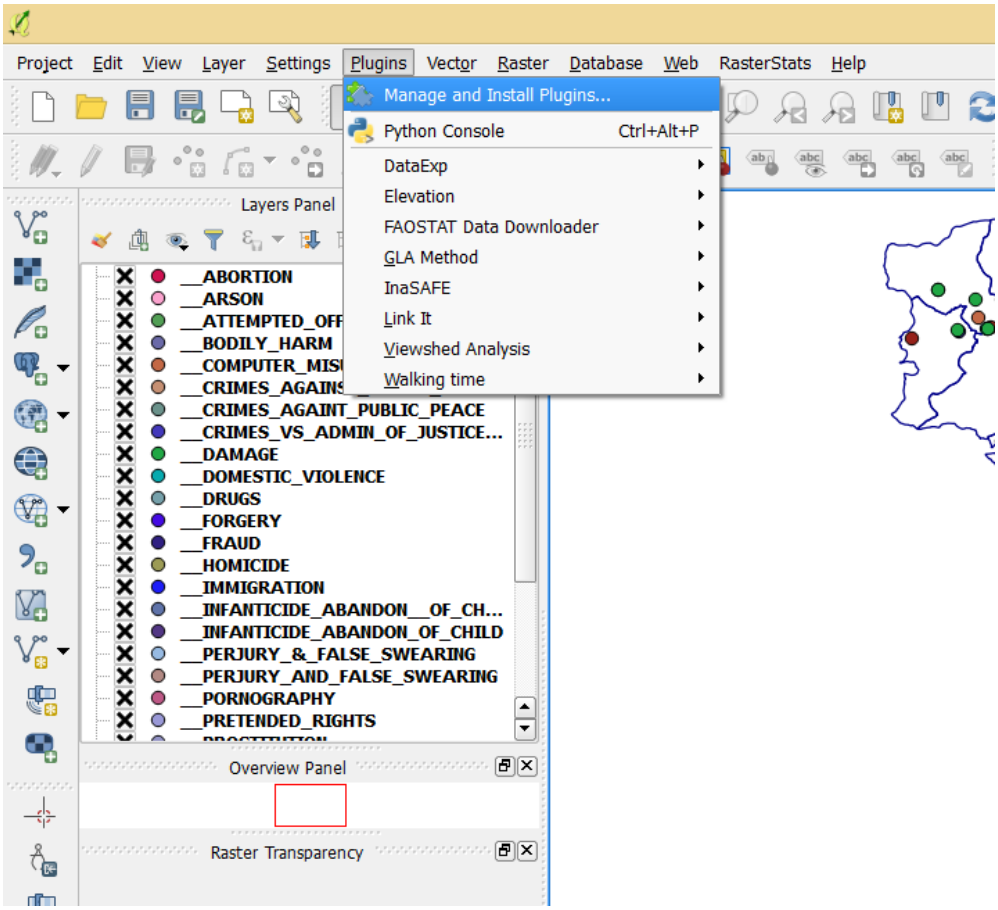




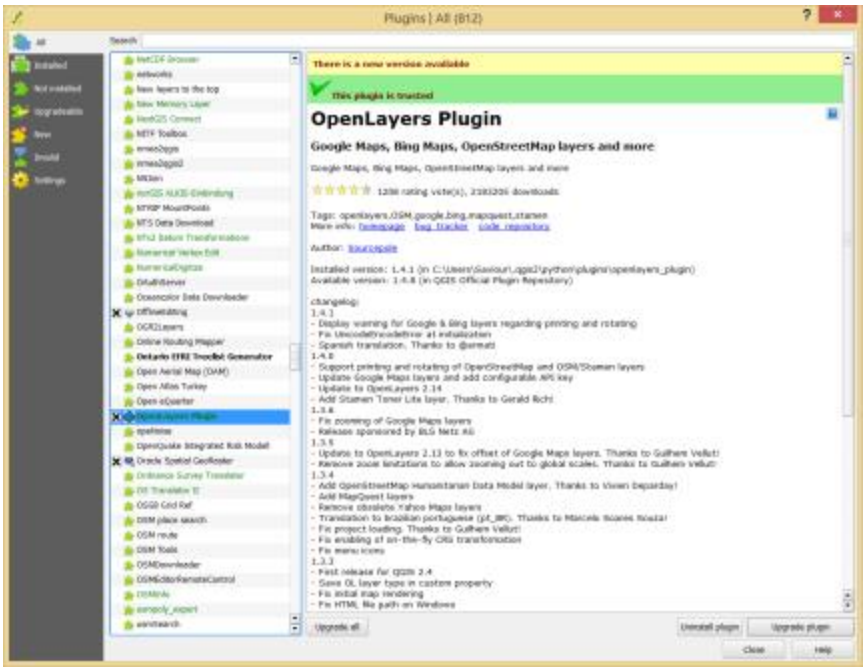
Data layers are loaded in the GI map window



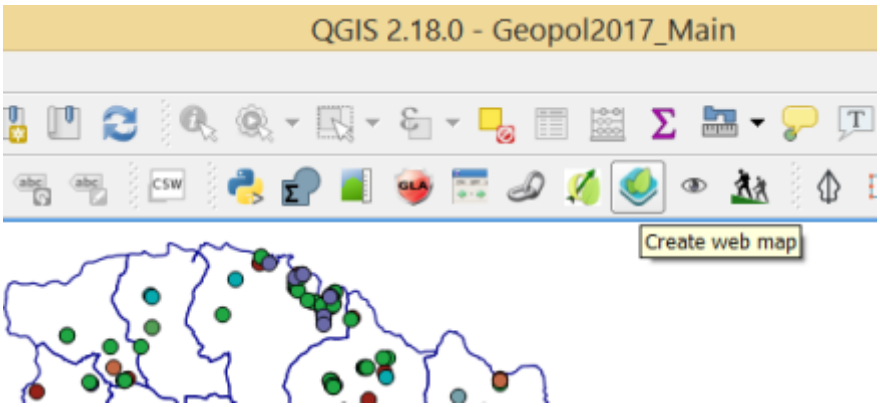
Under plugins load: Manage and Install Plugins



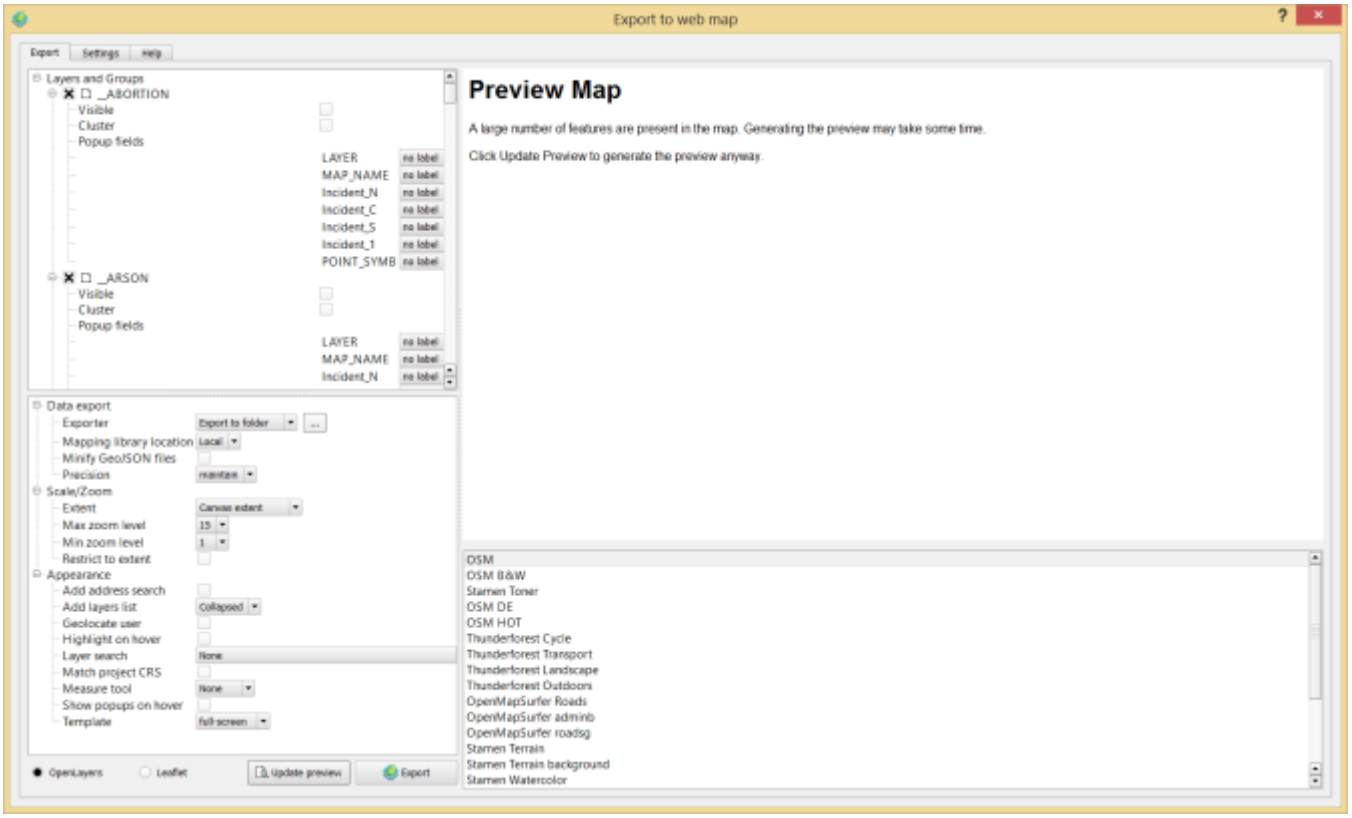
Choose OpenLayers Plugin



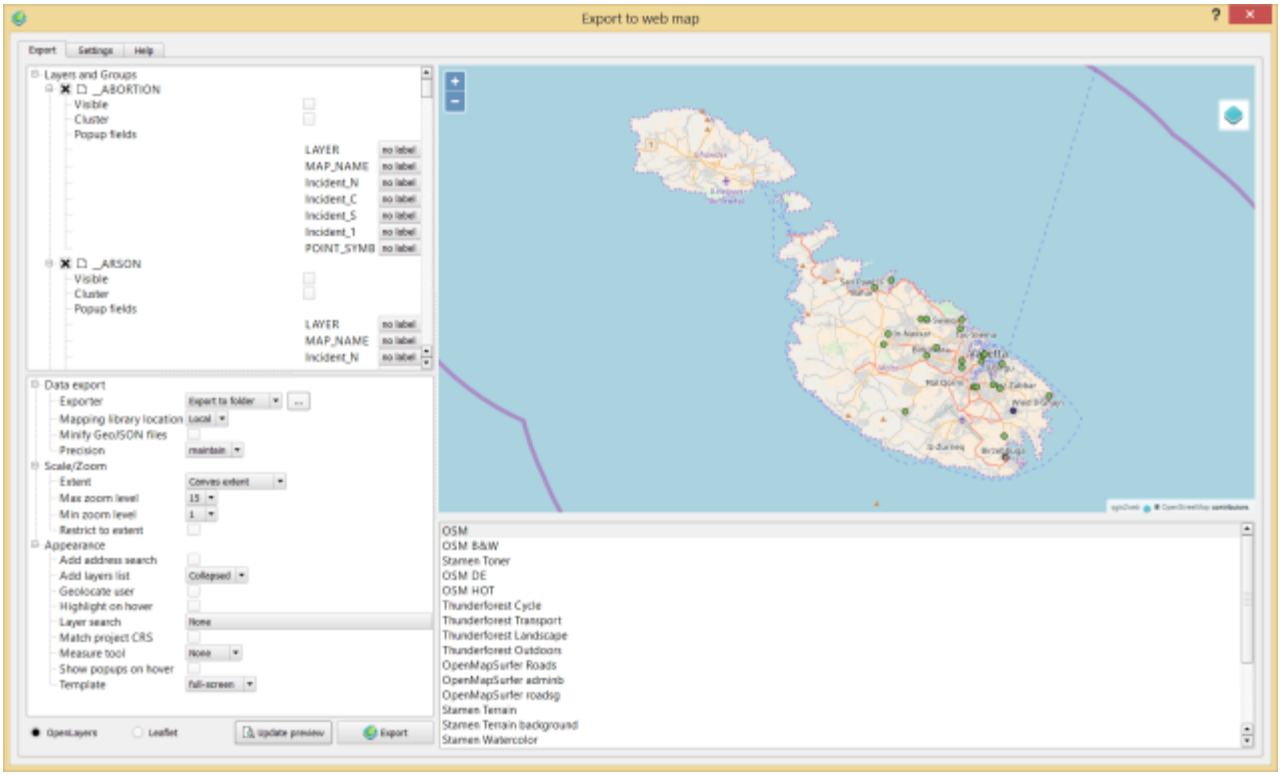
To activate the app click on the "Create Webmap App"



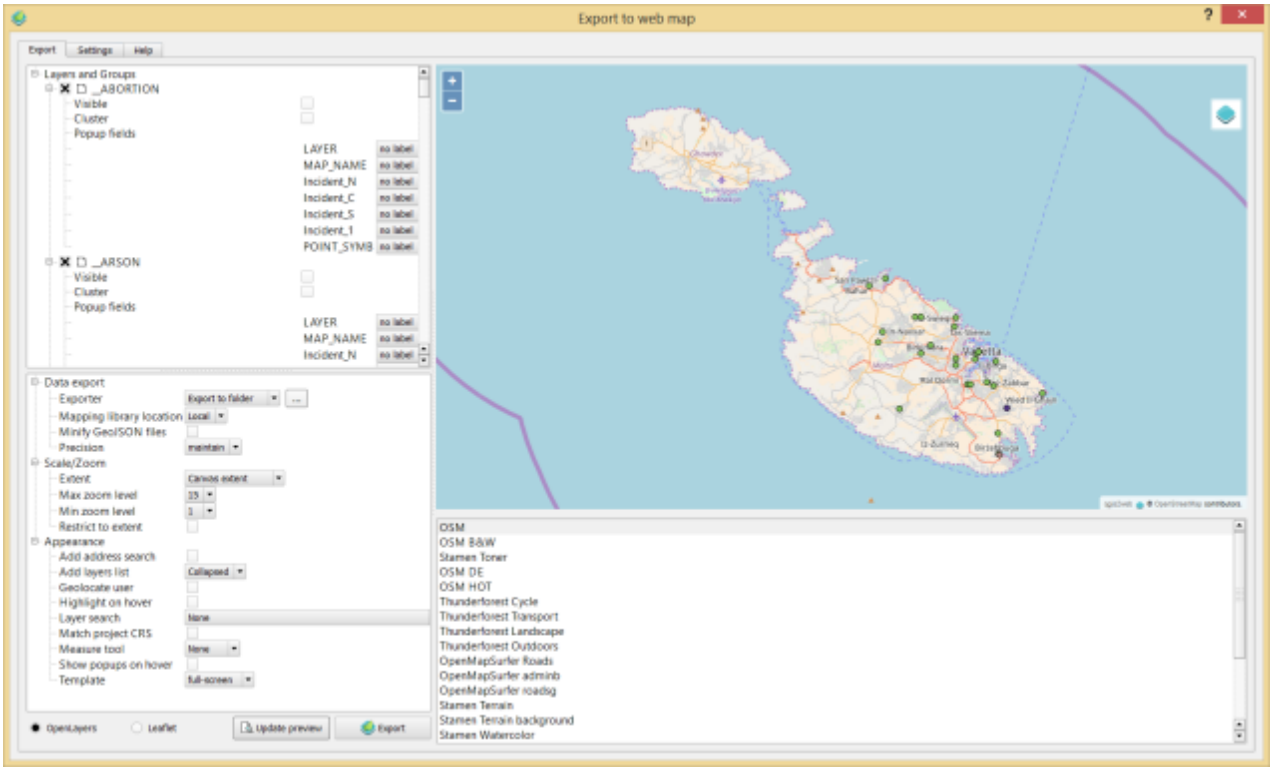
Choose the OSM map on the bottom right



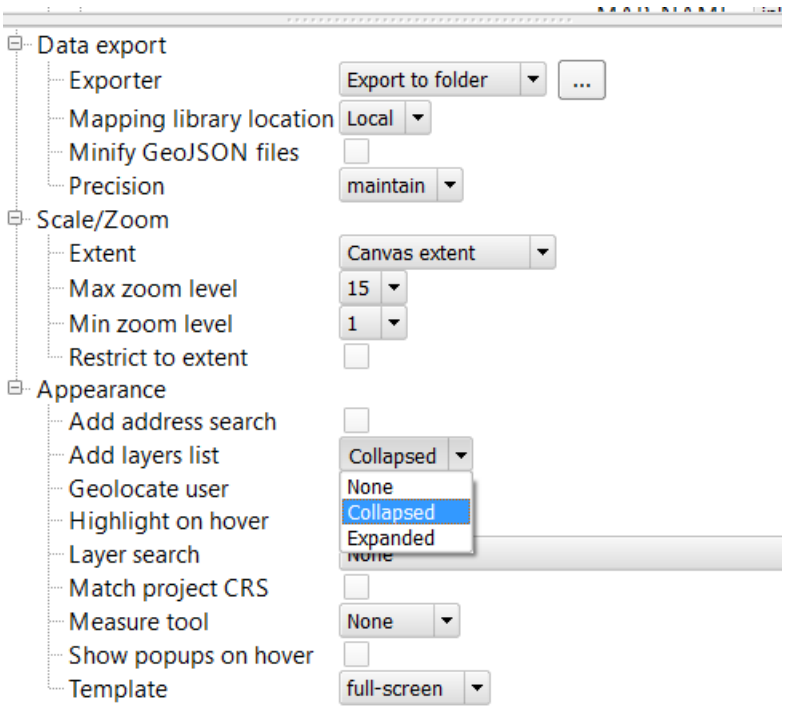
And click "Update Preview"



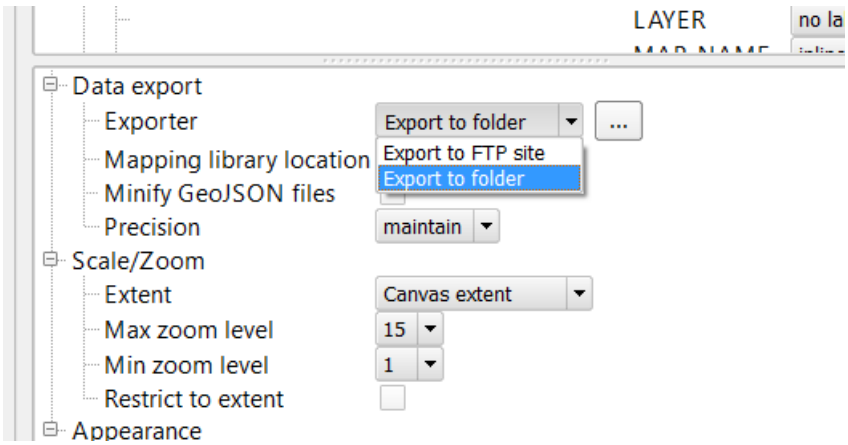
Choose the layers from the top left window that one wishes to upload onto the web:



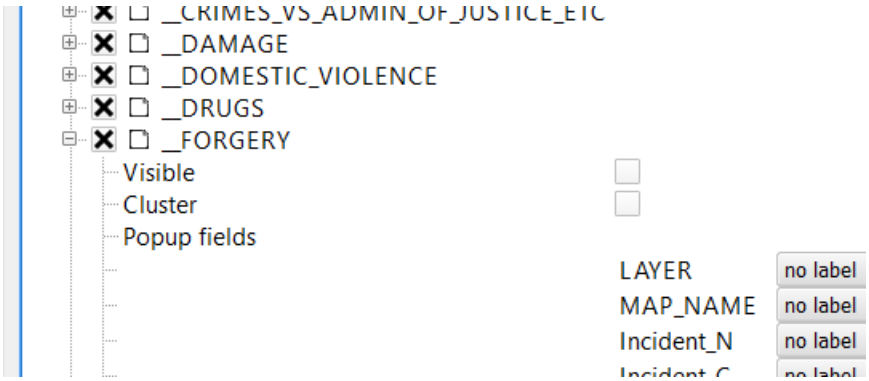
In the bottom left pane choose "Add layers list" as collapsed



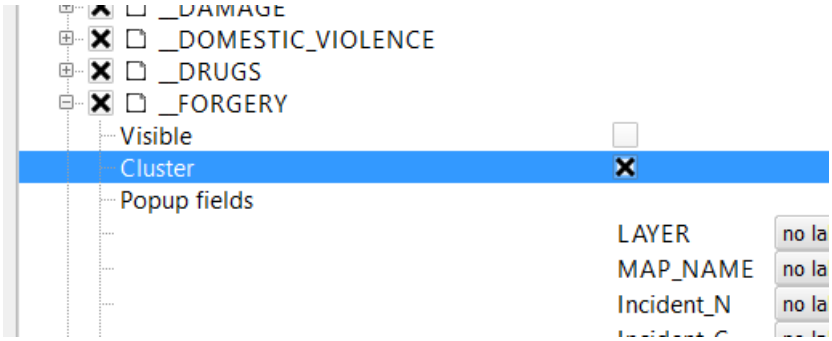
Click on export to folder and choose a saved folder location, where the webmaps will be saved:



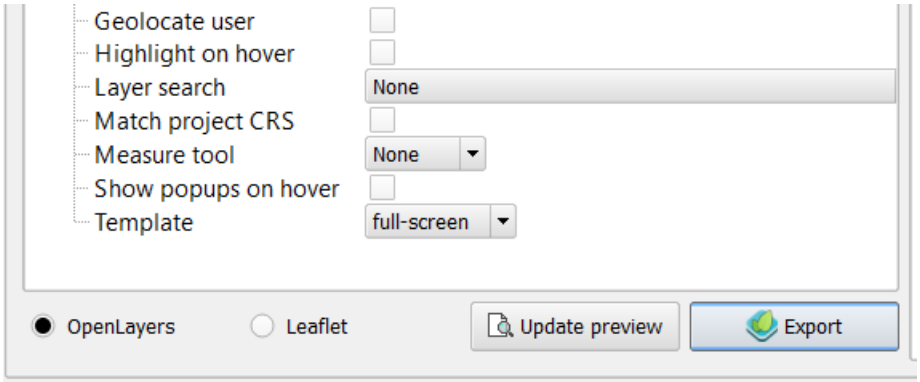
For maps that require a basemap only (such as OSM) map showing, the unclick the Visible map tickbox.

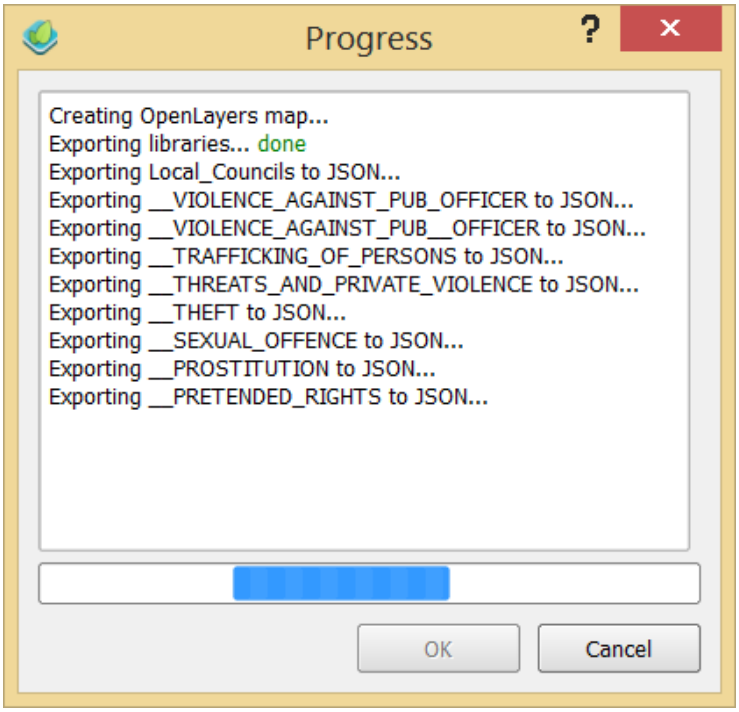


For maps that require cluster mapping (a map that depicts clusters changing size on zooming) click the Cluster tickbox.

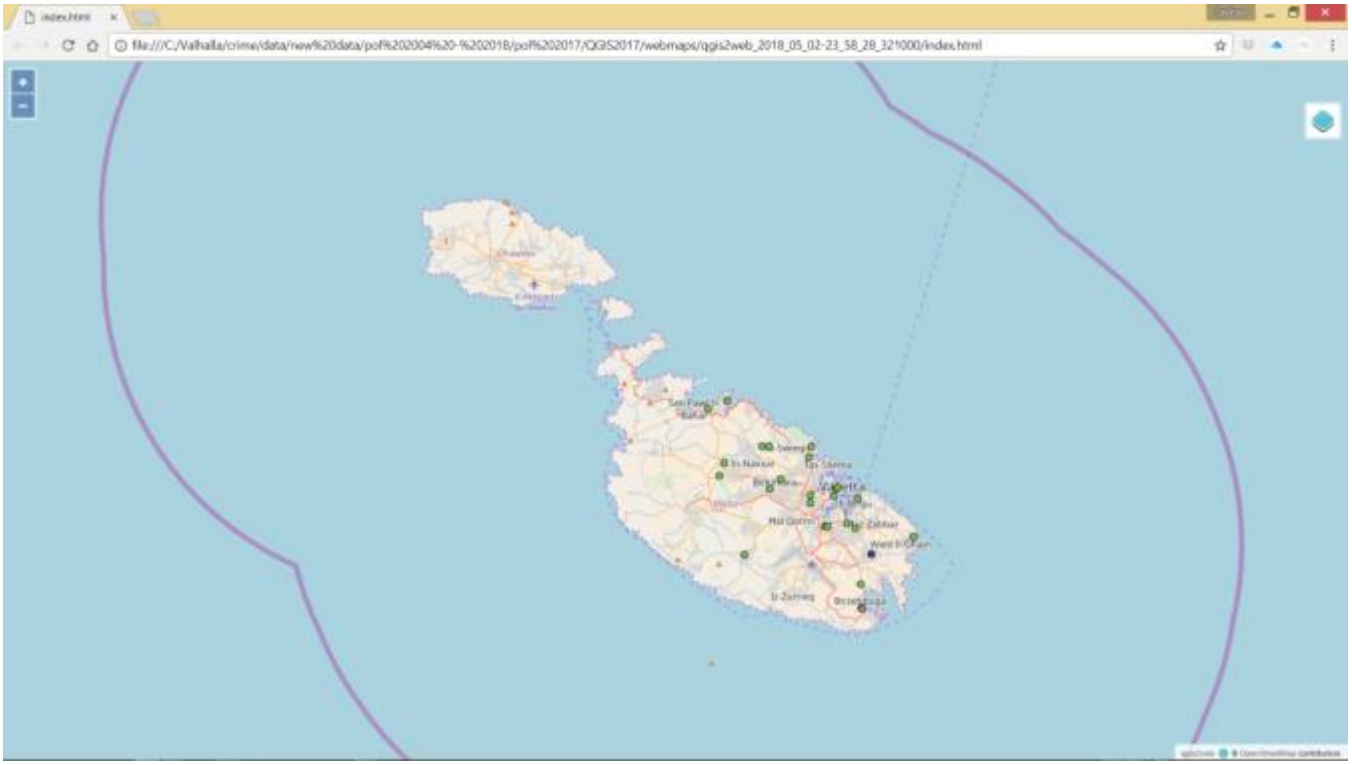


Click on export to create the webmap



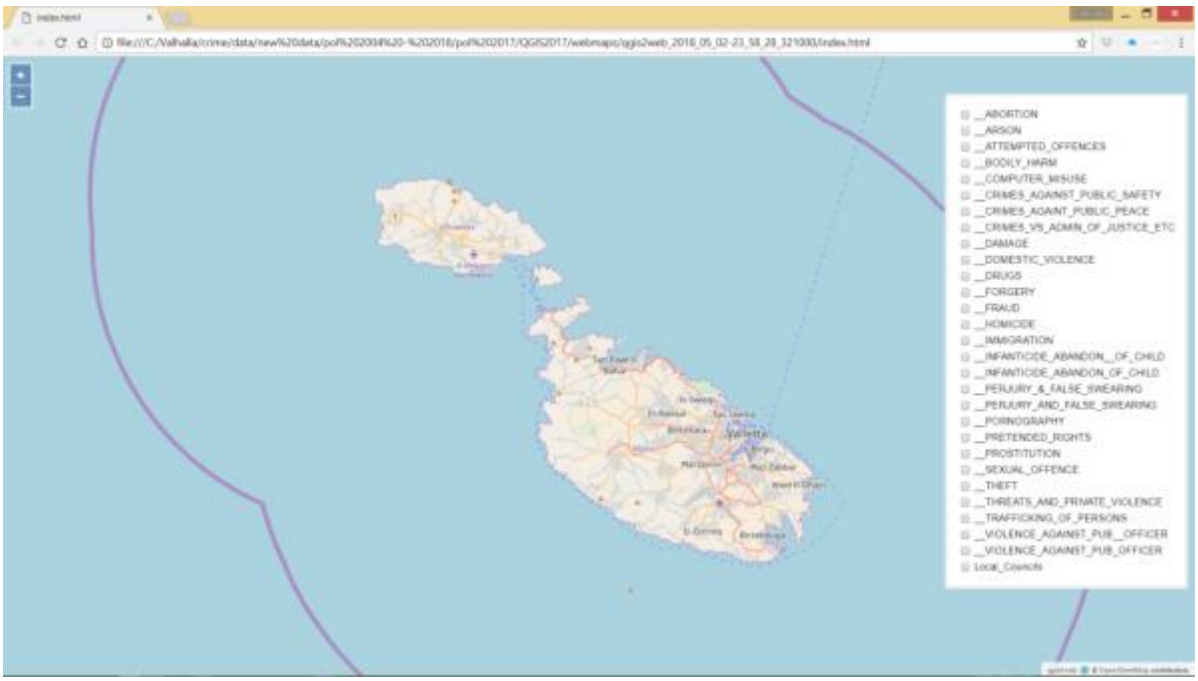


The tool will save and open the webmap in a web browser:

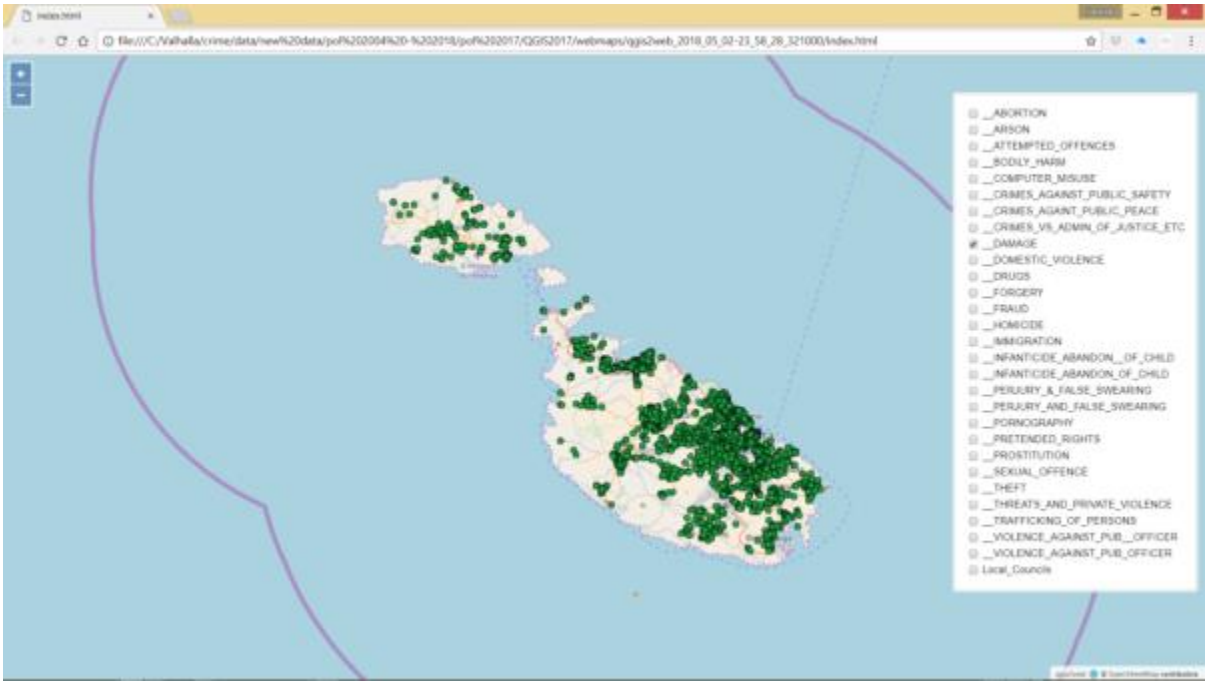


Click on the left buttons to zoom in or out (or use the mouse wheel).

Click on the right hand layers button to choose the layer that one wishes to view:

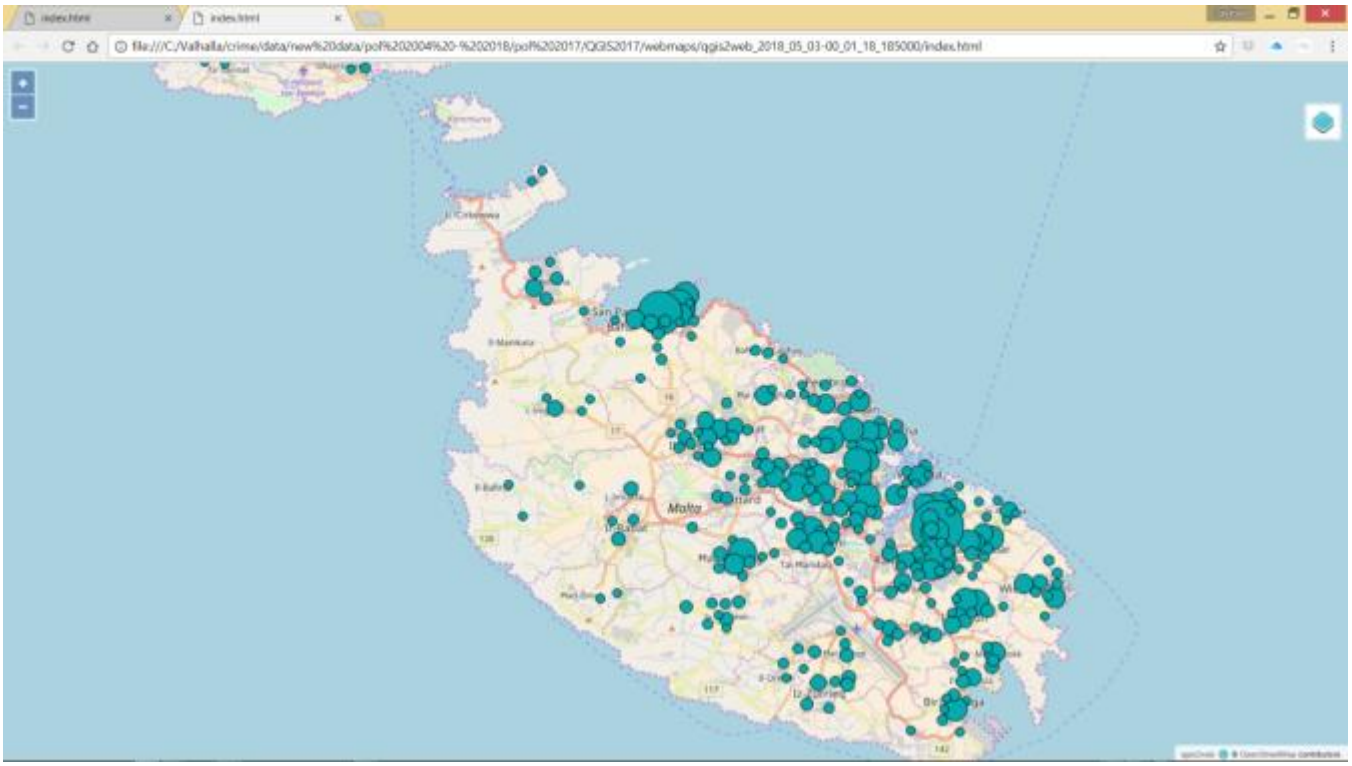


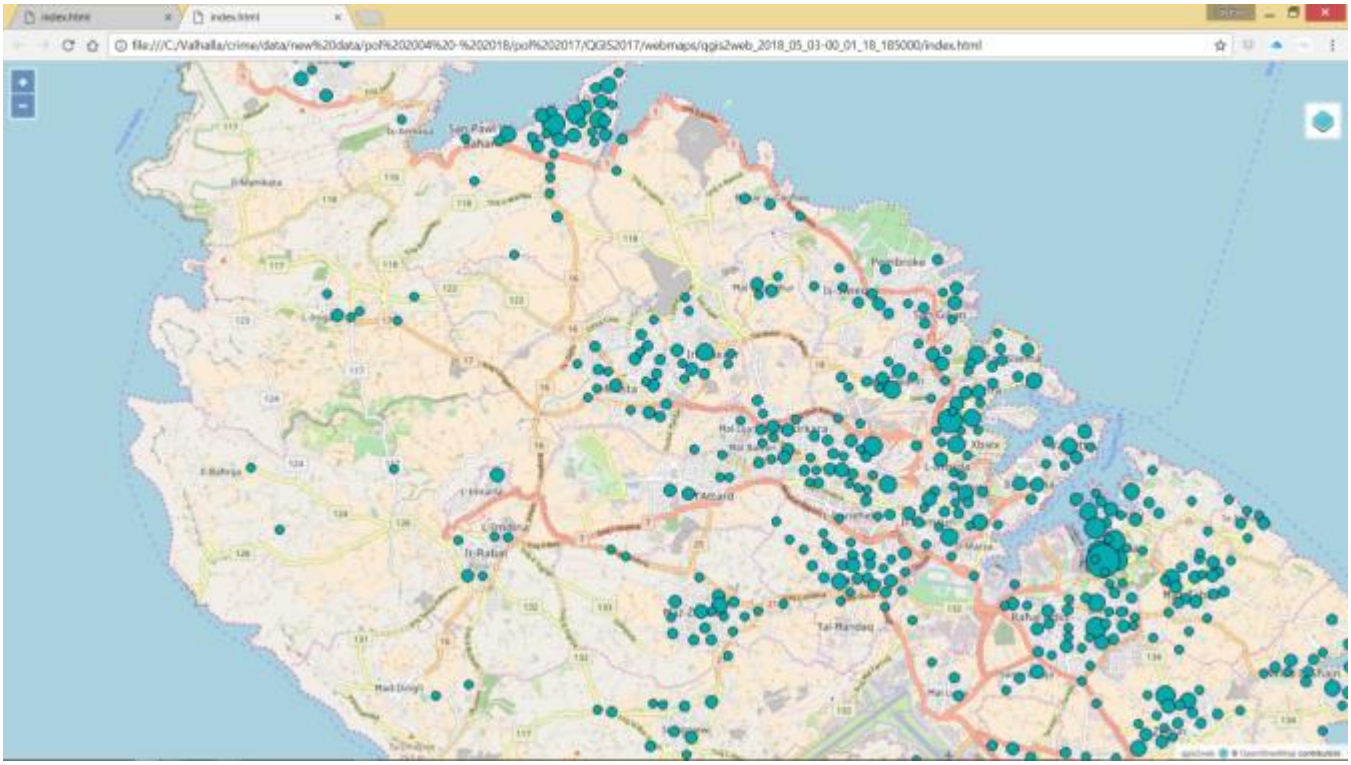
Points layer

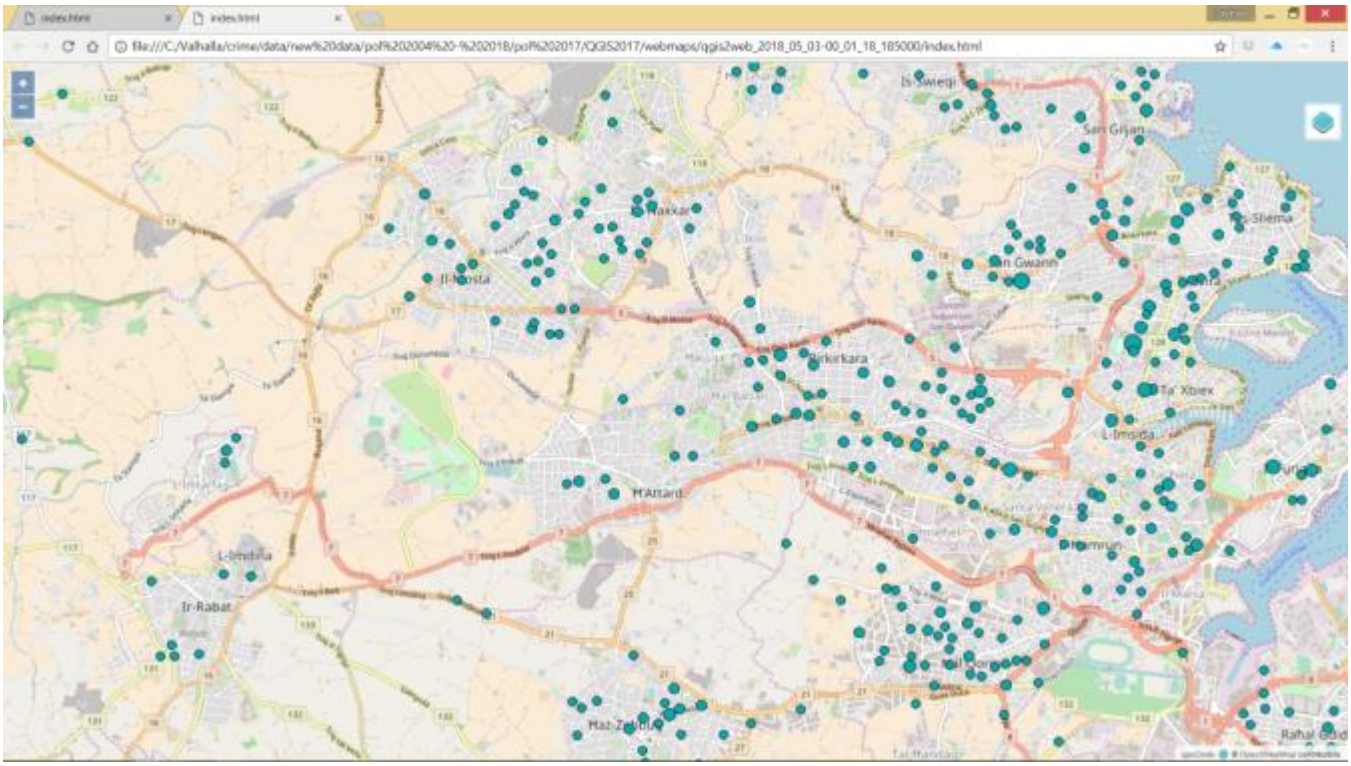


Cluster map


_ABORTION
_ARSON
_ATTEMPTED_OFFENCES
_BODILY_HARM
_COMPUTER_MISUSE
_CRIMES_AGAINST_PUBLIC_SAFETY
_CRIMES_AGAINT_PUBLIC_PEACE
_CRIMES_VS_ADMIN_OF_JUSTICE_ETC
_DAMAGE
_DOMESTIC_VIOLENCE
_DRUGS
_FORGERY
_FRAUD
_HOMICIDE
_IMMIGRATION
_INFANTICIDE_ABANDON__OF_CHILD
_INFANTICIDE_ABANDON_OF_CHILD
PERJURY&_FALSE_SWEARING
_PERJURY_AND_FALSE_SWEARING
_PORNOGRAPHY
_PRETENDED_RIGHTS
_PROSTITUTION
_SEXUAL_OFFENCE
_THEFT
_THREATS_AND_PRIVATE_VIOLENCE
_TRAFFICKING_OF_PERSONS
_VIOLENCE_AGAINST_PUB__OFFICER
_VIOLENCE_AGAINST_PUB_OFFICER
Local_Councils


Malta

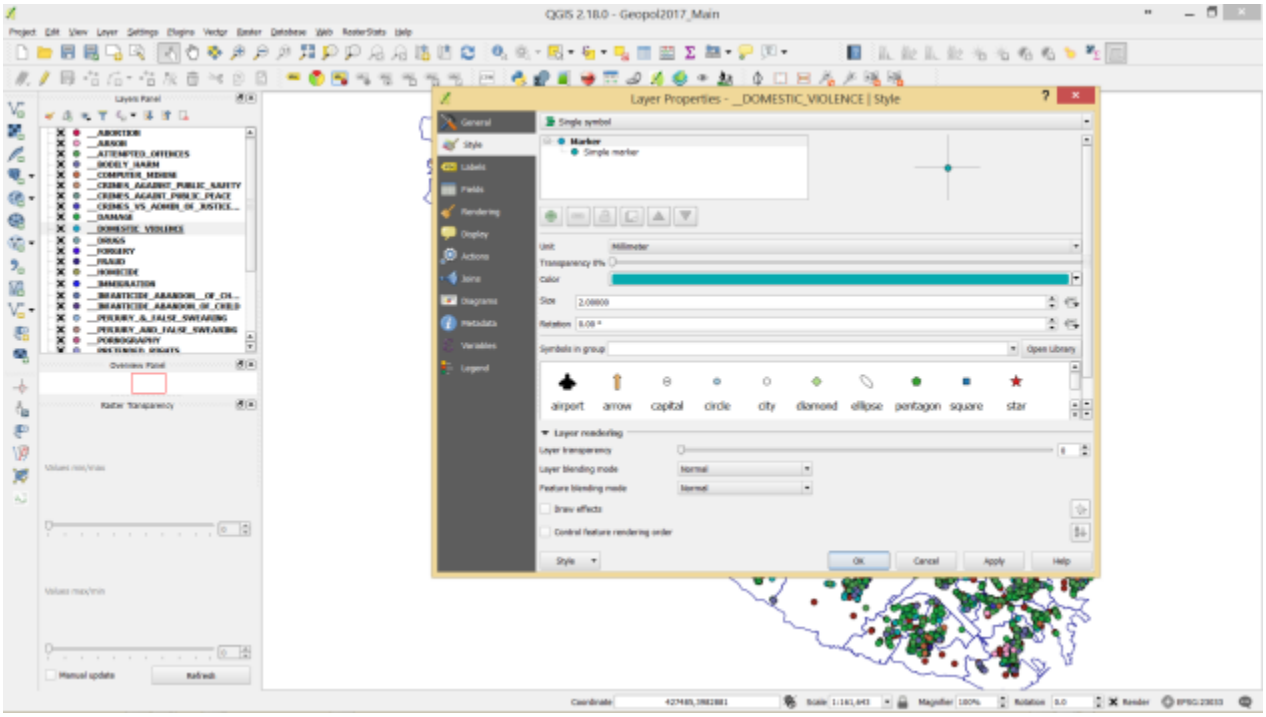


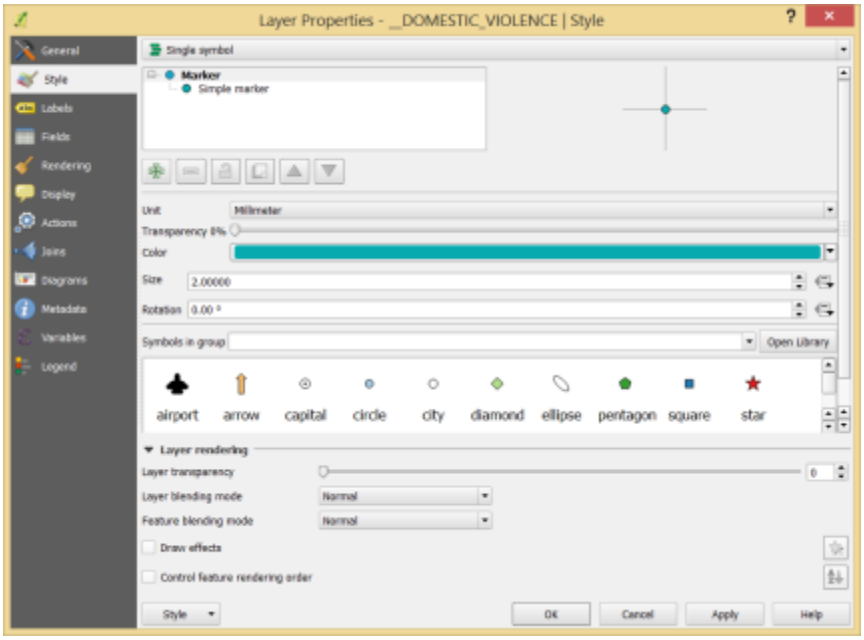


Styles such as heatmap:

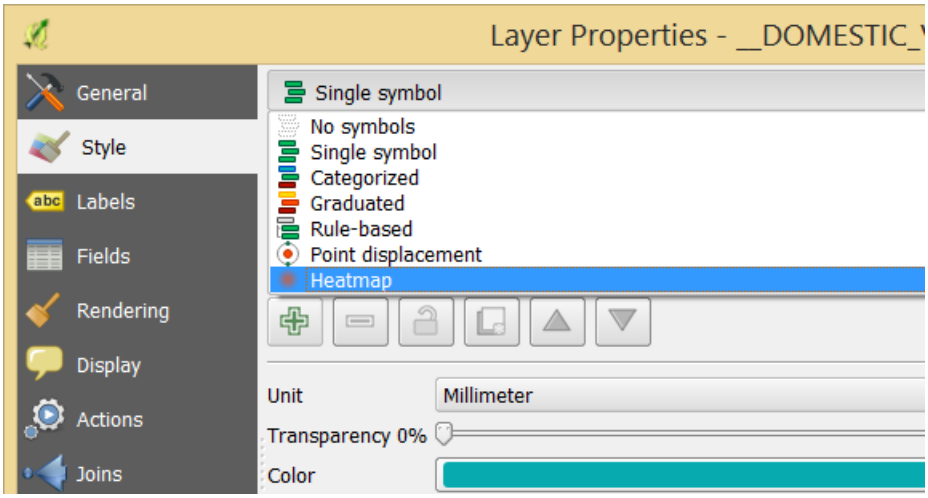
To create maps such as a heatmap one needs to create the new layer from the style table:

Doubleclick on the layer and a popup window is displayed:

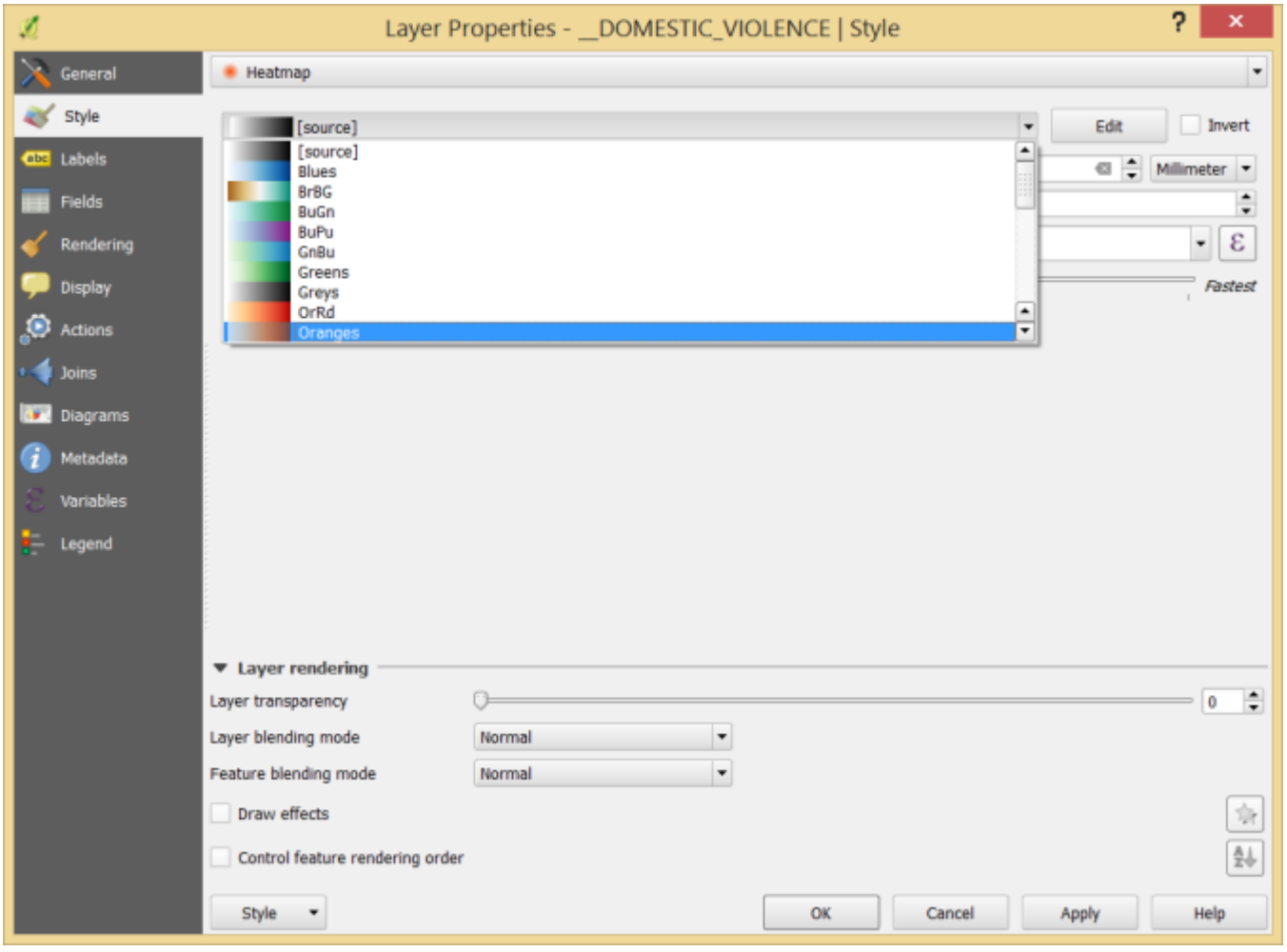




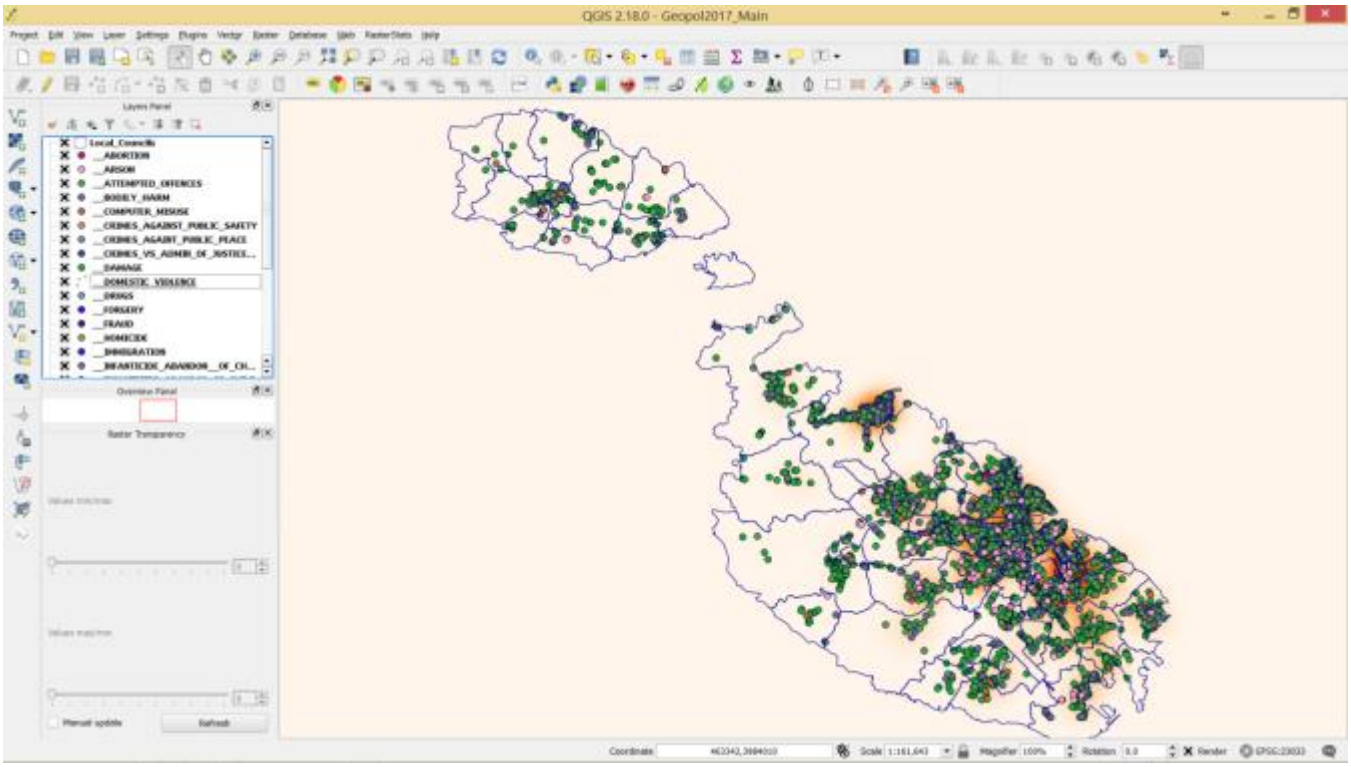
Double click on Single symbol and choose heatmap

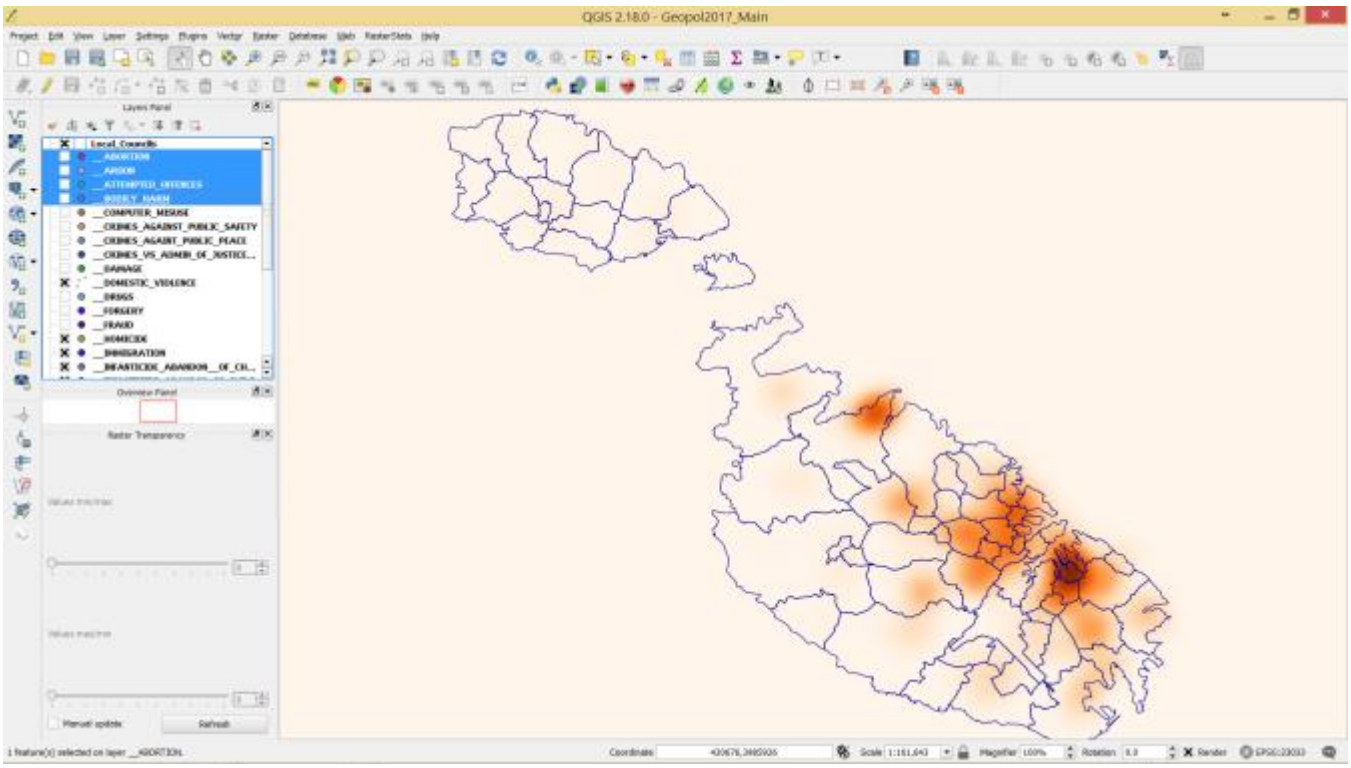


Choose heatmap colour scheme

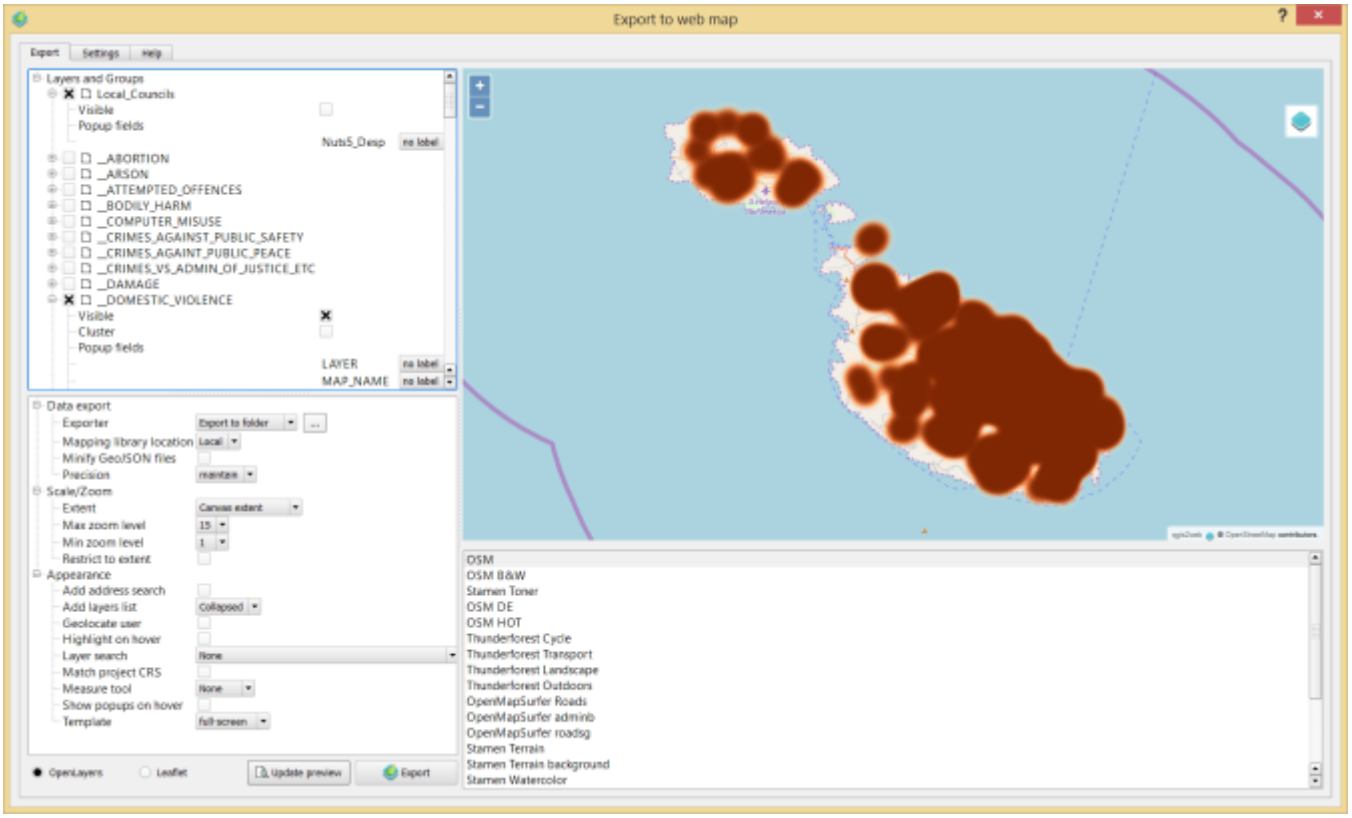


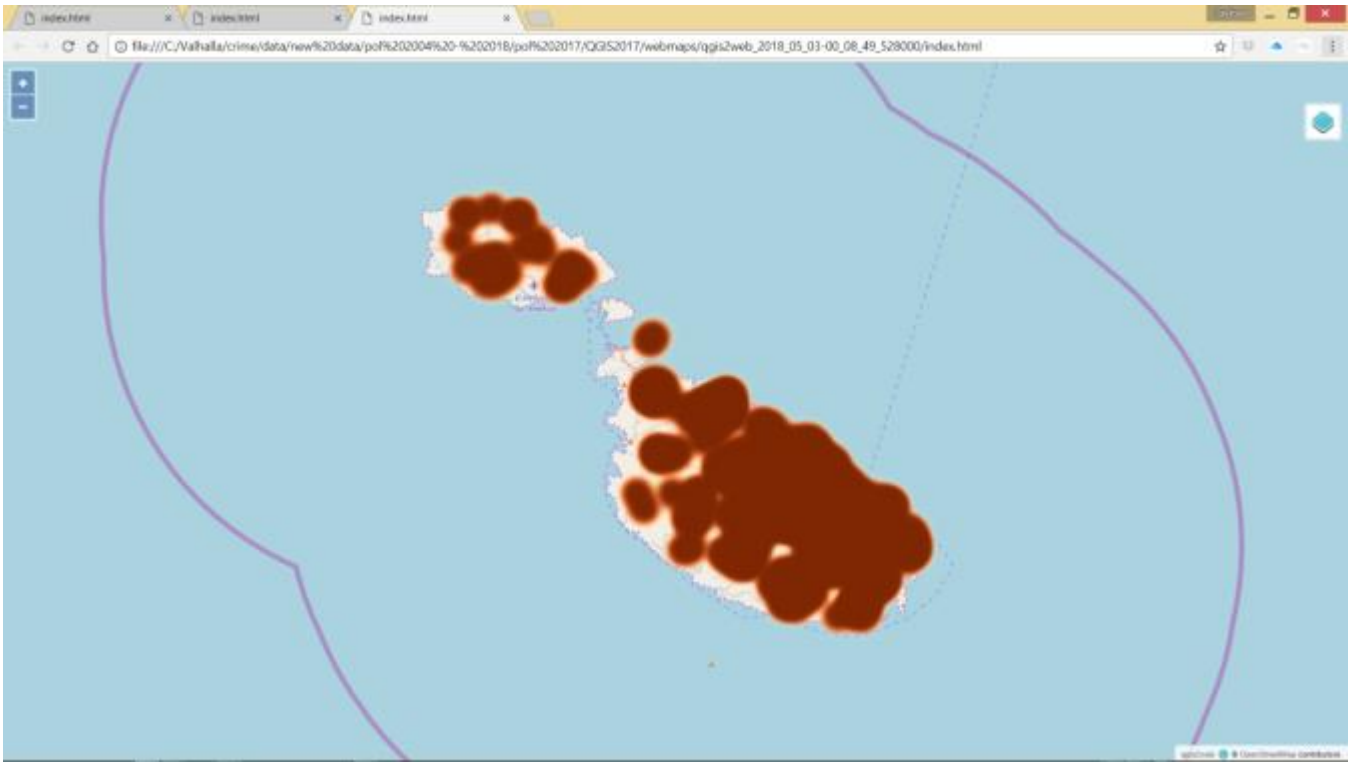
Click apply



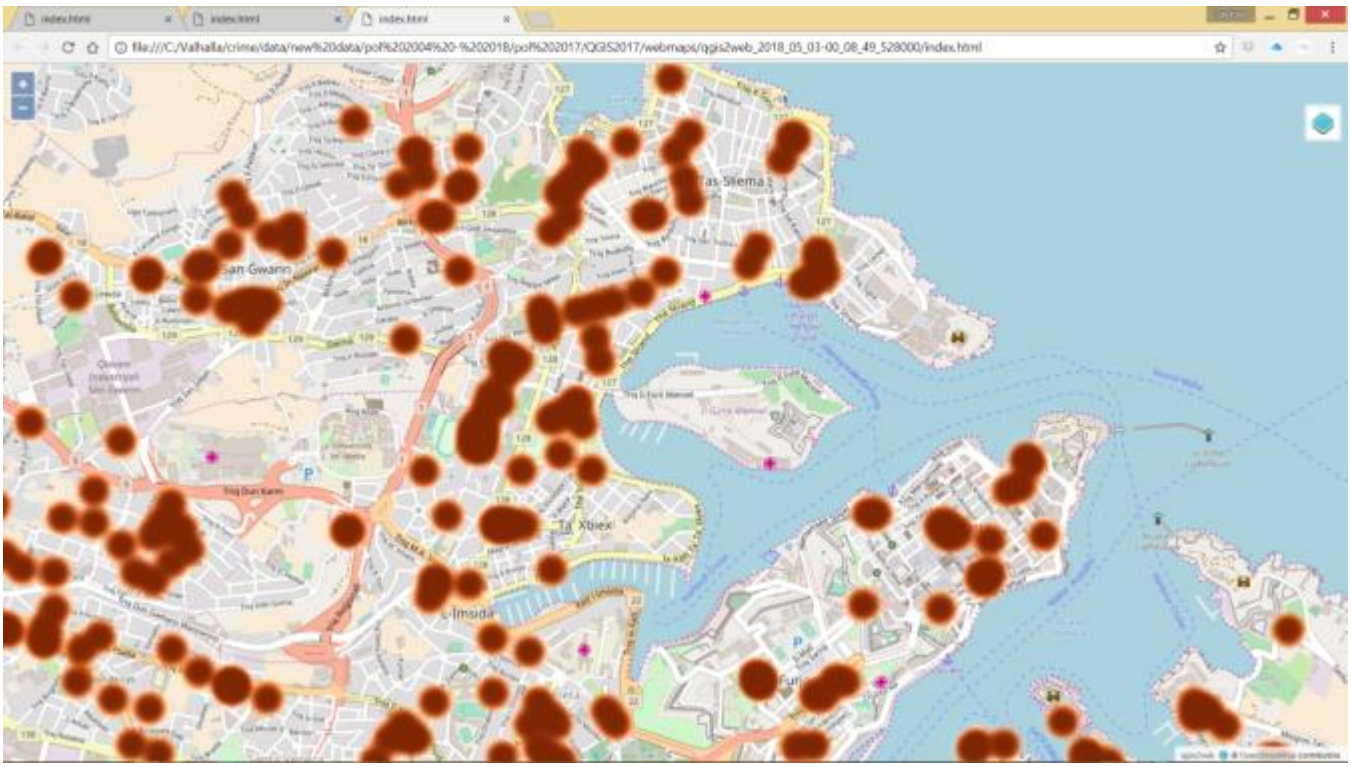


Export to webpage

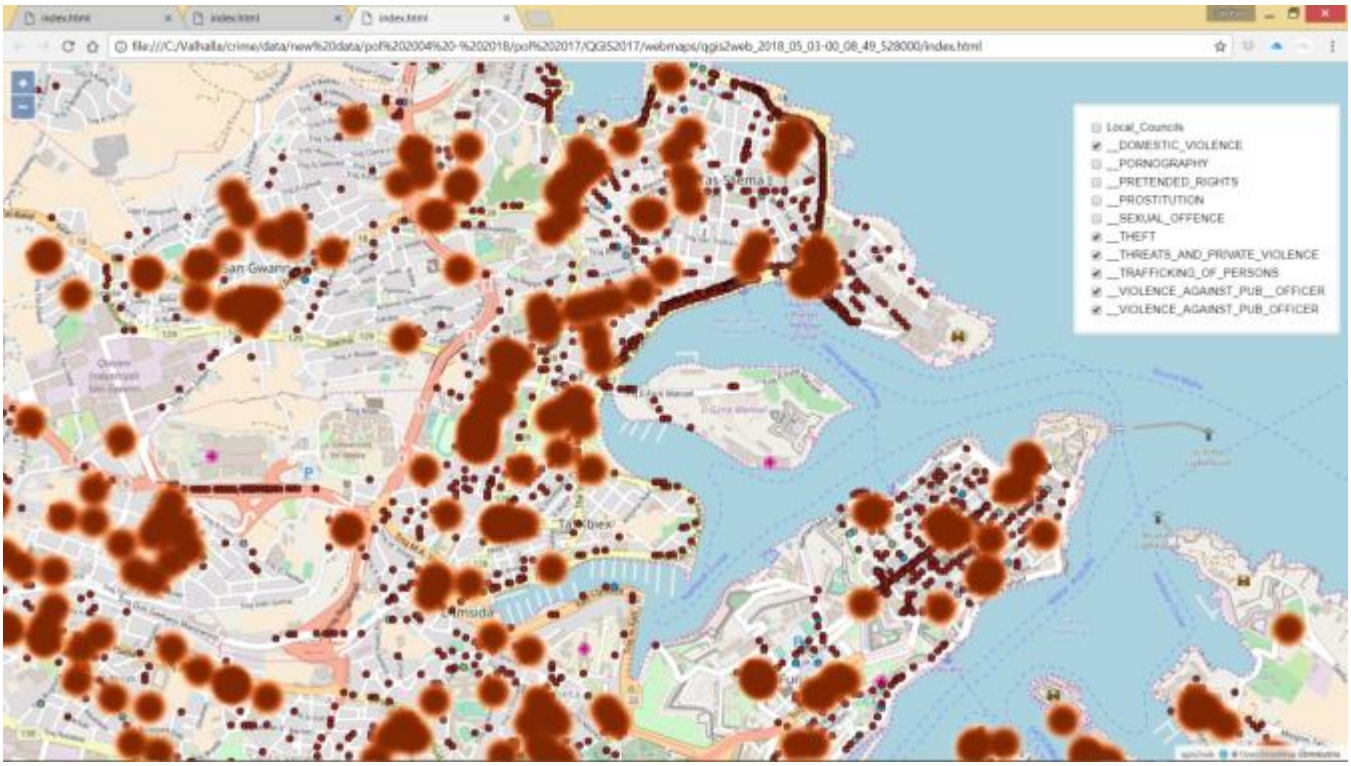




Zoom in and the heatmap is defined as one zooms in to reflect the concentration of thematic aspect one is viewing:

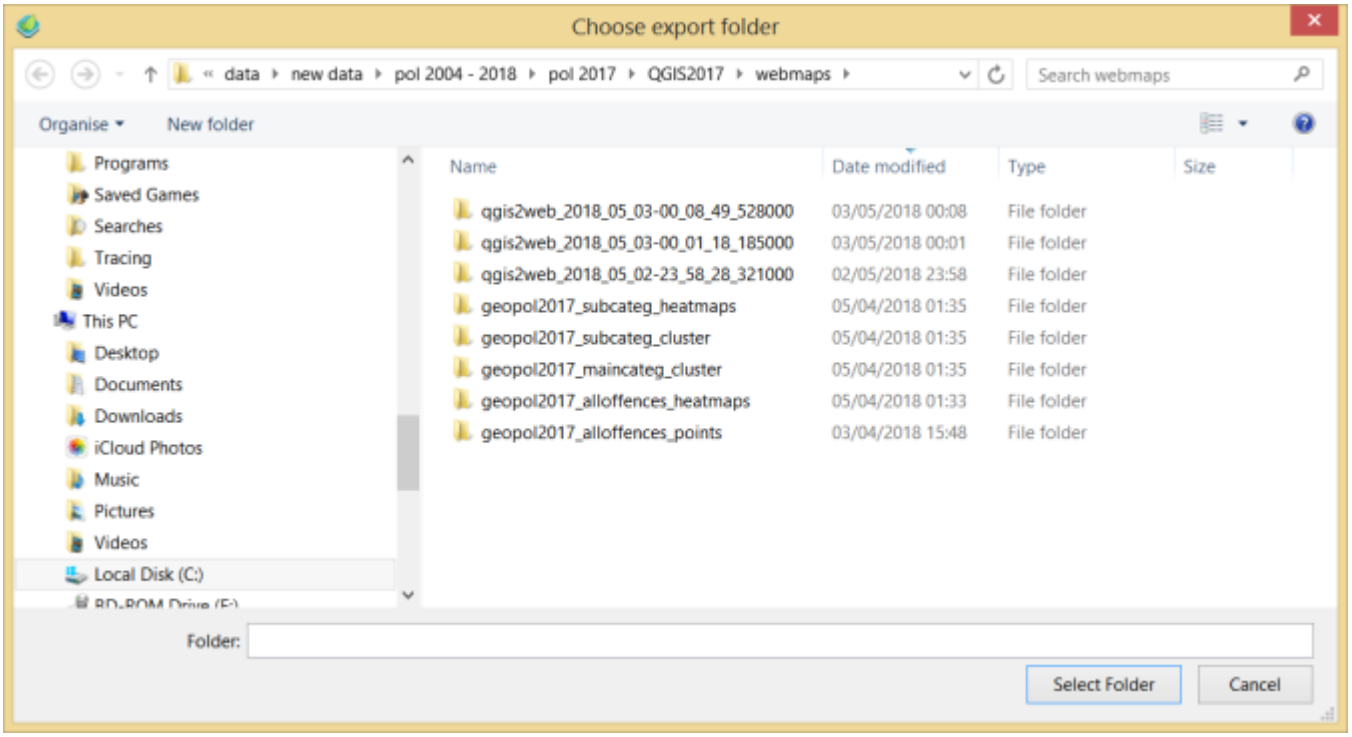


Multiple overlaying layers can be viewed



To save to a website:

ii) Copy the entire saved folder to the web either through ftp or
iii) contact web domain administrator to upload file as best detailed in PA protocol



Appendix IV - Training Manual forCreation of File Geodatabase in Arcmap 10.5

Lineage Documents

Project: Creation of File Geodatabase in Arcmap 10.5

User: Omar Hili

Date: March 2018

Source File Name: First draft Document

Destination Directory: C:\Temp

Project Description: Quick guide on how to create and import data in a File Geodatabase

Document Verified By Brian Borg:

Abbreviations used: GDB - Geo database

Lineage Steps

Load ArcMap 10.5

From Catalog tree list, right click on Home, New ans File Geodatabase. In our case we are using the default ARC folder but any folder, over network or local storage can be chosen. The chosen folder will be the file GDB.

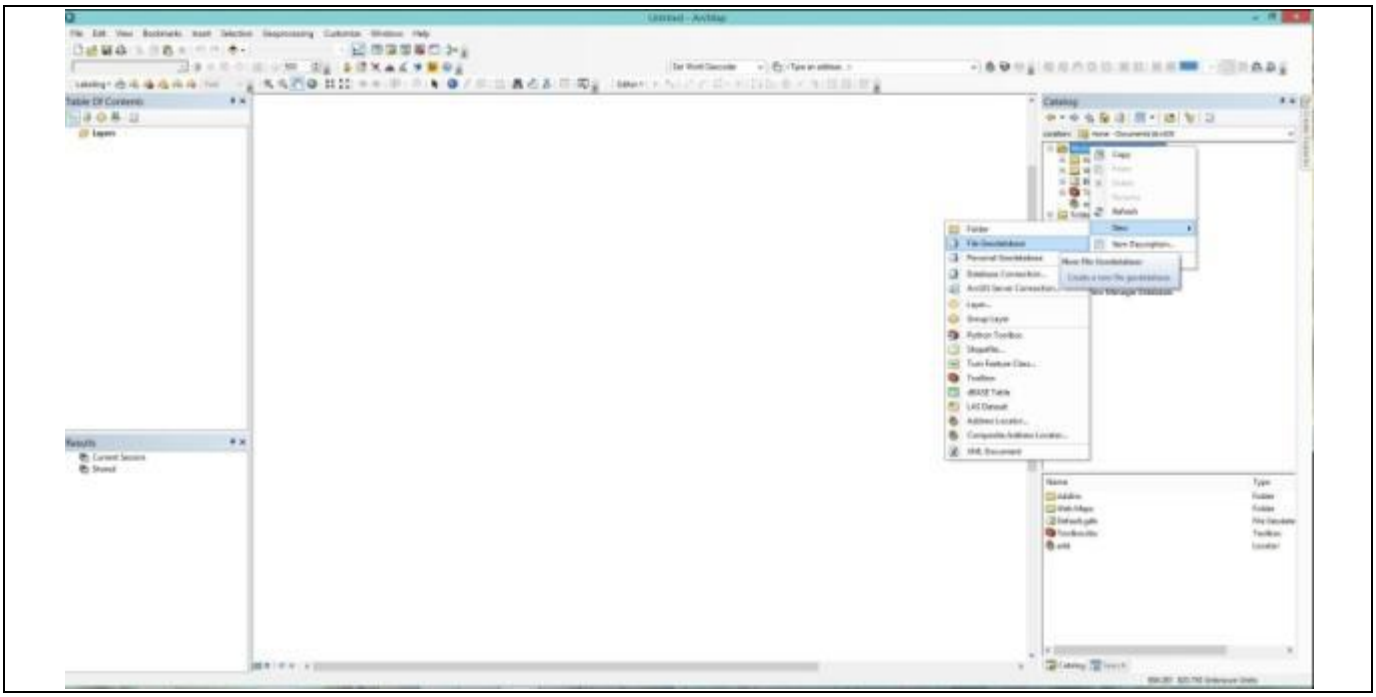


Figure 2 Creation of File Geodatabase

Once File Geodatabase is created please rename to desired GDB name. Right click on new database and rename.

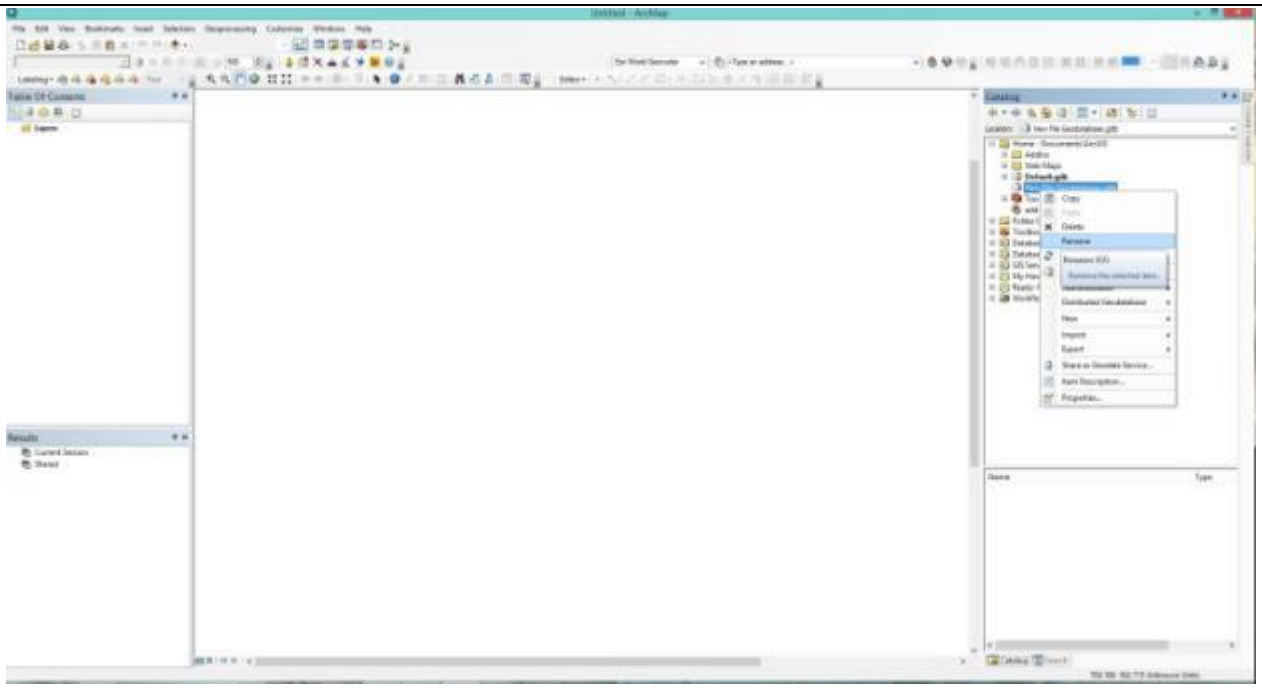


Figure 3 Rename of Geo-Database

Once Created the File Geodatabase has all features of features of a Web database without the Multi-user editing functionality. Different users can edit the data but not simultaneously.

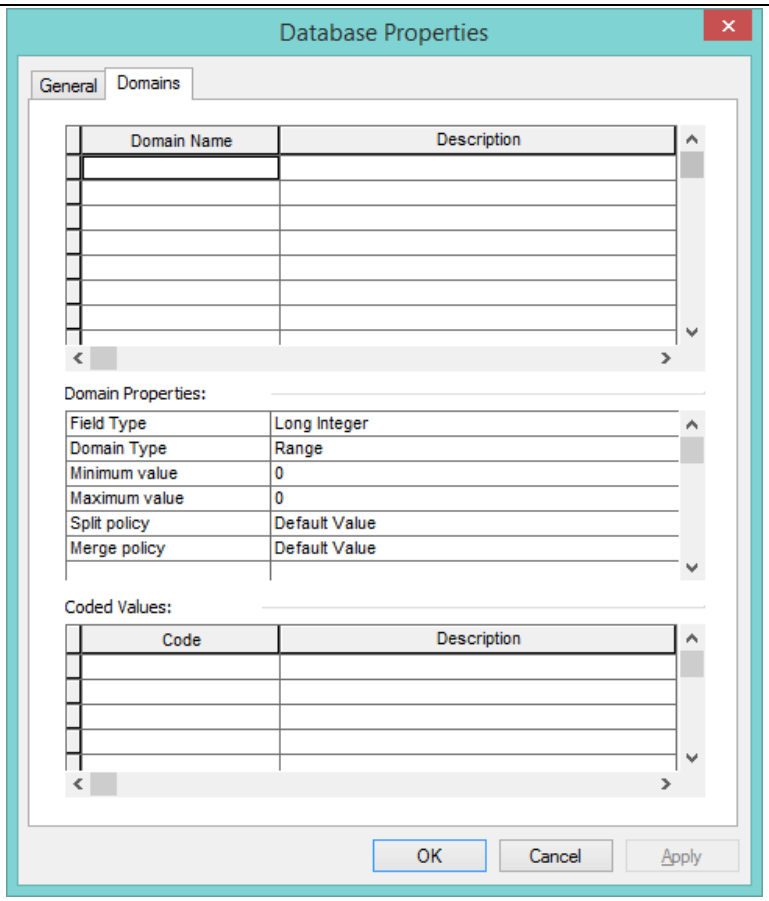


Figure 4 Details nd Functionality of Geodatabase

Create Feature Data classes or Raster catalogue to import Vector and Raster Data.

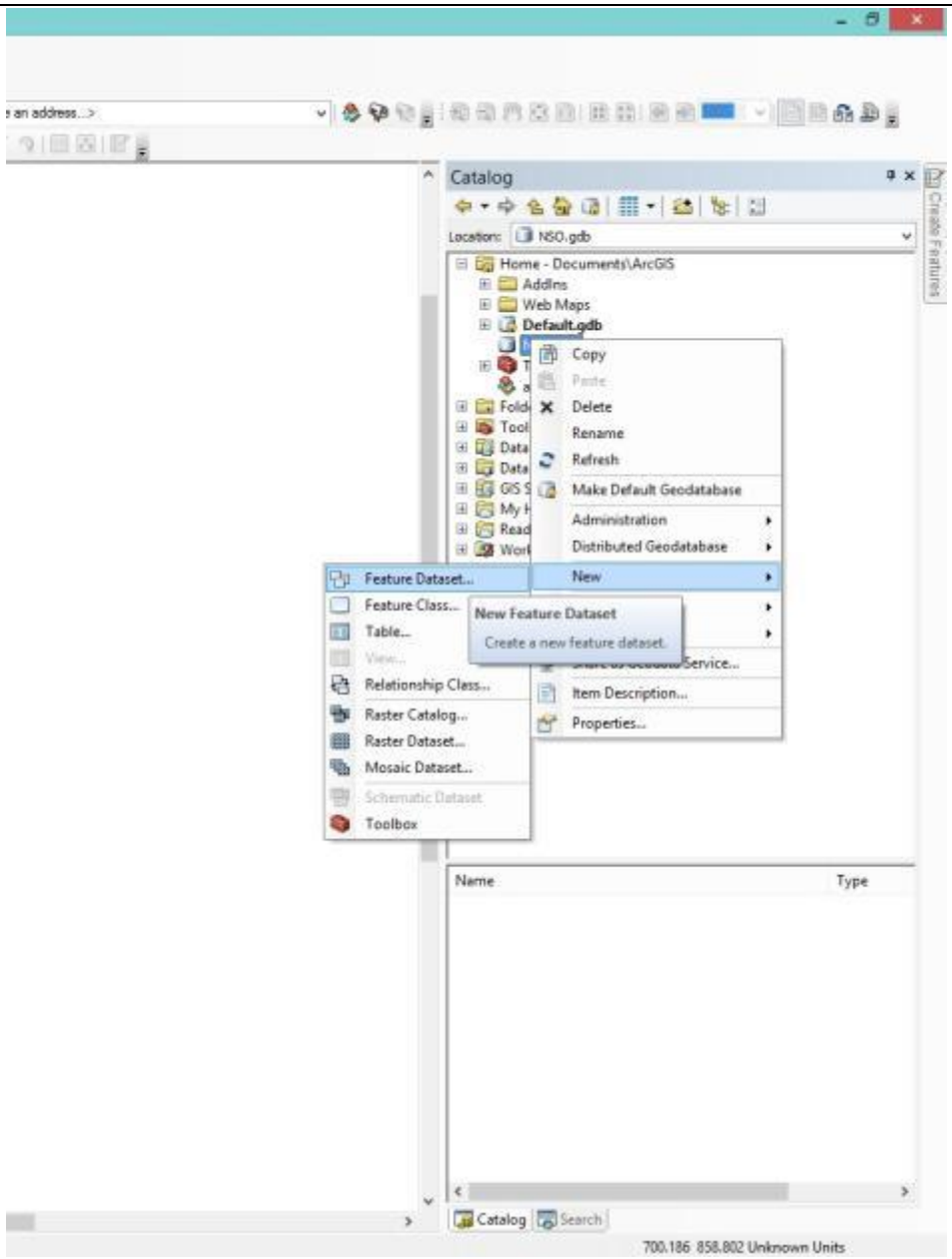


Figure 5 Creation of Feature Dataset and other options

Right click on the new PA.GBD will allow user to import and access other functionality for the Database.

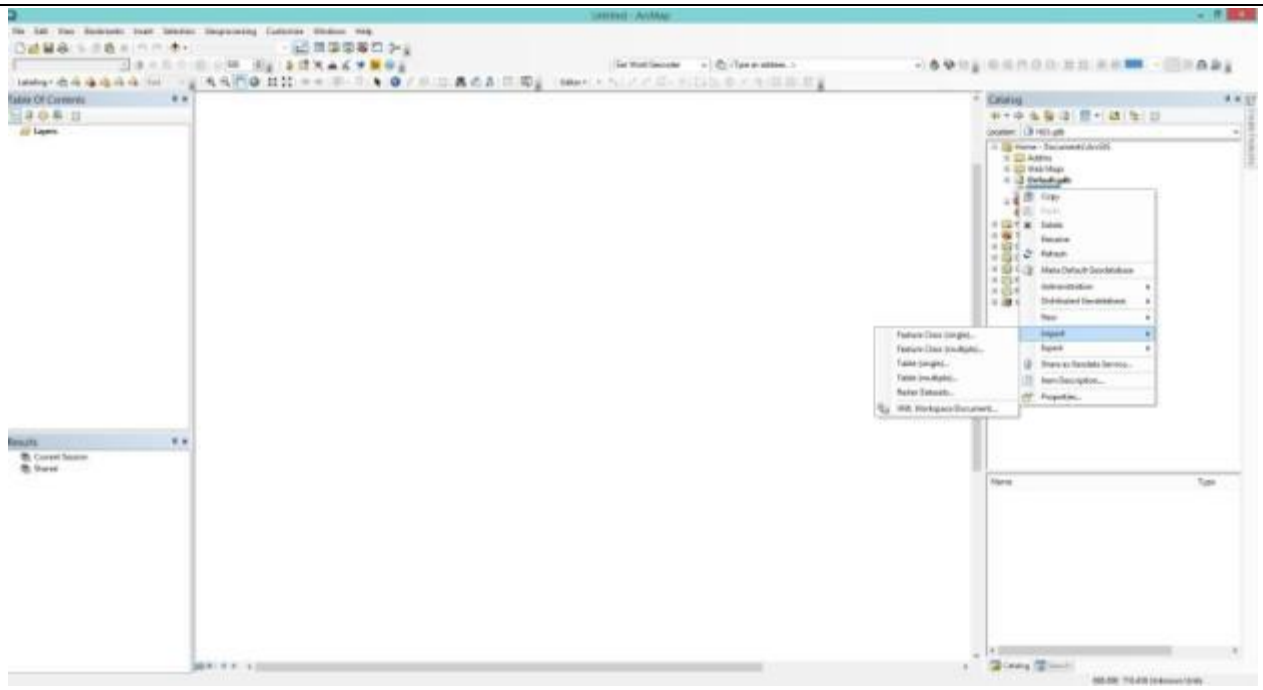


Figure 6 Import Functionality for PA.GDB

Importing a Feature dataset, select input shape and output feature class.

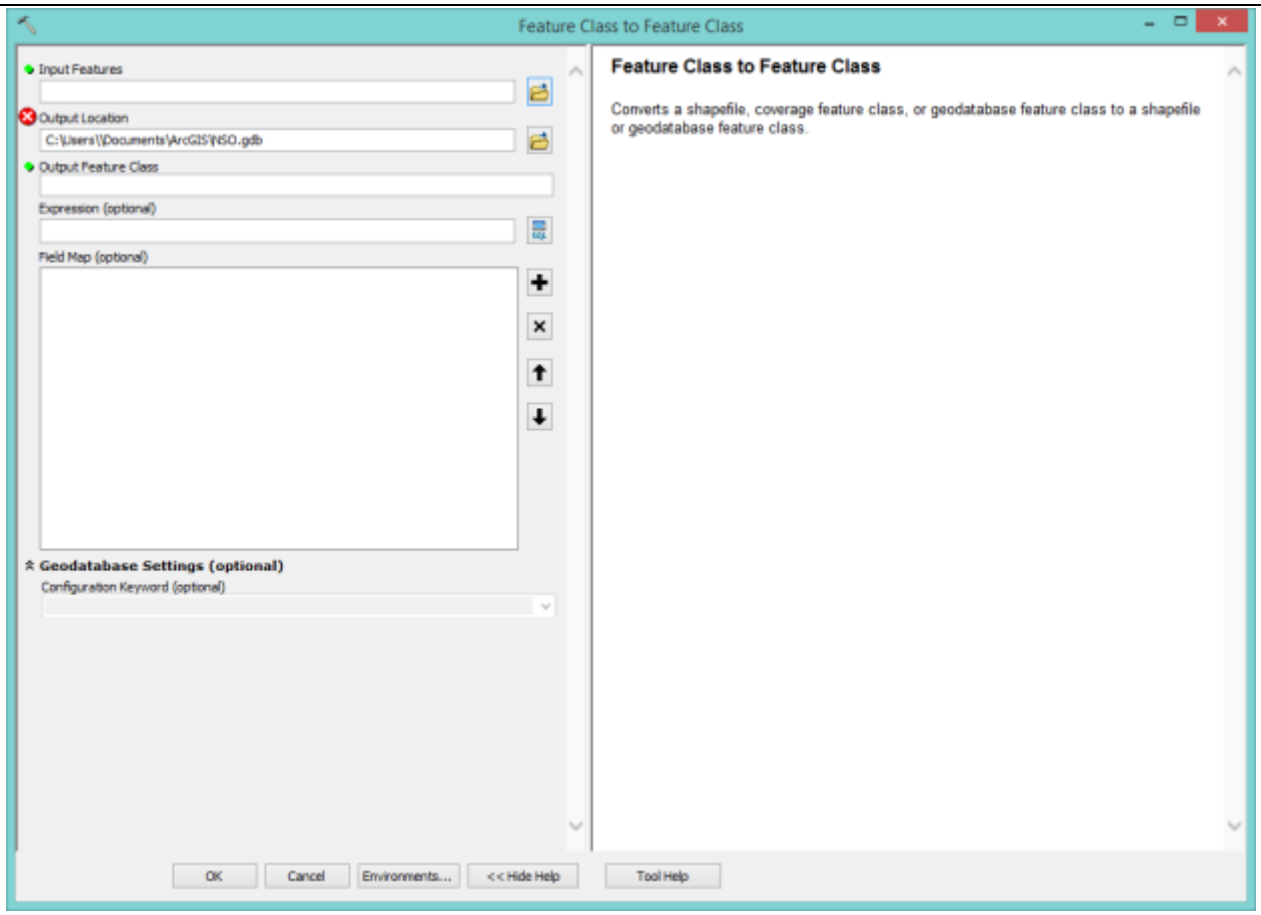


Figure 7 Import Feature Class

Once populated the file Geodatabase functionality offers maintenance tools such as, compact database and compress file geodatabase. The file Geodatabase is easily backed up as a single flat file.

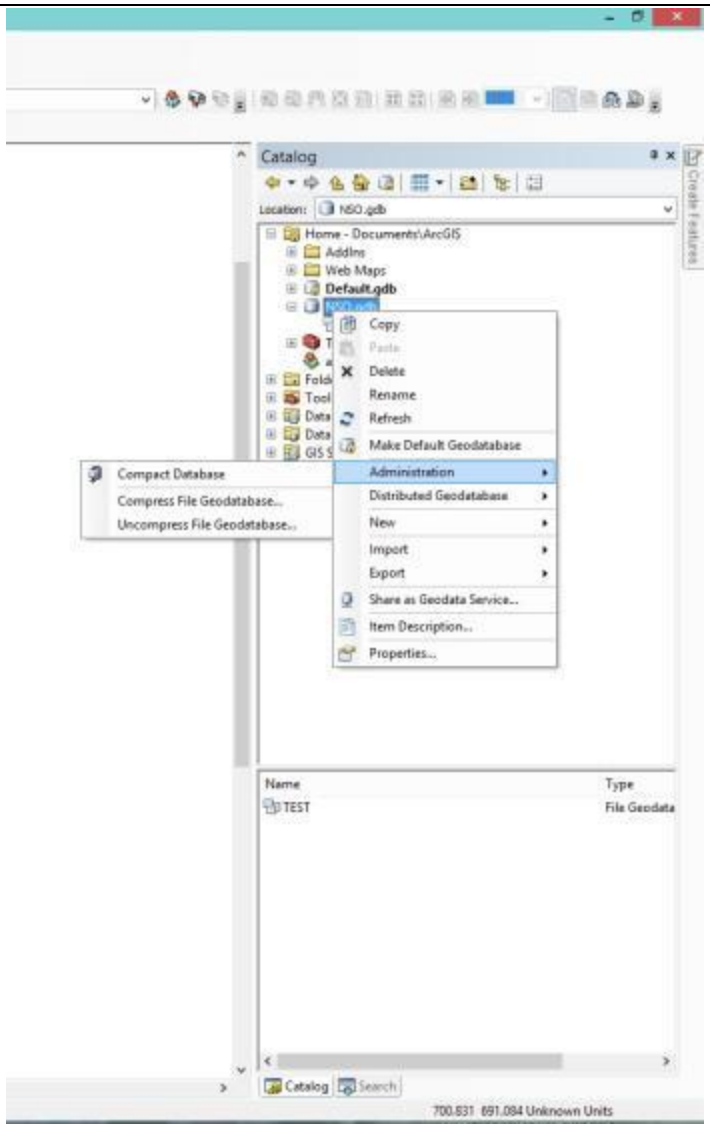


Figure 8 Geodatabase functionality

Appendix V - Training Manual for Creation of an ArcMap Web Service

Lineage Documents

Document Name:	**Creation of a Web Service**
Document No:	**1**
Category:	**Lineage Document**

Rev: 1.0 **Document Owner: Omar Hili** **Date of Release:1st June 2018**

Definitions used in manual:

- "ArcMap" refers to Esri ArcMap version 10.3.2
- "MXD" Refers to the format ArcMap saved the documents.
- "WMS" refers to World Map Services a standard used as an open standard.
- "WFS" World feature services.

Assumptions have to be madewithin this lineage document. We are assuming that the person applying the lineage is in possession of Esri ArcMap Desktop software and also ArcGIS Server and a Geodatabase running within their own authority.

Issues that may be found are:

1. Heavy data publishing, the choice of data and if it's better to subdivide in different service rather then one service.

2. Choice of service publishing, raster data may be published using only the map service but should data be needed then feature service should be adopted.

3. Whether to adopt WMS of WFS services – Wms service ismainly used to view and query data but WFSallows users t directly edit the data through the service

4. Publishing a Geo-database – works exactly like publishing a shapefile and is mainly used to replicate databases in remote locations.

Identify and Load data

Open ArcMap Software and identify the requested data to be published as a service. For this exercise, we will be loading the Generic Coast Data. In this part, the user has to decide the amount of data to publish in the service. Large datasets should be divided into separate services to facilitate data query and loading.

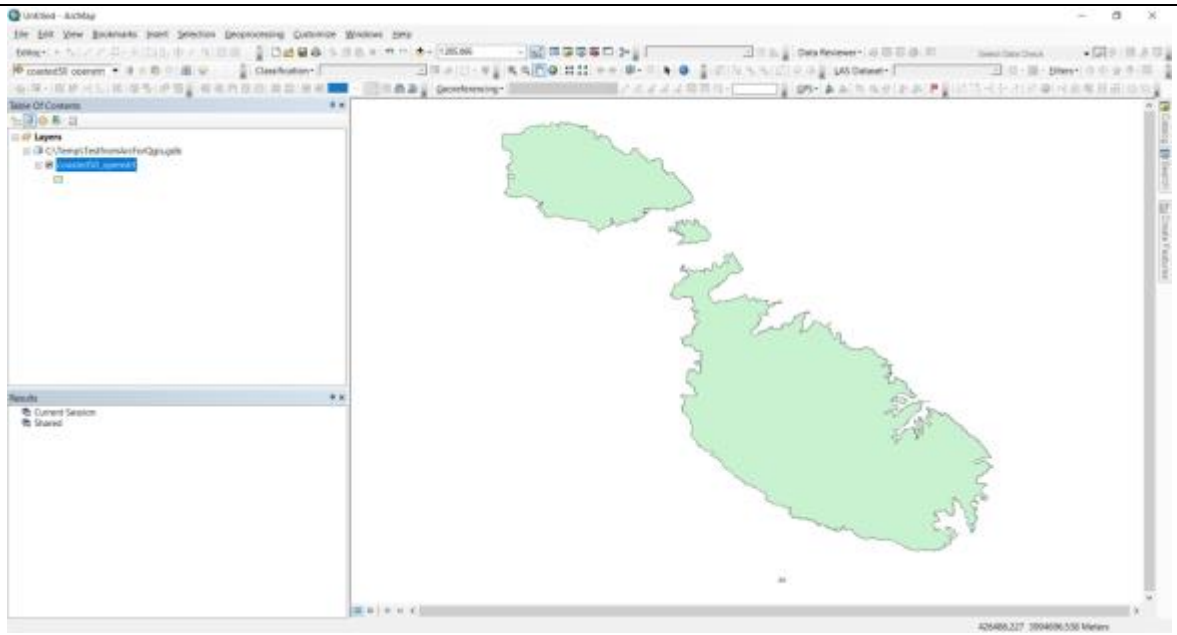


Figure 9ArcMap software with requested Coast data.

Adjust esthetical and labeling of data

The second step is to adjust symbology, colors and other visual aspects requested by the client or as deemed fit by the publisher. This is the esthetical aspect of the service. Providing different color symbology and polygon labeling. The user must under that "what you see is what you get" so the final result on the screen will reflect the published service.

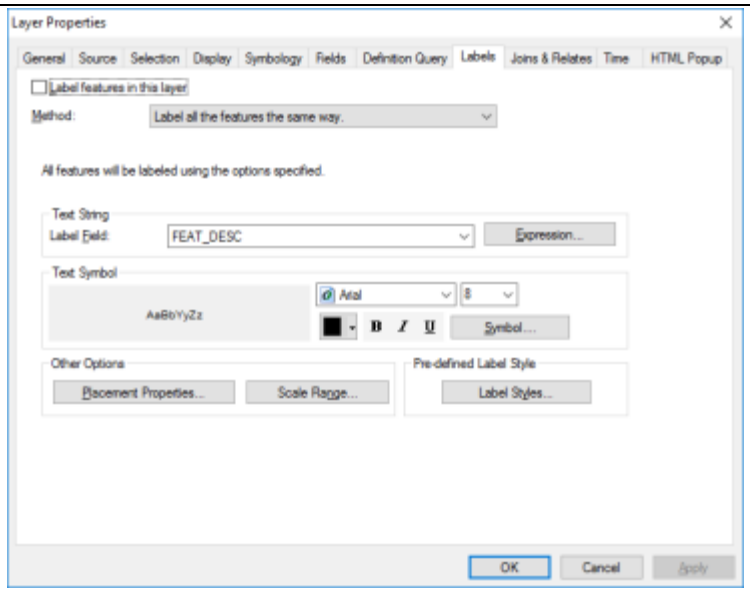


Figure 10Layer properties to adjust visuals

After adjustments have been done the next step is to save the "MXD" document to be able to publish. MXD is the format in which Arc saved the whole template of the document.

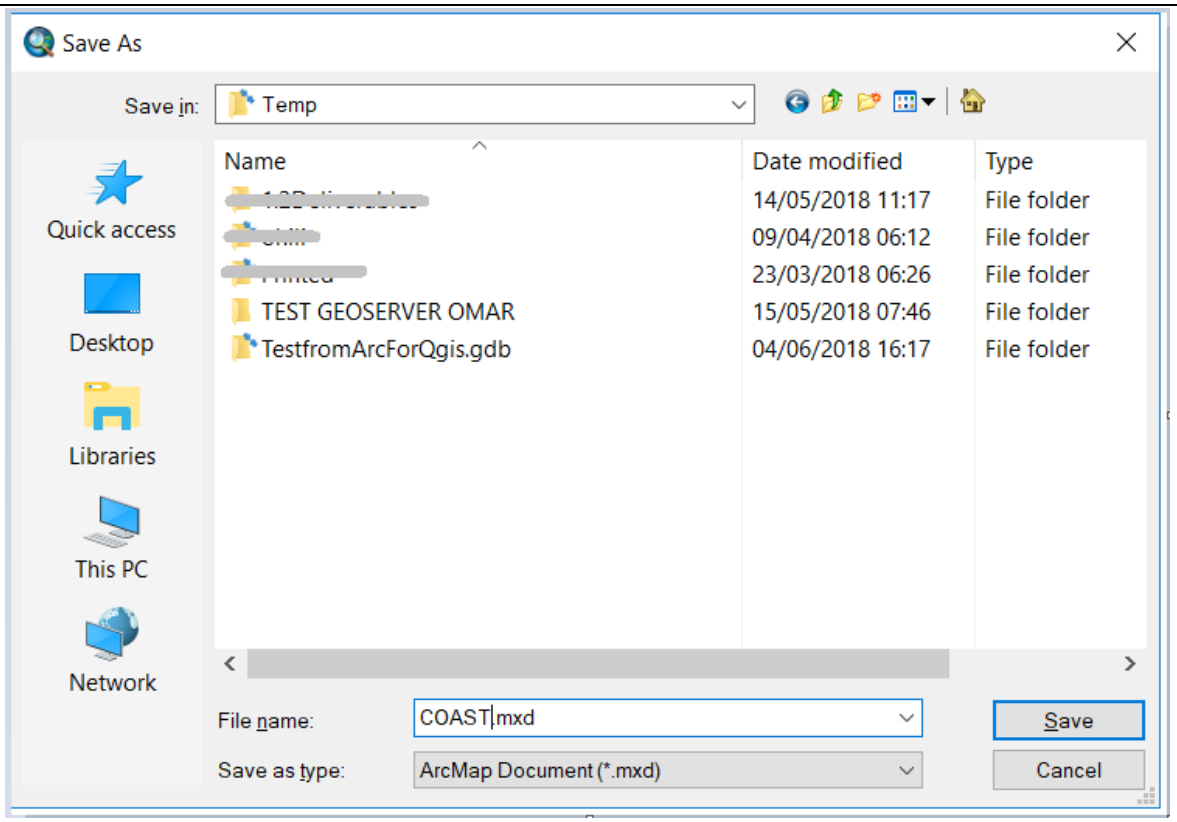


Figure 11 The MXD folder

Publishing of the Service

From the top menu Select *File* and choose *Share as* and choose *Service*. This will open the Publishing Wizard. The following steps are fine tuning before publishing the service.

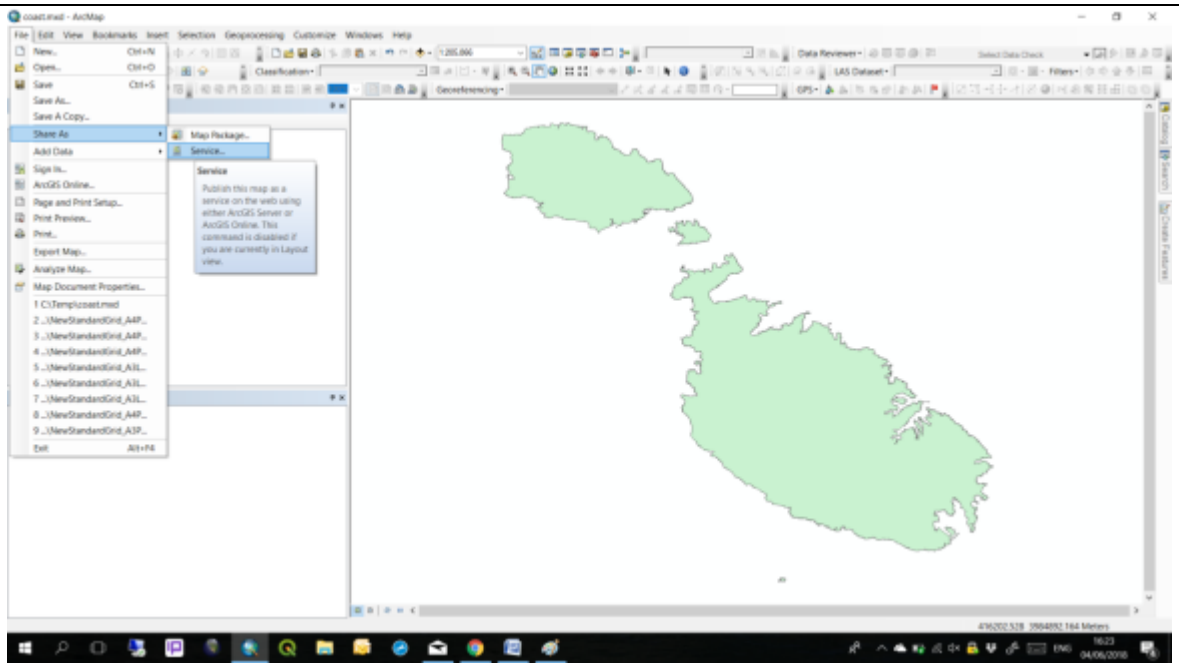


Figure 12 Share as Service screen

The first dialog is to select the publication of a new service or overwritesan existing one. The options are self-explanatory if a new service needs to be published option one needs to be chosen. Should you have a service but need to amend its content then overwrite is the option. A service definition file contains information about service properties, capabilities, and the service type, which is encapsulated into one portable file.

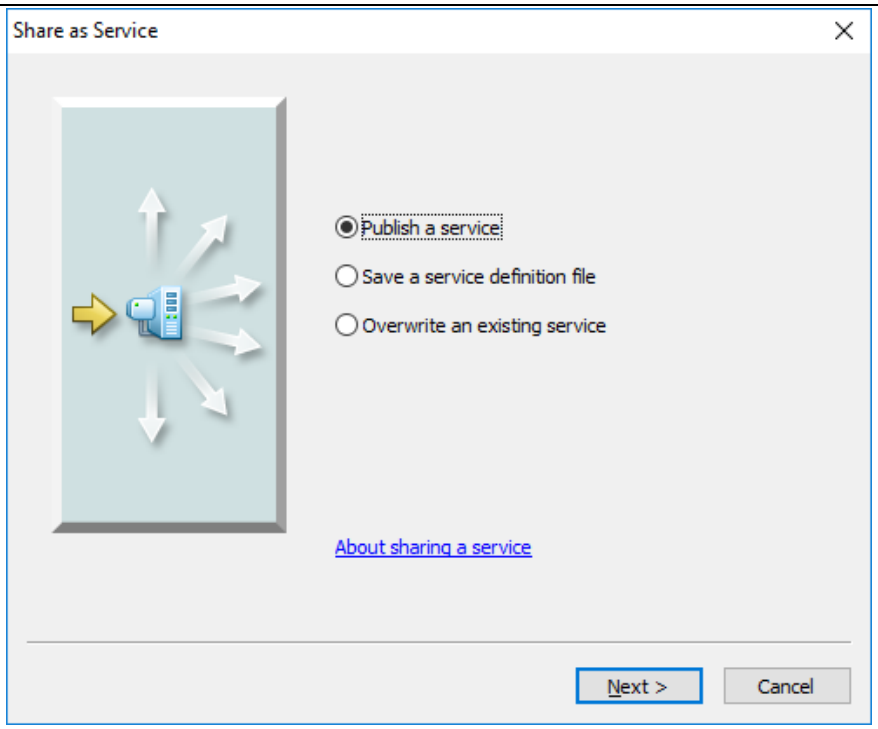


Figure 13 Service Dialog

Choose which ArcGIS server to publish too and also the Service Name

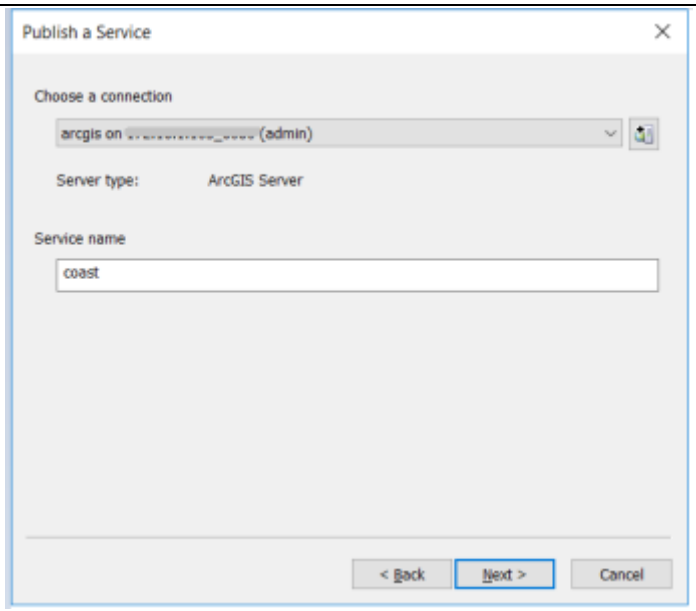


Figure 14 Choose Publishing Server

Choose directory were to save the service. The directory is listed on the server thus if the new services form part of another group please choose a directory. In our case, this is a new service so we are using a new folder. Using folders is a good way to organize yourcatalog of services. You can look at folders as a method of organization.

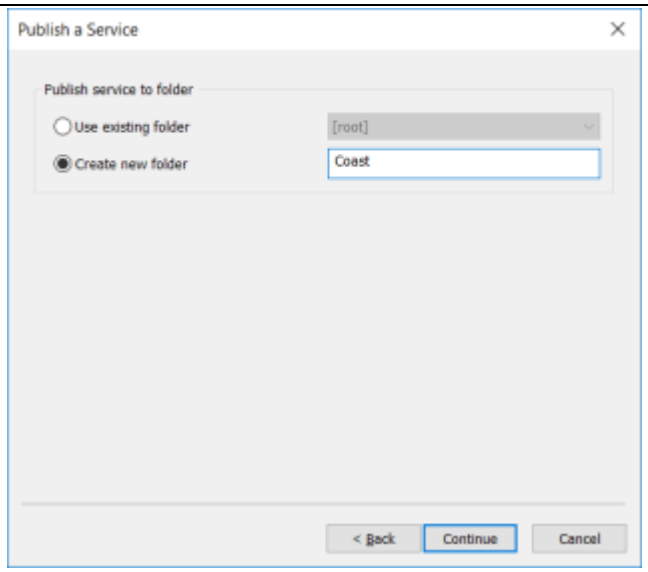


Figure 15 Folder choice. Use existing or create a new one.

Service Editor

Next is the configuration of the service, this is the most important part of publishing. Most of the times service chosen are standard but you may be requested to add new services. Below is a set of parameters you can choose from.

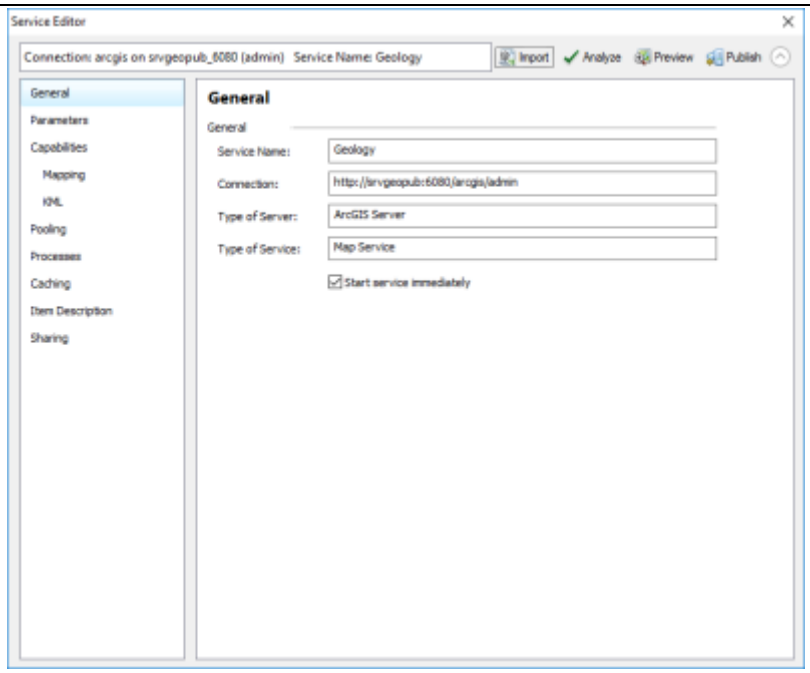


Figure 16 Service Editor

In our case, we need to enable WMS and Feature Access, as previously stated we need to provide the visual of the coast (WMS) and also allow to query its properties (Feature option). Mapping service is enabled by default. Other services can be used, share a kml service for google earth of it your company uses mobile applications then the Mobile accesscan be used.

WCS - The Open Geospatial CoPArtium, Inc. (OGC) Web Coverage Service (WCS) provides an open specification for sharing raster datasets on the web. ArcGIS Server allows you to publish WCS services from imagery collections, maps, or geodatabases that contain rasters.

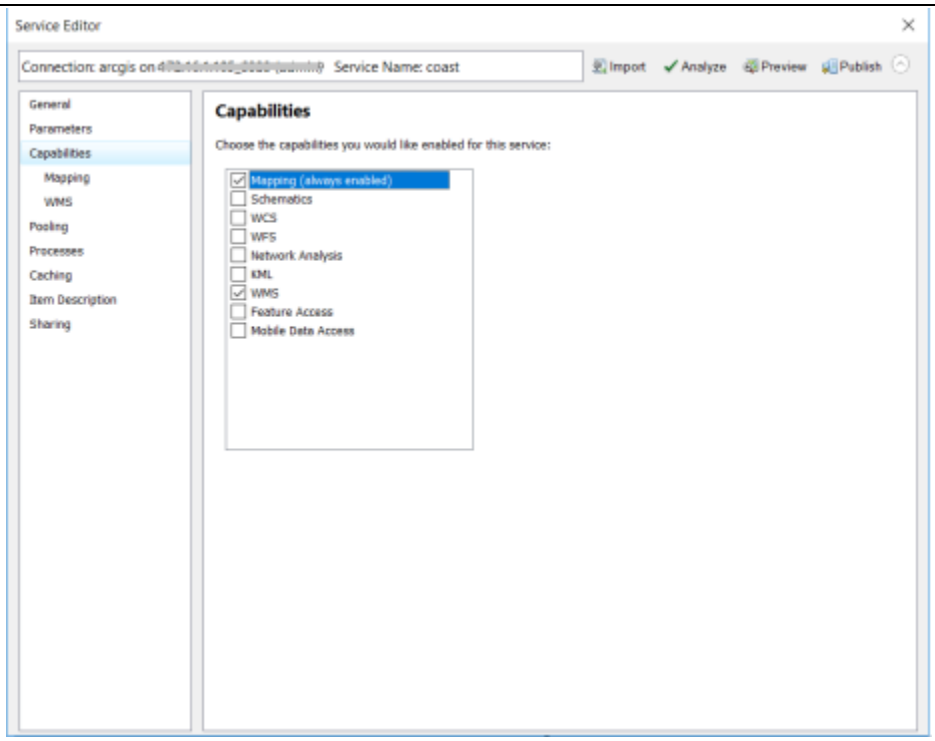


Figure 17 Services Chosen

An important part of the pre-service sharing is the "item description". This data will be visible on the map and allow it to be discoverable in searches. It allows the use of Tags and provides the credit or originator – a small part of inspire requirements. Options in figure 10 below.

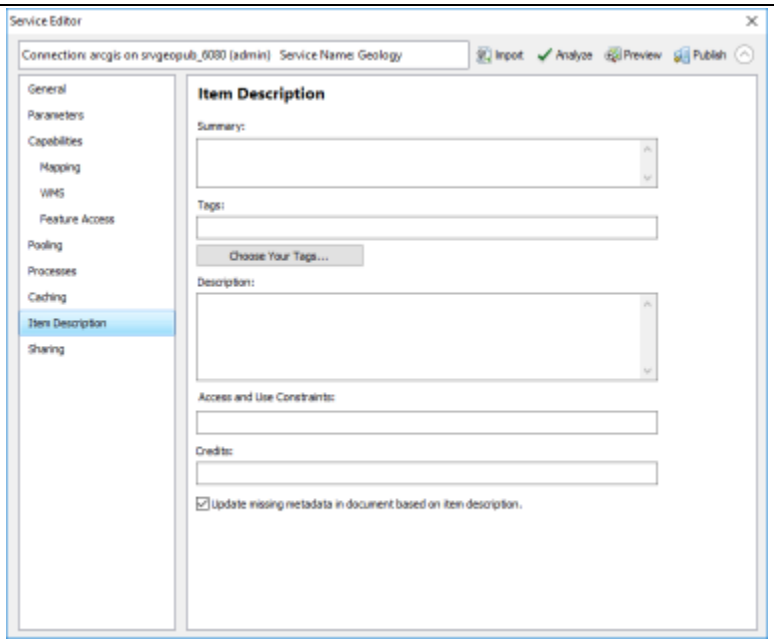


Figure 18 Information on Service

The final step is to publish the Service. Select top right button to publish.

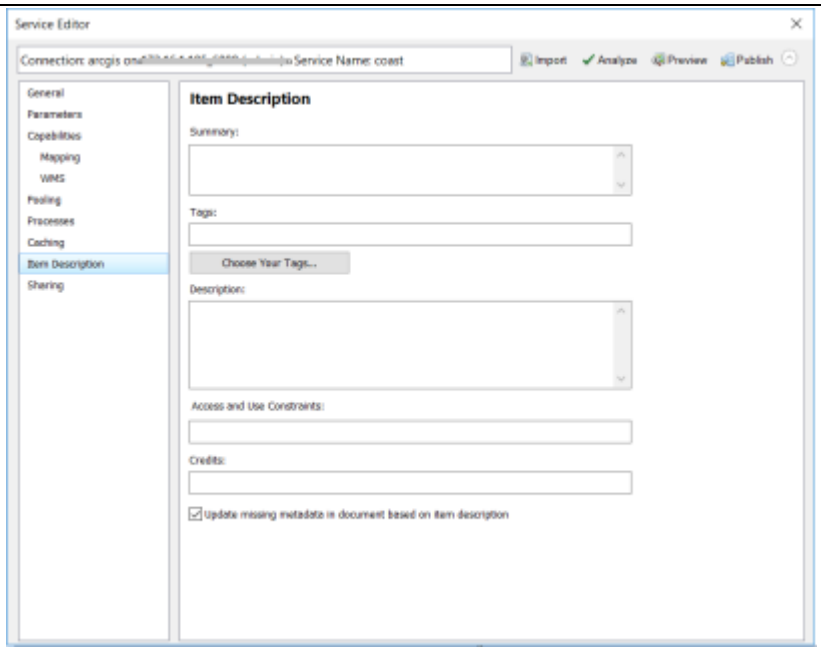


Figure 19 Publish Service

Confirm Service

After service is published ArcMap will prompt with a Successful service but it is always good practice to test the service before disseminating.

To confirm service please visit the ArcGIS Services page http://Yourgisserver/arcgis/rest/service and be sure to find your new service. In our case GEOLOGY

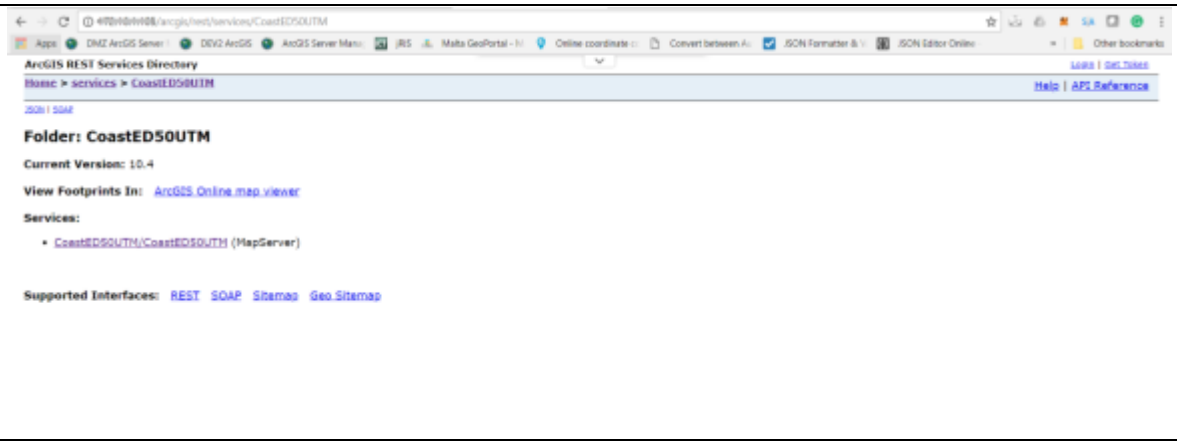


Figure 20 Service URL

Click on the Coast Tab, choose MapServer and then use the ArcGISJava script to view the end result

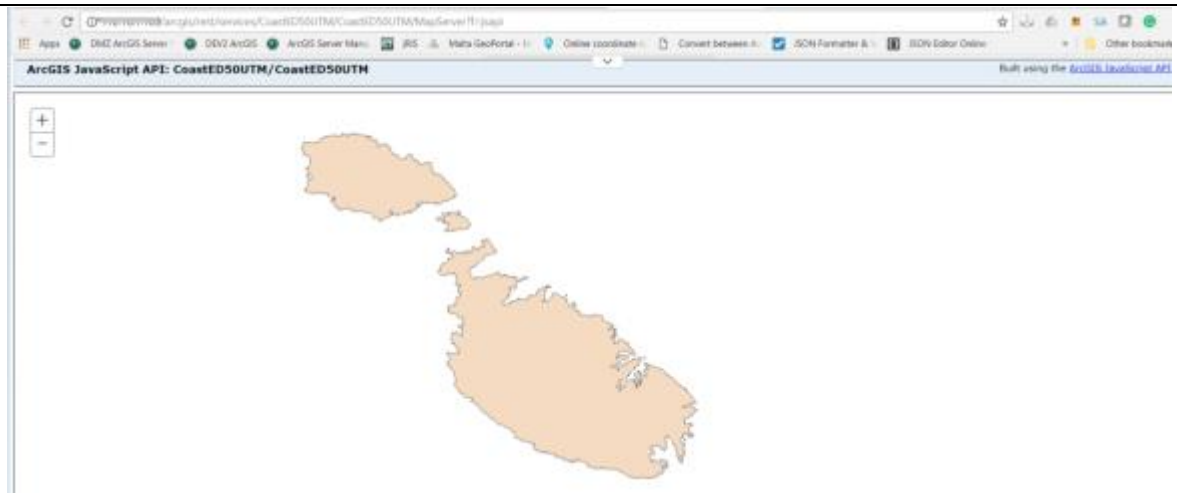


Figure 21 Java representation of Service

Service can now be used for internal systems. The same procedure applies to external service with the difference is to publish in an EXTERNAL ArcGIS server.

Appendix VI– INSPIRE Input Form xls: Spatial data template

INSPIRE METADATA ELEMENTS		
Component	**Description**	**Input cells**
Identification		
Resource Title	Geographic / thematic description	Free text
Abstract	Summary of resource content	Free text
Resource Type	Type of dataset	Choose one
Resource locator	URL to view	Free text
Unique Resource Identifier	Spatial object ID - value uniquely identifying an object within a namespace	Free text
Coupled Resource	For SDS only - Name of spatial dataset targeted by spatial data service	Free text
Resource language	Language used within resource	Free text
Classification of spatial data and services		
Topic category	Grouping of spatial data	Choose one
Classification of spatial data services	Grouping to assist search of spatial data services	Choose one
Keyword		
Keyword value	Keyword to describe relevant spatial data theme	Choose word from GEMET Thesaurus link below
Originating controlled vocabulary	Citation of controlled vocabulary used e.g. GEMET Thesaurus version 1.0	GEMET Thesaurus version 1.0
		Click to access online Thesaurus
Geographic location		
Geographic bounding box	Bounding box extents in decimal degrees	Free text
Temporal reference		
Temporal extent	Time period covered by the content of the resource (individual date/ date interval/ both)	YYYY-MM-DD

INSPIRE METADATA ELEMENTS		
Date of creation	Date of creation of resources	YYYY-MM-DD
Date of publication	Date when dataset became available	YYYY-MM-DD
Date of last revision	If resource has been revised, date of last revision of the resource	YYYY-MM-DD
Alternate references	Temporal references as expressed by different thematic communities	YYYY-MM-DD

Quality and validity		
Lineage	Process history and overall quality of the spatial dataset. Include whether dataset has been validated, quality assured, if it is the official version, and has legal validity	Free text
Spatial resolution	Scale or raster resolution / intervals	Free text

Conformity	Info on degree of conformity with IRs on interoperability of SD and SDS	
Degree	Degree of conformity of resource to related specification	Choose one

Conditions applying to access and use	Conditions for access and use of spatial datasets and services. Fees, where applicable, to access and use the resource.	
Conditions		Choose one

Limitations on public access	Info on limitations (if they exist) on public access to SD and SDS	
Limitations	Reasons for such limitations	Choose one

Organisations responsible for the establishment, mangement, maintenance and distribution of spatial datasets and services

INSPIRE METADATA ELEMENTS		
Responsible party	Name & e-mail of organisation	Free text
Responsible party role	Role of responsible organisation (Can choose more than one)	Choose One
		Choose One
		Choose One

Metadata on metadata	Keeping metadata up to date	
Metadata point of contact	Name & e-mail of organisation responsible to create and maintain metadata	Free text
Metadata date	Date specifying when the metadata record was created or updated	YYYY-MM-DD
Metadata language	Language in which metadata components are expressed	Free text

Appendix VII – INSPIRE Input Form xls: Non-Spatial data template

INSPIRE METADATA ELEMENTS

Component	Description	Input cells
Identification		
Resource Title	Unique name	Free text
Resource Abstract	Summary of resource content	Free text
Resource Type		Choose one
Resource locator	URL to view	
Resource language	Language used within resource - ISO 639-2	English
Classification of spatial data and services		
Topic category	Grouping of data.	Choose one
Keyword		
Keyword value	Keyword to describe relevant data theme	Choose word from GEMET Thesaurus link below
		Click to access online Thesaurus
Geographic location		
Geographic location	NUTS Catgories	Choose one
	If Other, specify	Free text
Temporal reference		
Temporal extent	Time period covered by the content of the resource (individual date/ date interval/ both)	YYYY-MM-DD
Date of creation	Date of creation of resources	YYYY-MM-DD
Date of publication	Date when dataset became available	YYYY-MM-DD
Date of last revision	If resource has been revised, date of last revision of the resource	YYYY-MM-DD

INSPIRE METADATA ELEMENTS		
Quality and validity		
Lineage	Process history and overall quality of the dataset. Include whether dataset has been validated, quality assured, if it is the official version, and has legal validity.	Free text
Conformity		
Specification	Citation of specification to which resource is expected to conform. Title, reference date (date of publication, date of last revision or of creation) of the specification	Source: INSPIRE Directive, Article 7.1 - Interoperability of spatial datasets and services, EU Directive, 2007-04-25. - as amended by IRU for tabular data (2008-10-16)
Degree	Degree of conformity of resource to related specification:	Choose one
Conditions applying to access and use		
Conditions	Conditions for access and use datasets and services. Fees, where applicable, to access and use the resource.	Choose one
Limitations on public access		
Limitations	Info on limitations (if they exist) on public access to SD and SDS	Choose one
Organisations responsible for the establishment, mangement, maintenance and distribution of spatial datasets and services		
Responsible party	Name & e-mail of organisation	Free text
Responsible party role	Role of responsible organisation	Choose one
Metadata on metadata		
Metadata point of contact	Name & email of organisation responsible to create and maintain metadata	Free text

INSPIRE METADATA ELEMENTS		
Metadata date	Date specifying when the metadata record was created or updated	YYYY-MM-DD

Appendix VIII – Appleseed and Open-Portals paper

Ref: Formosa S., (2014). If Appleseed had an open portal: Making sense of data, SEIS and integrated systems for the Maltese Islands, in B., Murgante, S., Misra, A.M., Rocha, C, Torre, J.G., Rocha, M.I., Falcao, D., Taniar, B.O., Apduhan, and O., Gervasi, (Eds.). Computational Science and its Applications – ICCSA 2014 Lecture Notes in Computer Science, 2014, LNCS 8580, 709-722, DOI: 10.1007/978-3-319-09129-7_51, Springer, Heidelberg, ISBN: 978-3-319-09128-0 (Peer-Reviewed)

If Appleseed had an open portal: Making sense of data, SEIS and integrated systems for the Maltese Islands

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saviour.formosa@um.edu.mt

Abstract. Much sought and realistically distant, an open data system can serve as the Holy Grail for many a policy-maker and decision taker as well as the operational entities involved in the field. The steady seeding of data-related legislative tools has aided the setting up of exploratory and active systems that serve the concept of data-information-knowledge-action to academia, the general public and the implementing agencies. Legislation, inclusive of Data Protection, Freedom of Information, Public Sector Information, Aarhus, INSPIRE, SEIS and the still embryonic SENSE, have all managed to create a new reality that may be too complex for some still caught in a jurassic analogue stage where data hoarding might still be prevalent and little effort is made to jump to the post-modern reality. Efforts to push the process through various domains such as census, environment protection, spatial development and crime have helped the Maltese Islands to create a scenario that is ripe for a national data infrastructure, inter-entity data exchange, open data structuring, and free dissemination services. This process enhances the knowledge-base and reduces redundancy, whilst creating new challenges on how to make sense of all the data being made available, particularly in the interpretation or misinterpretation of the outputs. The paper reviews Malta's process to go through the birth pains of SEIS as an open data construct, through to the dissemination of various spatial datasets and the first open portals pertaining to the various regulatory directives.
Keywords: open data, Aarhus, SEIS, INSPIRE, Malta, data interoperability, geoportal, LIDAR, spatial data, integration

1 The long and winding road

1.1 Johnny Appleseed's legacy

Access to data posited many a dilemma for systems integration and dissemination. The transitional process from data to information to knowledge to action has been tackled from different perspectives, ranging from policymaking, through impact assessments to decision making exercises and recently to the integration of disparate datasets within integrated systems and eventually ported to the web for dissemination purposes. Each sector can be taken as a research topic in isolation, however the main fulcrum of the process revolves around the creation of a framework of policies and technologies that enable the exchange of spatial data across the different thematic and technological domains. This led to the establishment of a series of data-management processes aimed at setting-up and maintaining information resources structures through Spatial Data Infrastructures (SDIs) with early investigative work on conceptualization and international initiatives by Masser and Craglia [1] [2] [3] [4]. The drive was enhanced with inter-organisational studies by Nedovic-Budic and Pinto [5] as well as the work of the individual persons who pushed the initiative [6] and the eventual creation of an established SDI framework [7] that was also taken up at international level by the Global

Spatial Data Infrastructure Association [8] and at national level [9]. Not exclusively anchored to the generic data management disciplines, this process nonetheless finds broad scope in this field particularly due to availability of specialised tools employed in environmental monitoring and reporting.

This paper reviews the mythical Appleseed one-core-at-a-time process employed in the implementation of a shared environmental information system (SEIS) [10] for the Maltese Islands which emulated the seeding with sequential implementation measures. Through the implementation of an ERDF [11] project entitled "Developing National Environmental Monitoring Infrastructure and Capacity", Malta embarked on a process that points towards the implementation of an open data structure, with a main output being the delivery of a SEIS geoportal. The final output, based on a specific target to create a SEIS, based on the environmental themes of air, water, noise, radiation, soil and marine [12] [13] resulted in a comprehensive innovative system that serves as an initial launching pad for open data [14]. The steps taken outline a description of the basic data definitions, the legislative mechanisms, the international-reporting requirements, the tools available and projects that tackle the means to reach an open data construct.

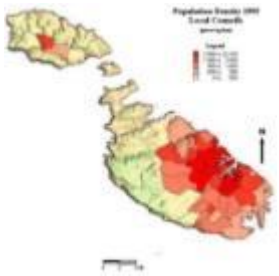

Fig. 1a. Population Density Imagemap, 1995

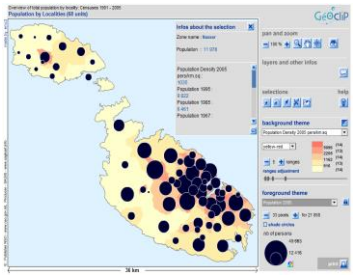

Fig. 1b. Census Interactive Map, 2005

Initial attempts to provide for an open portal [15] [16] [17], albeit limited by technology and/or lack of regulatory tools served to investigate user access and usage issues, with some basic Imagemap/GIS-client [18] (Figure 1a) and Interactive GIS [19] (Figure 1b) deliverables. The activities were based on the transposition of international directives, inclusive of the Data Protection Directive [20], the Public Sector Information Directive [21], the Aarhus Directive [22], the INSPIRE Directive [23], as well as the national initiative pertaining to the Freedom of Information Act [24].

1.2 Fertile fields

A review of the main agencies involved in the spatial data exercise show that there exist a wide range of disparate datasets that are either non-conformant with INSPIRE or do not fall under the legislative tools mentioned above. The agencies involved include the main IT agency MITA (responsible for INSPIRE), MEPA (responsible for development planning and the environment, landuse/land cover, GMES, Copernicus, GEO, GEOSS, Aarhus and EEA-related reporting) and other entities.

A number of government departments and entities make use of the base map owned by MEPA although their GIS operating architecture differs from one to another, inclusive of the Agriculture Department, Fisheries Department, Land Registry, utilities such as Enemalta Corporation, the Water Services Corporation, cable and telephony companies (private), the Malta Resources Authority and the Transport Malta. Other structures include defense and civil protection, as well as a number of other departments, corporations and authorities that own data in various structures and which still need to conform to internationally recognized data standards. The INSPIRE Directive provides the framework for this structure but an NSDI (National Spatial Data Infrastructure) would ensure the integrative processing required for such a system. The Maltese Islands have embarked and delivered on the pilot domains emanating from the ERDF project [11] and developed a SEIS [25] in order to ensure conformity for monitoring and reporting.

1.3 Trying to make SENSE

SEIS is not the first or only open-data conveyor for data, with such precursors including ENPI-SEIS (environmental protection project focusing on networking and open access through free tools) and a parallel project entitled ICT-ENSURE aimed at the management and dissemination of environmental information within a single informational infrastructure entitled SISE. Other initiatives include SEIS-BASIS (database structure on environmental monitoring programmes), NESIS (EEA-related state of play at national level), TESS (decision-making functional system), HUMBOLDT (aimed at the implementation of a European Spatial Data Infrastructure (ESDI), LENVIS (management systems for environment and health) and ORCHESTRA (risk-based management system for disaster reduction).

Spatially-targeted activities have also been implemented or are in such a phase, amongst which one can find the Copernicus Land Monitoring Services, the EEA's systems inclusive of the CLC runs (land-cover analysis), NATURA 2000, LUCAS and CCDA

projects (protection zones), PLAN4ALL (landuse planning), GEO (earth observation), GMES (monitoring and environmental security), GEOSS, (system of systems), and GENESIS (synergic exercise between INSPIRE and the previous initiatives listed above that ensure integration of information in line with the single system envisaged in ICT-ENSURE). A lacunae identification initiative (GIGAS) was aimed to look at the gaps between these systems and also to point entities towards the requirements of a systems-approach data gathering structure (SANY) where sensors on the ground can gather information in real-time in a cohesive whole [12] [13].

SEIS established itself as a mainstay for such projects through its location-based services that bring together spatial, social and physical domains within a place-based structure. Such is made possible through its WMS, WFS, WCS and other services. The parallel SEIS-development, entitled SENSE aims to enable the sharing of European and national state of the environment and that allows for cross-country selection and support to SOE Online, the latter targeted to create a forum for the state of the environment.

1.4 The Maltese initiative

Introducing a state to high-end information systems that encompass total national coverage is no mean task, even for such a small state as Malta with its 316 square kilometer area. Introducing a new paradigm in data creation and dissemination targeting spatial analysis points to a whole new reality [26] [27]. The Maltese Islands, through access to the European Regional Development Fund, managed to create a process aimed at environmental research that included innovative tool creation and scans that will help analysts to monitor the environment and related offences committed on the environment. In a process initiated by the author in 2006 and concluded in 2014, the SEIS-based activity resulted in the creation of fundamental datasets that also bring Maltese terrestrial and bathymetric baseline information to the public domain [25]. These activities have been carried out as part of a €4.6 million project, entitled Developing National Environmental Monitoring Infrastructure and Capacity, which also entailed the monitoring of air, water, soil, radiation, noise and marine themes [11]. This project was co-financed by the European Regional Development Fund, which provides 85% of the project's funding and the Government of Malta, which finances the rest under Operational Programme 1 - Cohesion Policy 2007-2013 - Investing in Competitiveness for a Better Quality of Life. Involving international experts from a number of countries and expert input from JRC, EEA, EC and other entities, whilst at a national scale, implementing partners included MEPA as project leader, the University of Malta, MRA, NSO and the Environmental Health Directorate.

SEIS in the Maltese Islands was based on a three-pronged approach; the alignment of its environmental structures to the varied legislative tools, the creation of integrated systems and the design of a reporting infrastructure. The main remit was to ensure such through the take-up of the SEIS initiative, where in 2008, the EU Commission published a Communication (COM (2008) 46 Final) "Towards a Shared Environmental Information System", which sets out an approach to modernise and simplify the collection, exchange and use of the data and information required for the design and implementation of environmental policy, according to which the current, mostly centralised systems for reporting are progressively replaced by systems based on access, sharing and interoperability. The overall aim was to maintain and improve the quality and availability of information required for environmental policy, in line with better regulation, while keeping the associated administrative burdens to a minimum.

Malta took part in the development of the SEIS, both at EU and national levels. The development of the national component of this system is particularly important for Malta, because it would streamline and simplify reporting processes to the EU – an essential consideration for a relatively small national administration, which nonetheless has the same reporting requirements as much larger countries. But the benefits of the SEIS for Malta are not limited to improved reporting procedures to the EU. At the national level, the system would simplify, reduce costs, and increase effectiveness at all stages of environmental data cycle. This, in turn, would translate into more and better quality information being available for a variety of purposes at a considerably lesser cost than is the case at present.

The project aimed to develop the Malta component of the Shared Environmental Information System at a time when MEPA's geoportal (mapserver) was not deemed to be a comprehensive environmental information system. This project was tasked with an analysis of the current systems in place to process environmental monitoring data and data flows required, the design of the SEIS for Malta, and the development of such a web-based environmental information system. The project had to result in the creation of a web-based environmental information system, on the basis of existing platforms, as well as on the basis of any other additional platforms and components that may be required, to achieve full interoperability and functionality of the Maltese component of the SEIS, in line with the applicable guidelines and best practices in this field. The deliveries had to include a web-based GIS dedicated to environmental monitoring data incorporating MEPA's aerial orthophotos and basemaps available at the start of the project in 2010, as well as newly acquired satellite imagery, oblique aerial imagery, LiDAR terrain datasets and bathymetric data acquired through the ERDF project, of which the SEIS component was a part. Moreover, the SEIS had to be developed using an ArcGIS Server platform, based on system migration from an ArcInfo database to an

ArcGIS geodatabase structure. This issue was set out due to the perceived need to fit such a system within the organisation's requirements at the time, which in turn could have also resulted in its main limitation, due to cross-system incompatibility as against a full-open structure. Also, the tendering process as such, limited the possibilities for alternate and innovative developments. One main issue concerned the need for the SEIS to be a modular and scalable system which is flexible to meet the varying demands of usage and applications over time.

The deliverables [11] were structured in a phased approach that sought to actuate:

- A review report on all requirements and parameters for the development and operation of the Maltese component of the SEIS and a proposal for the design and development of the SEIS;
- A report on the proposed ArcGIS geodatabase design for the SEIS based on an ArcGIS server architecture;
- A prototype and pilot of the SEIS implemented and tested;
- A final version of the customised SEIS with a dedicated geoportal implemented and put into operation following feedback on the previous phase.

2 They came before

The ERDF project SEIS component was one in a series of initiatives that set the stage for this encompassing system. With initiatives such as the Census web-mapping project [28], the National Protection Inventory [29] and the SEIS-precursor Ambjent project [16], the process entailed the move from an image-mapping system (Figure 2a) to an early interactive prototype system. Such was based on the creation of spatial entities and attribute designations that were integrated with digitised card material (Figure 2b), integrated with pseudo-3d graphical interfaces (Figure 2c) and eventually to dynamic query systems (Figure 2d).

The dissemination technologies available at the time were used as surrogates towards this advanced system with data integration proposed through accessibility made possible by Image-Maps and map-server options. The resultant information system was envisaged to deliver a layered approach where users could access data that is available in an immersive clickable scenario through direct linking to spatial entities (points, lines, areas).

Fig. 2a. Imagemap 1996

Fig. 2b. GIS layer

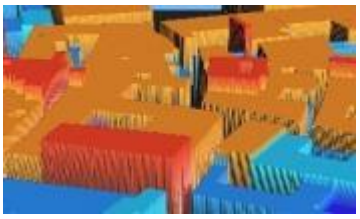

Fig. 2c. 3D extrusion

Fig. 2d. Query Interface

In addition, the system would incorporate links to multimedia, imagery, walkthroughs, thematic data and access to a dynamic array of live information systems. The case was the same for the subsequent Census mapping exercises, the MEPA mapserver (Figure 3a), the Plan4All geoserver (Figure 3b), amongst others, however few had yet to envisage a system as proposed by SEIS, which was only made possible through the foundation laying of the implementation rules laid out by INSPIRE, Aarhus and the SEIS initiative.

Fig. 3a. MEPA mapserver

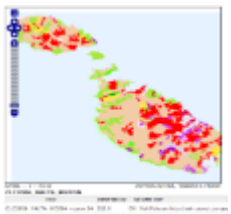

Fig. 3b. Plan4All geoserver

3 Implementing SEIS

3.1 A 6-stepped approach

With Malta being one of the first countries to initiate SEIS implementation, the aim was one to deliver information interoperability. It aimed to upgrade the methods employed to gather data, to streamline the reporting processes, to introduce implementation rules and to create a spatial data infrastructure as well as launch a visualisation and dissemination tool. The main aim was to develop data management and ingestion

systems, allow for online data editing options, allow for data export and metadata viewing. In addition the system had to ensure that the country did not need to reinvent the wheel every time an information packet is requested from the EU and international conventions but would develop a search tool for the metadata and in turn enable automated reporting processes as required, particularly the European Environment Agency priority dataflows, always in line with INSPIRE, Aarhus and other legislative tools.

A 6-Step methodology was adopted [12] [13] to ensure the base setting for the SEIS:

1. Analysis of the target Data Model (INSPIRE Data Specifications and EEA reporting schemas)
2. Analysis of the Source Data (MEPA)
3. Conceptual design of the geodatabase
a. to include all the INSPIRE elements for which a correspondence with the source data has-been found
b. to include all the additional elements not existing in the INSPIRE data model but present in the source data
c. to include the INSPIRE elements not existing in the source data
d. to include all the elements existing in the EEA reporting schemas
4. Preparation and filling-in of the matching table (MT)
5. Creation of the geodatabase structure, using different tools, according to the theme concerned
6. Import of the geodatabase in SQL Server(provided also an Esri geodatabase for each theme, as an additional resource available).

The resultant system had to deliver a SEIS portal that conformed to international standards, conditions and technologies set out by the same legislative and working documents described earlier. Table 1 describes the standards and technologies identified for the SEIS-Malta portal [13].

Table 1: Standards & Technologies

Standard	Description
OGC WMS	A Web Map Service (WMS) is a standard protocol for serving georeferenced map images over the Internet that are generated by a map server using data from a GIS database. The specification was developed and first published by the Open Geospatial Consortium in 1999.
OGC WMS - T	A WMS server can provide support to temporal requests. This is done by providing a TIME parameter with a time value in the request. WMS specifies that the basic format used for TIME requests is based on the ISO 8601:1988(E) “extended” format.
OGC WFS	The Open Geospatial Consortium Web Feature Service Interface Standard (WFS) provides an interface allowing requests for geographical features across the web using platform-independent calls.
OGC WCS	The Open Geospatial Consortium Web Coverage Service Interface Standard (WCS) provides an interface allowing requests for geographical coverages across the web using platform-independent calls.
ANSI SQL	The geodatabase will follow the ANSI/ISO SQL specifications
INSPIRE	INSPIRE is "an EU initiative to establish an infrastructure for spatial information in Europe that will help to make spatial or geographical information more accessible and interoperable for a wide range of purposes supporting sustainable development".
Z39.50	Z39.50 is a client–server protocol for searching and retrieving information from remote computer databases. It is covered by ANSI/NISO standard Z39.50, and ISO standard 23950. The standard's maintenance agency is the Library of Congress. Z39.50 is widely used in library environments and is often incorporated into integrated library systems and personal bibliographic reference software. Interlibrary catalogue searches for interlibrary loan are often implemented with Z39.50 queries.
CSW	The OGC Catalog Service defines common interfaces to discover, browse, and query metadata about data, services, and other potential resources. Web Catalog Service includes several profiles

Standard	Description
	including Catalog Service - Web.

Source: Bonozountas, M., and Karampourniotis, I., (2013), p. 15

3.2 The resultant interface

Learning from the outcomes of the precursor exercises, particularly the Plan4All project, which had indicated that it was sometimes difficult to bring together the different datasets across the different thematic social and physical fields and required stringent rules for inter-operability, the SEIS project learned from the need to 'listen' to the outcomes of conceptual models that served as a veritable exercise in comprehensiveness due to their holistic and detailed approach. The main issues in the Maltese context deal with the fact that the conceptual models reflect their name: they are concepts that require tweaking and need to consider different levels of conformity: local-national (NUTS 2,3,4,5 as compared to NUTS 1) and national-super-national (NUTS 1 as compared to EU). The CLC1990-2000-2006 runs proved that this can be done if one uses a harmonisation of the top-down (model) and bottom-up approach (users-data creation), whilst remaining loyal to the legislative requirements.

Based on a GeoNetwork Open Source (GNOS) approach, the Malta SEIS webportal delivered various services that went beyond the precursors of ambjent.org.mt and the census webmaps and also beyond the development of the Plan4All geoserver. The new seismalta.org.mt portal was resultant of the ERDF project.

Fig. 4a.

Basemapping

Fig. 4b.

Heatmaps

Fig. 4c. Data

Fig. 4d. 3D

outputs viewer

SEISmalta.org.mt offers a veritable plethora of services, made possible through the ERDF geoportal, which requires the ArcGIS Silverlight API, employing visual tools, though the latter has served many a criticism by users who do not wish to install the tool or use other platforms, something that needs to be rectified over the updated versions of the portal, especially if it needs to be full open. The services cover: Download Services (Figure 4a), Ingestion Service, a Data Quality Service, a Sensor Observation Service for real-time data input, as well as a Feedback Service to the geoportal administering agency. In addition, the SEIS output includes a reporting Notification Service, a Registry Service for new databases, a Reporting Service, which service queries the database and prepares reporting outputs for EC and national requirements' consumption. Figure 4 depicts the Seismalta portal's basemaps (Figure 4a), thematic heatmaps (Figure 4b), data portal (Figure 4c) and a 3D topographic viewer (Figure 4d).

3.3 Post-SEIS

Post-SEIS project conclusion, the entities are in the process of establishing a wider national inter-agency approach, where the main tenet is based on the underlying strategy for data management built on a 'gather-once / use-many' approach. Such ensures that data is gathered once but used by all without incurring further costs, access and implementation bottlenecks, whilst at the same time employing one tool for dissemination services through an enhancement of the SEIS portal. This proposal looks at the setting up of an organisation through a two-phased approach where an entity is tasked with implementing short-term targets, such as the creation of a SEIS-base-data structure for all entities and in the long-term tasked with the integration of all these systems into one entity with dedicated thematic expertise across the diverse GI-enabled domains.

Phase I should ensure the migration from the current isolated-entities system to one where the datasets are harmonised, aligned and prepared in line with the SEIS process for the eventual integration that would be required in Phase II. The Phase I concept envisages a scenario where the setup would be similar to the current system of individual-entity ownership where the entities are defined as "owners of data" meaning that each department, authority, corporation or organisation is responsible for collecting, maintaining and managing data relevant to the running of its activities and operations. This data will be shared with other entities in an open mode and free disseminated through the SEIS-based tools. The advantages lie in the fact that:

- the data is maintained by the owner of the information;
- updating of the system is done in an "informed" or more professional manner rather than straight forward data entry;
- the organisation itself and its officials maintaining the information are made responsible and accountable for the data;
- this system also allows the other entities to create their value-added data on to the same datasets which the 'guardian' entity can then decide to implement as part of that dataset.

It is imperative that each dataset has to comply with legislative implementation rules, even for those that do not fall under the diverse Directives. It is vital that the data inputted in the system, once the necessary data collection exercise is carried out, will be almost completely error free. Thus, it is of the utmost importance, that the project is set in the right perspective and that there are clear guidelines and standards to which all participants within the system would have to abide

by. This at a time when another MED project entitled HOMER [30] is specifically focusing on the Open Data theme, as based on the Public Sector Information Directive and its update. In addition, new issues are cropping up with the emergent EU level e-Reporting systems ensconced within the Structured Implementation and Information Framework (SIIF) concept [31]. Such a situation calls for an interesting development that places the Islands at an advantage for takeup through the enhancement of the SEIS geoportal into a wider thematic construct, going beyond environmental domains into highly integrated societal systems.

3.3 Tasting the Apples

The project's trust serves its main purpose only if its functionality is translated into tangible outcomes and usability. The SEIS output has been both augured and criticised by users in terms of ease of use and requirements to install additional tools due to browser constraints. The main users were professionals in the field and students who regularly reviewed the site outputs for their research studies. Non-governmental organisations welcomed the initiative though highlighted the issue that now that data was being made accessible, it was difficult to interpret without expert input. The latter issue is interesting since it posits a state of affairs that users may not be willing to take up new technologies beyond their wow-factor, that data and especially open-data can be overwhelming due to its large volumes, that users find themselves lost in receipt of data even when supplied with lineages and all metadata. Interestingly, when challenged with the fact that data is shared by all and that it is available in real or quasi-real time, users showed both disbelief and worry, ironically due to the fact that they must now criticise themes based on scientific facts as against opinion or second-hand comments from reports; NGOs and experts alike now have the tools and the data to reach informed opinions on their say and offer data-backed feedback for social-change initiatives. This process also serves to increase the number of researchers who were previously holding back due to access issues.

Having sowed the initial SEIS portal in the Maltese Islands, it is time to compare and contrast the system with the new developments in SEIS coming out from the EEA, the Austrian Umweltbundesamt and similar initiatives.

4 Conclusion

In conclusion, the Malta SEIS geoportal depicts an integrated system based on a geodatabase that includes those INSPIRE elements where source data has been found in conjunction with other elements that were not required by INSPIRE but were available within the source dataset. The basic requirements emanating from the ERDF project requirements were satisfied, whilst additional services as yet not possible due to space and bandwidth restrictions have been provided through alternative measures such as physical pickup of the data that measures at 600Gb and counting.

In reviewing the process to establish a framework for the development of the system in Malta, the project established various factors, mainly on the potential uses of such a system, the need for user consideration and feedback as well as the need to ensure that there is conformity to the regulations that guide such developments.

With limitations imposed by the same procedural process as outlined in this paper, such a project would have overcome benefitted from more 'openness' on systems choice, creation of various parallel tools for comparative analysis of the outputs and a critical approach to similar systems under development in other countries. The latter, though entering the scene late in the day, would have co-benefitted from the successes and pitfalls of the Malta SEIS.

However, the SDI concept and its SEIS initiate is a phenomenon that will not go away, as the cores have been planted and the roots established.

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