



REPORT
ON
INFORMATION TECHNOLOGY AUDIT
OF
MONTERRAT LAND INFO - ONLINE MAPPING PORTAL



Office of the Auditor General
Brades
Montserrat

August 2019

**MONTERRAT LAND INFO
ONLINE MAPPING PORTAL**

This is a Report of an
Information Technology Audit
conducted by the Office of the
Auditor General

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ABBREVIATIONS

DFID	Department for International Development
DMCA	Disaster Management Coordination Agency
DTM	Digital Terrain Model
ESRI	Environmental Systems Research Institute
GIS	Geographical Information Systems
GISC	Geographical Information Systems Centre
GoM	Government of Montserrat
HMRU	Human Resource Management Unit
ISSAI	International Standard of Supreme Audit Institutions
ISAE	International Standard on Assurance Engagements
IT	Information Technology
JNCC	Joint Nature Conservation Committee
NICT	National Information & Communication Technology (NICT) Policy, Strategy, & Implementation Plan
PPU	Physical Planning Unit
LIS	Land Information System
LSD	Land & Survey Department
MATLHE	Ministry of Agriculture, Trade, Lands, Housing, and the Environment
MLI	Montserrat Land Info
MOU	Memorandum of Understanding
MUL	Montserrat Utilities Ltd
NDW	National Data Warehouse
OAG	Office of the Auditor General
RDBMS	Relational Database Management System
SAERI	South Atlantic Environmental Research Institute
SCAF	Small Capital Assets Fund
UAS	Unmanned Aerial System
UNDP	United Nations Development Programme
UNV	United Nations Volunteers

PREAMBLE

Vision Statement

“To be a proactive Supreme Audit Institution that helps the nation make good use of its resources.”

Mission Statement

“The OAG is the national authority on public sector auditing issues and is focused on assessing performance and promoting accountability, transparency and improved stewardship in managing public resources by conducting independent and objective reviews of the accounts and operations of central government and statutory agencies; providing advice; and submitting timely Reports to Accounting Officers and the Legislative Assembly.”

The Goal

Our goal is “to promote staff development, enhance productivity, and maintain a high standard of auditing and accounting in the public sector, thereby contributing to the general efficiency and effectiveness of public finance management.”

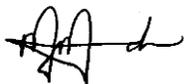
AUDITOR GENERAL'S OVERVIEW

The Government of Montserrat in seeking to build a better economy has introduced a number of public sector reform initiatives which emphasizes the need for a more efficient and effective public service. Some of these initiatives focused on the use of providing e-government services by using information and communication technology systems to facilitate easier and timely accessibility to information. A number of computer systems were implemented to support resource management, environmental planning, and infrastructure development. The Montserrat Land Info Online Mapping Portal was one such system to provide geo-spatial data to all stakeholders.

Our review revealed that the benefits of the implementation of the online mapping portal were achieved and is very user-friendly, provides external users access to land information, aerial photography and shows the terrain of Montserrat and its infrastructure. However, we found that the aerial photography dataset is out-of-date and does not provide a true and accurate mapping of the island and its development over the last 9 years. Further, the accessibility to the online mapping portal is through Microsoft Internet Explorer Silverlight enabled web browsers; the design will only allow users to make payments but limits the information and features, if accessed from other web browsers.

We recommend the purchase of an appropriate drone, which has mapping capabilities and would be beneficial for all stakeholders. Additionally, it is recommended that support be given to ensure the portal is accessible from other types of browsers to enable ease of access to data.

There are also issues with the user subscription plan such as the inability to change the user access level, without users being subjected to multiple payments for access. Each log-in access requires a payment, which is discouraging to subscribers and it is therefore recommended that a more practical and cost-effective method of payment, is required. We have also highlighted other findings and recommendations, and the acceptance and implementation of these will improve the services internally and externally.



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EXECUTIVE SUMMARY

The Montserrat Land Info Online Mapping Portal is one of the outcomes of previous GIS based projects. This online platform has been operational since 2012, and its main objective was to provide real time up-to-date geo-spatial data to local and international stakeholders. It is also a source of revenue within the Physical Planning Unit (PPU) developed and implemented by the Geographical Information Systems Centre. There was support from the Lands and Survey Department who played an important role in the developmental stages of the precursory GIS-based LIS project; and are responsible for updating the GIS data with their cadastre maps.

Main Findings

The main findings and key recommendations of this Post-Implementation Benefits study were as follows:

- The aerial photography dataset of the geo-spatial database is very outdated, as the last aerial photography of Montserrat was taken in 2010. The Geographical Information Systems Centre's (GISC) numerous proposals for financial aid to procure a drone to collect the latest geo-spatial data of Montserrat have been unsuccessful.
- The MLI provides additional revenue for the Government of Montserrat to offset the annual budget for education, health, roads, and so on.
- GIS technology has been utilised in various ways and in several sectors, on island, such as: Crime; Telephone/Network services; Disaster Management; Land Information; Surveying; Tax Management; Statistical Information; Volcanoes; Coastal Management; provide support in Geothermal Energy project; Produced map for trails and hike routes and for Ash Clean-Up project; assisted in the Airport project, and the Look Out and Davy Hill housing projects; conducted Vulnerability Assessment for climate change; risk mapping of low lying areas that are prone to storm surges, landslides, and wind susceptibility; and so forth.
- The Lands & Survey Dept. (LSD) has not been continuously updating the GIS data with cadastre map/sheets, as they do not have any work protocols that mandates the updating of the database. Efforts are already being made by the department to resolve the issue.
- Both the GISC and LSD are short staffed. As a result, this leaves the GISC Manager with very little time to focus on aspects that can progress the department; and the cadastral maps/sheets data of Montserrat at the LSD, being very out-of-date.

Key Recommendations

- We strongly recommend that MATLHE purchases a drone for the capture of aerial photography of Montserrat's current terrain, in order to update the very outdated imagery dataset.

- We recommend that the GISC, LSD, and the Human Resource Management Unit (HRMU), renew their efforts to recruit the much needed qualified personnel for both departments.

Audit Conclusion

The GISC successfully achieved the goals and objectives pertaining to the development and implementation of the MLI Online Mapping Portal. This user-friendly web portal, provide users with access to Montserrat's geo-spatial database, for a small cost.

However, the geo-spatial data does not give a true representation of the Montserrat's terrain and infrastructure as it is very dated. Therefore, efforts should be made to update it, as the utilization of this GIS technology could be very beneficial in the continued and future development of the island.

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CHAPTER 1 INTRODUCTION

Background

1. A Geographic Information System (GIS) is a computer system built to capture, store, manipulate, analyse, manage, and display all kinds of spatial or geographical data. The GISC developed and implemented a GIS-based Land Information System (LIS) project, with aid from the United Nations Development Programme (UNDP). This project was the foundation for the Montserrat Land Info (MLI) Online Mapping Portal which offers access to Montserrat's geo-spatial data.

Audit Objectives

2. The objectives this Post-Implementation Benefits review, were to:
- (a) Establish whether MLI Online Mapping Portal met the original project objectives and delivered the anticipated benefits
 - (b) Determine whether the MLI Online Mapping Portal adhered to the requirements of the system development methodology; met the specified functional requirements; and met the users' needs and
 - (c) Determine whether those involved in development of the MLI Online Mapping Portal were, and are, properly skilled/trained/qualified.
 - (d) Assess the project's cost/benefit analysis and any improvements/changes made to the MLI Online Mapping Portal during the developmental phase
 - (e) Establish if there are any plans for future enhancements; and if pertinent,
 - (f) Provide direction for the future of the MLI Online Mapping Portal/platform.

Management Responsibility

3. Management is responsible for ensuring that project objectives were achieved. More specifically, management must ensure that the project output is beneficial to both internal and external users of the GIS software and GIS-based online mapping portal.

Auditor's Responsibility

4. The auditor's responsibility is to independently express a conclusion on the Post-Implementation Benefits IT audit of the Physical Planning Unit/Geographical Information Systems Unit's Montserrat Land Info Online Mapping Portal, based on our audit.

5. Our work was conducted in accordance with International Standards of Supreme Audit Institutions (ISSAI) 100, 5300, and ISAE 3000. These principles require that we comply with ethical requirements and plan and perform the audit in order to obtain reasonable assurance whether tried and true policies, plans, procedures, and internal controls exist and are functioning effectively, proper records have been and are being kept, and all the necessary information and explanations for the purpose of our audit, has been obtained.

Audit Mandate

6. The Office of the Auditor General (OAG) is mandated through the Montserrat Constitution Order 2010 to perform the audit. This mandate is supported by International Standards of Supreme Audit Institutions (ISSAI) 1, 200, 300, 400, and strengthened by the Public Finance Management and Accountability Act (PFMAA) 2008 and the Public Finance Management and Accountability Regulations (PFMAR) 2009.

Audit Standards & Guidelines

7. The standards and guidelines used to assess the Montserrat Land Info (MLI) Online Mapping Portal included the use of Standards of Supreme Audit Institutions (ISSAI) 1, 100, 3100, and 4100.

Audit Scope and Methodology

8. The study will cover the period January 2008 to March 2017 and will focus on the examination of the Post-Implementation Benefits of the MLI Online Mapping Portal project. The Auditors will monitor the audit in the field and may amend any area or the audit scope in consultation with the Auditor General, so as to maximize the efficiency of the audit.

9. A combination of techniques were utilised to gather information and assess whether relevant controls existed, were implemented, and if they were effective in ensuring that candidates' personal data and automated test itself are protected and there is continuance of service. These included, but were not limited to, interviewing of the key stakeholders of the MLI Online Mapping Portal from Physical Planning Unit, Geographical Information Systems Centre, Montserrat Land Development Authority, Lands & Survey Department, and inspection of documents and assets, the issuance of questionnaires to PPU/GISC staff and, in order to gather in-depth information about the online mapping portal.

10. The findings of this report were discussed with the Chief Physical Planner, and GISC Manager; their views were taken into consideration when finalising the report.

CHAPTER 2 PHYSICAL PLANNING UNIT & GEOGRAPHICAL INFORMATION SERVICES CENTRE

Physical Planning Unit

11. The Physical Planning Unit (PPU) is the agency for regulating all development in accordance with the Physical Planning Act (2002); this is to ensure that all development occurs in the most efficient, equitable, orderly and environmentally sustainable manner.

12. The impact of the volcanic crisis impacted and changed patterns of land use settlement and necessitated the need for proactive physical development, since nearly two-thirds of the island was, and still is, considered to be unsafe; a large proportion of property and infrastructure has been lost. The principal functions of the PPU are to:

- Plan, facilitate and regulate the orderly development of land and buildings in Montserrat in accordance with the Montserrat Building Code and Guidelines and monitoring and enforcing unauthorized building activity.
- Ensure the most efficient, equitable and environmentally sustainable use is made of land.
- Protect and enhance the environment and quality of life for the people of Montserrat.

13. In discharging the above functions, the Unit serves as the main technical, professional, and secretarial focal point for the Planning and Development Authority (PDA), and the Electrical Licensing Authority.

Purpose and Mandate

14. The purpose of the PPU is to provide a framework in which development (physical and environmental) planning can take place in Montserrat in a controlled manner, while not impeding the pace of development. The unit's mandate is to ensure that all development occurs in the most efficient, equitable, orderly and environmentally sustainable manner.

Geographical Information Systems Centre

15. Due to the volcanic crisis that began in 1995, Montserrat's key businesses and populace had to be relocated to the most northern part of the island. Consequently, the Geographical Information Systems Centre (GISC) was established in 2001, out of the need to resettle and rebuild "...a socially and economically viable country..."¹

16. In 2008, the core functions of this department were identified by the PPU as:

- Coordinating and supervising body for the management of all GIS related activities on Montserrat.
- Offer GIS services and assistance to other agencies and departments in quality maintenance and development of geographic spatial and attribute data.
- Provide a link (fibre optic) to various governmental departments towards the establishment of a National Data Warehouse to share data of common interest.

¹ Iftikhar Ahmed, Franklyn Greenaway, (2002) - *GIS Application for Land Planning and Management in Montserrat, West Indies*,

- Assist the PPU and the Chief Physical Planner in identifying strategic uses and applications for GIS.
- Provide additional support to Lands and Survey in the maintenance and easy retrieval of data, from the LIS database.
- Provide maintenance licenses for all GIS software utilised by other government Departments.²

² *Work Programme for Fiscal Year 2008: Physical Planning Unit*

CHAPTER 3 GEOGRAPHICAL INFORMATION SYSTEM

Geographical Information System Defined

17. A Geographical Information System is a computer system designed to capture, store, manipulate, analyze, manage, and present a variety of spatial and geographical data, related to positions on the Earth's surface. It allows the viewing, questioning, understanding, visualizing, and interpreting the data into number of ways which will reveal relationships, trends, and patterns in the form of globes, maps, charts, and reports.

18. Hence, this computer system is very important especially for planning, as many different types of information can be compared and contrasted using GIS. For example, data about people, such as population, income, or education level; information about the landscape, such as the location of streams, different kinds of vegetation, and different kinds of soil; information about the sites of factories, farms, and schools; or storm drains, roads, and electric power lines.

Components of GIS

19. GIS applications include both hardware and software systems. These applications may include:

- **Cartographic data** that are already in map form, and may include such information as the location of rivers, roads, hills, and valleys. Cartographic data may also include survey data, mapping information which can be directly entered into a GIS.
- **Photographic interpretation** is a major part of GIS. Photo interpretation involves analysing aerial photographs and assessing the features that appear.
- **Digital data** can also be entered into GIS. An example of this kind of information is computer data collected by satellites that show land use - the location of farms, towns, and forests.
- **Remote sensing** provides another tool that can be integrated into a GIS. Remote sensing includes imagery and other data collected from satellites, balloons, and drones.
- **Data in table or spreadsheet form**, such as population demographics. Demographics can range from age, income, and ethnicity, to recent purchases, and Internet browsing preferences.

GIS Data Capture and Formats

20. GIS technology allows all these different types of information, no matter their source or original format, to be overlaid on top of one another on a single map. It uses location as the key index variable to relate these seemingly unrelated data. Information that is already in digital form, for e.g. tables and images taken by satellites, is inserted into GIS, by uploading them into the system. Maps have to be scanned or converted to digital format, first.

21. The GIS stores two types of data that are found on a map; the geographic definitions of earth surface features and the attributes or qualities that those features possess. The two major types of GIS file formats are raster and vector:

- a. **Raster** - Raster data is cell-based or pixels such as aerial imagery and digital elevation models. These images are represented by the number of pixels in a row-and-column format that compose the image. The number of pixels (or cells) can be quite large, especially for a high-resolution image. Each point within a raster data set has an implied location based on its relationship to a single known location on the raster image, which can be determined by the GIS.
- b. **Vector** - Vector data is spatial data represented as points, lines, and polygons that use points/nodes and lines; vector data representation is based on the exact location of these geographic elements (lines and areas). Data storage is usually more efficient for vector data because the geographic features can be represented by points (nodes) that are connected by lines (arcs) to form the features, whereas usually all of the raster cells need to be stored.

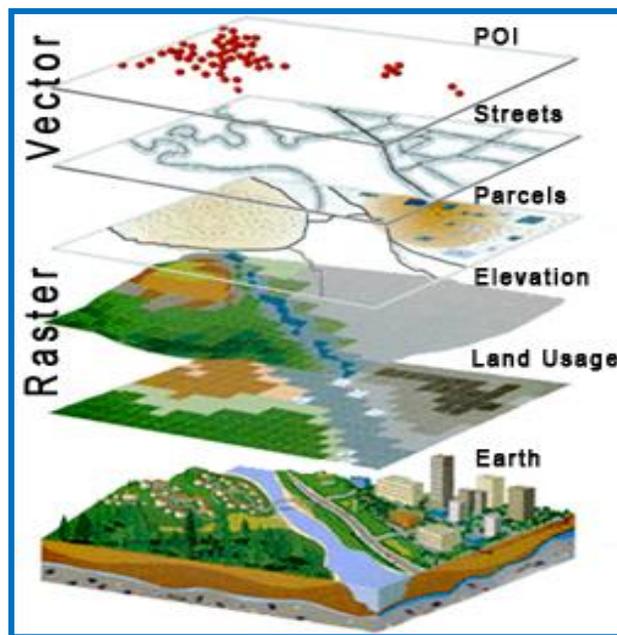


Figure A - GIS Formats for Storing Data

GIS Maps

22. Detailed data entry into the GIS system can be combined to produce a wide variety of individual maps and three-dimensional images, depending on which data layers are included; any GIS data layer can be added or subtracted to the same map.

23. GIS technology makes updating maps much easier than updating maps created manually. Updated data can simply be added to the existing GIS program. A new map can then be printed or displayed on screen. This skips the traditional process of drawing a map, which can be time-consuming and expensive.

Uses of GIS Technology

24. Listed below, are some of the ways in which the Geographical Information System technology can be utilised:

- (a) **Crime:** Crime mapping is a key component of crime analysis. Satellite images can display important information about criminal activities. The efficiency and the speed of the GIS analysis will increase the capabilities of crime fighting.
- (b) **Telephone/Network services:** Data is used to incorporate geographic data into the complex network design, planning, optimisation, maintenance, and activities. It provides a location based service for engineering applications and customer relationship management.
- (c) **Managing Disasters:** Can manage the risk of a disaster by monitoring areas prone to natural or man-made disasters.
- (d) **Land Information:** GIS based land acquisition management system will provide complete information about land assessments and tracking of land allotments.
- (e) **Surveying:** Land survey is measuring the distance and angles between different points on the earth surface.
- (f) **Tax Management:** Inland Revenue Dept. can use GIS to provide property maps and information for tax records, and used in assessment for collection and planning.
- (g) **Volcanoes:** Potential volcanic hazard zones can be recognised by the characteristic historical records of volcanic activities, it can incorporate with GIS.
- (h) **Coastal Management:** The coastal zone represents varied and highly productive ecosystem such as mangrove, coral reefs, sea grasses, and sand dunes. GIS could be generating data required for macro and micro level planning of coastal zone management and in creating a baseline inventory of mapping and monitoring coastal resources, selecting sites for brackish water aquaculture, studying coastal land forms.^{3,4,5,6,7,8}

³ <https://grindgis.com/what-is-gis/what-is-gis-definition>

⁴ <https://www.nationalgeographic.org/encyclopedia/geographic-information-system-gis/>

⁵ http://shodhganga.inflibnet.ac.in/bitstream/10603/108205/12/12_chapter%204.pdf

⁶ <https://www.gislounge.com/what-is-gis/>

⁷ <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2921721/>

⁸ <https://360hr.com.au/28-uses-of-gis-technology/>

CHAPTER 4 PHYSICAL PLANNING UNIT GIS-BASED PROJECTS

Land Information System

Project Summary

25. After the relocation from the unsafe zone due to volcanic activity, development of 10 out of the 15 administrative sections (and subsections), were suspended in 1997. Development activities were only being carried out in 5 administrative sections located in the northern part, or safe zone of the island.

26. Efficient planning of the available limited land resources had become inevitable and a major concern for the government. Another major concern was the storage and archiving of critical data from departments such as LSD, PPU, Agriculture, Inland Revenue, Land Registry, and other government agencies that had important paper-based data. Hence, in mid-1998, the PPU, in collaboration with the Department of Land and Survey, and the United Nations Volunteers Programme (UNVP), began developing a GIS based LIS for the effective planning and better management of land resources.

27. At the time of the project proposal, the available cadastre and topographic maps of the sections of safe zone and daytime entry zone were already being digitised and converted into thematic layers to establish an effective base for the LIS. A total of 118 maps of different scales were transformed into spatial database and the following themes/features were developed and converted into shape files:

- Administrative boundaries,
- Road Network (primary and secondary)
- Hydrology (rivers, streams etc.)
- Coastal boundary
- Reserved Forest Areas
- Land Parcels
- Slopes
- Contours (at 50-foot interval)

28. There was also significant progress towards the transformation of existing paper records of national cadastre, land registry, and agriculture into Relational Database Management System (RDBMS). These numeric databases in integration with spatial database set the nucleus for the most of land use planning and infrastructure development activities in Montserrat.

29. However, one of the big challenges that existed was the lack of proper equipment and personnel to perform the conversion task. Therefore, in order to further advance and complete the GIS-LIS project, the PPU submitted a proposal to secure financial assistance from the United Nations Development Programme (UNDP) and UNVP.

30. A modular approach was adopted to develop the Montserrat LIS, as shown below in *Diagram 1*. The project was divided into phases in order to have better control and management over the available resources that were financial, human, and timings.

31. The flowchart displayed the types of paper-based information at the various agencies that required storage and archiving, and the methods of gathering information to be digitised, stored, and archived in the LIS.

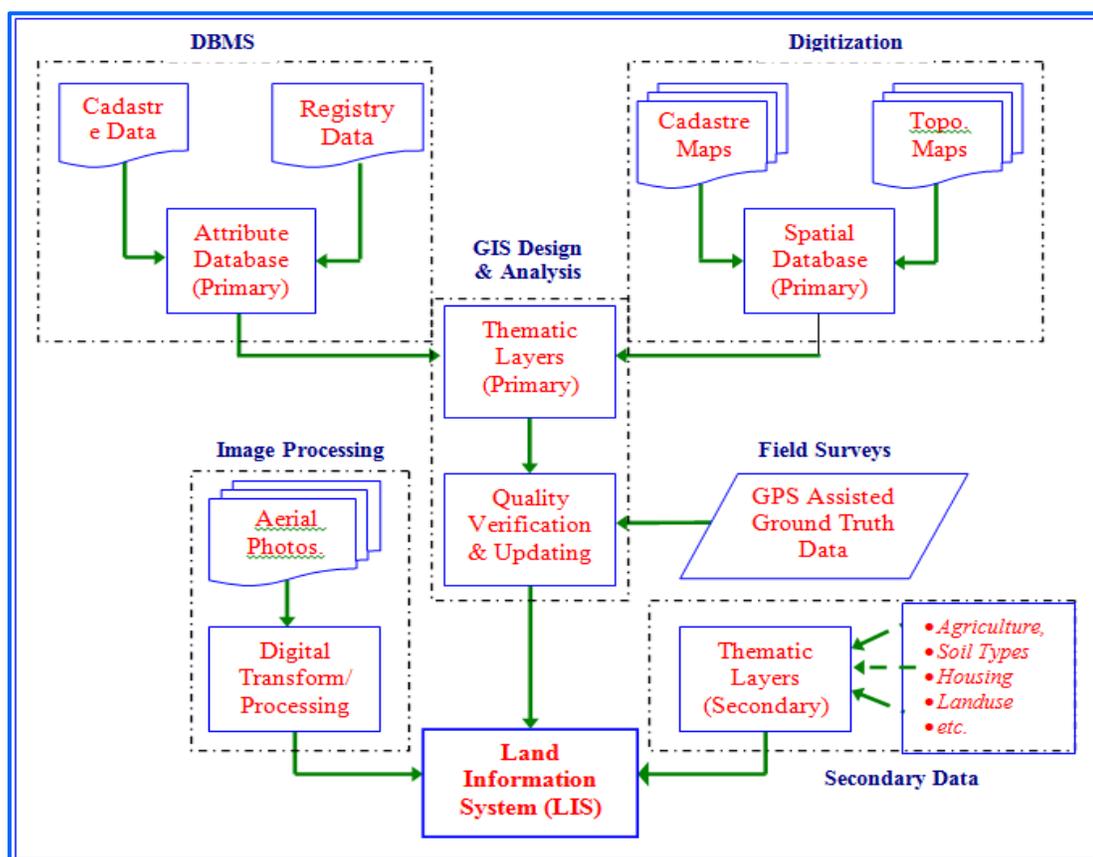


Diagram 1 - Flowchart showing activities involved in development of Montserrat LIS

Planned Project Deliverables

32. The GIS-based LIS project objectives and deliverables outlined in the proposal were:
- Computerisation of existing manual Cadastre and Land Registry systems.
 - Digitisation of existing cadastral maps.
 - Development of core thematic layers for LIS.
 - Development of LIS by integrating all attribute and thematic databases.
 - Digital transformation of Aerial Survey, conducted in late 90s and its integration with the LIS to update existing maps and to create new thematic layers.
 - Provide a basis for the development of a National Data Warehouse (NDW), which could effectively be utilised for the better management of various public utility services and other resources of the country.
 - Provide support in economic development and social stability of Montserrat.⁹

⁹ Iftikhar Ahmed & Franklyn Greenaway (2002, *GIS Application for Land Planning and Management in Montserrat, West Indies*,

Project Cost

33. There was no set budget for the project; UNDP/UNV Programme had funding available and bodies on Montserrat were invited to apply for funding by way of project proposals. PPU submitted the GIS-based Land Information System project proposal and was awarded approximately EC\$1 million dollars.

Project Schedule

34. The entire project objectives were to be achieved commencing from 1997 - 2004; a December 2004 deadline was set to complete the project.

Aerial Photography & Digital Mapping of Montserrat

Project Summary

35. Aerial Photography plays an important role in the management of land use on Montserrat; that is, land use as it relates to environmental sustainability, disaster management, utility management and a host of other related fields.

36. In 2010, the need to have the aerial photography dataset updated arose, as the initial data was acquired in 2002 for the LIS project. Since then, the rate of development on Montserrat has accelerated in order to continue to provide sustainability in an island that has been ravished by a volcanic situation.

37. BLOM Aerofilms that were previously contracted in April 2002 by the Ministry of Agriculture, Land, Housing, and the Environment, were hired again to provide the following services: aerial photography, ground control, aerial triangulation, DTM capture, topographic mapping, orthophotos production, and quality control.

38. The proposed project was in line with the Strategic Development Plan objectives for 2008-2010 particularly, *SDP Objective 3: To conserve Montserrat's natural resources, ensure development is environmentally sustainable, and that appropriate strategies for disaster mitigation are in place.*¹⁰

Planned Project Deliverables

39. The objectives of this project were to, as follows:

- provide accurate data, which would assist in the management of land whilst protecting the natural resources through prudent management
- ensure effective environmental management, education, and participation in decision making, as well as to protect and conserve biodiversity and other natural resources.
- assist the PPU/GIS department with the monitoring of development activities to ensure orderly growth of the island.
- facilitate risk assessments when determining which areas are best suited for human habitation
- track land use changes to ensure compliance with the Physical Development Plan for Montserrat.

Project Cost

Item	Requirement	Price EC\$
1	<ul style="list-style-type: none">a. Mobilisation of aircraft, digital camera, and GPS/INS.b. GPS and ground control preparationc. Acquisition of 25cm GSD photography with full stereoscopic overlap of the required area.d. Delivery of imagery together with a flight index plan in digital and hard copy format	\$455,298.00

¹⁰ *Aerial Photography & Digital Mapping of Montserrat, proposal*

2	<ul style="list-style-type: none"> a. Ortho-rectified digital imagery to be supplied in the Montserrat National Grid b. Revised DTM data for all of the island with accuracies of: +/- 0.750m in plan and +/- 0.3m in height c. Revised contour data for all of the island 	\$86,574.00
3	<ul style="list-style-type: none"> a. Revised mapping for the areas produced during the 2002 project 	\$73,560.00
	Project Total	\$615,432.00
Option	As part of the 2002 mapping project contours at 2m intervals were delivered for the North of the island. BLOM Aerofilms can produce contours and DTM for the South of the island from the 2002 archive photography for the following sum:	\$49,040.00
	Project Total + Option	664,472.00

Table I - Budget for Aerial Photography & Digital Mapping of Montserrat Project¹¹

Project Schedule

40. The timeline for the completion of gathering the aerial datasets was set for six (6) months (see Appendix I).

¹¹ *Aerial Photography & Digital Mapping of Montserrat Project, proposal*

Montserrat Land Info Online Mapping Portal

Project Summary

41. The Montserrat LIS project was the precursor to the Montserrat Land Info, which as advanced further than what was originally proposed in the PPU's 2002 GIS Application for Land Planning and Management in Montserrat, West Indies proposal.

42. This online mapping portal is a modified, user-friendly, version of the desktop GIS, which provides the ease of access to the GIS database. It gives external users access to land Information, aerial photography, and the terrain of Montserrat - roads, buildings and vegetation, both locally and outside of Montserrat.

Planned Project Deliverables

43. The objective of the MLI project was to improve the LIS in-house service by developing a fully functional website, and migrating the database to an online mapping portal <http://landinfo.gov.ms>.

44. The MLI online mapping portal project deliverables were:

- Enable all map layers to be viewed and queried, including Geospatial searches.
- Facilitate user-friendly navigation of the data.
- Enable users to visualize the information, which will allow for complex analysis.
- Enable access to the digital mapping information held by PPU and Lands & Survey Department, and integration of this information with Montserrat's Land Registry data. Integration provides ready access to this combined dataset for Government Departments, Statutory Bodies and also for the public.
- Aid in all land related decision-making in the furtherance of Montserrat's development.
- Generate a source of revenue for the GoM via subscription-based access to the MLI database.^{12,13} The subscription plans are as follows:
 - Silver – USD\$3.50
 - Gold – USD\$4.50
 - Platinum – USD\$5.50

Project Cost

45. There were no cost constraints or pre-approved budget for the MLI online project. GIS only submitted proposals with quotations received from Lavabits for the PlugNPay, and ESRI for software licensing and maintenance.

Project Schedule

46. There was no set timeline for GIS-MLI project as MLI is an ongoing project with no real timeline.

¹² <http://landinfo.gov.ms/Default.aspx>

¹³ <https://events.esri.com/conference/sagList/?fa=Detail&SID=2265>

CHAPTER 5 GIS-BASED PROJECTS ACHIEVEMENTS

Land Information System

47. Since the successful initiation of the LIS in 2001, the system has become an important tool and main source of data for most of the resource management, environment planning, and infrastructure development projects on island¹⁴ as follows:

- In its developmental stage, the Montserrat LIS intermittent results and various GIS techniques were effectively utilised to support landuse planning, infrastructure development, better management of utility services, and other projects of good governance.
- Montserrat LIS was successfully applied to identify land ownership categories in some of the residential areas for better land use planning of unclaimed, unutilised and under utilised lands, available in those areas. Land properties in the whole section were divided into crown, private and unclaimed categories.
- GIS/LIS was a useful tool in mapping changes in “Physical Development Plan for North Montserrat 2000 – 2009” due to construction of new Airport in Gerald’s area. LIS data was also used to assess impact on land due to airport construction. This exercise greatly helped in formulating the land acquisition policy for the new Airport and also in defining new housing policy for that section of the island.
- Utility services provider companies of Montserrat applied LIS based maps and associated data for better management of their services. Montserrat Water authority (MWA) (now MUL) had used LIS data and maps for mapping the existing water distribution network. Other service provider companies that utilised LIS were Montserrat Electricity Services Limited (MONLEC) (now MUL) and Cable & Wireless (now FLOW).

Geographical Information System

48. On GIS Day in 2015, the Minister responsible for MALHE listed the various projects that the Montserrat GIS capability was being utilised for in relation to the rebuilding of the island and its sustainable development:

- a. Provided support in the development of Geothermal Energy on island, such as:
 - mapping the location of the 1st and 2nd drilling wells and the actual location for the 3rd drilling well; and
 - incorporating this data into the environmental impact assessment for further analysis and discussion.
- b. Montserrat Blue Halo Project Partner, the Waitt Institute incorporated the GIS data into their Sea Sketch program to help develop a comprehensive management of Montserrat’s marine environment (marine spatial planning). This will enable:
 - the advancement of sustainable fisheries in Montserrat.
 - coastal zoning for Montserrat where all the best fishing zones are, and where to avoid the loss of fish-pots in the precipices beneath the seas.

¹⁴ Iftikhar Ahmed & Franklyn Greenaway (2002, *GIS Application for Land Planning and Management in Montserrat, West Indies*,

- awareness of where to take action to protect/conservate as part of the government's contribution to the impact of global climate change and saving other species of life.
- c. GISC provided and will continue to provide support to local Statistics Department in collecting census data. Producing maps with municipal data (to capture housing population data) for census & surveys for the Statistics Department. GISC also provided data for the Statistics database known as 'Dev-Info' (Montserrat's National Dev-Info System).
 - d. Assisted indirectly with the IRD Property Tax section, through Land Registry and the location of land parcels
 - e. International collaboration with other agencies such as the Joint Nature Conservation Committee (JNCC) and Falkland Islands South Atlantic Environmental Research Institute (SAERI). The JNCC programme aims to facilitate a number of partnerships across the UK's Overseas Territories. The Territory to Territory Partnership between the Falkland Islands Government Institute SAERI and the Government of Montserrat aims to transfer knowledge and skills on information management and marine spatial planning.
 - f. Assisted with the positioning and location of Montserrat's airport, its facilities, including the alignment of the runway.
 - g. Assisted with the development of the Look Out and Davy Hill housing projects during the crisis.
 - h. Produced maps for the Ash Clean-Up project
 - i. Assisted the Royal Montserrat Police Force with necessary resources for narcotics or other illegal substances.
 - j. Produced maps for trails and hike routes for Montserrat Tourist Board
 - k. Produced maps of forest boundary, and habitat & vegetation, for the Department of Environment
 - l. Annual observance of GIS Day in November, where the unit hosts a day of events such as presentations, hands-on demonstrations, etc.; the objective is to increase spatial awareness and knowledge.
 - m. GISC helped in the production of the Physical and Infrastructure Development Plan 2012 - 2022 for the northern part of Montserrat. The unit provided the maps, local area plans, and spatial planning mapping of where lands are allocated and uses for zoning purposes, etc.
 - n. GISC conducted a Vulnerability Assessment in 2014, for risk analysis in terms of climate change. This risk mapping identified the risk areas, such as the low lying areas that are prone to storm surges, landslides, and wind susceptibility. This risk mapping can also be used for environmental impacts from the likes of oil spillage from Delta Petroleum in the ocean or on land.
49. It is important to note that the GISC have assisted in, and collaborated with, more local projects than listed above.

Montserrat Land Info

50. The MLI provides an additional revenue stream for the Government of Montserrat to offset the annual budget for education, health, roads, etc. The system is capable of facilitating various queries in relation to the island's physical planning and infrastructure development. Available records of cadastre have been computerized and linked with GIS in order to provide real-time interactive data query services to the general public about their land properties.¹⁵

51. The GISC received a SAG Award or '*SPECIAL ACHIEVEMENT IN GIS*', from ESRI (Environmental Systems Research Institute) User Conference in San Diego, California in 2016. This award was received for the project's goal of allowing users to have access to Montserrat's geographic information through an online portal, in which map layers can be viewed, queried and also for geospatial searches to be made. Having all the information in a one-stop/shop format and being able to visualise this data in a dynamic way, provided a solution to the mundane tasks of going through hundreds of paper maps.¹⁶

¹⁵ <https://discovermni.com/2015/11/18/gis-day-speech-by-minister-claude-hogan/>

¹⁶ <https://events.esri.com/conference/sagList/?fa=Detail&SID=2265>

CHAPTER 6 FUTURE INITIATIVES

52. As part of the unit's vision and way forward, the GISC have a number of strategies that they want to initiate and implement:

53. **Acquisition of a Drone** in order to reduce the overall costs and for the speedy updating Aerial Photography for GIS mapping purposes. Drones are fast becoming popular in the field of GIS and its associated disciplines for collecting high resolution aerial photography, video images, and digital mapping data.

54. **Further Development of the current Web Portal.** At the time of this review, GISC were in the process of making plans to use open source software (such as Postgres and LIS-Maps) in order to further develop the web portal. This Phase 2 development, would be called *Web GIS*, and would give free access to persons in Government departments who need to see the GIS data for planning purposes.

55. The *Web GIS* would be accessible on any type of browser from any kind of internet enabled device. However, access to the GIS data would be restrictive; users will not be able to retrieve Land Registry/land ownership information.

56. **Increase the functionality of the current MLI online mapping portal** by including additional features and tools on the web site.

57. **Incorporating GIS with mobile applications on their smart phones, tablets, and watches.** There are proposals in the pipeline with government departments like DMCA and agencies such as the Montserrat Tourist Board.

58. **Peer to Peer learning exchange with other entities** for the sharing of knowledge and expertise between PPU, Lands & Survey Department, and the Montserrat Volcano Observatory.

59. **Conduct training sessions** in order to encourage the pertinent GoM departments and other entities to utilise the GIS software.

60. **Extend GIS Awareness Day** event for the local schools, from just one day to several days throughout the month of November.

CHAPTER 7 FINDINGS AND RECOMMENDATIONS

Findings

61. **Outdated Spatial Aerial Photography Data.** The aerial photography dataset that was acquired in 2010 needs to be updated urgently, as the rate of development on Montserrat has accelerated over the years. According to PPU, the recommended update of aerial photography spatial data for Montserrat should be every 3 - 5 years; this however is dependent on its rate of development. Since this acquisition, there has been significant new infrastructure to include commercial and new housing developments, roads, bridges that are not in the existing dataset. Therefore, the inability of the LSD to provide real-time information requested by all stakeholders has proven to be challenging and does not give a true and accurate mapping of the island.

62. In addition, the GISC has submitted three proposals to various stakeholders for the acquisition of a drone as a more cost effective alternative for aerial photography compared to the previous method of gathering the geo-spatial data. All of which were unsuccessful.

63. **Insufficient Human Resources.** A vacancy exists within the GISC which has resulted in there being only two members of staff (Manager and a Technician) to perform the day-to-day operation and technical management of the GISC and MLI Online mapping Portal. The unit's staff compliment should be at three (3); the third position has been vacant for the past six years.

64. In addition, a dedicated Clerical Officer was employed at the LSD, for the input of current cadastre data into the GIS geo-spatial database; since the departure of this officer around in 2010/11, the database has not been updated.

65. **Establishing Legal Framework and Work Protocols.** The LSD has indicated that they have not been actively updating the GIS data with cadastre map/sheets, because there is no reference in the Land Registry Act, nor are there any current work protocols that mandate the updating of the GIS database. However, there have been internal discussions of incorporating the update of GIS data, into their future policies and procedures.

66. **MLI Platform Brower Incompatibility.** Persons wanting to access Montserrat's geo-spatial data on the MLI online mapping portal will only be accessed from Microsoft Internet Explorer Silverlight enabled web browsers. The design of the MLI platform, will only allow persons to pay, but not see the information or use the features (for e.g. zoom/pan, annotations, sharing, measurement, etc.), from other internet web browsers such as Opera, Microsoft Edge, Google Chrome, Safari, Mozilla Firefox, Vivaldi, etc.

67. Another related issue, is that the MLI platform annual licenses come with upgrades to the software, which requires installation in order to harness the full functionality of the MLI Online Mapping Portal's platform. The GISC has sought continuous assistance from DITES to resolve the web browser incompatibility issue to make the MLI platform compatible with other internet web browsers, by using the Hypertext Markup Language (HTML) 5 format. However, DITES has been unable to assist the department due to their own internal challenges.

68. **User Subscription Plan issues.** Users have three (3) available levels of subscription to choose from on the MLI web portal, offering various services/functions per plan. The following issues were observed:

- There is no option for users to change their user access level. User selection is associated with a username and email address; therefore, to up-/down-grade the level of access, a new username and email address must be created for the desired subscription plan.
- Users are subject to multiple payments for access to the MLI platform. A payment is required each log-in to gain access to the online geo-spatial mapping database and features; for example, logs-in five (5) times within a given day, 5 payments must be made.

69. **Non-Functional GIS-LIS Steering Committee.** The LIS, which was a precursor GIS based projects, was governed by a Steering Committee; it was comprised of representatives from the Planning and Development Authority, LSD, DMCA, Montserrat Electricity Services, Montserrat Water Authority, Cable & Wireless, and Inland Revenue. The intent of this committee was to provide a broad-based approach to land management and real time information of geospatial data for the Land Information System.

70. The committee had initially met once a month to discuss ways to achieve and meet objectives of GIS-LIS project and its direction but over the course of the project the team dispersed, mainly due to factors such as lack of enthusiasm and motivation.

Recommendations

71. **Procurement of a Drone.** We strongly recommend that the Ministry of Agriculture, Trade, Lands, Housing, and the Environment (MATLHE) acquire an appropriate drone or Unmanned Aerial System (UAS) which has mapping capabilities, as this technology would be very beneficial for the department and other stakeholders for the following reasons:

- I. A drone is capable of collecting high resolution aerial photography, video images, and digital mapping data. They survey data in less time and use fewer natural resources than manned aircrafts. Furthermore, they have shown great potential in increasing work efficiency, productivity and improving accuracy. Accurate geo-data would be collected in hours instead of days, thereby significantly reducing the time for capturing data and more time for analysis and application to real world situations to improve urban planning and land management.
- II. There is potential to improve Government revenues through the actual provision of services and the spin-off effects. For example:
 - Increased availability of data could bolster the real estate market, which in turn can result in increased Stamp Duty and Taxation Revenue.
 - The updating of the geo-spatial information on the web mapping portal would generate additional revenue from new subscribers and the purchase of additional subscriptions from existing users.
 - Several applications could be derived through drone technology in MATLHE, such as:
 - Agricultural land management to support the farmers for efficient crop management.

- Pinpoint those areas on their lands that more care may be needed for improving yield and conserving waste; and areas of Land Surveying such as topographic mapping and boundary demarcation.

III. A multi-agency user approach is envisaged and memorandums of understanding (MOUs) can be agreed upon with other government departments in order to utilise this technology for maximum gain. The MOU would underscore the need for only trained personnel to operate the drone and that it would rest within the Ministry of Agriculture, Trade, Land, Housing, and the Environment (MATHLE) at the GIS Centre.¹⁷

72. After the acquisition of the drone, the Ministry should include in their recurring annual budget, support for the maintenance of the drone, software licences, and so forth.

73. **Employment of Additional Staff.** The existing vacancy in the GISC has resulted in the Manager having to perform regular day-to-day tasks, in addition to effectively manage the department strategically and administratively. Being short staffed leaves very little time to focus on other aspects that can progress the department.

74. The same applies to the LSD; there is the need for at least one trained, dedicated staff to update the cadastral maps/sheets data, which are important in providing real-time and relevant geo-spatial information about Montserrat.

75. Therefore, we recommend that these departments and the Human Resource Management Unit (HRMU) renew their efforts to take the necessary steps to fill these vacant posts with the required qualified personnel.

76. **Revision of User Subscription Plans.** The current payment scheme can be discouraging to subscribers; therefore, in order to modernize the data access and payment processes, we suggest that the GISC consider more practical and cost-effective methods of payment. For example the department can:

- offer subscribers either (i) monthly (ii) quarterly or (iii) annual subscription plans, with full access to the geo-spatial data; or
- offer subscribers the ability to change the user level of access, with only one username and associated email address; or
- eliminate the different user levels and offer subscribers just one level.

¹⁷ PPU/GISU - DRONE ACQUISITION PROJECT PROPOSAL

CHAPTER 9 AUDIT CONCLUSION

77. From this Post-Implementation Benefits audit, we have determined that the PPU and GISC accomplished the majority of the original project objectives pertaining to the development and implementation of the MLI Online Mapping Portal.

78. However, although it has delivered the anticipated benefits of providing ease of access to Montserrat's geo-spatial database at an affordable cost, the imagery dataset is very outdated and does not reflect the real-time or true representation of the island's infrastructure and terrain.

79. The updating of Montserrat's geospatial database, and the utilisation of this type of technology, would be very beneficial in the continued and future development of Montserrat.

CHAPTER 10 MANAGEMENT RESPONSE

As the GIS Manager with responsibility for the GIS Centre within the Physical Planning Unit, the report presented highlights the issues and challenges which we have faced over the years. The key recommendations suggested are ones that we share our sentiments with. We will continue to seek opportunities for their implementation in order to further enhance the delivery of geo-spatial services for the Government of Montserrat.

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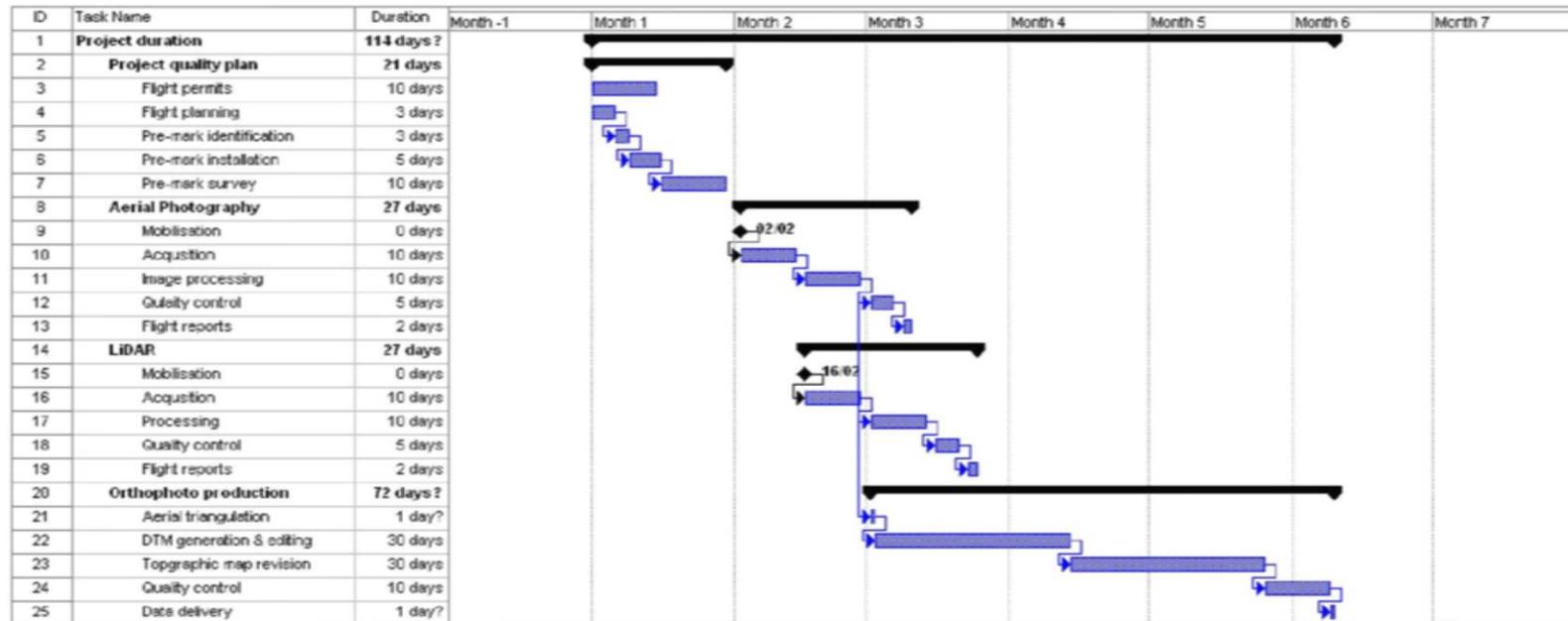
APPENDICES

APPENDIX I - BLOM



**Physical Planning Unit
Government of Montserrat
4.0 – Project programme**

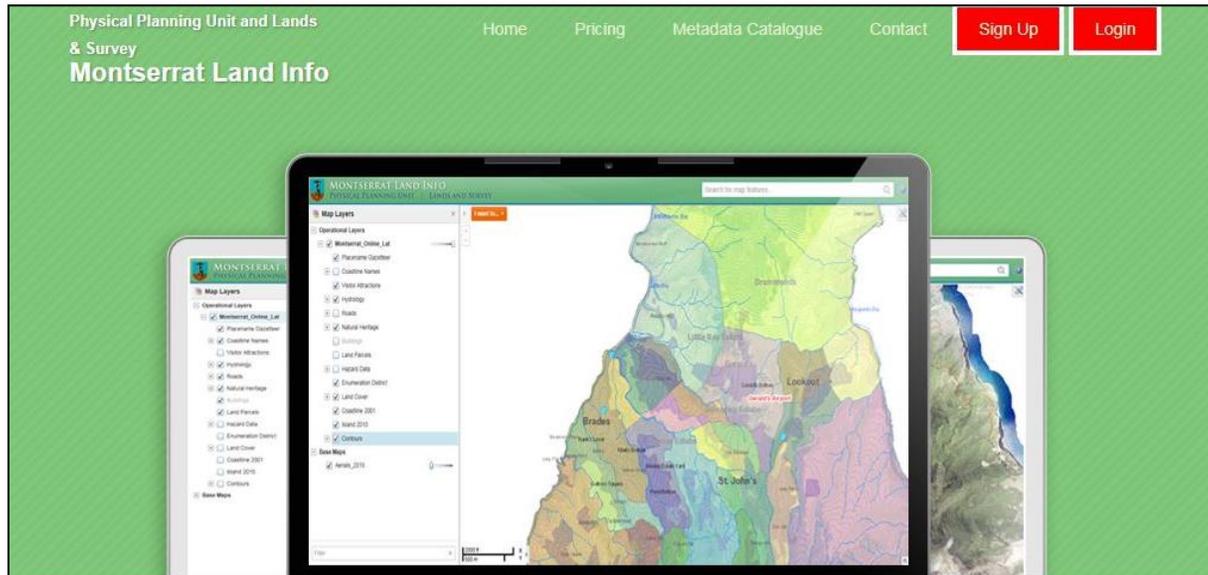
The following programme demonstrates that the project can be completed in a six month period following commencement. At present we anticipate mobilising December 2008 or January 2009.



APPENDIX II - Available User Level Subscription Plans, Cost and Features

Pricing			
	Silver	Gold	Platinum
Credits	1	1	1
Cost	USD \$3.50	USD \$4.50	USD \$5.50
Roads	✓	✓	✓
Parcel Boundaries	✓	✓	✓
Coastlines	✓	✓	✓
Vegetation	✓	✓	✓
Gazetteer	✓	✓	✓
Enumeration District	✓	✓	✓
Forest Reserve	✓	✓	✓
Visitor Attraction	✓	✓	✓
Hiking Trails	✓	✓	✓
Rivers/Ghauts	✓	✓	✓
Streamlines	✓	✓	✓
Springs	✓	✓	✓
Volcanic Deposit	✓	✓	✓
Hazard Boundaires	✓	✓	✓
Buildings	✓	✓	✓
Basic Property Information	✓	✓	✓
Aerial Photography		✓	✓
Contours			✓
Property Ownership			✓
	Select Plan	Select Plan	Select Plan

APPENDIX III - MLI Web Page

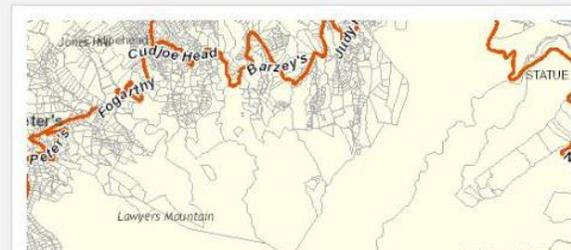


Montserrat's beauty. Upclose and Personal. [Sign Up](#)

Disclaimer: For absolute accuracy, please verify all land ownership information with the Land Registry Department, Montserrat.

Land Information

Land Information can be obtained by entering a Parcel Identification Number (PID). This is a combination of the section number, block and parcel number. The results of your search can be viewed in your web browser or as a file that can be sent to your printer.



APPENDIX IV – Registration Process

Signup

Personal Information

First Name:

Last Name:

Username:

E-mail:

Password:

Confirm Password:

Country:

Signup

Select Plan

Role:

Rate Per Credit: USD

Number of Credits:

Total: USD

Payment Information

Name on Card:

Card Number:

Verification Code:

Expiry Date:

APPENDIX V – MLI Platform Registration Errors

Signup

Please enter a different user name.

Personal Information

First Name:

Last Name:

Username:

E-mail:

Password:

Confirm Password:

Country:

Signup

The e-mail address that you entered is already in use. Please enter a different e-mail address.

Personal Information

First Name:

Last Name:

Username:

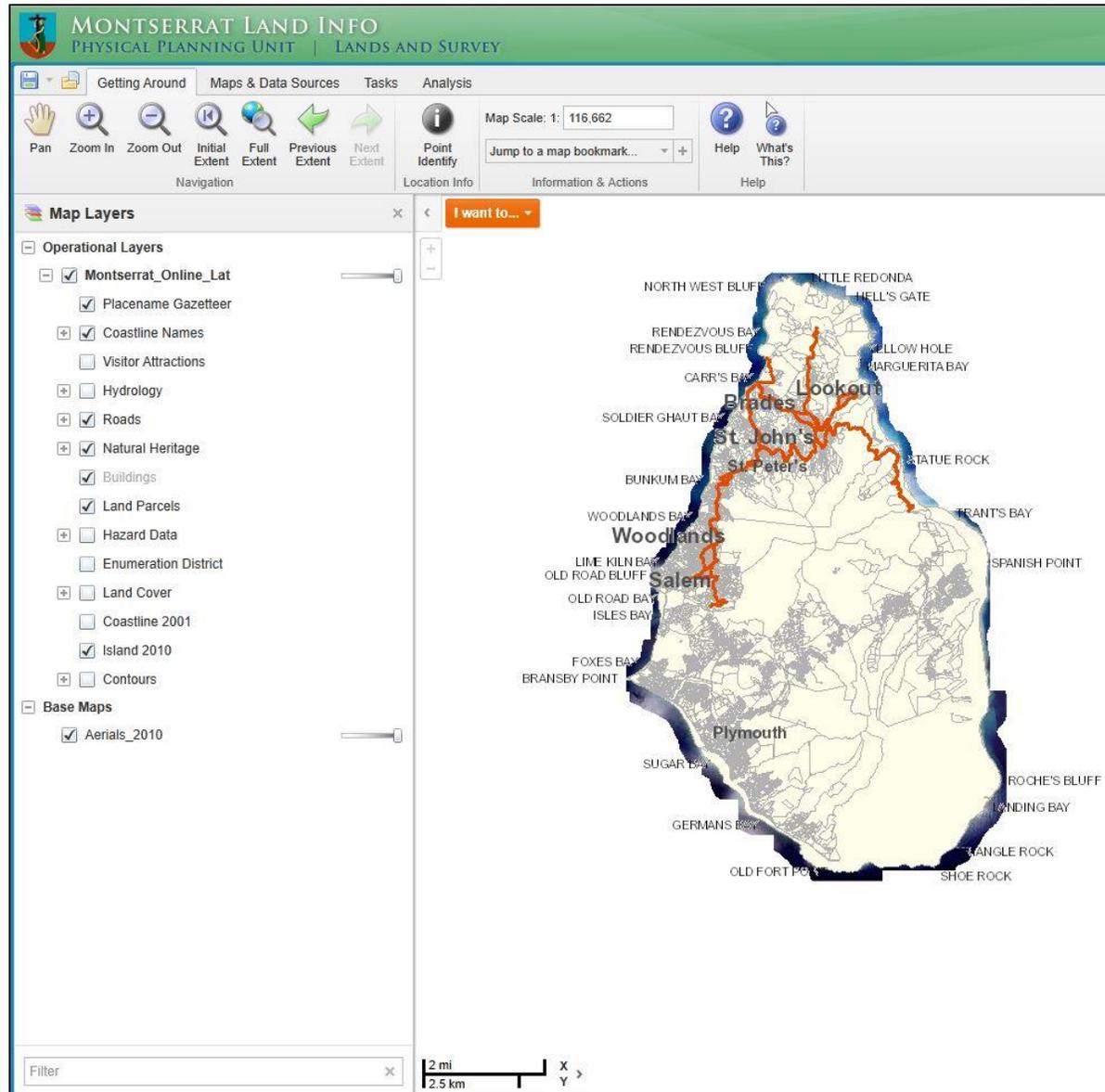
E-mail:

Password:

Confirm Password:

Country:

APPENDIX VI – MLI Online Mapping Platform



APPENDIX VIII – Software 3D Mapping of Montserrat

