PI Name and Address

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MAURITIUS RESEARCH COUNCIL
FINAL REPORT

PART I- PROJECT IDENTIFICATION INFORMATION

1. Type the name of the MRC Scheme under which grant is made
   Unsolicited Research and Innovation Grant Scheme

2. Award Dates (MM/YYYY)　　From: **11 Feb 2016**　　To: **10 Feb 2017**

3. Organisation and Address
   Faculty of Ocean Studies
   University of Mauritius
   Reduit, Moka

4. Award Number: **MRC/RUN-AO114/13**

5. Project Title

An Ocean Data Management System

Mauritius Research Council

MRC Grant Conditions require submission of a Final Report to the MRC no later than 30 days after the expiration date of the award. Final Reports for expired awards must be received before new awards can be made.

Use this format to provide a summary of the completed projects and technical information. Be sure to include your name and award number on each separate page. See below for more instructions.

PART II - SUMMARY OF COMPLETED PROJECT (for public use)

The summary (about 200 words) must be self-contained and intelligible to a scientifically or technically literate reader. Without restating the project title, it should begin with a topic sentence stating the project's major thesis. The summary should include, if pertinent to the project being described, the following items:

- The primary objectives and scope of the project
- The techniques or approaches used only to the degree necessary for comprehension
- The findings and implications stated as concisely and informatively as possible

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PART III - TECHNICAL INFORMATION (for program management use)

List references to publications resulting from this award and describe in full primary data, samples, physical collections, inventions, software, etc., created or gathered in the course of the research and, if appropriate, how they are being made available to the research community. This section should be limited to 30 pages.

I certify to the best of my knowledge (1) the statement herein (excluding scientific hypotheses and scientific opinion) are true and complete, and (2) the text and graphics in this report as well as any accompanying publications or other documents, unless otherwise indicated, are the original work of the signatories or of individuals working under their supervision. I understand that willfully making a false statement or concealing a material fact in this report or any other communication submitted to MRC is a criminal offense.

Principal Investigator Signature:	Date:
J. Von Busch	08 · 03 · 2017

MRC Form 1050

PART II – SUMMARY OF COMPLETED PROJECT

OCEANIS: AN OCEAN DATA INFORMATION SYSTEM

The Exclusive Economic Zone (EEZ) of Mauritius is one of the largest of the world but also one of the least exploited. The discovery of high-priced resources can turn the Republic of Mauritius into a high-income economy within a few years. However, there are some challenges that still need to be surmounted. First and foremost, the lack of a central database on the marine fauna and flora is a serious constraint that leads to the failure of many projects right at the start. The lack of co-ordination and co-operation between the different actors of the marine sector is also a hurdle for progress. Thus, in this work, we have created an online platform which provides a number of useful services to researchers, policy makers, students, marine-related communities and to the public at large. First and foremost, the portal has been used to bring together different institutions on the same platform. A social network has also been developed in order to encourage collaboration between the different stakeholders. A web-based Geographical Information System has been integrated in this system and this can be used to provide location information of relevant resources to fisherman, coastguards, incoming and outgoing ships, tourists and other people involved with the sea. Both Android and iOS users can use the WordPress app to publish articles, images and videos on the blog section using their smartphone from anywhere and at anytime. A central link has also been created to access marine data from all around the world. The existence of this common platform will contribute towards the vision of the government of transforming Mauritius into an ocean-based high-income economy. In the future, it will also be possible to use the portal to send notifications to all those who are connected to it especially in times of national disasters or other emergencies. This platform may also be upgraded to create a local databank that conglomerates data from all the different institutions into a single database that will be accessible by different types of users from any part of the world.

AN OCEAN DATA MANAGEMENT SYSTEM

FINAL REPORT

MRC/RUN-AO114/13

STARTING DATE: 11 February 2016

COMPLETION DATE: 10 February 2017

PI: **Associate Professor (Dr) Manta Devi Nowbuth**

Members: Dr Ranjeet Bhagooli, Sameerchand Pudaruth, Sharveen Chelliah and Shazia Sheik Manoga

FACULTY OF OCEAN STUDIES

UNIVERSITY OF MAURITIUS

SUBMITTED ON: 06 MARCH 2017

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Abstract

Mauritius manages a maritime zone of 2.3 million km^2. The potential for economic advancement and prosperity that this resource can generate if developed in a sustainable way could take Mauritius to that of a high-income country. Already, the ocean territory contributes significantly to the wealth of Mauritius. The GDP share has been estimated at 10.8 per cent in 2012, with a value addition of MUR 32.5 billion, of which over 90 per cent currently comes from three established sectors - coastal tourism and marine leisure, seaport-related activities and seafood-related activities where significant scope for future growth exists.

However, the real prosperity from the ocean is expected from the new clusters. Among the economic activities identified as possible priority areas, the utilisation of pure, nutrient-rich and cold deep sea water to develop the Deep Ocean Water Application (DOWA) projects will provide sea-water air conditioning to industrial and commercial users, reducing the dependence of Mauritius on fossil fuels, as well as create a plethora of downstream business activities for high-end aquaculture, seaweed and algal culture, cosmetics and pharmaceuticals, agrochemicals, water bottling and thalassotherapy.

In order to achieve all these wonderful goals, it would be imperative to have a common platform for all the stakeholders (Mauritius Research Council (MRC), Mauritius Oceanography Institute (MOI), University of Mauritius (UoM), Mauritius Ports Authority (MPA), Mauritius Police Force (MPF), Mauritius Meteorological Services (MMS), Ministry of Ocean Economy, Marine Resources, Fisheries and Shipping, Ministry of Education and Human Resources, Tertiary Education and Scientific Research, the private sector, regional organisations, international organisations and others) where they can meet, discuss and get trustworthy data for them to take important decisions for their respective organisations.

In line with this vision, this project aims at developing an online portal – Oceanis http://www.oceanis.info/ - which would enhance communication and collaboration between all parties and would help reduce duplicity in research work. In this optic, a research/academic

network has been created such that the different users may easily get in touch with one another, can create posts, can share ideas and so on.

Apart of extending the networking possibilities, this platform can also be used for educational purposes. Site visitors can consult the Glossary of Terms section in case they are having difficulties understanding key marine terms. Besides, Oceanis also provides links to a number of different national as well as international marine-related organisations.

Side by side, this online platform also improves community engagement. For instance, the About Us section contains a user-generated marker map, whereby a site visitor can tag a location with a specific information which will be visible to others. Likewise, the WordPress mobile application can also be used to publish posts in the Blog section of Oceanis.

1.0 Introduction

Mauritius manages a maritime zone of 2.3 million km^2. The potential for economic advancement and prosperity that this resource can generate if developed in a sustainable way could take Mauritius to that of a high-income economy. Already, the ocean territory contributes significantly to the wealth of Mauritius. The GDP share has been estimated at 10.8 per cent in 2012, with a value addition of MUR 32.5 billion, of which over 90 per cent currently comes from three established sectors - coastal tourism and marine leisure, seaport-related activities and seafood-related activities where significant scope for future growth exists.

However, the real prosperity from the ocean is expected from the new clusters. Among the economic activities identified as possible priority areas, the utilisation of pure, nutrient-rich and cold deep sea water to develop the Deep Ocean Water Application (DOWA) projects will provide sea-water air conditioning to industrial and commercial users, reducing the dependence of Mauritius on fossil fuels, as well as create a plethora of downstream business activities for high-end aquaculture, seaweed and algal culture, cosmetics and pharmaceuticals, agrochemicals, water bottling and thalassotherapy, among others.

The discovery of hydrocarbons in our EEZ would be a potential game changer for our economy. The rich untapped living organisms in our EEZ can also bring high returns to our nascent marine biotechnology industry should we find new molecules that can be commercially exploited. The core asset of the Mauritian Ocean Economy rests in the protection of its maritime health and the preservation of its biological diversity (OceanEconomy, 2014).

The Ocean Economy can also open up new business opportunities for existing services sectors such as marine ICT and marine finance. For example, the existing local ICT capabilities could be extended to develop new applications for ecosystem and wave modelling tools, fish habitat monitoring and sustainable fisheries resource management systems, trade and maritime-transport related data, amongst others. Equally, marine finance would focus on delivery of niche services such as ship management, yacht leasing, marine insurance and trading on carbon exchange platforms, amongst others. Ship registration activities would also be significantly developed as

part of the marine services sector, with a ripple effect on ship leasing, ship insurance and ship repairs. Significant job opportunities exist for trained technical resources for ship surveying and related activities as well as for seafarers.

The enablers such as regulatory and legal frameworks for sustainable development, international and regional cooperation, business development and promotion strategies, research and innovation, investment issues and incentives have been identified for each cluster by the government and would need to be implemented in a coordinated and efficient manner, taking into account priorities and cost requirements.

In order to achieve all these wonderful goals, it would be imperative to have a common platform for all the stakeholders (MRC, MOI, UoM, MPA, MPF, MMS, Ministry of Ocean Economy, Marine Resources, Fisheries and Shipping, Ministry of Education and Human Resources, Tertiary Education and Scientific Research, the private sector, regional organisations, international organisations and others) where they can meet, discuss and get trustworthy data for them to take important decisions for their respective organisations. The new portal will also enhance communication between all parties and would help reduce duplicity in research work.

This report proceeds as follows. In the next section, we provide a list of all the functionalities that have been integrated in the Oceanis portal. Section 3 describes all the background and analytical work that have been done in order to choose the right components and collect relevant data for the portal. The initial objectives that were set at the beginning of this endeavour are evaluated in Section 4. And finally, Section 5 concludes this report with a brief note on future works.

2.0 Work Completed

(i) Setting Up and Configuration of Website Hosting Platform

The Ocean Data Management System online portal has been successfully setup and configured on private hosting service (bluehost.com). The link to access the portal is http://www.oceanis.info.
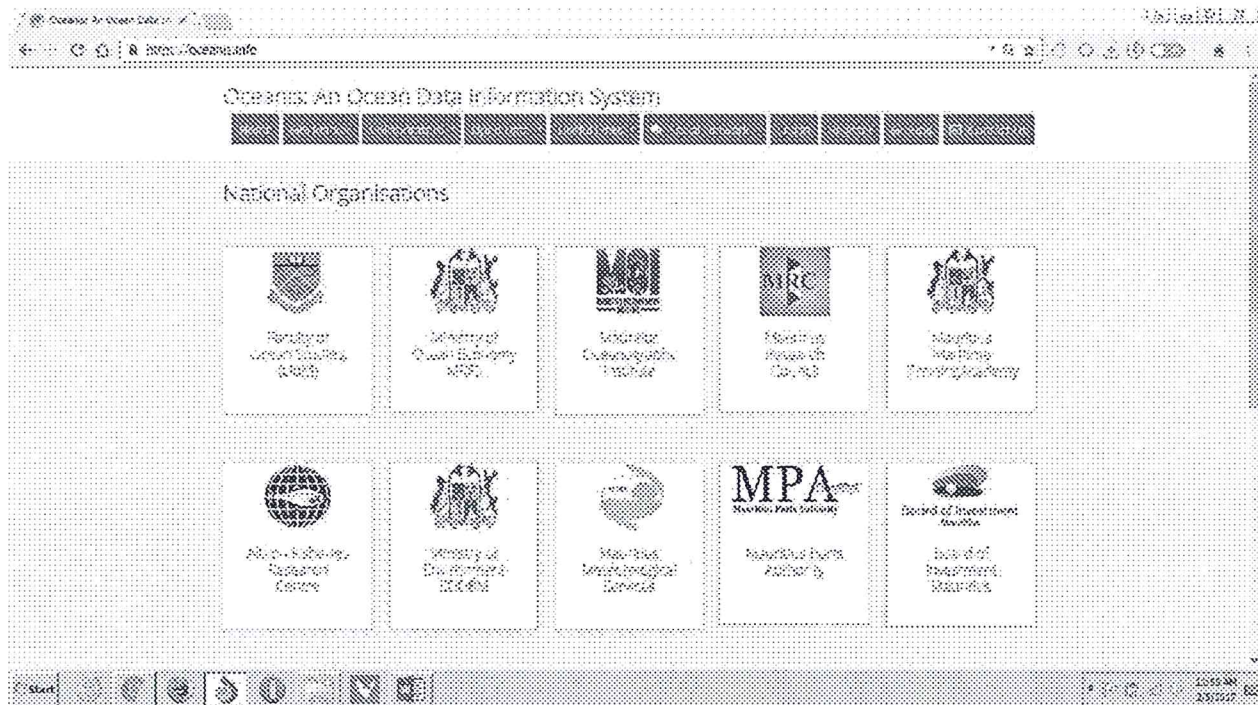

(ii) Evaluation of Existing Web Content Management Systems (WCMSs)

Existing WCMSs have been compared *(Section 3.3)* and the 3 most popular ones, which are WordPress, Drupal and Joomla, had been installed on a webserver for evaluation. Freely available plugins and trial versions of premium templates have been tried for hands-on experience. The WordPress platform was finally chosen as it was easier to get technical support.

(iii) Development of an Oceanic Portal

A working prototype has also been developed with components being integrated in an incremental fashion. The main components integrated are as follows:

- Blog with the possibility of using WordPress App to upload content to the portal from anywhere
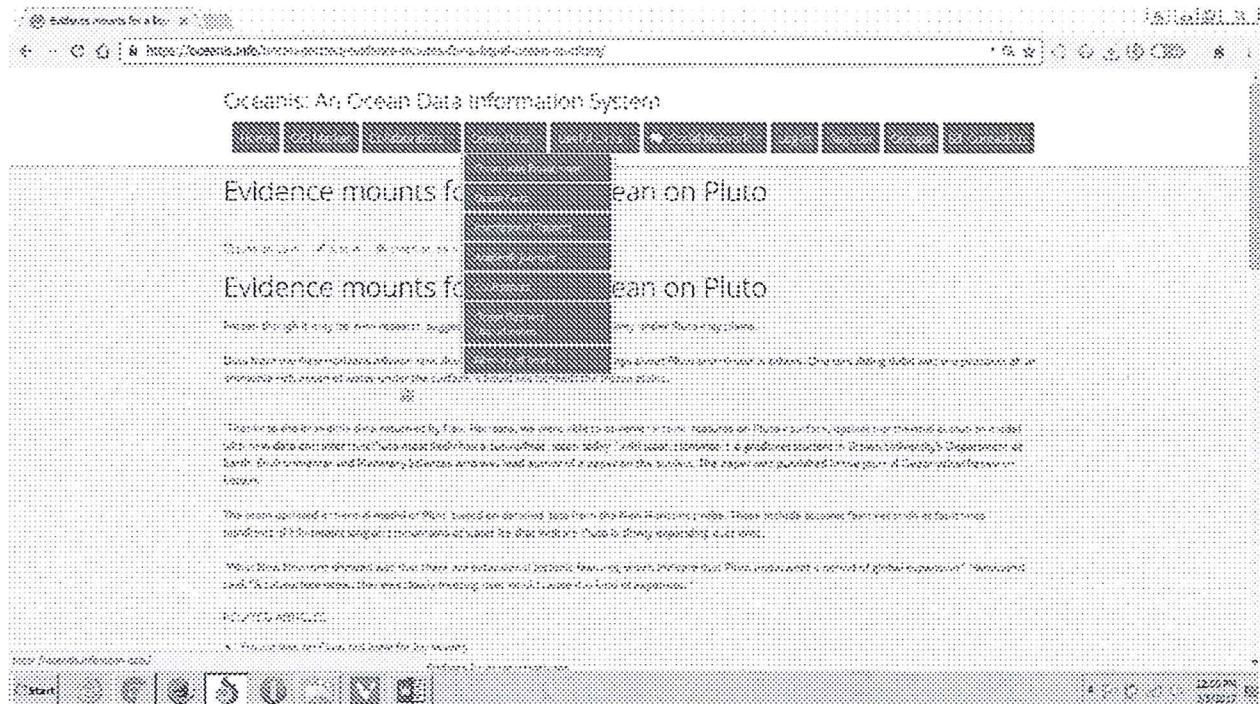
- Latest Oceanography News
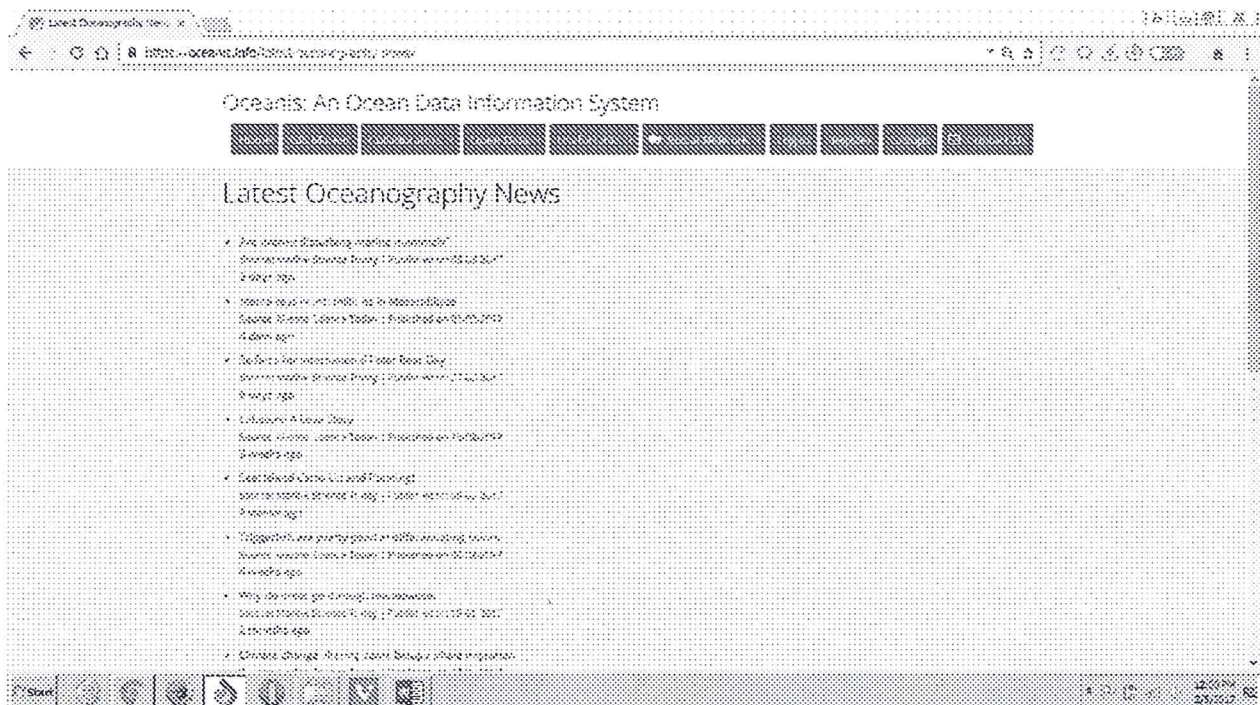
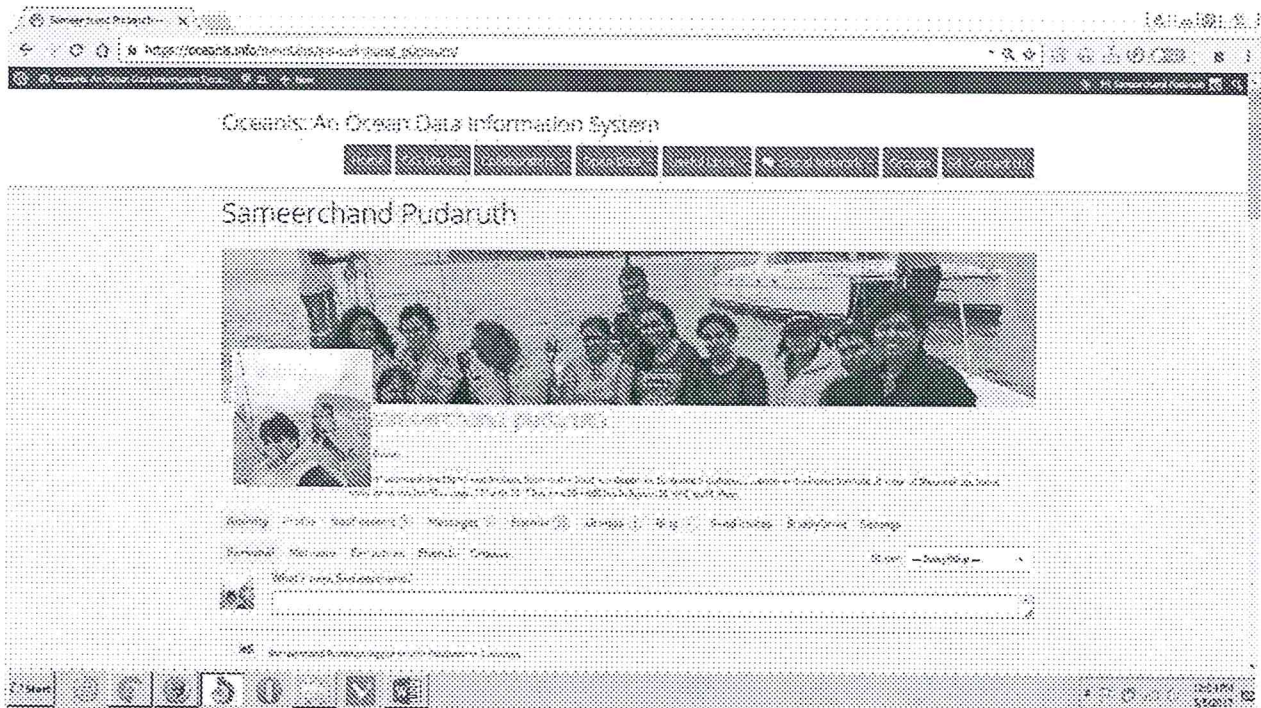## - Puzzle game

- Quiz
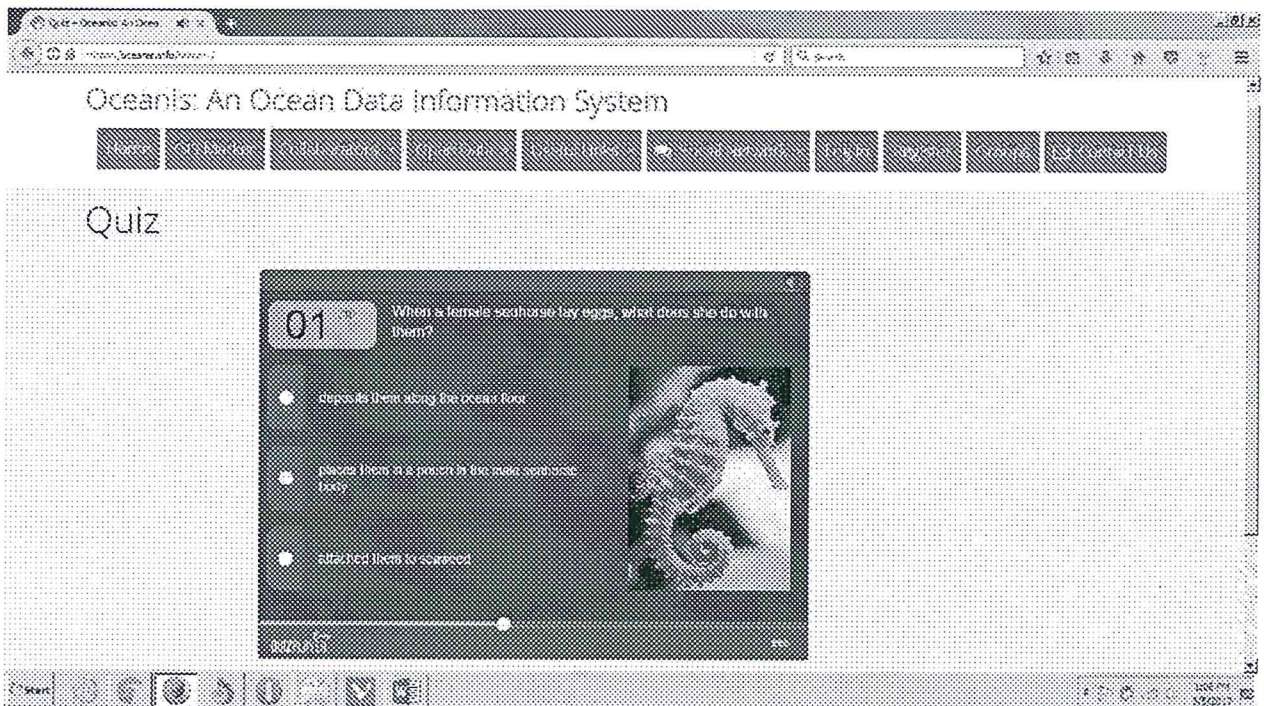
- Google Map with basic GIS capabilities
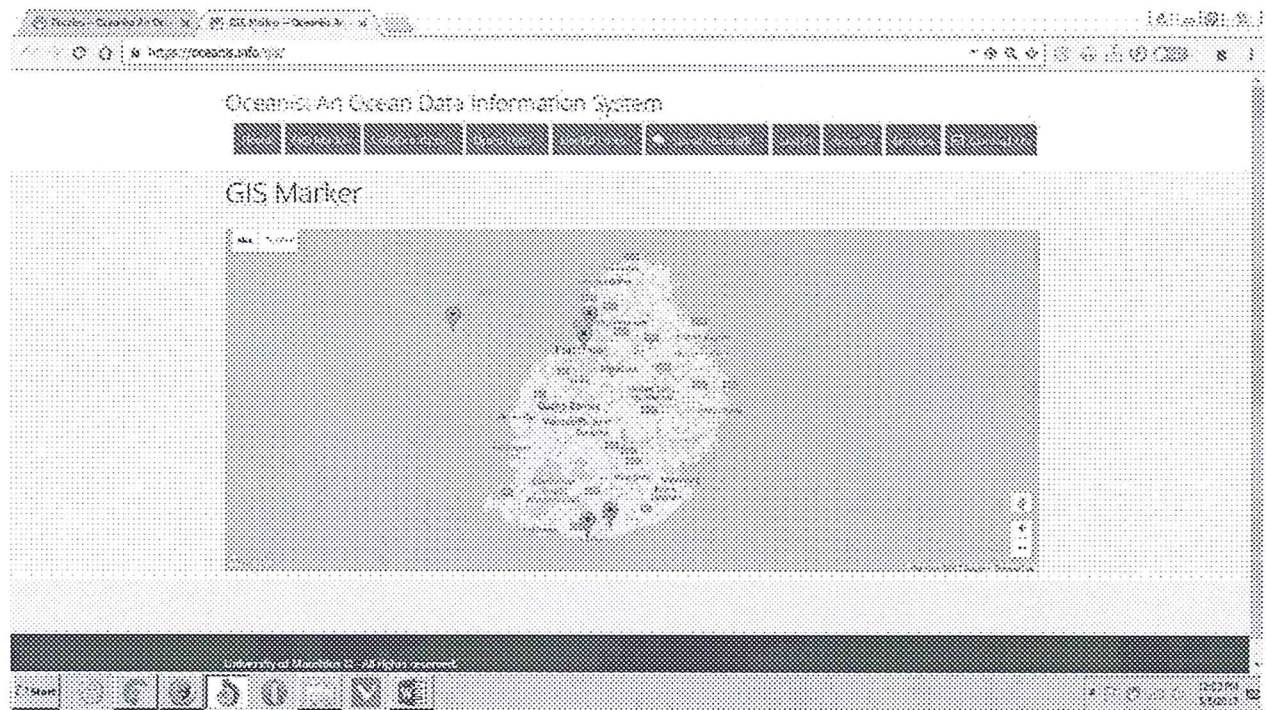
- List of Collaborating institutions
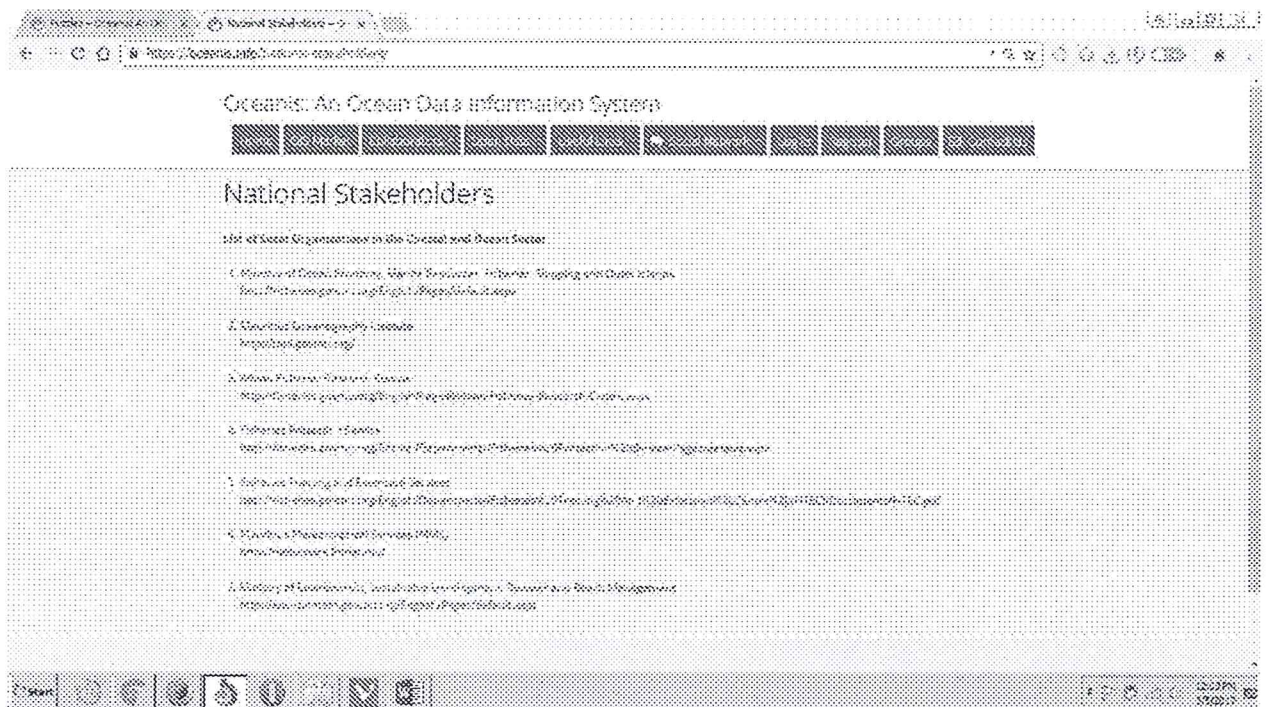
- Social Network

(iv) Design of a Website Logo

The portal has been named Oceanis which stands for **Ocean** Information System. The blue colour as well the wave outline has been chosen in order to represent the marine sector.

(v) Purchase of Premium Themes and Plug-ins

Following in-depth investigations, freely available templates as well as plug-ins were observed to offer poor performance. Hence, premium templates and plug-ins were explored and suitable ones have been purchased in order to improve the online portal. The theme Intuition Pro (http://cpothemes.com/theme/intuition) was considered to be best suited for the purpose of this project. Plug-ins such as WP Google Maps Pro (http://www.wpgmaps.com/purchase-professional- version/) and add-ons such Visitor

Generated Markers Add-on (http://www.wpgmaps.com/visitor-generated-markers-add-on/) were also purchased.

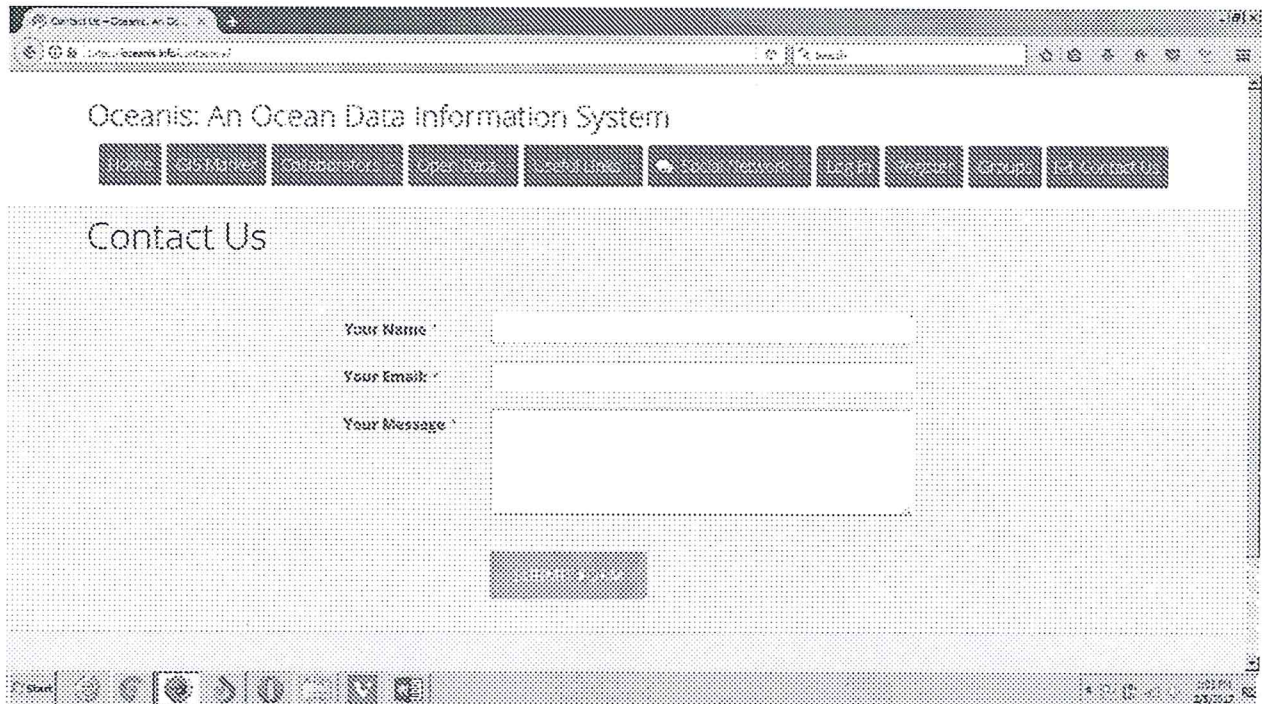### (vi) Evaluation of Tools for building Social Networks

Existing academic networks have been compared and the 3 most popular ones, which are BuddyPress, WP Symposium and PeepSo, have been installed on a web server for hands-on experience.

(vii) Content Materials

Content materials obtained from various team members of this project have been edited and presented in an appropriate format on the Oceanis website. These content materials include textual information about international and national stakeholders and freely available oceanic data.

(viii) Contact Us notification

To enable users to contact the administrator, a contact us form is provided on the portal.

(ix) Development of an Image Uploader Mobile Application

This mobile/web application aims at providing end-users (tourists, marine officials and the public in general) the ability to upload images taken from their hand-held device camera. Their hand-held device can be a mobile phone, a tablet, a wearable computer or a personal digital assistant.

Note: This application requires internet connection to operate. However, images/videos can be captured while being offline. The upload will eventually be performed when the device is connected to a Wi-Fi hotspot. Furthermore, both the Android or iOS version of the WordPress app can be used.
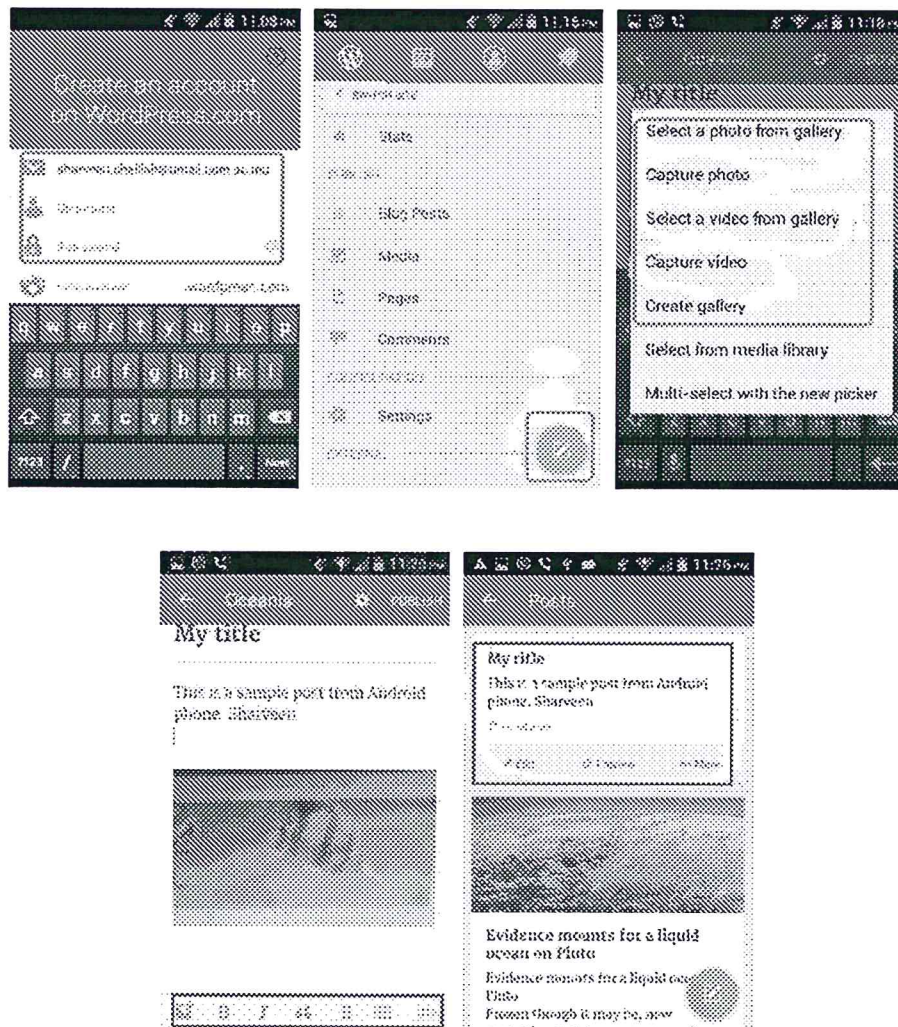
(x) Social (Facebook) Login

As mentioned before, a social network has been developed. A number of notable features has been added. A social signup/login tool has also been included. It is a form of single sign-on using existing login information from a social networking service such as Facebook to sign into a third party website instead of creating new login credentials specifically for that website. This tool has been included in order to increase the sign-up rate and to simplify logins as it eliminates the need for traditional registration forms. A user can also send friend requests, public messages and private messages to other users.

Opening a discussion or sharing opinions via posts and comments is one of the elements which make a social network interactive. The ability to comment on existing posts have also been provided.
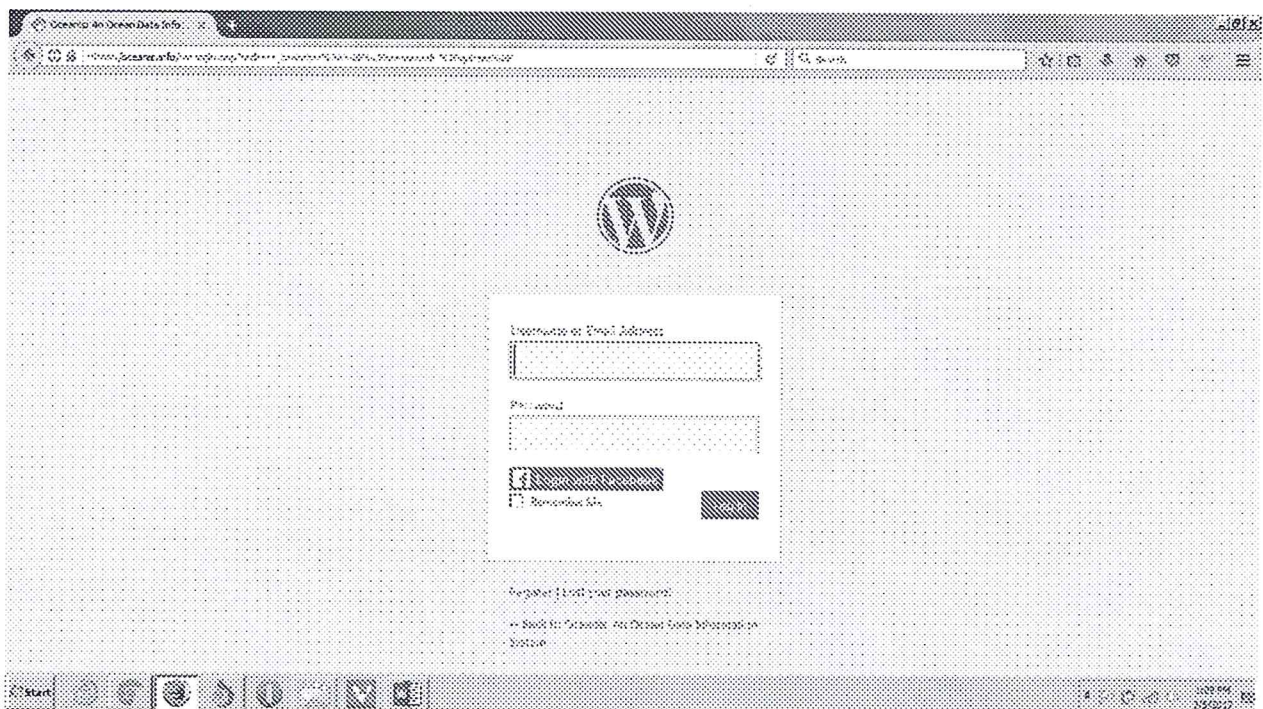
3.0 Background Studies

3.1 Web Content Management Systems

A Web Content Management System (WCMS) is typically a computer application that provides website development features and web publishing capability so as to allow non-technical developers to create and manage website content with little effort and difficulty. Indeed, this powerful tool allows developers with little or no knowledge of web programming languages or markup languages to easily build websites or web-based applications from a central interface.
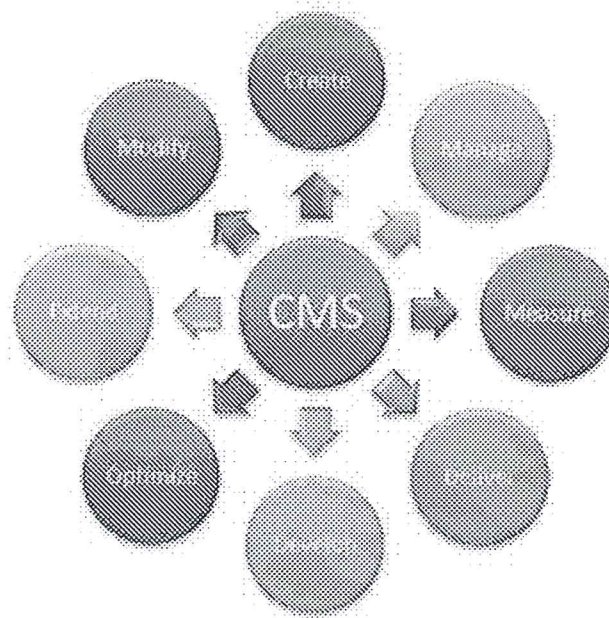
One of the primary aims of using WCMSs is to bypass the need for hand coding and development from scratch (Patel *et al.*, 2011). Plug-ins are readily available to perform complex tasks for the developer. In addition to that, being a website maintenance tool, developers can make use of WCMSs to bring modifications to web content (Ghorecha and Bhatt, 2013) in a seamless way. Typically, WCMSs are used to develop blogs, news, and e-commerce websites for corporate and marketing organisations. Most WCMSs include web-based publishing, layout management and search features (Ghorecha and Bhatt, 2013).

3.2 Comparison of existing WCMSs

The most commonly used WCMSs are WordPress, Joomla and Drupal. An in-depth investigation was conducted in order to grasp a better understanding of the features that each of the aforementioned WCMSs provide. A comparison was subsequently conducted in order to determine the most appropriate WCMS for this project.

3.2.1 WordPress

Released in 2003, WordPress was originally developed for the creation of blogging platforms. However, since 2009, this tool has been upgraded into a full-fledged WCMS. WordPress is written in PHP and uses the MySQL database. WordPress is led and supported by the for-profit company Automatic.

The following table summarises the key features of WordPress.

Table 1 - Description of WordPress Features

Latest Version	4.7.2
Hosting Environment	- Can be hosted on a standard shared Linux/Apache/MySQL/PHP environment.
Hosting Requirements	- Compatible with Linux, Windows and Macintosh OS - Requires MySQL as a database and PHP as a scripting language
Installation Time	- Less than 10 minutes

Documentation Support	- Large amount of documentation, including live chat with WordPress representatives, published books, online forums, video tutorials, is available

Plug-in/Add-on Support	- 43,427 community-contributed add-ons available at the official WordPress directory of plug-ins (https://wordpress.org/plugins/) - Community ratings and reviews are also available
Design Flexibility	- Hundreds of pre-packaged graphical themes available on the official WordPress website - Provides a high degree of flexibility in site appearance and layout - Supports all webpages that can be designed via HTML and CSS
Structural Flexibility	- Supports an unlimited number of pages in a hierarchy of unlimited levels
Search Engine Support	- Available: Based on a keyword search - Does not perform search in documents hosted on the website
Multi-Language Support	- Add-ons available to perform automatic webpage translation
Interface Languages	- Administrative interface available in 61 different languages
Comment Functionality	- Allows website visitors to post comments - Provide the option of blacklisting/whitelisting website visitors, hence preventing them from commenting
Blog Support	- Registered visitors can create their own personal blogs on the website - Supports multi-author blogs - Add-ons available to allow website visitors to befriend each other and create groups
Learning Curve	- Relatively easy to learn - Relatively high reliance on plug-ins compared to Joomla
Security Update	- Security vulnerabilities are not published on WordPress.org - Updates occur frequently - No official process for evaluating add-ons or themes for security issues beyond community ratings.

3.2.2 Joomla

Developed in 2005, Joomla is one of the most powerful open-source WCMS for publishing web content. Written in PHP, Joomla makes use of object-oriented programming techniques, making it ideal for designing interactive multi-language websites in a short period of time (Patel *et al.*, 2011). Joomla is commonly used to develop online communities, media, portals, blogs and e-commerce applications (Wakode and Chaudhari, 2013).
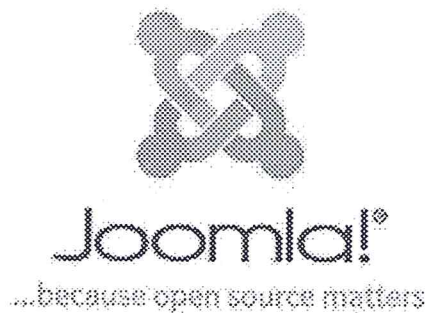
Description of the features provided by Joomla is presented in Table 2 below.

Table 2 - Description of Joomla Features

Latest Version	3.6
Hosting Environment	- Can be hosted on a standard shared Linux/Apache/MySQL/PHP environment.
Hosting Requirements	- Compatible with Linux, Windows and Macintosh OS - Requires MySQL as a database and PHP as a scripting language or Oracle as a database and Microsoft SQL as a scripting language
Installation Time	- Less than 30 minutes
Documentation Support	- Less support available compared to WordPress and Drupal
Plug-in/Add-on Support	- Over 7000 extensions available at the official Joomla directory of extensions (http://extensions.joomla.org/) - Community ratings and reviews are also available

Design Flexibility	- Has no official template repository, but has numerous third-party sites offering templates Provides a high degree of flexibility in site appearance and layout - Supports all webpages that can be designed via HTML and CSS
Structural Flexibility	- Supports an unlimited number of pages in a hierarchy of maximum 3 levels
Search Engine Support	- Available: Based on a keyword search, using any word, all words or exact phrase matching. - Search result can be ordered by date, popularity, alphabetically and by section. - Searches can be limited by section, for example only showing articles, or news feeds - Does not perform search in documents hosted on the website
Multi-Language Support	- Add-ons available to perform automatic webpage translation
Interface Languages	- Administrative interface available in 100 different languages
User Interface	- Simple to use - Highly customisable
Comment Functionality	- Primarily does not allow website visitors to post comments, but an add-on can accommodate this feature - Provide the option of blacklisting/whitelisting website visitors, hence preventing them from commenting
Blog Support	- Registered visitors can create their own personal blogs on the website - Supports multi-author blogs - Add-ons available to allow website visitors to befriend each other and create groups - Difficult to monitor activities
Learning Curve	- Relatively difficult compared to WordPress - Operates using a WYSIWYG interface

	- Low reliance on add-ons compared to WordPress and Drupal for a standard website since the majority of basic features are already available in the Core System
Security Update	- Security vulnerabilities and updates are published on Joomla.org - Updates occur frequently - The Joomla community has introduced a "Vulnerable Extensions" list, which contains all add-ons that were previously flagged by security third-parties. These add-ons are subsequently removed from the official Joomla directory of extensions until the security issue is fixed

3.2.2 Drupal

Released in 2001, Drupal is another open-source platform for building robust, flexible websites. According to Patel *et al.* (2011), Drupal is considered suitable when web developers need to perform critical tasks of high complexity. Drupal provides not only flexibility but also provides a fair amount of documentation support as well.

The features available in Drupal can be found in the table given below.

Table 3 - Description of Drupal Features

Latest Version	8.1.0
Hosting Environment	- Can be hosted on a standard shared Linux/Apache/MySQL/PHP environment
Hosting Requirements	- Compatible with Linux, Windows and Macintosh OS - Requires MySQL or PostgreSQL as a database and PHP or Microsoft SQL as a scripting
Installation Time	- Less than 30 minutes
Documentation Support	- Considerable amount of documentation, including published books, online forums, video tutorials, is available - Less support available compared to WordPress
Plug-in/Add-on Support	- 33,430 add-ons available at the official Drupal directory of extensions (https://www.drupal.org/) - Community ratings and reviews are also available

Design Flexibility	- Hundreds of pre-packaged graphical themes available on the official Drupal website - Provides a high degree of flexibility in site appearance and layout - Supports all webpages that can be designed via HTML and CSS
Structural Flexibility	- Supports an unlimited number of pages in a hierarchy of unlimited levels
Search Engine Support	- Available: Based on a keyword search - Does not perform search in documents hosted on the website
Multi-Language Support	- Add-ons available to perform automatic webpage translation
Interface Languages	- Administrative interface available in 69 different languages
Comment Functionality	- Primarily does not allow website visitors to post comments, but an add-on can accommodate this feature - Provide the option of blacklisting/whitelisting website visitors, hence preventing them from commenting
Blog Support	- Registered visitors can create their own personal blogs

	- Supports multi-author blogs - Add-ons available to allow website visitors to befriend each other and create groups
Learning Curve	- More or less same as WordPress - Does not operate using a WYSIWYG interface - Relatively high reliance on add-ons compared to Joomla for a standard website
Security Update	- Security vulnerabilities and updates are published on Drupal.org. - Updates occur frequently - The Drupal community has a security team to review contributed Add-ons. The community subsequently publishes a known vulnerabilities list

The aforementioned WCMSs have also been analysed and compared with respect to the key requirements of this project. Table 4 illustrates the result of this evaluation.

Table 4 - WCMS Comparison

Requirement	WordPress	Joomla	Drupal
Learning Curve	Moderate	High	Moderate
Ease of Use	Moderate	High	Moderate
Documentation Support	High	Moderate	Moderate
Prob. of obtaining support for unresolved issues	High	Moderate	Moderate
Prob. of having required plug-ins available	High	Low	High
Prob. of having suitable themes/template available	High	Low	High
Security	Low	High	High

3.3 Choice of WCMS

As it can be depicted from Table 4, WordPress, Joomla and Drupal all have various notable strengths and weaknesses. WordPress has been considered best suited for this project because of its large array of built-in features as well as a large selection of additional plug-ins, which enhances the value of websites as well as enrich visitors' experience. For instance, via the "BuddyPress" WordPress plug-in, social networking capabilities can be integrated to the website. This would allow end-users to connect with one another, upload albums photos, create groups as well as share documents.

Moreover, a substantial amount of documentation and support for WordPress is available in the form of live chat with WordPress representatives, published books, online forums and video tutorials. In addition to that, hundreds of pre-packaged graphical themes and templates are also readily available.

In August 2013, 14.3 % of websites were using WordPress compared to 2.7 % for Joomla and 1.6 % for Drupal (Ghorecha and Bhatt, 2013). Its popularity among professionals of the world of web development is another factor that contributed in the choice of WordPress being the preferred WCMS for the web portal to be developed in this project.

3.4 Geographic Information Systems

A Geographic Information System (GIS) is a software system that describes the use of space technologies available to facilitate the management and analysis of spatial phenomena. GIS is a tool which connects map layers with tables of information. This tool is not limited to terrestrial applications only as it has expanded its boundaries to accommodate oceanography as well. Indeed, in recent years, the ability to measure change in the open oceans, shores and coasts is increasing, not only because of improved measuring devices and scientific techniques but also because new GIS technologies are contributing to the better understanding of this dynamic environment (Wright, 2012). Ocean GIS (also known as Marine GIS) can be used in ocean protection, preservation and management (Mehta, 2014). Ocean GIS can also be used in assessing geological hazards such as erosion risks (Ma, 2011).

This tool has been upgraded from simple applications that collect and display data to providing facilities for complex simulation and modeling. GIS applications provide the possibilities to integrate, visualise and analysis geospatial information (Wright, 2012). GIS applications can be classified as either Inventory (what is there?), Analysis (answering questions such as shortest distance) or Modeling (making predictions). Numerous innovations in remotely sensed data, both satellite and acoustic, as well as hydrographic models and other emerging data collecting techniques have been added to information data structures (Mehta, 2014).

Web GIS is a GIS system that uses web technologies. It originates from a combination of web technologies and Geographical Information Systems. A Web GIS is a type of distributed information system.

3.5 Geo Datasets

GIS data can be stored in 2 popular formats - raster format and vector format. The section below will focus extensively on the raster dataset. In its simplest form, a raster consists of a matrix of cells (or pixels) organised in rows and columns whereby each cell contains a value representing some information, such as temperature. Rasters are digital aerial photographs, imagery from satellites, digital pictures, or even scanned maps.
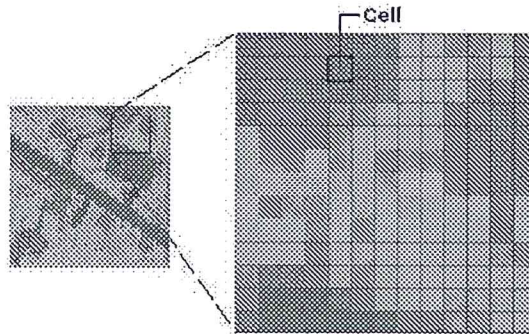
Data stored in a raster format represents real-world phenomena, such as:

- Thematic data (also known as discrete data), representing features such as land-use or soils data

- Continuous data, representing phenomena such as temperature, elevation or spectral data such as satellite images and aerial photographs

Raster data can be categorised in either one of the following:

1. Rasters as Basemaps

A common use of raster data in a GIS is as a background display for other feature layers. For instance, orthophotographs displayed underneath other layers provide the map user with confidence that map layers are spatially aligned and represent real objects, as well as representing additional information. The main sources of raster basemaps are orthophotos from aerial photography, satellite imagery, and scanned maps.

A Basemap displaying Road Data

2. Rasters as Surface maps

Rasters are well suited for representing data that changes continuously across a landscape. They provide an effective method of storing the continuity as a surface. They also provide a regularly spaced representation of surfaces. Elevation values measured from the earth's surface are the most common applications of surface maps, but other values, such as rainfall, temperature and population density can also define surfaces that can be spatially analysed. The figure below illustrates a surface using different colours - green to show lower elevation and red, pink and white cells to show higher elevation.

A Surface Map displaying Elevation

3. Rasters as Thematic Maps

Rasters representing thematic data can be derived from analysing other data. A common analysis application is classifying a satellite image by land-cover categories. Basically, this activity groups the values of multispectral data into classes (such as vegetation type) and assigns a categorical value to each class.
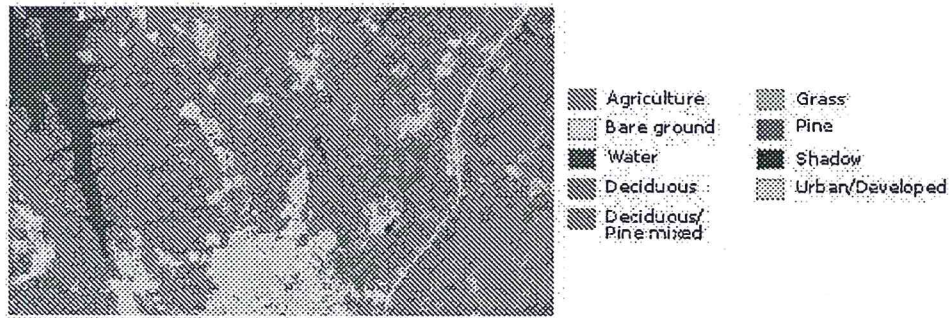
Figure 40 - A Classified Raster Dataset showing Land Use

4. Rasters as Attributes of a Feature

Rasters used as attributes of a feature may be digital photographs, scanned documents, or scanned drawings related to a geographic object or location. A parcel layer may have scanned legal documents identifying the latest transaction for that parcel or a layer representing cave openings may have pictures of the actual cave openings associated with the point features.

3.6 Importance of GIS in Oceanography

For terrestrial purposes, GIS is widely used in precision management of agriculture, forestry, urban planning, business and national defense. There is now equally strong demand for precision management of coastal as well as marine resources (Mehta, 2014). Marine GIS has wide range of applications and can be categorised as coastal, oceanographic and fisheries. In practice these 3 are not absolutely separated and may overlap with one another. For example, fisheries GIS require data on oceanographic processes describing fish population areas (Mehta, 2014).

In addition to that, the exploration and exploitation of deep-water, oil and gas have a tendency to suffer from high-risk geo-hazards such as submarine landslide, soft clay creep, shallow gas, excess pore-water pressure and mud volcano (Mehta, 2014). Therefore, it is necessary to survey the seafloor topography, identify the unfavourable geological risks and investigate their environment and mechanism before exploiting these deep-lying resources (Mehta, 2014).

3.7 Comparison of existing GISs

Existing Web GIS applications have been discussed in this section. An in-depth investigation was conducted in order to grasp a better understanding of the features provided by each of the GIS applications given below.

A. TerraView

TerraView is a free GIS application built using the TerraLib GIS library and distributed under the General Public License (GPL) license. The main goal of this tool is to make available to the GIS Community an easy geographic data viewer with resources that include database queries and data analysis, exemplifying the use of the TerraLib library. The latest version of TerraView - version 4.2.0 - is available since October 2011.
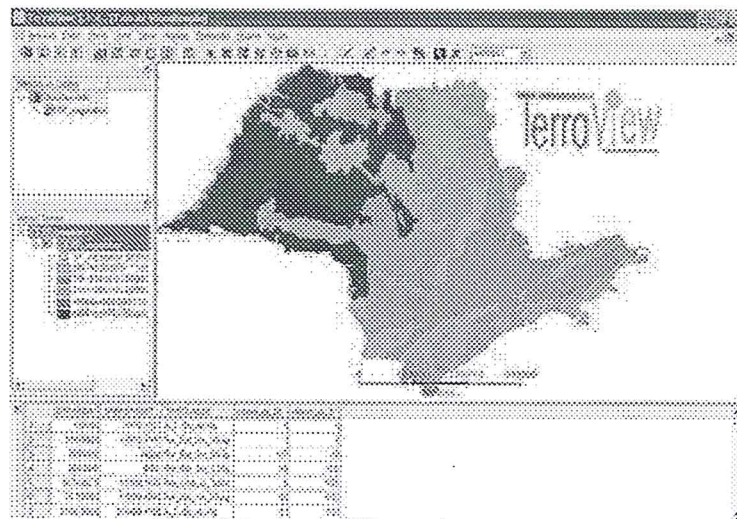
User Interface of Terraview

TerraView can handle vector data (polygons, lines and points) and raster data (grids and images), both stored in a relational or geo-relational database, including ACCESS, PostgreSQL, MySQL and Oracle. It also has a visualisation interface that allows attribute and spatial queries on objects from the geographical database and can provide different views of the database by producing thematic maps with different types of legends.

TerraView is able to manage raster data in the geographical database and allows the visualisation and manipulation of raster data together with vector data. Raster data can be shared in different formats such as GeoTIFF, TIFF, JPEG, RAW, ASCII-Grid or ASCII-Spring. TerraView also supports vector operations including intersection and buffer maps. It also has statistical analysis functions: local and global autocorrelation indexes, semivariograms and regionalisation.

B. Capaware

Capaware is a free 3D multilayer geographical framework which was first released in 2007. Capaware allows interaction with 3D virtual terrain mapping and like TerraView, Capaware is also distributed under the GPL license (Capaware, 2017). This 3D general purpose virtual worlds viewer was developed in the C++ programming language and supports both Microsoft Windows and the Linux operating systems. Capaware uses OpenSceneGraph as graphics engine, achieving extremely high frame rate rates. In addition to that, Capaware also allows the flexibility to incorporate plugins. The latest version of Capaware - version rc2 - is available since July 2011.

User Interface of Capaware

Capaware also allows the 3D viewing of landscape. Furthermore, Capaware does not only enable the creation and modification of new layers of data through access to remote servers but also provides a useful and powerful tool for visual analysis and decision-making situations such as operational feasibility for implementing a power plant or hydroelectricity power stations in specific regions.

C. MapWindow

Built using Microsoft .NET technology and written in C#, MapWindow GIS is an open source GIS application and provides a set of programmable mapping components. MapWindow GIS can be reprogrammed to perform different or more specialised tasks. There are also plug-ins available to expand compatibility and functionality. Updates for MapWindow GIS are regularly released by a group of students and volunteer developers. This tool is distributed under the Mozilla Public License (MPL) distribution license. The latest version of MapWindow - version 4.8.8 - is available since August 2013.
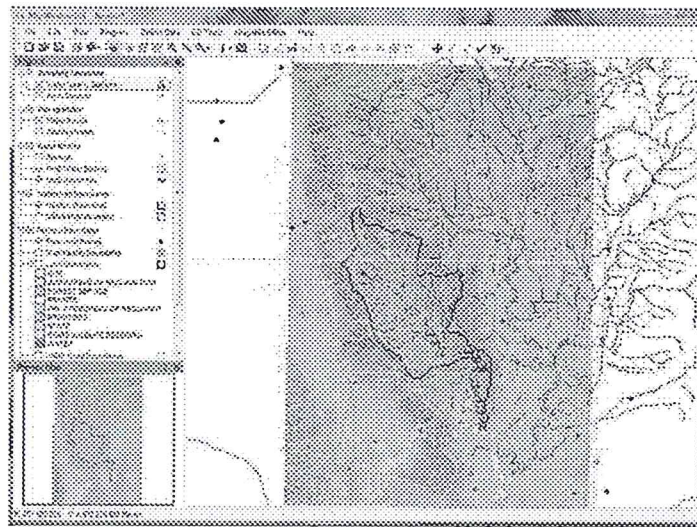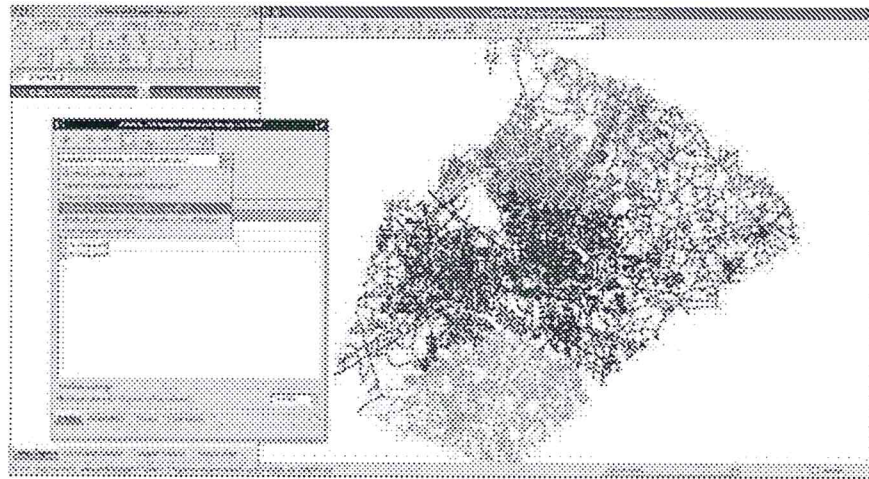

User Interface of MapWindow

MapWindow is an extensible GIS that allows data viewing and provides additional functionality such as models, special viewers, hot-link handler and data editors. It also provides data visualisation features as well as attribute table editing, shapefile editing and data converters (Ames, 2017).

D. GRASS GIS

Geographic Resources Analysis Support System (GRASS GIS) is a open-source GIS software used for geospatial data management and analysis, image processing, producing graphics and maps, spatial and temporal modeling and visualisation (GRASSGIS, 2017).

It contains over 350 modules to render maps and images on monitor and paper; manipulate raster and vector data including vector networks; process multispectral image data; and create, manage, and store spatial data. Written in C, C++ and Python, GRASS GIS is distributed under the GNU GPL license. The latest version of GRASS GIS - version 7.0 - is available since February 2015.

User Interface of GRASS GIS

GRASS GIS can be used for data management, image processing, graphics production, spatial modelling, and visualisation of many types of data. It can also be used to manipulate raster and vector data as well as to process multispectral image data.

E. QGIS

QGIS (previously known as Quantum GIS) is a cross-platform, free and open-source desktop geographic information system (GIS) application that provides data viewing, editing and analysis capabilities (QGIS, 2016).

Similar to other software GIS systems, QGIS allows users to create maps with many layers using different map projections. Maps can be assembled in different formats and for different uses. QGIS allows maps to be composed of raster or vector layers. Typical for this kind of software, the vector data is stored as either points, lines or polygon-features. Different kinds of raster images are supported and the software can georeference images.

QGIS integrates with other open-source GIS packages, including PostGIS, GRASS GIS, and MapServer to give users extensive functionality. Plugins written in Python or C++ extend QGIS's capabilities. Plugins can geocode using the Google Geocoding API, perform geoprocessing using fTools, which are similar to the standard tools found in ArcGIS, and interface with PostgreSQL/PostGIS, SpatiaLite and MySQL databases.

A mobile version of QGIS is currently being developed for Android. This version is optimised for touch, multitouch and stylus input. Geolocation of the mobile device can be used to create GIS features at the users current position.
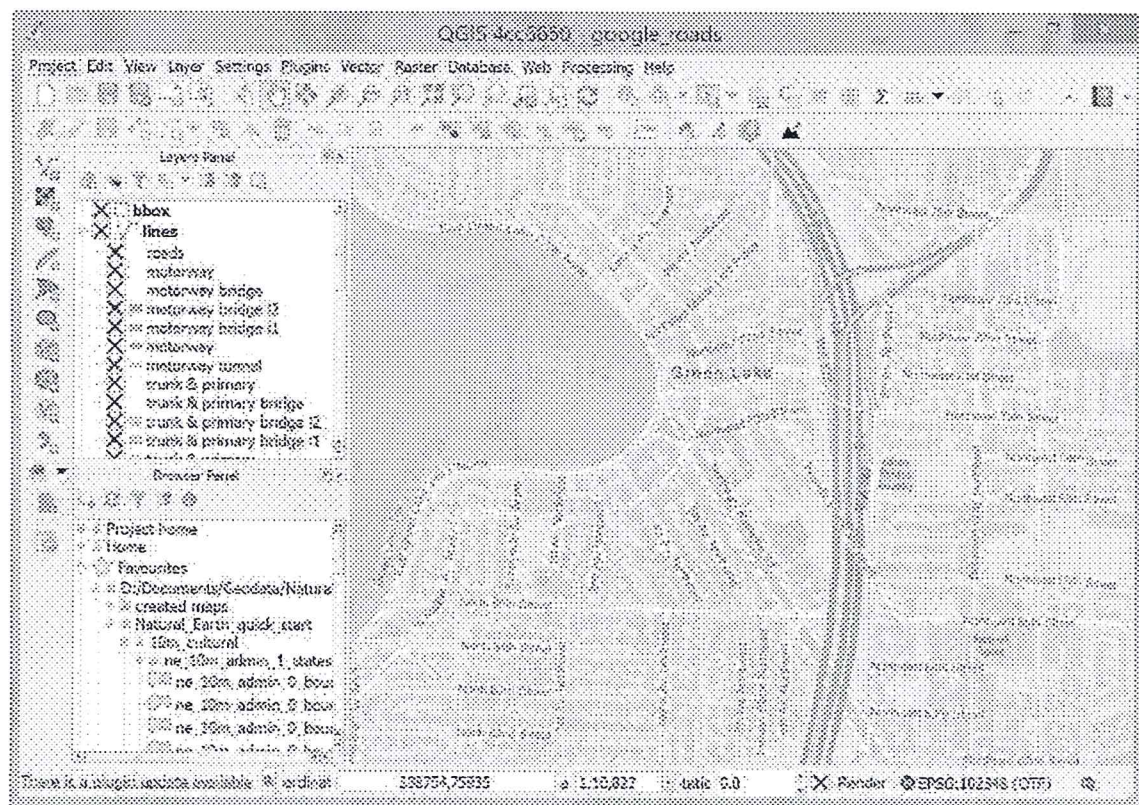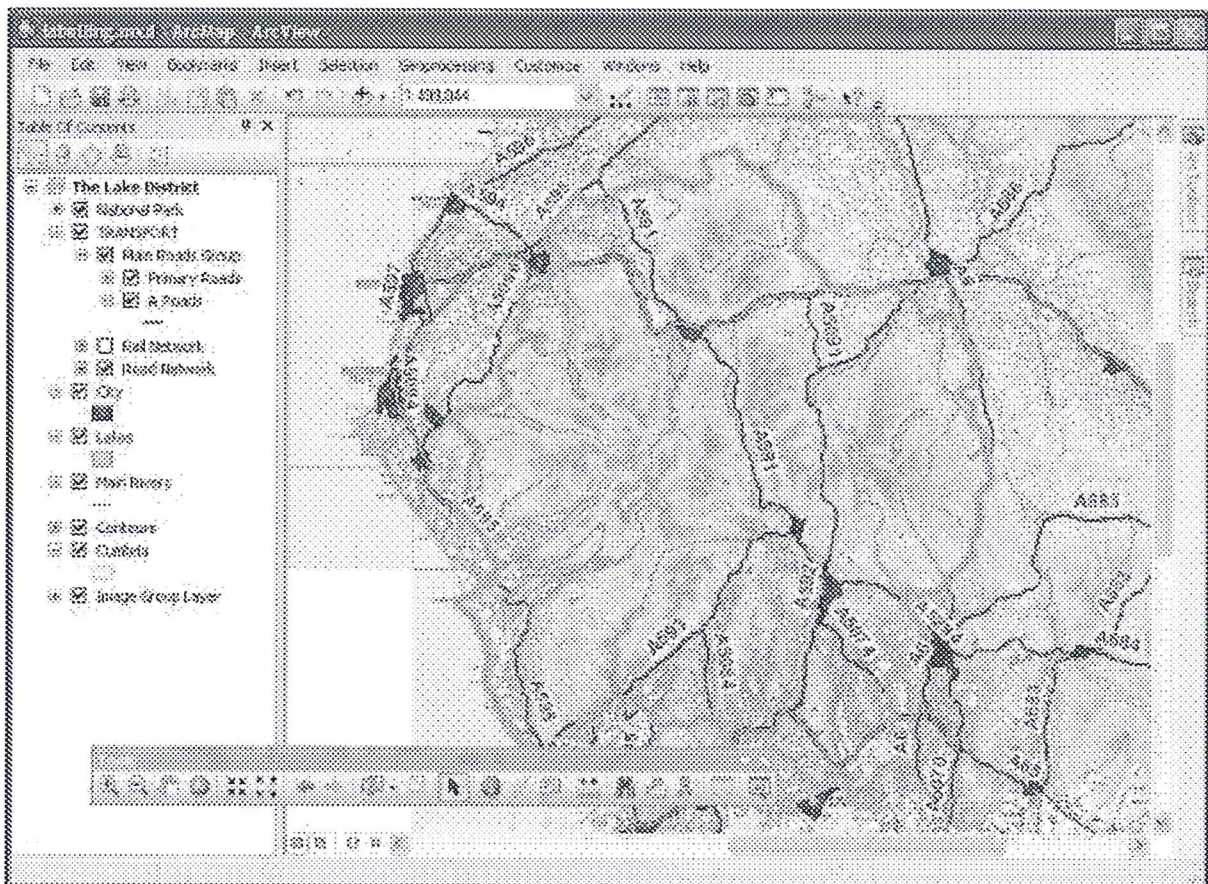

QGIS User Interface

F. ArcGIS

ArcGIS is a cross-platform, commercial geographic information system (GIS) for working with maps and geographic information. It is used for creating and using maps; compiling geographic

data; analysing mapped information; sharing and discovering geographic information; using maps and geographic information in a range of applications; and managing geographic information in a database (GIS247, 2016). The system provides an infrastructure for making maps and geographic information available throughout an organization, across a community, and openly on the Web.

ArcGIS uses the geocoding service to convert addresses to and from geographic coordinates. It serves up directions, optimal routes between multiple destinations, and drive time calculations around a point of interest. Given a point, area, or street address, it can find demographic and contextual data about the study area such as average income, household size and population density. It creates thematic interactive maps that allow your users to explore and understand their geographic data.
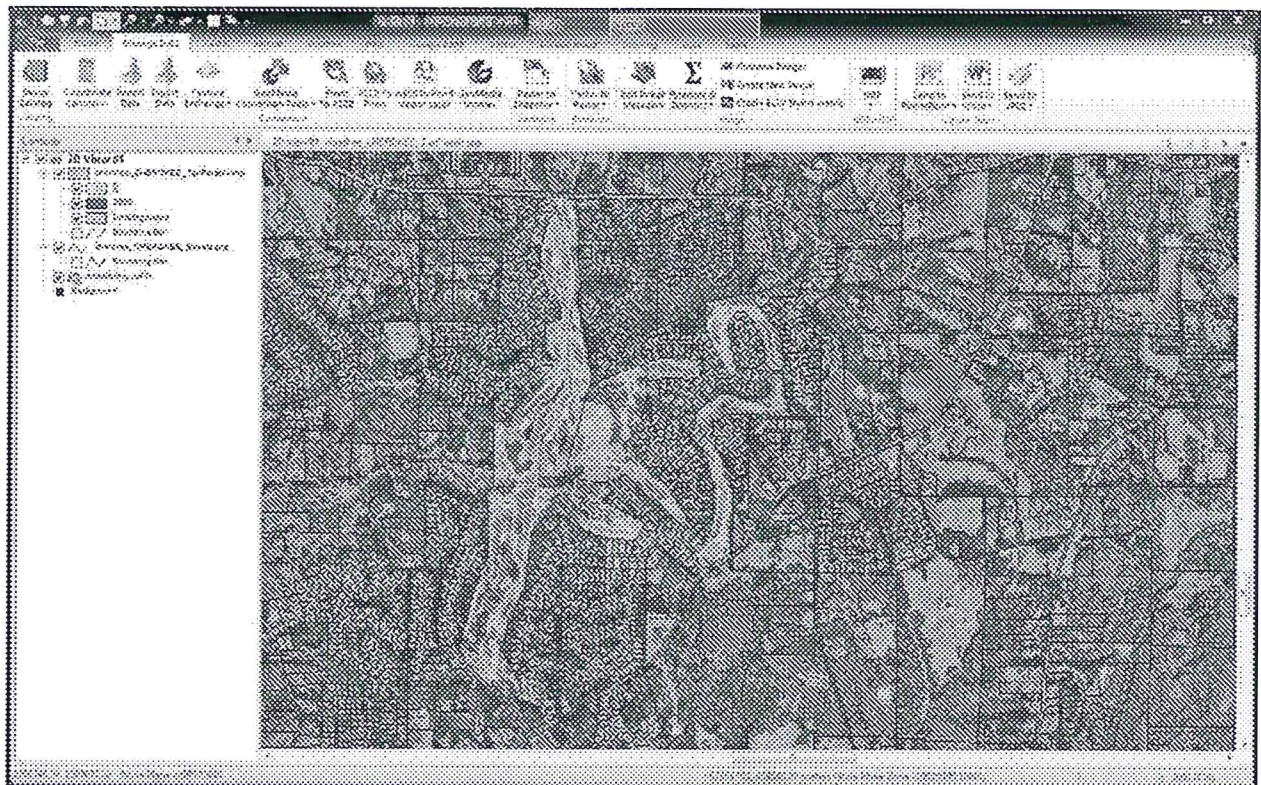

ArcGIS User Interface

G. Erdas Imagine

ERDAS Imagine is a commercial remote sensing application with raster graphics editor abilities designed by ERDAS for geospatial applications running on Windows (Intergraph, 2016). The latest version is 2015. Imagine is aimed mainly at geospatial raster data processing and allows users to prepare, display and enhance digital images for mapping use in geographic information system (GIS) and computer-aided design (CAD) software. It is a toolbox allowing the user to perform numerous operations on an image and generate an answer to specific geographical questions.

By manipulating imagery data values and positions, it is possible to see features that would not normally be visible and to locate geo-positions of features that would otherwise be graphical. The level of brightness or reflectance of light from the surfaces in the image can be helpful with vegetation analysis, prospecting for minerals etc. Other usage examples include linear feature extraction, generation of processing work flows (spatial models in Imagine), import/export of data for a wide variety of formats, orthorectification, mosaicking of imagery, stereo and automatic feature extraction of map data from imagery.


Erdas Imagine User Interface

H. Mobile GIS

Mobile GIS extends the traditional indoor GIS manipulation to the outdoor work and provides a mobile outdoor operation platform for field surveyors to collect, modify and measure the spatial data in an easy and effective way (Digitaleg, 2016). SuperGeo uniquely offers complete GIS product selections to satisfy the field surveyors who have various needs and to assist them in diverse survey tasks (SuperGeo, 2016). Some of the available mobile GIS are:

a. SuperSurv

SuperSurv, a commercial mobile survey system, integrating GIS and GPS technologies is a mobile GIS system for surveying field data, which works on mobile devices (Geocollection, 2012). It has been designed for both the Android and iOS platforms. The main functions include data collection, orientation, map display and waypoint guidance. It efficiently collects point, line, polygon data and support offline editing. It displays map data with global coordinate system settings. It creates and manages waypoints with ease and queries maps with GIS tools (SuperGeo, 2016).
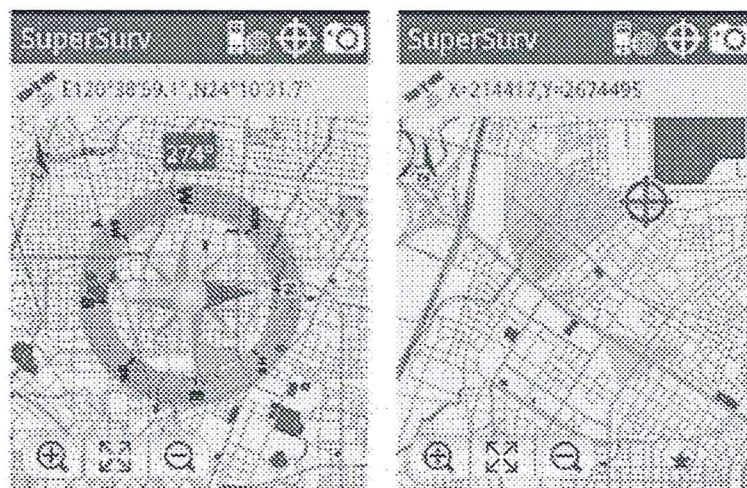
SuperSurv Interfaces

b. SuperPad

SuperPad is a cross-platform, commercial, feature-rich mobile GIS application. SuperPad provides complete mobile GIS functions and receives the data from the server side to offer various services (SuperGeo, 2016). It has been designed for the field workers who need to cope with advanced tasks. It fulfills reliable and accurate field data collection. It performs various advanced field tasks

effortlessly and synchronises field data from enterprise server. It integrates GPS, laser rangefinders and digital cameras and customises diverse functions to improve the productivity of your work.
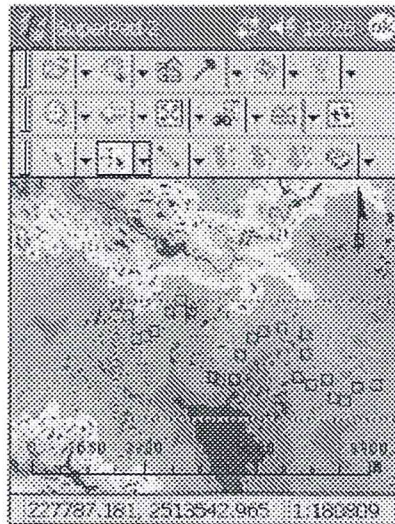
SuperPad

c. SuperVeyor

Running on Windows, SuperVeyor is positioned as an effortless GIS Solution for field survey and data collection; the full-function commercial mobile GIS software allows surveyors to easily collect, edit, measure and query spatial data for greater field productivity (SuperGeo, 2016). It has an easy-to-use user interface, full GPS support and integration. It provides data collection and measurement and convenient layer management.

SuperVeyor

d. SuperGIS Mobile Engine

SuperGIS Mobile Engine, a commercial mobile GIS SDK that runs on Windows, is suitable for the advanced users who have the ability to develop mobile GIS applications and higher customisation demand for mobile GIS functions.

SuperGIS

3.8 Social Networks

A social network is a platform which facilitates the building of social networks or social relations among people who share similar personal and career interests, activities, backgrounds or real-life connections (Du *et al.*, 2012). A few examples of popular social networks are Facebook, MySpace, Twitter, and LinkedIn. A variety of specialized social network services, enterprise social network services, and campus social network services for colleges and universities have emerged during the last few years (D *et al.*, 2012).

Social networking is the practice of expanding the number of one's business and/or social contacts by making connections through individuals. These networks engage people as they have the capability to reach a wide audience and bind them together in a simple and easy way. In addition, they are often free to use, which makes them ideal for small and large businesses. Moreover, social networks can not only act as a free marketing/advertisement tool and can also act as a customer relation management tool as well (Alexandra, 2013). The most commonly used social networks on the WordPress platform are BuddyPress, WP Symposium and PeepSo. An in-depth investigation was conducted in order to grasp a better understanding of the features that each of the aforementioned academic WordPress social network plug-ins, in order to determine the most appropriate plug-in for this project.

3.8.1 BuddyPress

BuddyPress is a freely available social networking software package owned by Automattic since 2008. This open-source plug-in inherits and extends upon the integral functional elements of the WordPress engine including themes, plug-ins and widgets. As it is built on WordPress it is written using the same primary technologies, PHP and MySQL.

BuddyPress Logo

BuddyPress allows developers to build any type of community website using WordPress, with member profiles, activity streams, user groups, messaging and more. Indeed, BuddyPress has a range of features that will allow the creation of a social network application. A few of the major features are listed below:

- Activity streams (post messages and replies)
- User profile customisation (options to add user profile fields and sections, Avatar uploads, Cover image uploads)
- Group creation (Group discussion forums. Group logo and Wire, Group cover)
- Friend system
- Messaging
- Email notifications

BuddyPress is used by various institutions and organisations. A few examples are given below:

Institution Name	Purpose
The University of Mary Washington	School Social Network
Cheung Kong School of Journalism and Communication	E-Learning
Maharishi University of Management	Alumni Website

BuddyPress is a cross-platform system which is licensed under the GNU General Public License version 2. The latest stable release - BuddyPress version 2.5.2 - was released in March 2016. BuddyPress requires a minimum WordPress version of 4.1 and is compatible with up to version 4.5.2. Having an active install count of over 200,000, BuddyPress has a rating of 4.2 out of 5 stars among the developers' community.

More information is available at https://buddypress.org/

3.8.2 WP Symposium

Built on WordPress, this tool can administer social networking capabilities to a website. This would allow end-users to connect with one another, upload albums photos, create groups as well as share documents. WP Symposium is also written using the same primary technologies, PHP and MySQL.

A few of the major features of WP Symposium are listed below:

- Forum discussion
- User profile customisation (options to add user profile fields and sections, Avatar uploads, Cover image uploads)
- Activity streams (post messages and replies)
- Member directory
- Private mail/messaging
- Group creation
- Email notifications

WP Symposium Logo

WP Symposium is also a cross-platform system but is licensed under the GNU General Public License version 3. The latest stable release - WP Symposium version 14.05 - was released in May 2014. WP Symposium requires a minimum WordPress version of 4.0 and is compatible with up to version 4.5.2. Having an active install count of slightly over 1,000, WP Symposium has a rating of 4.4 out of 5 stars among the developers' community.

More information is available at http://www.wpsymposiumpro.com

3.8.3 PeepSo

Trademarked as *"Your people. Your community. Your way,"* PeepSo is the newest contender in the WordPress' social networking plug-ins. Indeed, PeepSo is a light and freely available social network plug-in for WordPress that allows you to quickly and effortlessly add a social network or an online community, similar to Facebook into a WordPress site.

PeepSo Logo

PeepSo core includes basic profile pages, activity stream, front page registration and login. However, in order to add more functionality, a number of commercial add-ons are required. The major available add-ons are as follows:

- PicSo – PicSo adds the ability to add photos on the stream.
- VidSo – VidSo adds the ability to post videos on the stream.
- MsgSo – Private messaging between members of their community. Photos, moods, videos and location attachments are added when the relevant plugins are installed.
- MoodSo – Members can share one of 16 different moods on their stream and express their moods with the relevant emoticons.
- TagSo –TagSo adds the ability to tag friends or a member who contributed to a stream post.
- FriendSo –FriendSo, adds the ability to make friends by sending friend requests

PeepSo is also a cross-platform system but is licensed under the GNU General Public License version 2. The latest stable release - PeepSo version 1.6.0 - was released in April 2016. PeepSo requires a minimum WordPress version of 3.5 and is compatible with up to version 4.5.2. Having an active install count of slightly over 800, PeepSo has a rating of 4.6 out of 5 stars among the developers' community. The annual subscription fee for the PeepSo Pro bundle is at $149 and it includes a 1-year premium support, updates and beta releases.

More information is available at https://www.peepso.com/

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3.8.4 Choice of Social Network

As it can been depicted from the above, all the 3 social networks discussed above achieve more or less the same goals. However, they do not all contain the same features.

BuddyPress has been considered best suited for this project because of its ever-increasing array of extended features developed by an active and thriving plugin development community, with hundreds of free-and-open BuddyPress-compatible plugins available. As depicted by the community rating, BuddyPress has made good impressions to developers. Its popularity among professionals of the world of web development is another factor that contributed in the choice of BuddyPress being the preferred academic network for the web portal to be developed in the project. Indeed, BuddyPress also has the most install count (200,000) compared to that of WP symposium (1,000) and PeepSo (800).

In addition to that, BuddyPress is focused on ease of integration and ease of use. This powerful tool is known to be unbelievably simple to operate and manage. A substantial amount of documentation and support for BuddyPress is also freely available in the form of online forums and video tutorials.

3.9 List of International Organisations with Free Information

1. Ocean Data Viewer (UNEP,WCMC) - Cambridge, United Kingdom
   http://data.unep-wcmc.org/

2. International Oceanographic Data & Info Exchange (IODE) - Belgium
   http://iode.org/index.php?option=com_oe&task=advancedSearch

3. Australian Ocean Data Network (AODN) portal - Tasmania, Australia
   https://portal.aodn.org.au/search

4. International Research Institute for Climate & Society (IRI) - Columbia
   http://iridl.ldeo.columbia.edu/%20docfind/databrief/cat-ocean.html

5. International Research Institute for Climate & Society (IRI) - Columbia
   http://iridl.ldeo.columbia.edu/%20docfind/databrief/cat-ocean.html

6. Carbon Dioxide Information Analysis Center(CDIAC) - United States
   http://mercury.ornl.gov/ocean/

7. dataMares (Data, metadata, analyses and integration) - United States
   http://datamares.ucsd.edu/eng/global-data/

8. National Oceanic & Atmospheric Administration (NOAA) - United States
   https://www.ncdc.noaa.gov/data-access/marineocean-data

9. National Centers for Environmental Information (NCEI) - United States
   http://data.nodc.noaa.gov/geoportal/catalog/search/search.page

10. Long Term Ecological Research Network (LTER) - Mexico
    https://portal.lternet.edu/nis/home.jsp

11. National Environment Research Council (NERC,BODC) - United Kingdom
    https://www.bodc.ac.uk/data/online_delivery/

12. Marine Geoscience Data System (MGDS, IEDA) - Columbia, United States
    http://www.marine-geo.org/tools/new_search/search_map.php

13. European Directory of Marine Environmental Data (EDMED) - United Kingdom
    http://www.bodc.ac.uk/data/information_and_inventories/edmed/search/

14. Marine Metadata Interoperability (MMI)-Harte Research Institute, United States
    https://marinemetadata.org/add

15. Marine Environmental Data and Information Network (MEDIN) - United Kingdom
http://www.oceannet.org/finding_data/search/full

16. Ocean Biogeographic Information System (OBIS) - Duke University, United States
http://seamap.env.duke.edu/

17. Marine Biodiversity and Ecosystem Functioning(MarBEF) Data System - Belgium
http://www.marbef.org/data/imis.php?module=dataset&show=searchfrm

18. European Ocean Biogeographic Information System (EurOBIS) - Belgium
http://www.eurobis.org/imis?module=dataset&extfrm=1

19. European Marine Observation and Data Network (EMODnet) - Belgium
http://www.emodnet-biology.eu/portal/

20. Global Biodiversity Information Facility (GBIF) - Denmark
http://www.gbif.org/species

21. MarineCadastre.gov - United States
http://marinecadastre.gov/data/

22. Landsat Data (USGS) - United States
https://www.usgs.gov/science/science-explorer?lq=

23. Ocean Data Catalog - United States
https://catalog.data.gov/dataset?groups=ocean9585#topic=ocean_navigation

24. Northeast Ocean Data-United States
http://www.northeastoceandata.org/data/data-download/

25. SeaDataNet - Europe
http://seadatanet.maris2.nl/v_cdi_v3/search.asp

26. Woods Hole Oceanographic Institution (WHOI) - United States
http://dla.whoi.edu/catalog

27. NASA Global Change Master Directory - United States
http://globalchange.nasa.gov/search/Titles.do?search=#titles

28. National Data Buoy Center - United States
http://www.ndbc.noaa.gov/

29. Knowledge Network for Biocomplexity - United States
https://knb.ecoinformatics.org/#data

30.NASA SEDAC- Columbia, United States
http://sedac.ciesin.columbia.edu/search/data?contains=

31. International Council for the Exploration of the Sea (ICES) - Denmark
http://ecosystemdata.ices.dk/Inventory/index.aspx?LatN=&LatS=&LonE=&LonW=&Sdate=&Fi
lter=&Edate=&Area=Species&Species=0

32. Ocean Data Portal- Russia
http://www.oceandataportal.org/

33. Global Land Cover Facility (GLCF) - Maryland, United States
http://glcfapp.glcf.umd.edu:8080/esdi/index.jsp

34. Digital Globe-United States
https://www.digitalglobe.com/

35. Fifth Assessment Report (Climate Change) - Switzerland
http://www.ipcc.ch/report/ar5/wg3/

3.10 Factual information about the Ocean

1. Save the Sea

http://savethesea.org/STS%20ocean_facts.htm

2. National Oceanic and Atmospheric Administraton (NOAA)

http://oceanservice.noaa.gov/education/pd/climate/welcome.html

3. Defenders of Wild Life

http://www.defenders.org/marine/basic-facts

4. Natural Resource Defense Council (NRDC)

https://www.nrdc.org/issues/oceans

5. Southeast Coastal Ocean Observing Regional Association (SECOORA)

http://secoora.org/classroom/virtual_wave/waves_fact_sheet

6. Integrated Marine Biogeochemistry and Ecosystem Research (IMBER)

http://www.imber.info/News/News/20-facts-about-ocean-acidification-a-fact-sheet-to-help-scientists-communicate-ocean-acidification-to-media-and-the-public

7. Women working for Oceans

http://womenworkingforoceans.org/w2o-fact-sheet/

3.11 Jobs in the Oceanic and Maritime Industry

1. Maritime Employment
https://www.maritimeemployment.com/default.aspx

2. Maritime Connector
http://maritime-connector.com/jobs/

3. Find Maritime Jobs
http://www.findmaritimejobs.com/

4. Ocean Wide
https://www.oceanwidecrew.com/

5. Crowley
http://www.crowley.com/Careers/Seagoing-Terminal-Jobs

6. Fast Stream
http://www.faststream.com/shipping_jobs/

7. Maersk
http://www.maersk.com/en/the-maersk-group/career/shipping-careers

8. Maritime Jobs
https://www.maritimejobs.com/j-teco-ocean-shipping-jobs

9. Oceanic Resources
https://www.oceanicresources.com/careers-at-oceanic.cms.asp

10. Sea Farer
http://seafarerjobs.com/

11. All Cruise Jobs
http://www.allcruisejobs.com/

12. Find a Mariner
https://www.findamariner.com/

13. Job2sea
http://www.job2sea.com/

13. Viking Recruitment
http://www.vikingrecruitment.com/jobs/

14. Job Ships
http://www.jobships.com/global/jobshipsglobal/homepage/default.asp

15. Rigzone
http://www.rigzone.com/oil/jobs/

16. Sea Job Hunt
http://www.seajobhunt.com/

17. V Group
http://www.vcrew.com/

3.12 Ocean Business Opportunities

1. Moceanone - Turn ocean into Business

http://mocean-one.com/

2. Offshore Wind - Business Network for Offshore Wind

http://www.bizmdosw.org/see-ocean-wind-fact-sheet/

4.0 Objectives Evaluation

The main objectives of this research project were as follows:

- **Create a knowledge management system (an online portal) to store and manage all ocean-related information.**

  Successfully completed: The online portal has been successfully created. The portal link is http://www.oceanis.info

- **Study various web-based geographical content management systems in order to create and integrate a Geographical Information System in the platform.**

  Successfully completed: A number of GIS tools have been analysed and a Web GIS tool has then been included in the portal. The GIS tool can be accessed via the following link: http://www.oceanis.info/data-sets/.

- **Study several spatial data infrastructures (SDI) that have been deployed in other countries and see how one can be developed and/or deployed for Mauritius.**

  Successfully completed: Refer to http://www.oceanis.info/data-sets/ for a comprehensive list of organisations and/or portals offering marine data on a global basis.

- **Create a mini-dictionary of oceanographic terms.**

  Successfully completed: Refer to http://www.oceanis.info/glossary-of-terms/ for a complete list of marine-related terminologies.

- **Facilities to share information with other institutions and researchers.**

  Successfully completed: The social network is expected to facilitate the sharing of information between researchers and policy makers at both national and international levels. The link is: http://oceanis.info/members-2/.

- **Facilities for users to upload new information to the portal.**

  Successfully completed: On-the-fly end-users can make use of the mobile version of WordPress to capture photos/videos which can eventually be uploaded in the blog section of Oceanis. The link is: http://oceanis.info/blog/

- **Facilities for users to comments on data that have already been uploaded.**

  Successfully completed: This is part of the blog (http://oceanis.info/blog/).

- **Only registered users will be able to access certain parts of the system. Registration can be done online and is free.**

  Successfully completed: The link is http://oceanis.info/register/.

- **Evaluate and review the portal after receiving feedbacks and comments from various stakeholders.**

  Feedback received from students, colleagues and other stakeholders were used to improve the portal at all stages of its development. Some of the improvements that were made as a result of comments received from users were:

  a. A facility for Facebook users to login into the system using the existing Facebook profile. This makes it very easy for new members to join in if they already have a Facebook account.

  b. A blue background has been used for the menu items to make them more visible.

  c. A facility to upload images has also been added in the GIS Marker application.

  d. Users can now upload and share documents within a group.

  e. A list of relevant academic conferences and journals have been added on the portal.

  f. It is now easier for group administrators to invite people to their group. They can do so within oceanis.info. They do not need to use an external email application.

- **Publish the outcome of this research project in an international research journal. The local press will also be invited to write short articles on the system.**

  Not yet achieved but it will be done once the website has attracted a sufficient number of users from whom we can get some additional feedback in order to further improve this portal to provide more services and/or to make it even more user-friendly.

- **Gather statistics on the usage of the website. These statistics will tell us whether the website is being used as per our expectations.**
  Successfully completed: A visitor's count has been incorporated on the home page. The link is: The link is http://oceanis.info/.

- **Collection of relevant data from multiple sources.**

  Successfully completed: Data sets from a large number of sources have been included in the website. The link is http://oceanis.info/data-sets/.

- **Validate the data.**

  Successfully completed: The accessibility of each data source has been verified. The link is http://oceanis.info/data-sets/.

- **Structure the data so that it can be stored in computer systems and accessed easily and rapidly via a simple user interface.**

  Successfully completed: All the data sources are accessible from a single webpage. The link is: http://oceanis.info/data-sets/.

5.0 Conclusion

The Exclusive Economic Zone (EEZ) of Mauritius is one of the largest of the world but also one of the least exploited. The discovery of high-priced resources can turn the Republic of Mauritius into a high-income economy within a few years. However, there are some challenges that still need to be surmounted. First and foremost, the lack of a central database on the marine fauna and flora is a serious constraint that leads to the failure of many projects right at the start. The lack of co-ordination and co-operation between the different actors of the marine sector is also a hurdle for progress. Thus, in this work, we have created an online platform which provides a number of useful services to researchers, policy makers, students, marine-related communities and to the public at large. First and foremost, the portal has been used to bring together different institutions on the same platform. A social network has also been developed in order to encourage collaboration between the different stakeholders. A web-based Geographical Information System has been integrated in this system and this can be used to provide location information of relevant resources to fisherman, coastguards, incoming and outgoing ships, tourists and other people involved with the sea. The existence of this common platform will contribute towards the vision of the government of transforming Mauritius into an ocean-based high-income economy. This platform can also be upgraded to create a local databank that conglomerates data from all the different institutions into a single database that will be accessible by different types of users from any part of the world.

Software

A portal has been developed to encourage collaboration and sharing of expertise, data and resources among the different stakeholders in the ocean economy.

The website can be accessed at: http://www.oceanis.info/

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Appendix 1

Quiz Question List

1. Which two elements make up water?

   A: Hydrogen and Oxygen   B: Sodium and Calcium

   C: Calcium and Oxygen   D: Hydrogen and Sodium

2. Sound travels faster through water than air.

   A: True   B: False

   C: N/A   D: N/A

3. How long can the average human survive without water?

   A: 1 day   **B: A few days**

   C: A few weeks   D: 1 month

4. What is the average pH level of pure water?

   A: 3   B: 5

   C: 7   D: 9

5. What percentage of the Earth's water supply is fresh water?

   A: 3%   B: 9%

   C: 15%   D: 20%

6. What property of water allows it to stick to itself?

   A: Adhesion   B: Coagulation

   C: Condensation   **D: Cohesion**

7. What is the name of the largest ocean on earth?

   A: Indian Ocean   B: Atlantic Ocean

   C: Artic Ocean   **D: Pacific Ocean**

8. The Great Barrier Reef is found off the coast of which country?

A: Cape Town, South Africa

B: Queensland, Australia

C: Bali, Indonesia

D: Sri Lanka, India

9. Which mammal is the largest sea creature?

A: Blue Whale

B: Hammerhead Shark

C: Killer Whale

D: None of the above

10. How many pairs of legs does a crab have?

A: 4

B: 6

C: 5

D: 3

11. What does the largest fish, the whale shark eat?

A: Other fishes

B: Planktons

C: Both other fishes and planktons

D: None of the above

12. When a female seahorse lay eggs what does she do with them?

A: deposits them along the ocean floor

B: attaches them to seaweed

C: places them in a pouch in the male seahorse body

D: hides them in between corals

13. The eyes of scallops are typically of which colour?

A: Blue

B: Brown

C: Black

D: Green

14. Which colour is the blood of an octopus?

A: Black

B: Green

C: Blue

D: Red