

A FRAMEWORK FOR SPATIAL DATA VISUALIZATION: SRI LANKA GLOBE (S-GLOBE)

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Abstract

Data visualization is a spectacular technique in the modern business world. Spatially Enabling Information -- location intelligence -- is empowering business efficiency in many ways. Sri Lanka Globe (S-Globe) must have the ability to present all of our geographical data on every possible topic imaginable from a traditional mapping of topographic data, contours, addresses, and properties. This is to be achieved through the thematic categories such as farming, environment, transportation plan, health, and education. As such, we should use a visualization tool with a capable platform that is independent and free because the implementation is aimed at businesses, communities, and the government. In this research, an investigation is conducted on open data and open source approaches up to the final development for the Sri Lankan spatially enabled society. Finally, the research found that Google Earth is the most reliable tool for this development through WebGL and HTML5. The framework to the report is based on six open data principles, which are open by default, protected, prioritised, discoverable, and usable where required. It is also primary and timely, well-managed, trusted, and authoritative as well as free where appropriate, and subject to public input.

Keywords: *location intelligence, Spatial data, Open data, Open source, Visualisation technique, Data Interoperability Standards*

1. INTRODUCTION

Information and Communication Technology Agency (ICTA) is leading the Government's Policy and Action Plan in relation to ICT in Sri Lanka. It is noticeable that they are actively involving smart and sustainable online government services, which are open and responsive especially in the local government. It is also coordinated and connected Government Evidence-driven policy making to Smart enterprises, high-quality jobs, an attractive business environment and a globally competitive ICT/BPM (Business Process Management) sector Building a smart and inclusive information society, Empowering the citizens to enable a citizen-centric government and enable participatory governance in all aspects. However, the Sri Lankan government is missing the adoption of spatial data enabled technology, which encourages sustainable development and increasing economic growth.

Spatially enabled societies represent the realisation of the promises offered by building spatial data infrastructures (SDIs), and reforming land administration systems. These building blocks which have been established over decades make it possible for spatially enabled societies. However, without the tools for managing metadata, building complete national cadastres, modelling, and integrating the 3rd dimension, and much other foundational work of spatially enabled societies cannot emerge. (Williamson et al, 2011).



Figure 1. Spatial Enabled Societies (Geographic Information Panel, 2008)

A spatially enabled government organizes its businesses and processes around a “place” based technology, which is as distinct from using maps, visuals, and web-enablement. This relates to institutional challenges to a range of stakeholder interests including ministries, local authorities, utilities, and civil society -- businesses and citizens. Creating awareness of the benefits of developing a shared platform for integrated land information management takes time. Figure 1 shows simple pictures of the above. Figure 2 is showing graphically the reach data converting to knowledge using with information.

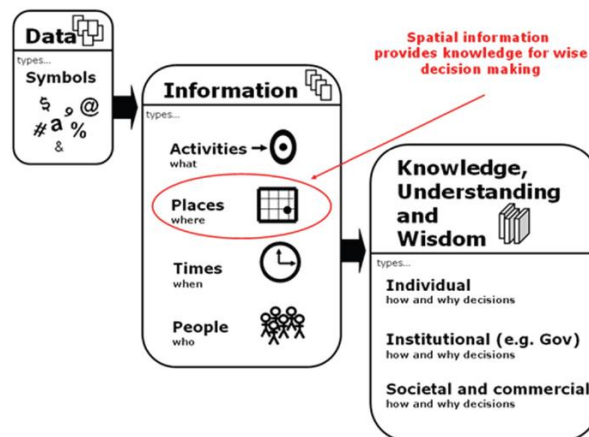


Figure 2. Place as a sorting system to improve manageability (Wallace, 2007).

The impact of spatial enabled services on the economy is various, bringing long term benefits needed by the sector. It is also the best for the economy of the country through consumption by businesses or consumers. (See figure 3)

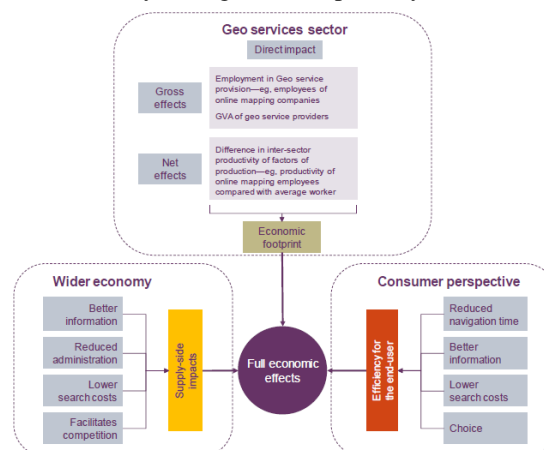


Figure 3. Stylised explanation of the economic impact of Spatial enabled services (Oxera, 2013)

2. AVAILABLE SPATIAL DATA IN SRI LANKA

Fortunately, Sri Lanka Infrastructure Framework draft report issued in June 2014 and Sri Lanka Spatial Data Infrastructure Road Map issued 26th November 2014. However, Sri Lanka has only these same systems similar to the year before 2014. The Department of Survey (SoD) is supporting the creation of the National Spatial Data Infrastructure (NSDI), and the following systems are being created and being maintained. In this paper, only the SoD is being investigated because other agencies are not providing the government, businesses, and citizens with a way to visualize and explore data in ways to derive information and knowledge. The SoD announced the following digital data available with but some of them did not continuous update.

Data: **Digital Road Map, Digital Topographical Maps, Digital Map of Western Province, Digital Map of Southern Province and Town Maps.**

Independently maintaining systems: **Land Information, GEO Information and Geodetic Surveys**

3. JUSTIFICATION PROPOSED FRAMEWORK

Stage1– Develop National Shared Services Capabilities

Objective 1.1. Develop geospatial interoperability reference architecture

Anticipated Outcomes. More current and complete data is to be made available to all through improving the capabilities for NSDI partners to develop, maintain, share, and use geospatial information. Better cost savings by leveraging shared technology infrastructure across government agencies and all stakeholders.

Objective 1.2. Establish the Geospatial Platform as the Sri Lankan geospatial data, services, and applications Web-based service environment

Anticipated Outcomes. Efficient, and effective use of shared technology infrastructure to encourage and support better information sharing. Improved cost savings through shared geospatial investment planning.

Objective 1.3. Expand the use of cloud computing

Anticipated Outcomes. Improved cost savings through the expanded use of commodity cloud-hosting capabilities for the benefit of all NSDI partners.

Objective 1.4. Promoting the use of geospatial multiagency acquisition vehicles for interagency and intergovernmental purchases

Anticipated Outcomes. Improved cost savings by leveraging the government's purchasing power when buying geospatially related goods and services for the benefit of multiple partners

Stage 2 – Ensure Accountability and Effective Development and Management of Sri Lankan Geospatial Resources

Objective 2.1. Advancing the portfolio management process for National Geospatial Data Assets (NGDA)

Anticipated Outcomes. Increased access to highly prioritised, documented, and standardised national geospatial datasets and services. Transparency into federal activities and resources that are required to manage and provide access to geospatial resources will improve dramatically.

Objective 2.2. Identify potentially duplicated investments and opportunities for collaborative investments

Anticipated Outcomes. Increased information is made publicly available on geospatial acquisition plans resulting in cost efficiency and decreased duplication of effort. It is also expected to have an enhanced return on geospatial investments through partnerships across National and non-national sectors.

Stage 3 – Convene Leadership of the National Geospatial Community

Objective 3.1. Lead and participate in the development and coordination of national and international standards applicable to the geospatial community

Anticipated Outcomes. Greater adoption and utilization of standards resulting in enhanced interoperability of geospatial data, services, and systems. Decreased barriers to exchanging geospatial content effectively and efficiently by reducing technical impediments to sharing geospatial data and services.

Objective 3.2. Convene the leadership of the geospatial and non-geospatial communities to develop shared approaches to critical national issues

Anticipated Outcomes. More effective collaboration in the development and oversight of critical geospatial activities required for the effective management of the NSDI.

Objective 3.3. Raise awareness of the NSDI and its impact on critical national issues

Anticipated Outcomes. Enhanced level of understanding, engagement, and investment by all affected communities in the development, and maintenance of the national spatial data infrastructure. (Federal Geographic Data Committee, 2013)

Some of the above mention objects were achieved by Sri Lanka Infrastructure Framework draft report and Sri Lanka Spatial Data Infrastructure Road Map. It is supporting for Coordinating Geographic Data Acquisition and Access.

4. THE FOURTEEN SPATIAL DATA THEMES

The following themes are defined on Sri Lanka Spatial Data Infrastructure Road Map. This section is trying to give an extensive discussion under each theme and trim base on practical requirements of the government, industry and the community.

Themes: (1) Administrative Boundaries, (2) Geodetic Network, (3) Land Parcel and Property (4) Transportation, (5) Utility (Water, Electricity, Telephone..etc (6) Hydrography, (7) Land Use (8) Reserves, (9) Place Names (10) Imagery, (11) Buildings, (12) Topography, (13) Elevation and Depth and (14) Geo-coded Addressing - Street Address

Reserves, buildings and topography themes are overlapping with other theme and they are not a necessity for the accountability of the systems. The following descriptions and datasets of each theme are giving strong evidence to ignore them. S-Globe has to consider only 11 themes after ignore overlapping themes.

4.1 Administrative Boundaries theme

Description

The Administrative Boundaries theme is a collection of legislative, regulatory, political, maritime and general administrative boundaries sourced from local and state boundary datasets.

Datasets

Parish
Suburb
Local Government Area
Province Electoral District
Province Border
Sri Lanka Bureau of Statistics Geographical Standard Boundaries

4.2 Geodetic Network theme

Description

Positioning is Sri Lanka's authoritative, reliable, high-accuracy spatial referencing system. The Positioning theme includes the coordinates and their uncertainty of all location-based data promulgated from, or related to, the CORS or other referencing / Moving to World Geodetic Datum.

Datasets

Permanent Survey Mark Register

4.3 Land Parcel and Property theme

Description

A land parcel is an area of land with defined boundaries, under unique ownership for specific property rights.

A property is something that is capable of being owned, either in the form of real property (land) .The interest can involve physical aspects, such as the use of land, or conceptual rights, such as a right to use the land in the future.

The cadastre is an up to date parcel based land information system, which contains a record of interests in land (that is, rights, restrictions, and responsibilities). The cadastre includes a geometric description of land parcels linked to other records describing the nature of the interests, the ownership or control of those interests, and often the value of the parcel and its improvements. A cadastral product or service visualises the boundaries of land parcels, often buildings on land, the parcel identifier, basic topographic features.

The land parcel and property theme provides the basic fabric of land ownership. It consists of the national cadastral database and associated parcel and property information.

Datasets

Cadastral Fabric, Cadastral Features, Property

4.4 Transport theme

Description

Transport data is a representation of the land, water and air networks used to move people and goods, and deliver services, from one location to another.

It includes network connectivity and characteristics such as type, name and potential restrictions on what can be moved through the network.

Datasets

Roads
Aviation
Rail
Maritime

4.5 Utility

Description

Utility data is a representation of the electricity, water and telecommunication.

Datasets

Topo50 Layers

4.6 Hydrographical theme

Description

The Water theme includes hydrology which is the study of the movement, distribution, and quality of water, including the hydrologic cycles, water resources, and environmental watershed sustainability.

Hydrology includes surface hydrology, hydrogeology, drainage basin management, and water quality where water plays the central role.

Water (surface water and groundwater) is concerned with information as aligned with the definitions under the Sri Lankan Government act

Datasets

Hydro Point
Hydro Area
Coastline
Named Water Course

4.7 Land Use theme

Description

Land cover is the visible, biophysical cover on the Earth's surface including trees, shrubs, grasses, soils, exposed rocks and water bodies, as well as anthropogenic elements such as plantations, crops and built environments. Land

cover changes for many reasons, including seasonal weather, severe weather events such as cyclones, floods and fires, and human activities such as mining, agriculture and urbanisation.

Remote sensing data recorded over a period of time allows the observation of land cover dynamics. Classifying these responses provides a robust and repeatable way of characterizing land cover types. These complement on ground survey where available.

Datasets

Land Use

4.8 Reserve

This theme is not useful to account separately because it is overlapping with Land Parcel and Property theme.

4.9 Place Names theme

Description

Place Names are the recorded names of cultural and physical features and their associated location and extent. Place Names within this theme refer to those names that have been officiated through the official government gazette.

Datasets

Geographical Names Register Place Names

4.10 Imagery theme

Description

Imagery is the final product created from the use of air borne, space borne or terrestrial sensors. These technologies detect, locate, classify and record objects relative to the surface of the Earth. This includes data sourced from satellite, aircraft and vehicle mounted cameras. These technologies have a range of capabilities. It includes but is not limited to orthorectified, multispectral, hyperspectral, laser and radar data.

Datasets

Standard Aerial Imagery, Town Aerial Imagery, Special Project Orthorectified Imagery (Lesley A, 2014a) and (Lesley A, 2014b)

4.11 Building

This theme is not useful to account separately because it is overlapping with Land Parcel and Property theme but it is giving more weight for disaster management purpose and Sri Lanka has special agencies for buildings.

4.12 Topography

This theme is not useful to account separately because it is overlapping with Elevation and Depth theme.

4.13 Elevation and Depth theme

Description

Elevation and Depth is the measurement of the Earth's surface above or below a vertical datum to obtain the height of the land. Data is collected using a range of sensors, including laser, sonar, radar, optical remote sensing. As well as survey techniques to derive spot heights, raster surfaces, contours, triangulated irregular networks and digital elevation models.

Datasets

Contours

Spot Heights

Relative Heights

Elevation - Point Cloud (LiDAR)

4.14 Geo-coded Addressing theme

Description

Addressing is the specific identification of a fixed location (for example, a plot of land, building, part of a building, way of access or other construction) which is represented by a structured arrangement of place names. It may be further detailed with the inclusion of other valuable attributes including geo-codes and Delivery Point Identifier (DPID).

Datasets

Address Point

5. RECOMMENDED MEMBER AGENCIES

The agencies could provide leadership for the spatial enabled infrastructure and coordinate the development, use, sharing, and dissemination of the Nation's geospatial data. In this research identified 21 departments, 10 authorities, 5 boards, 2 corporations, 2 bureaus and 5 government organisations could be potentially link with the national spatial data sharing.

6. FOUNDATION SPATIAL DATA

The Globe will use the foundation spatial data defined as “the authoritative geographic information that underpins, or can add significant value to, any other information. It supports evidence-based decisions across government, industry and the community”. (ANZLIC, 2014. The Australian and New Zealand Foundation Spatial Data Framework. ANZLIC April 2014, edition 2.)

According to the above, principally one or more of the following characteristics should be present for the accountability of the foundation spatial data.

- be geospatial
- essential for public safety and well-being
- critical for a national and state or government function
- contribute significantly to economic, social and environmental sustainability
- (NSW Foundation Spatial Data Framework version 2.0, 2015)

7. NATIONAL MAP PORTAL

National Map Portal is a spatial web service. This should have the following characteristics. (W3 Schools, 2015)

Application components

Communicate using open protocols
Self-containment and self-describing
Used by other applications

Typically the web service has the following one or more types.

Data discovery: provide search and discovery to spatial data and services

Data visualisation: provide visualisation images of the actual spatial data

Data access: provides access to the actual spatial data.

Service Type	Name	SDI Suite 1.0
<i>Data Discovery</i>	Catalog Service with CSDGM Metadata	Version 2.0 Z39.50 Protocol
<i>Data Visualization</i>	Web Map Service	Version 1.1.1
	Style Layer Descriptor	
	Web Map Context	
<i>Data Access</i>	Web Feature Service	Version 1.0
	Web Coverage Service	Version 1.1
	Geographic Markup Language	Version 2.1.2
	Filter Encoding	Version 1.1

Table 1: Approved OGC Specifications (Federal Geographic Data Committee, 2010)

The above table (Table 1) took accountability the above three of service types with related Open Geospatial Consortium. Figure 4 is showing simple graphical links over the geospatial web services types.

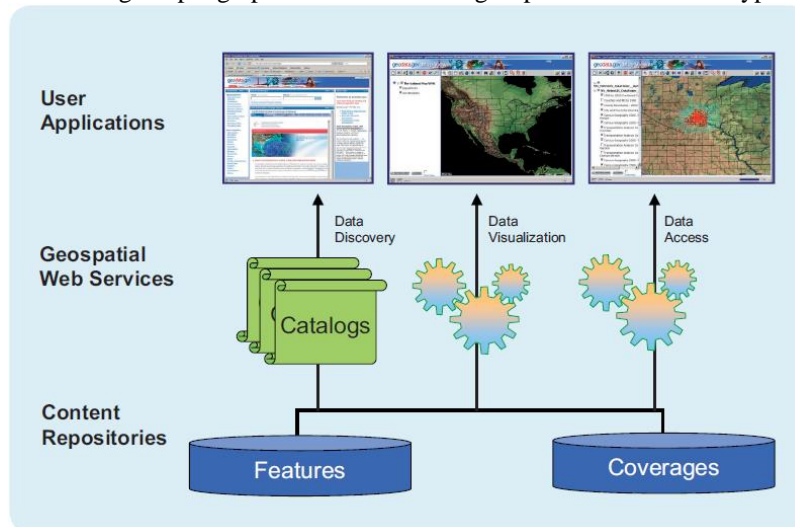


Figure 4: Geospatial Web Services Types (Federal Geographic Data Committee, 2010)

- Spatial Web Services supply many advantages to its users. Therefore, the portal provides the following benefits to government, industry and the community.
- Inherently interoperable enabling users to consume Sri Lanka Government web services outside private government networks, regardless of proprietary software or technology platforms
- Suitable to use in multiple instances by various customers at any one time. Example: direct use, mashups, mobile apps, GIS software8.
- Accessed using standard Internet technologies, allowing Sri Lanka Government agencies to distribute data quickly and easily9.
- Time savings through the provision of real time data delivery through live feeds and access to up to date spatial data and information enabling users to access and exploit a wide variety of spatial data on demand.
- Reduction in spatial data maintenance cost through the removal of storage and hosting requirements, ensuring web service providers can focus on maintaining and providing only the data they are responsible for.
- Encourages innovation and entrepreneurship by breaking down previous barriers to access via openly available streams of accurate, authoritative and timely spatial data and information.
- Substantial cost savings to the provider and the user of spatial web services through availability of services for use on existing platforms, hence not requiring the investment in more or later technology by the user.

- Enhanced analytics through the ability to provide linked data enabling the ability to connect data to other pieces of data, contextualising and adding value to the information that already exists.

The web portal should be Open Geospatial Consortium (OGC) compliant and suitable for consumption by common GIS platforms. The web portal facilitates available as either cache or non-cache, depending on client use or requirement. Therefore, S-Globe could be collaboration with web3D (webGL, X3D). (Microsoft Developer Network, 2007) , (UN-GGIM, 2013), (NSW Government, 2013a), (NSW Government, 2013b), (NSW Government, 2015a), (NSW Government, 2015b) and (NSW Government, 2015c)

8. DATA VISUALIZATION

Governors: Sri Lanka fulfilled the governor's requirement because they completed NSDI. It is giving Open Spatial Data Initiative Creative Commons.

Information: The major issue is information/data. A Central Registry of Spatial Data and Imagery is key to spatial data products for the future.

Access: Anyone can access the data at anywhere. This is open spatial data initiative web mapping services. It could go with mobile tools or web mapping channels. One country needs only one National Map Portal (Central service of data) (Lesley A, 2014a) for spatial data and data is being supplied by various agencies as web site content management.

9. S- GLOBE

It is a one-way visualisation tool to validate/asses and access Government loaded data that facilitates personalisation. It can be a front-end for agencies, via web services, to facilitate access to their source-of-truth data and a front-end for citizen-focused Government services and announcements. We should not want innovative and develop new technology solution because it has facility the freely available Google Globe product. This way is giving a simple tool that does not require users to have specialised knowledge or understanding of GIS systems or data.

The system is facilitating the release of additional government spatial datasets to ensure benefit to users. It can be a used methodology of the user's testing to ensure the user experience is enhanced as additional datasets are available, add additional historical datasets and availability of census data. The content management technique provides individual themes that are designed and built for specific purposes serving government and community information needs.

Finally, the requirements conclude S-Globe responsibilities for government agencies under six open data principles:

- Open by default, protected where required
- Prioritised, discoverable and usable
- Primary and timely
- Well managed, trusted and authoritative
- Free where appropriate
- Subject to public input

The above describes rights and responsibilities for people who use open data, according to these same principles.

The S-Globe will provide a wealth of information across Sri Lanka including current and high resolution imagery, accurate addresses, and detailed land parcel information with Google Earth Pro you can integrate your own data by importing native GIS data and spreadsheets to overlay on a 3D globe with map production capabilities not offered in the standard Google Earth product (Cynthia Dietz, 2010).

Google Earth Pro offers additional advanced functionality for performing measuring, visual impact assessment, fly through generation and data authoring. Google Earth Pro will allow you to fully leverage the S-Globe by being able to analyse your data and produce quality outputs that can be shared and managed.

The following figure (5) is showing very abstract level block diagram for S-Globe. The systems linked with 11 themes and maintain the data warehouse as well. User level is providing services to government, industry and community to enable full use of spatial data for their business without delay at anywhere in the world.



Users

Government, Industry and Community
Tasks : Searching, Browsing, Querying,
Viewing, Downloading, Uploading

S-Globe (National Spatial Data Portal)



11 Themes

Pre defined

View

Analytics

Spatial Data Access Enabling
Infrastructure

Firewall

Middleware

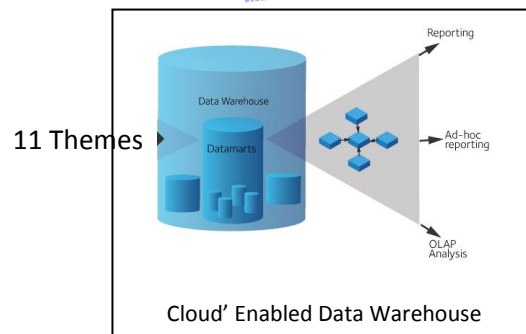


Figure 5. The S-Globe Conceptual Model

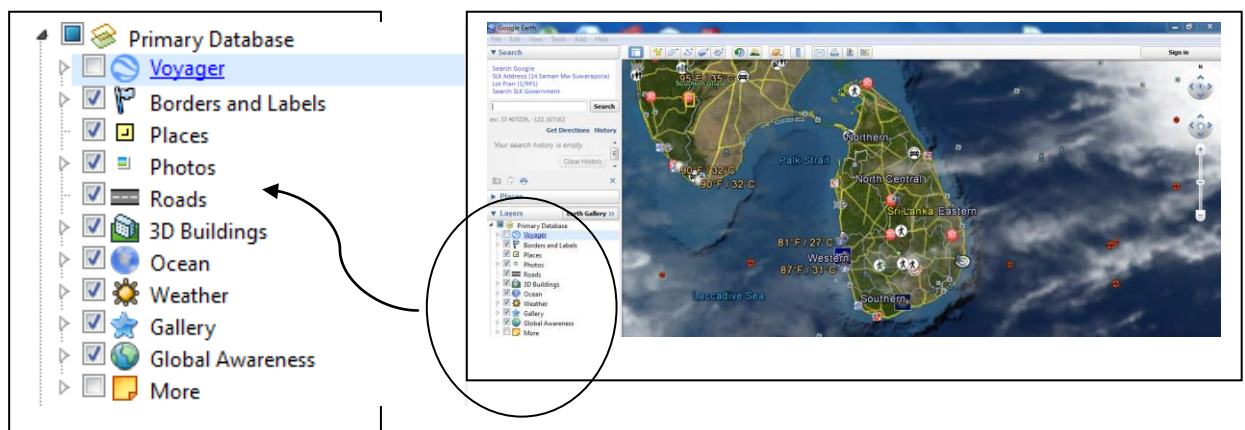


Figure 6. Initial Google earth



Figure 7. Google earth with S-Globe

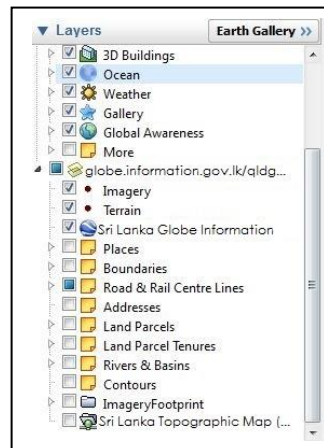


Figure 8. After select S-Globe

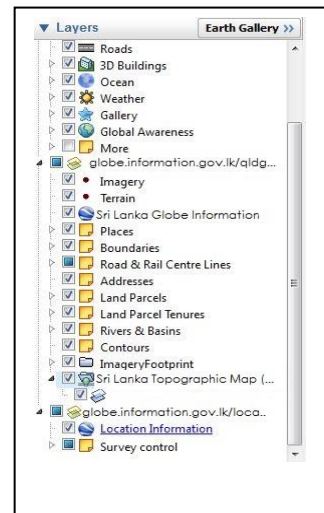


Figure 9. After added Geodetic Network theme

Figures 6-7 are showing screen shots of phototype S-Globe to give better understand for the readers. Figure 6 is depicting if we use google earth before called spatial enabled facility. Figure 7 is showing just upload spatial data to the system and figure 8 is giving explore of the facilities. You could see it has most of required themes. If you need further more add another theme you could see it on figure 9. It has location data like survey control points.

10. CONCLUSION

This case study found that the Sri Lankan government has a keen vision to achieve spatial enabled societies, but so far they have initiated the National Spatial Data Infrastructure Framework (July 2014) and the Sri Lanka Spatial Data Infrastructure Road Map (November 2014) supported by the World Bank. This research found that the documents are not fully crafted for the practical aspect for spatial data visualisation. But it has a significant amount of clear vision for further enhancement. Under spatial data, the government desperately needs to focus on building up the Sri Lanka Foundation Spatial Data Framework, Sri Lanka Planning Spatial Data Framework, Sri Lanka Government Custodianship Guidelines for Spatial Data and Sri Lanka Government Spatial Web Services Register.

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