Introductory Training on Geospatial Information System Applications for Environment Impact Assessment

SPREP GIS TEAM

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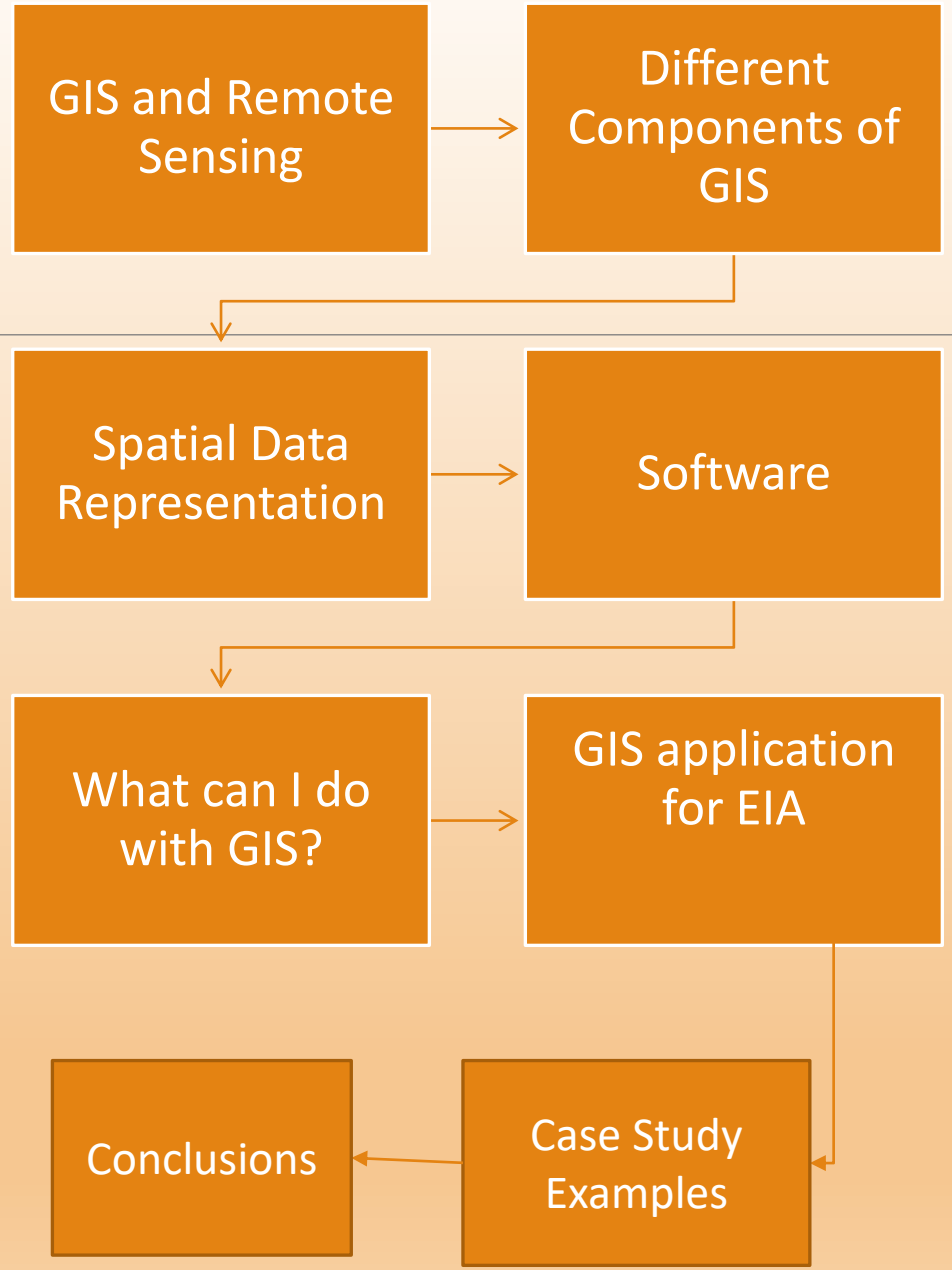
Overview


GIS and Remote Sensing
Different Components of GIS
Spatial Data Representation
Software
What can I do with GIS?
GIS application for EIA
Case Study Examples
Conclusions

GIS and Remote Sensing

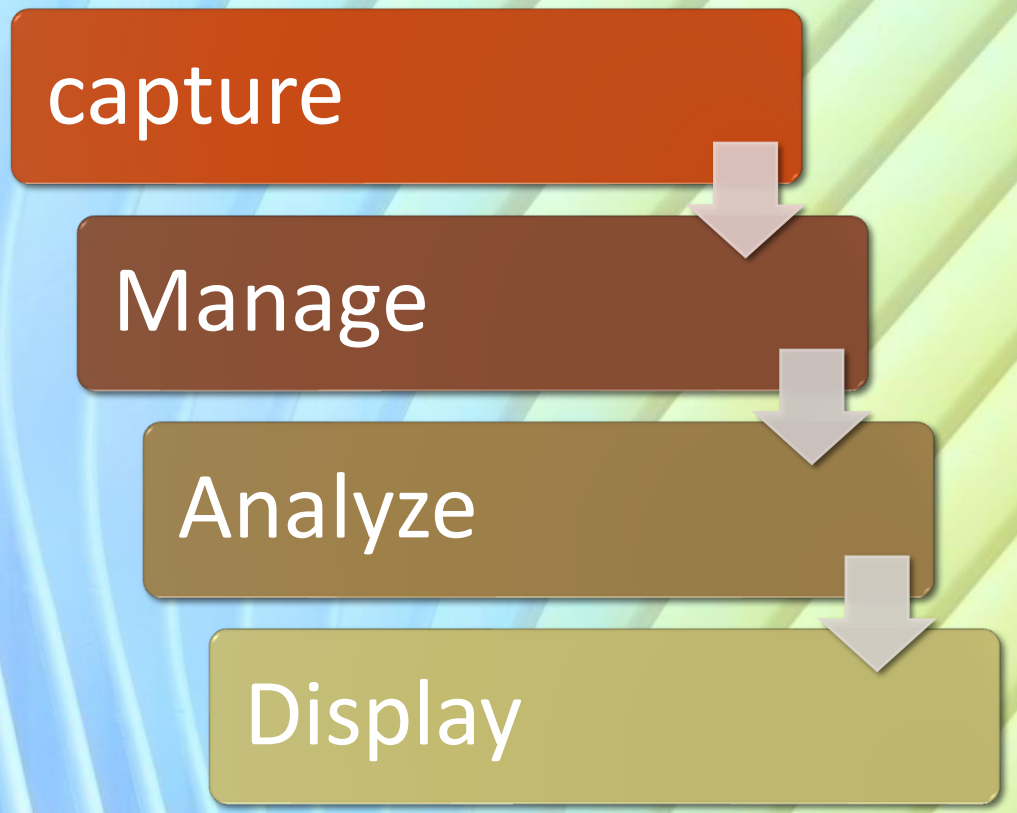
What is GIS ?

GIS – **G**eospatial **I**nformation **S**ystem

- Integrates hardware, software and data for *capturing, managing, analyzing, and displaying* all forms of geographic referenced information.
- A system for storing and manipulating data in a computer system using software.
- Computer based tools used to examine spatial relationships, pattern, and trends in geography

Back in History

In 1854, GIS was used (without computers of course!) to map a disease outbreak in the City of London. Fundamentally, we still use this type of spatial analysis today but in a more sophisticated way.



GIS and Remote Sensing

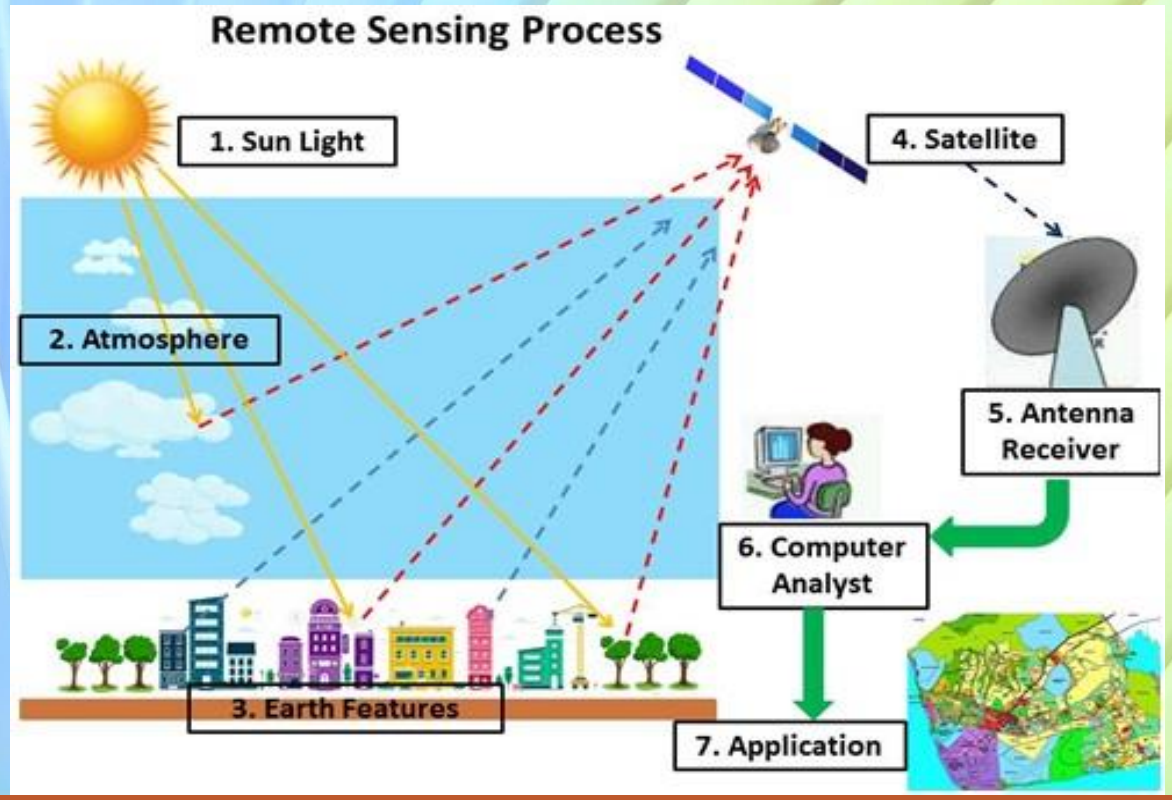
What is Remote Sensing ?

RS – **R**emote **Sensing**

Science of obtaining information about objects or areas from a distance, typically from aircraft or satellites.

Remote Sensors collect data by detecting the energy that is reflected from Earth. These sensors can be on satellite or mounted on aircraft.

- Sensors can be either Passive or Active
- Passive record natural energy that is reflected or emitted from earth surfaces.
- Sources of radiation detected by the sensors is reflected sunlight.



Key Components of GIS

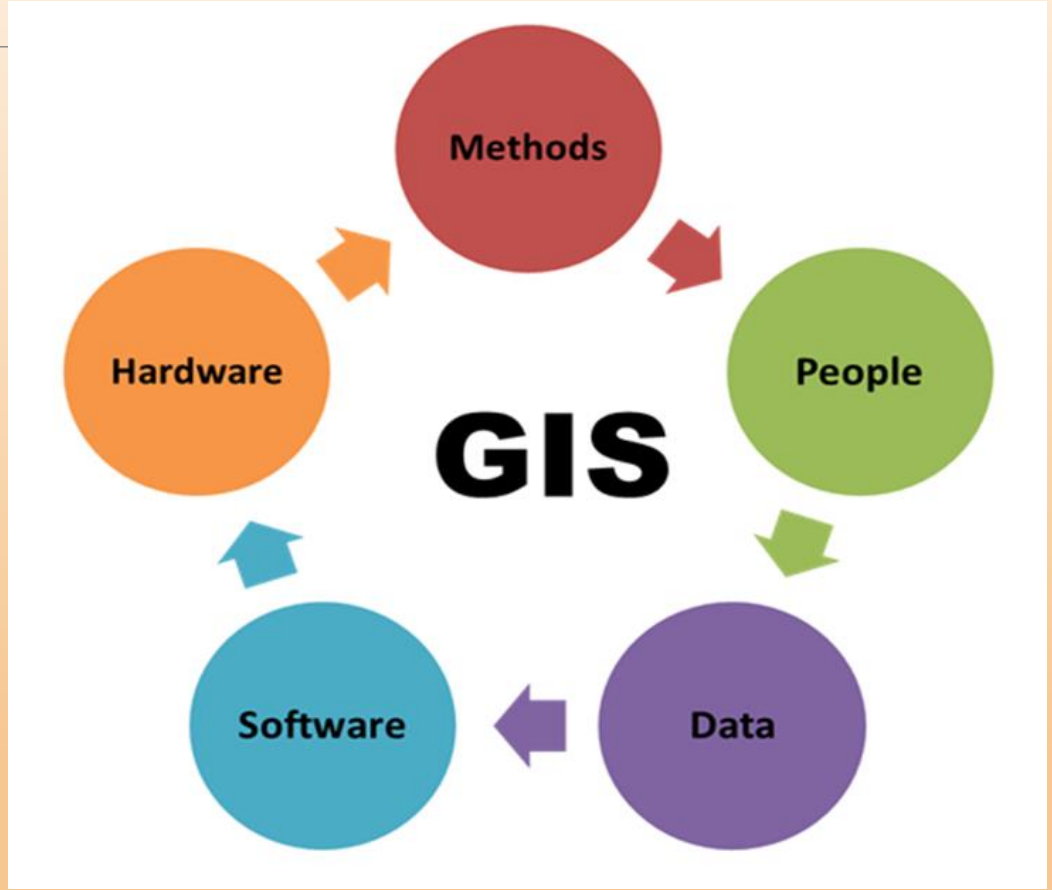
Hardware
- Computer on which systems operates.
- Special requirements due to processing needs.

Software
- Provide function and tools needed to store, analyze and display geospatial functions – ESRI - ArcGIS, Opensource - QGIS

People
- People who manage the system and to develop plans for its application.

Methods
- A well-designed plan and business rules unique to and organization, e.g., GIS workflows or model

Data
- One of the most important components, how are data to be used collected, in house or from secondary sources . E.g., Hard-copy data like traditional cartographic maps, demographic statistics, geographic reports, field observations and data capture.



Spatial Data Representations

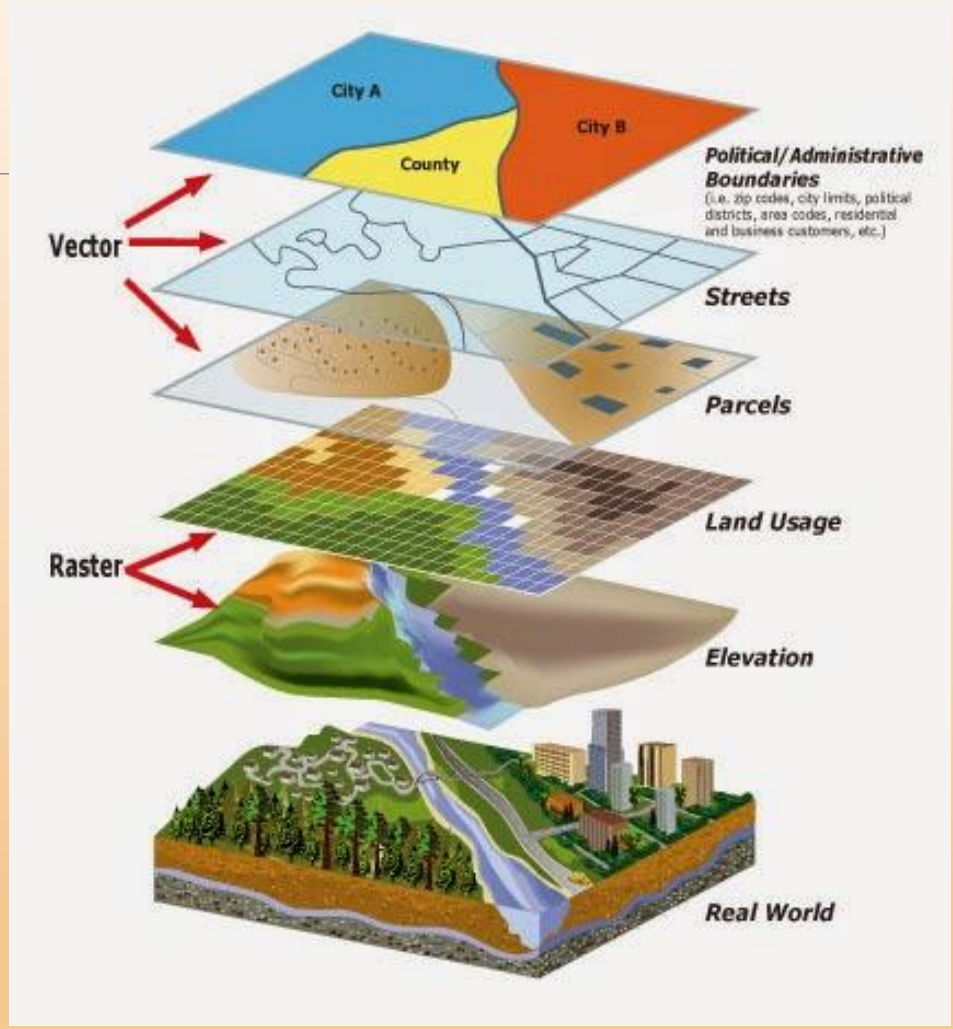
Geospatial data is created, shared, and stored in different formats.

The two primary data types are raster and vector.

Vector Data - A coordinate-based data model that represents geographic features as points, lines, and polygons. Used to represent discrete objects as points, lines, and areas.

Raster Data - consists of a matrix of cells (or pixels)

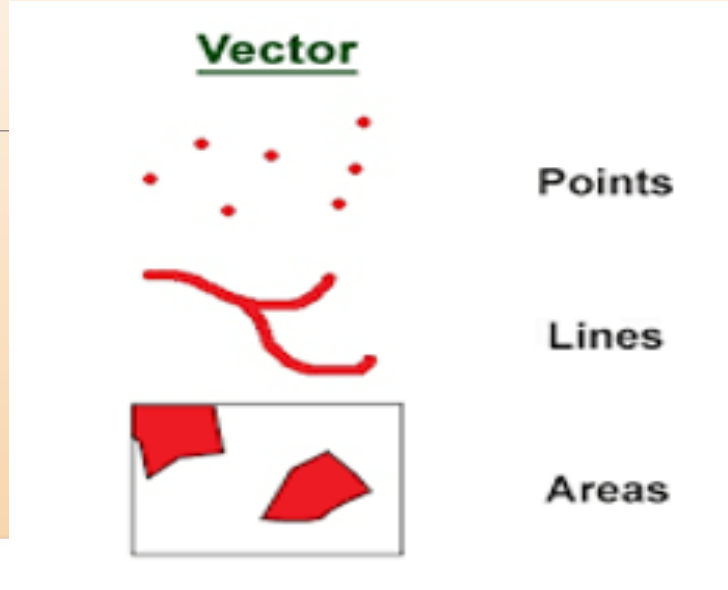
- organized into rows and columns (or a grid)
- where each cell contains a value representing information, such as temperature.

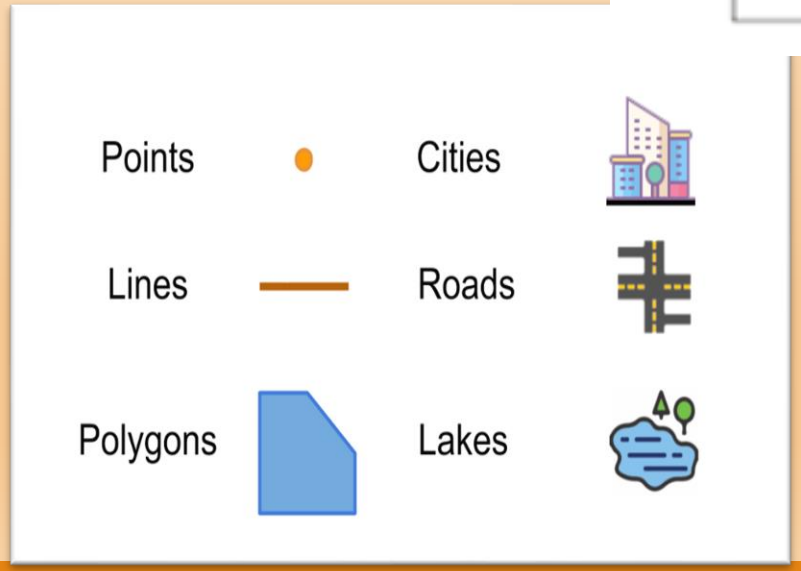


Vector Data

Used to represent discrete objects as points, lines, and areas.

- *Point* locations recorded as coordinates (e.g., trees, wells, schools, or points of interests).
- *Lines* as polylines (e.g., roads, rivers, creeks, Trails or Streets)
- *Areas* as polygons (e.g., buildings, city boundary, forests, Conservation Areas (Protected Areas), lakes/reservoir)

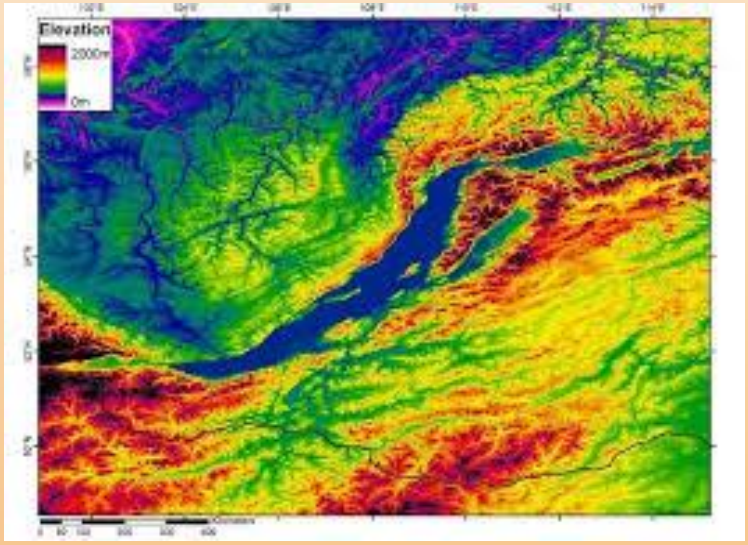




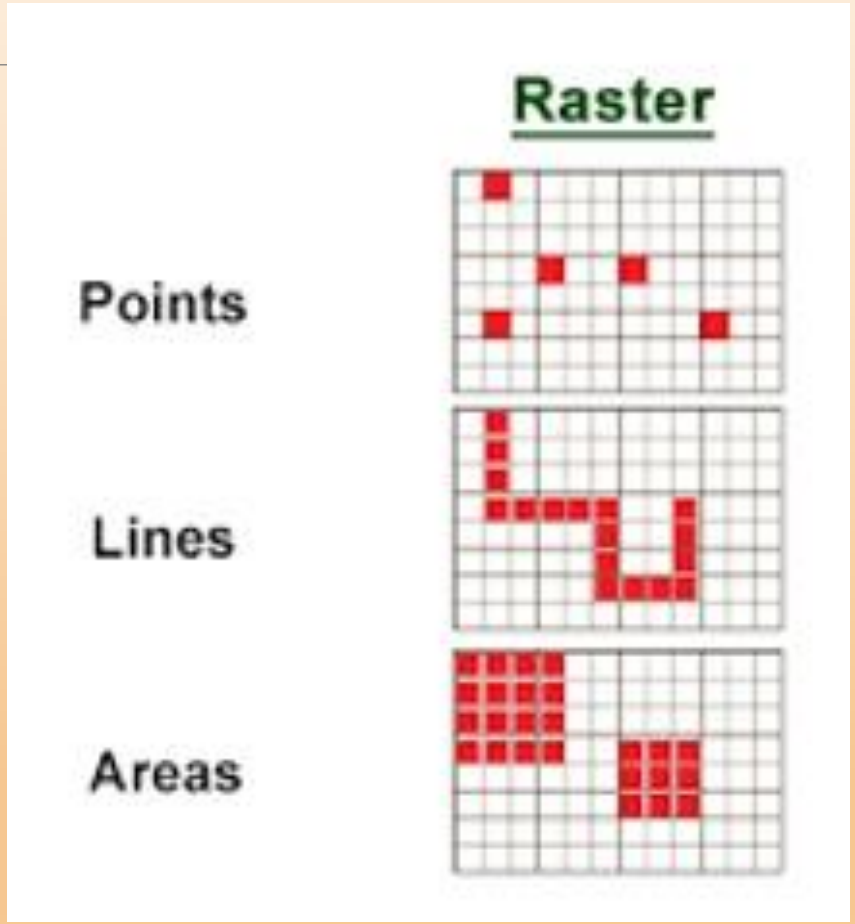
Raster Data

A spatial data model that defines spaces as *an array of equally sized cells* arranged in rows and columns. Each cell contains an *attribute value* and *location coordinates*.

Raster as satellite Imagery

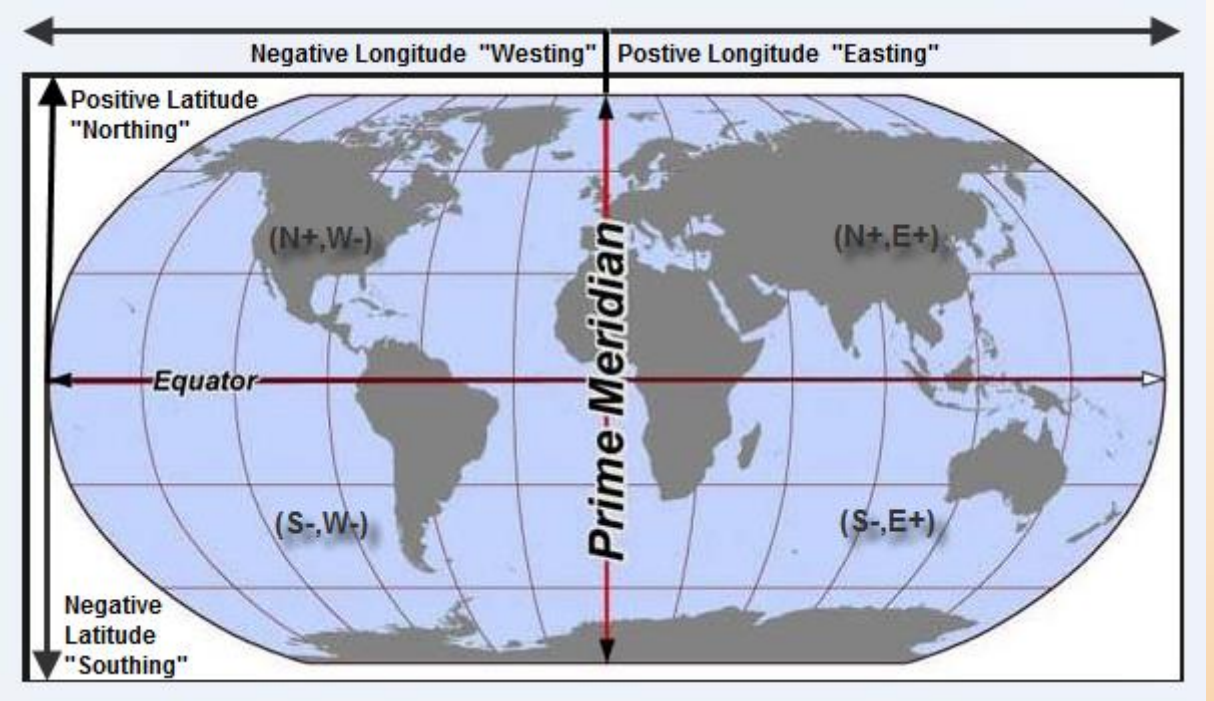


Raster as Elevation Surfaces



Coordinate System

- A method for identifying the location of a point on the earth. Used two numbers, *a coordinate*, to identify these point locations.
- The first number, known as the X value (Latitude), indicates how far left or right the point is from the origin.
- The second number, known as the Y value (Longitude), indicates how far above or below the point is from the origin.
- The Republic of Fiji is located at Fiji country in t Islands place category with the gps coordinates of
- A system that uses numbers or coordinates to determine the position of a point or geometric element within a geographic framework.



Country	Latitude (DD)	Longitude (DD)	DMS Latitude	DMS Longitude
Suva - Fiji	-18.141600	178.441895	18° 8' 29.7600'' S	178° 26' 30.8220'' E
Apia – W/Samoa	-3.8333300°	-171.7666600°	13°49.9998’ S	171°45.9996’ W
Nukualofa-Tonga	-21.13938,	175.2018	21° 8' 9.8340'' S	175° 12' 32.1804''
Port Vila - Vanuatu	-17.734818	168.322021	17° 44' 5.3448'' S	168° 19' 19.2756'' E

GIS Software

ESRI ARCGIS – Licensed Software

Pros

- Extensive geoprocessing tools from the most complex to the most basic.
- Constantly updated and improved by the ESRI team.
- This tool grows with your organization – storage, support services provided.

Cons

- Users - License subscription basis per year.
- Installation of ArcGIS is a more extensive process and requires administrator approval.

QUANTUM GIS (QGIS) – Opensource Software

Pros

- QGIS is free and very easy to install, and no license is required
- Has a friendly interface, it is very easy to use.
- QGIS has a wealth of plugins for data analysis.

Cons

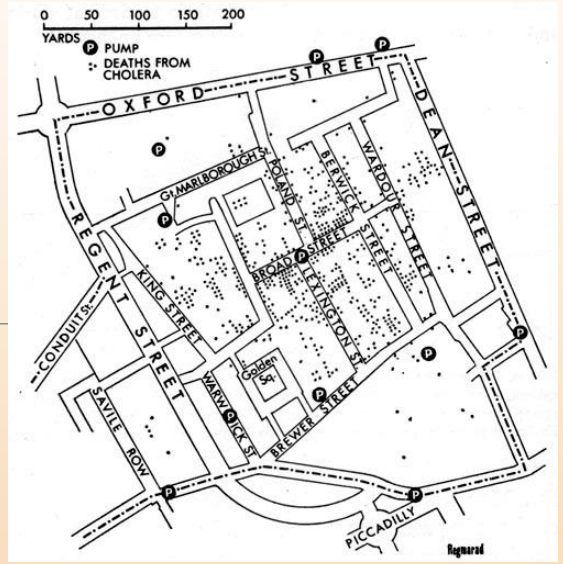
- Support services is tricky to find.
- It is compatible for basic GIS.
- QGIS does not have a large library of online courses to assist users.

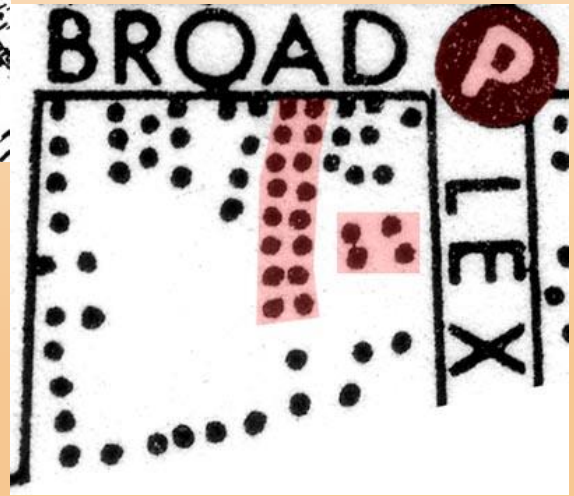
Any Questions so far ??

On the following topics that we had covered:

- What is GIS?
- What is Remote Sensing?
- Components of GIS?
- Spatial data representation?
- Types of GIS data?
- What is coordinate system?
- GIS software

Example of problem solving from the very first application of GIS (without computers)





- Cholera hit the city of London, England in 1854, the source of the disease was unknown,
- A British physician John Snow started mapping the disease outbreak in each household.
- Other layers were mapped- roads, property boundaries, and water lines.
- When these features were added to the map (overlayed) , interestingly he noticed that cholera cases were only along one water line.
- This was a breakthrough that connected geography to public health safety.

What can I do with GIS…..

GIS can be used as tool in both ***problem solving*** and ***decision-making*** processes, as well as for visualization of data in a spatial environment.

- Mapping *where things are* – Different Land Classes for agriculture purposes
- Mapping *quantities* – River Gravel Extraction locations for development
- Mapping *densities* – Population Density in an Enumeration Boundary
- Finding *what is within* – 5km buffer of the native forest boundary
- Finding the *best location* - for an evacuation center.
- Mapping *change* - Change in Forest Cover over 5 years

GIS Application for EIA

- Geospatial information system is an essential component of the Environmental Impact Assessment (EIA) process, as ***environmental resources are directly affected*** by changes in the shape and extent of the proposed disturbance.

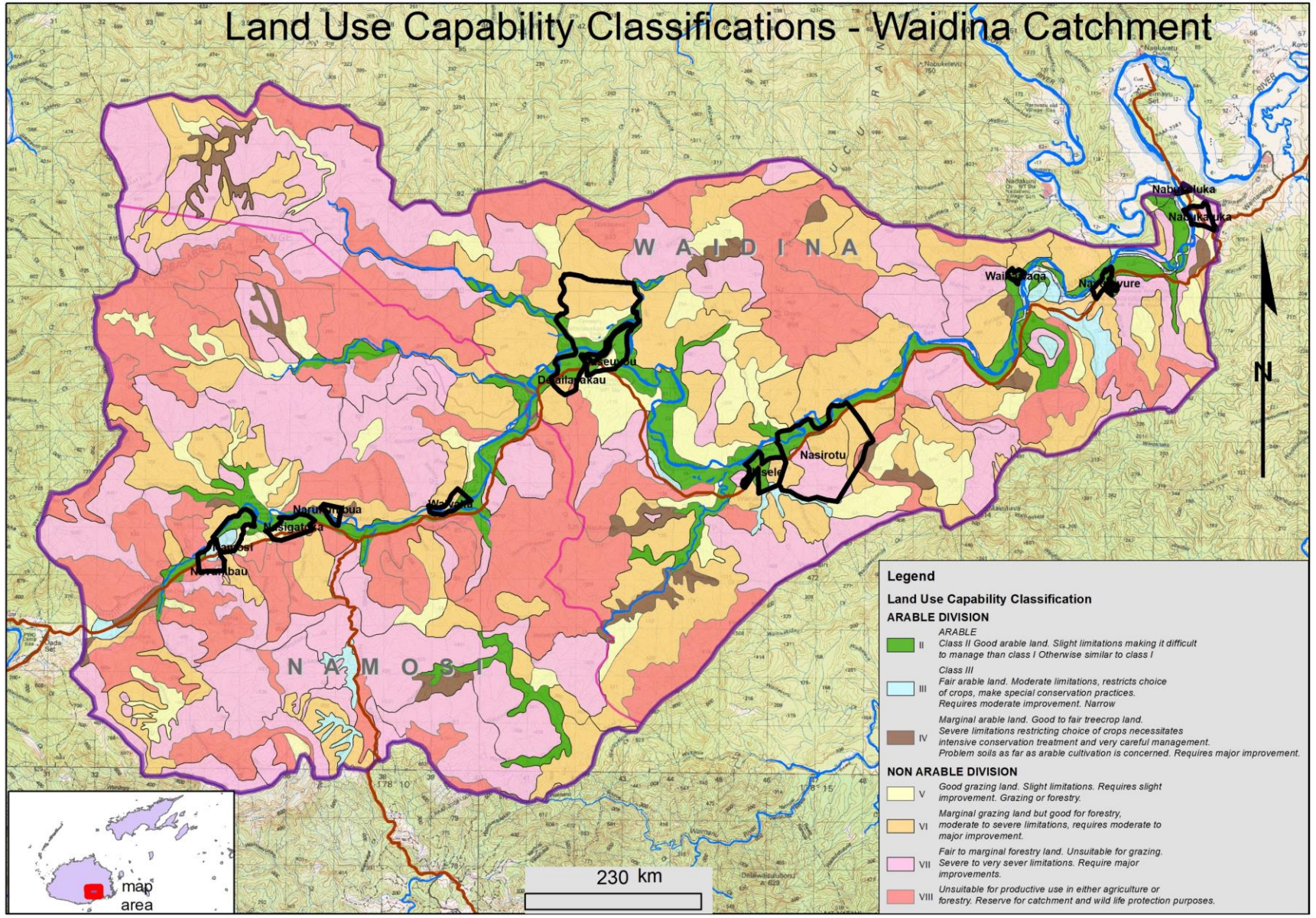
- Step 1 - It is important that there is an existing GIS setup in the organization as this will enable ease of data/information flow.

- Step 2 - What data is available and what data is to be acquired.

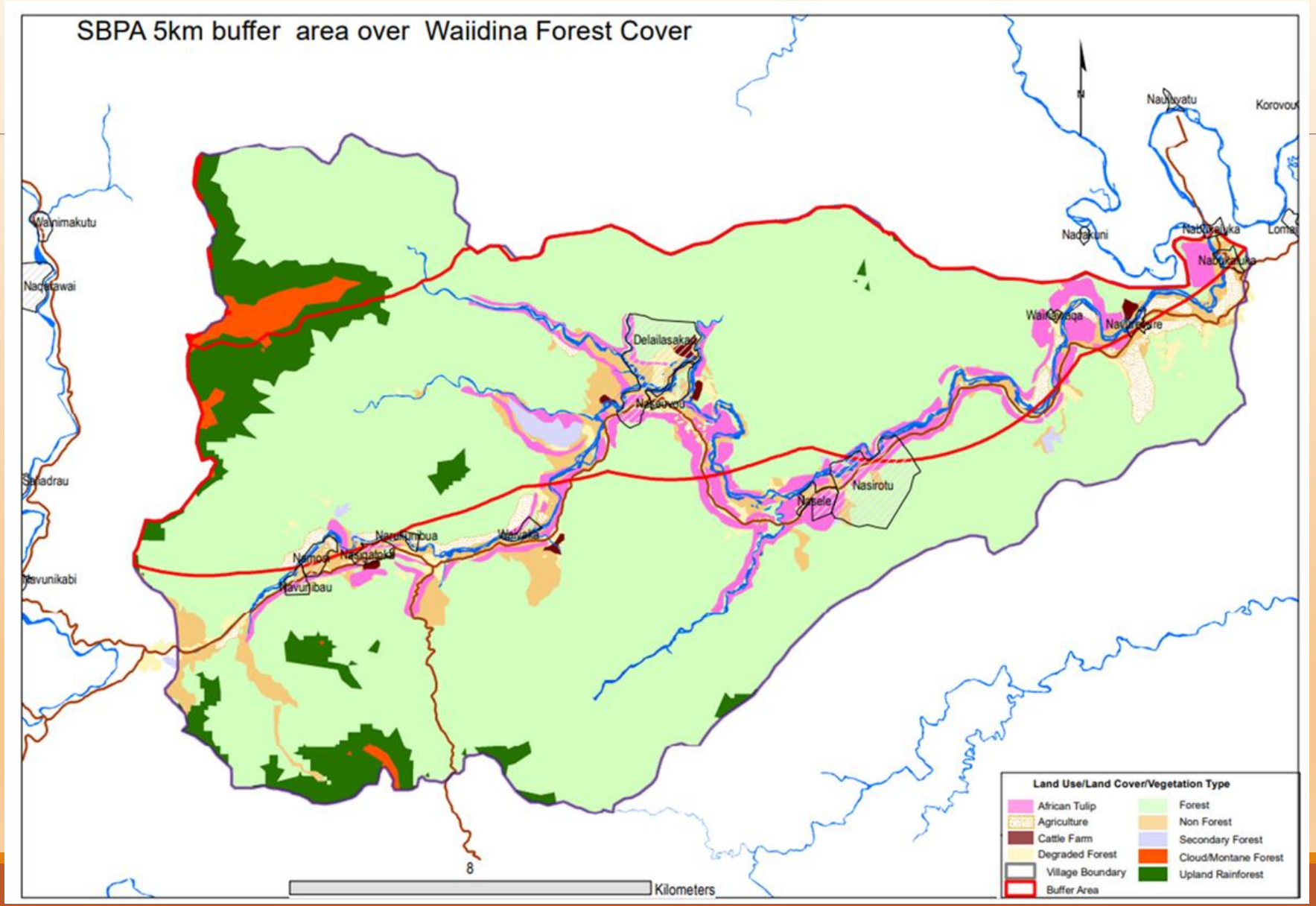
- Step 3 - Data Sources: Other ministries, stakeholders, consultant report, developer's report. To support GIS analysis & data compilation and cataloguing to assist regulating authorities in environment monitoring of developments.

- Step 4: Setting up of Environment Monitoring Committee (EMCs): GIS applications have assisted EMCs in providing updates of environmental findings from overlays of GPS locations for monitored data including all sampling locations, boundaries and areas of interests.

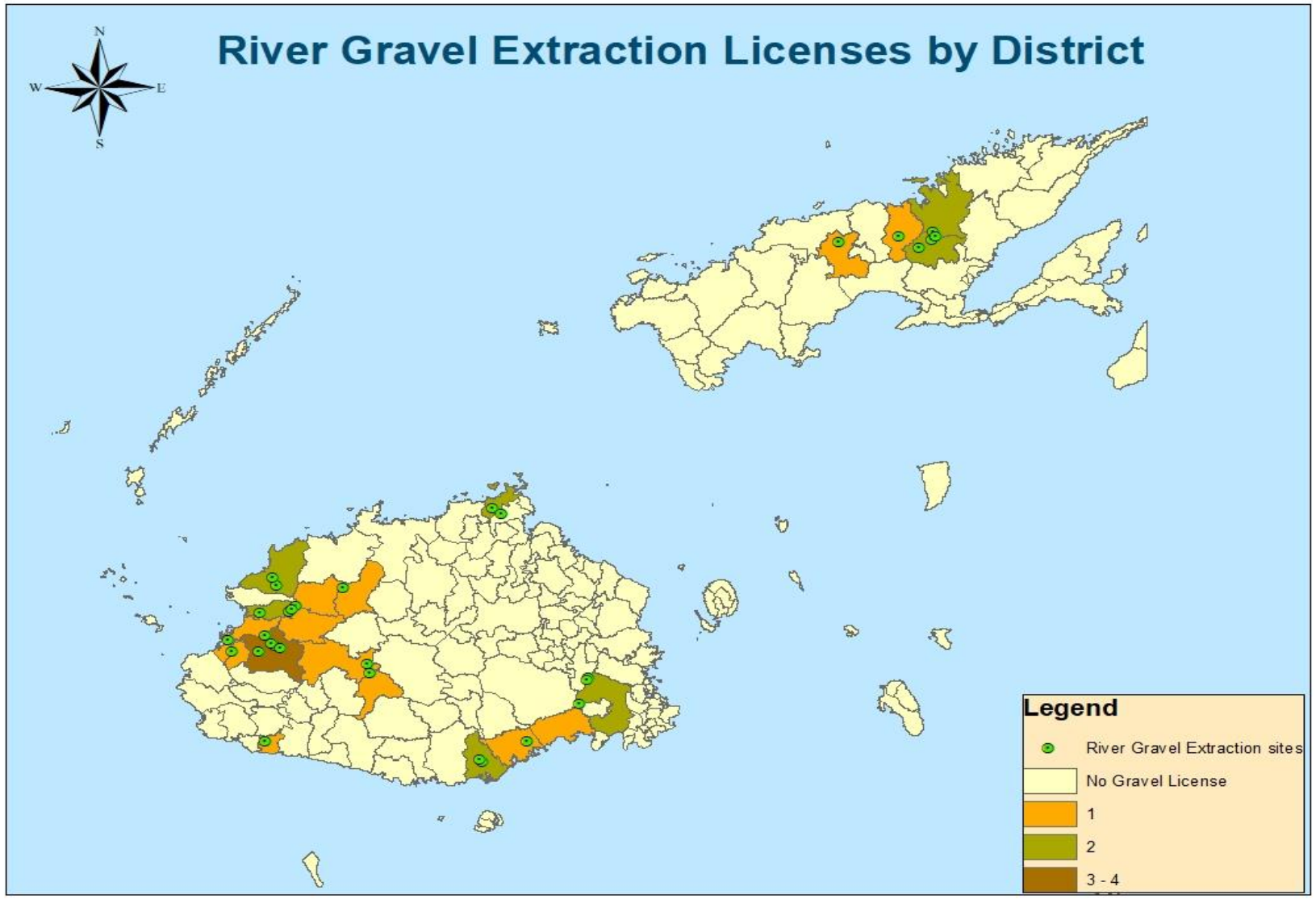
Mapping where things are



Locating forest type within a buffer (5km)



Mapping quantities - River Gravel location



Example: A map of active gravel extraction licenses in Fiji. The gravel extraction sites are represented as dots (dot density) and each district is color coded to show where the most and least are located (orange means fewer licenses)

Data used: Gravel sites
District boundaries
Rivers
Roads
Land use

Case Study Examples

i. EIA verification of rock resource extraction site
   - Determining site selection from report with field observation.
ii. Mineral Exploration Boundary Demarcation.
iii. The Impact of Land Slide in a Protected Area
iv. Mapping of Heritage buildings vulnerable to Hazards
   - Landslide, Flooding and Storm Surges
v. Change detection mapping 5 to 10 years using RS.

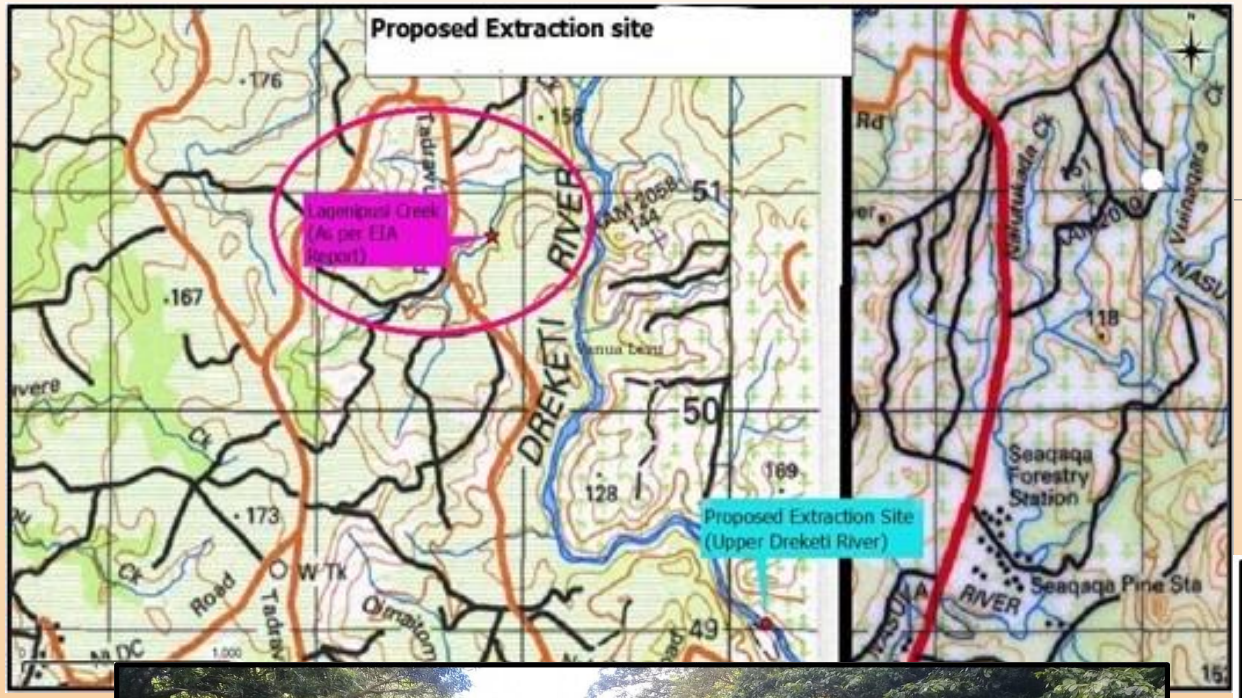
Application of GIS for EIA site verification

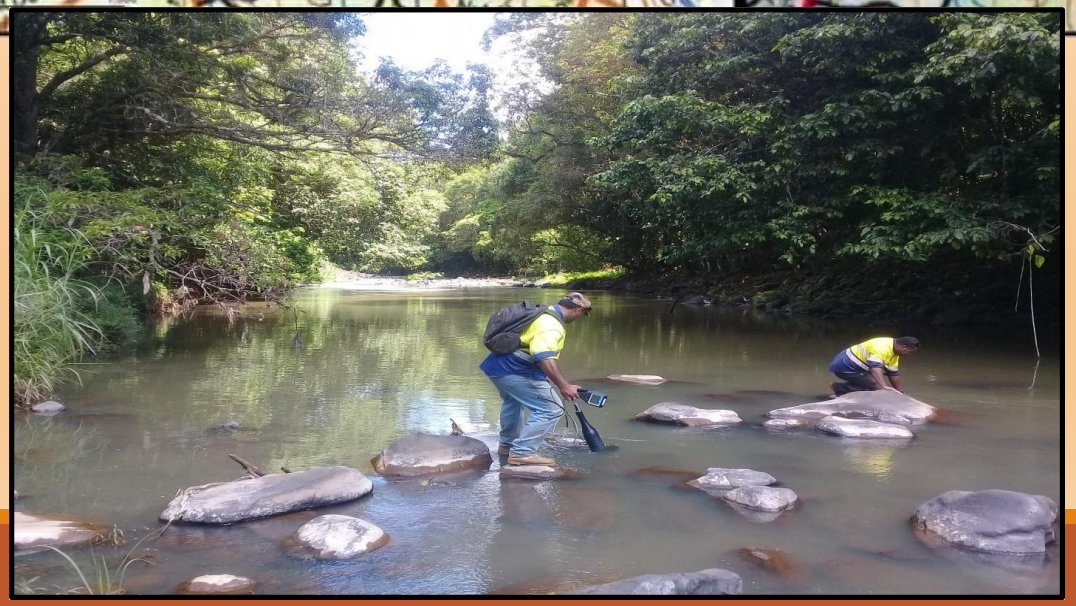
Problem Statement

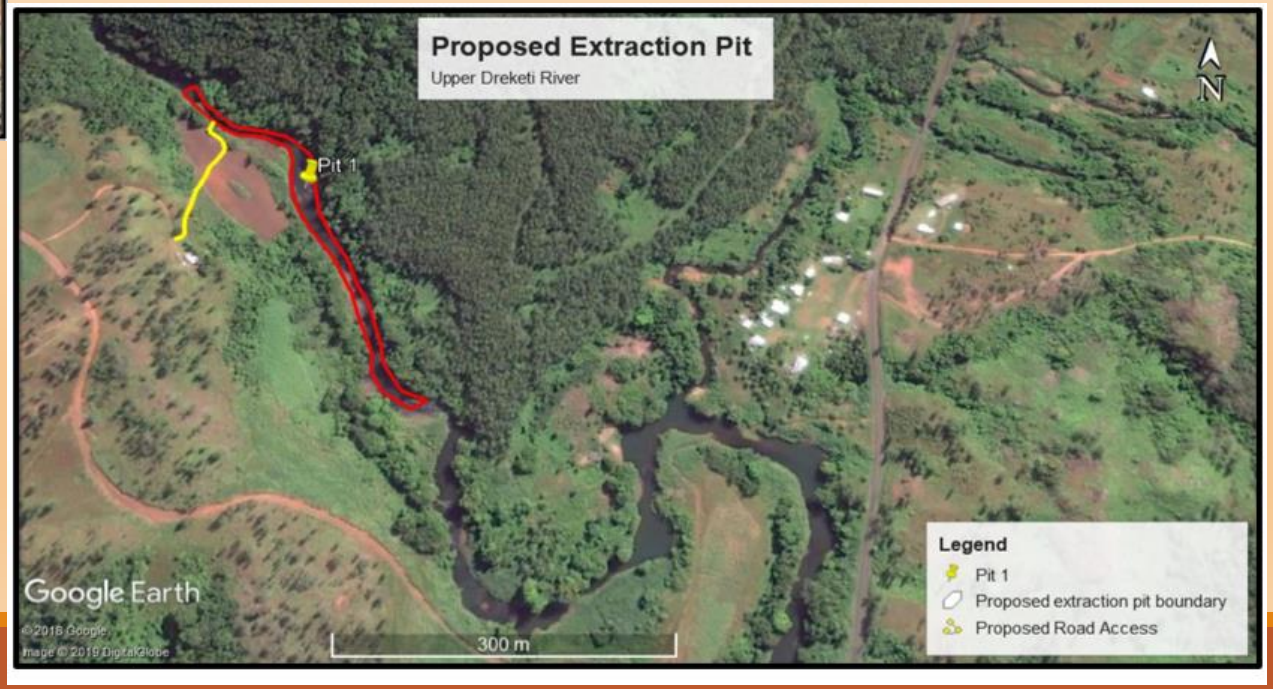
- To identify and verify the area of interest in a new application for the purpose of extracting boulders including river gravel for road construction.
- To ensure that information and data derived from consultant report is accurate and approval is granted on that basis.

Output: Area of interest is verified along with resources available onsite as EIA report indicated a different area.

EIA Report verification







GIS application for Mineral Exploration boundary demarcation

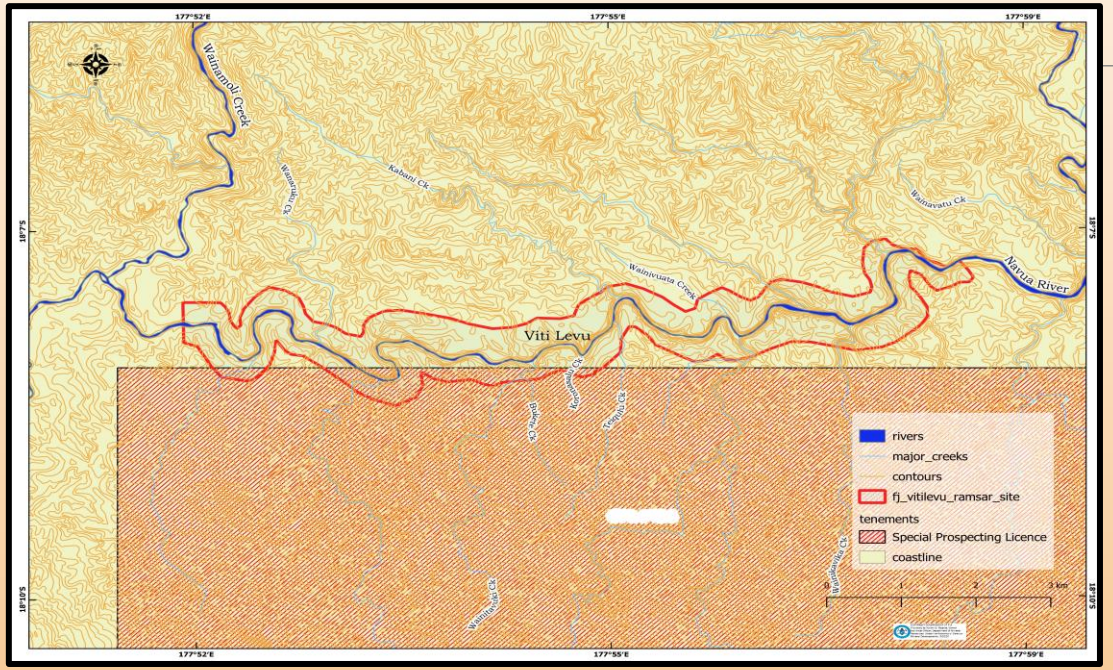
Problem Statement

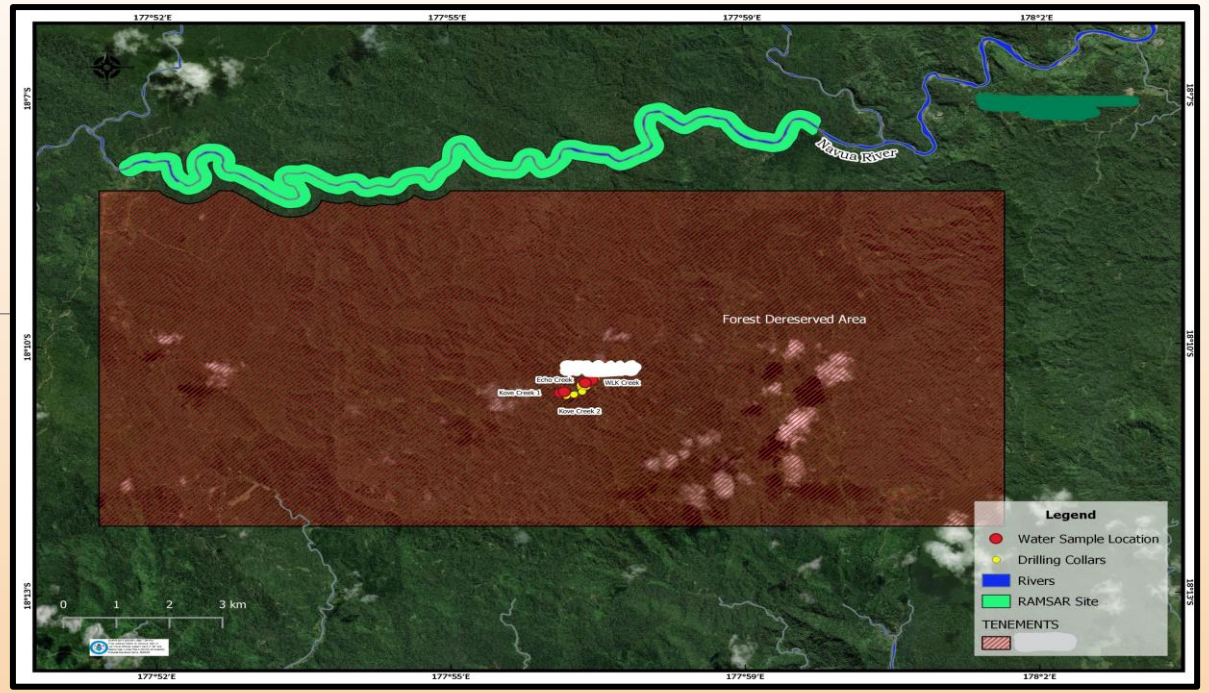
- To verify approved boundary for a new mineral exploration application.
- Ensure that there is no boundary overlap of the proposed exploration area with other conservation area of interest.

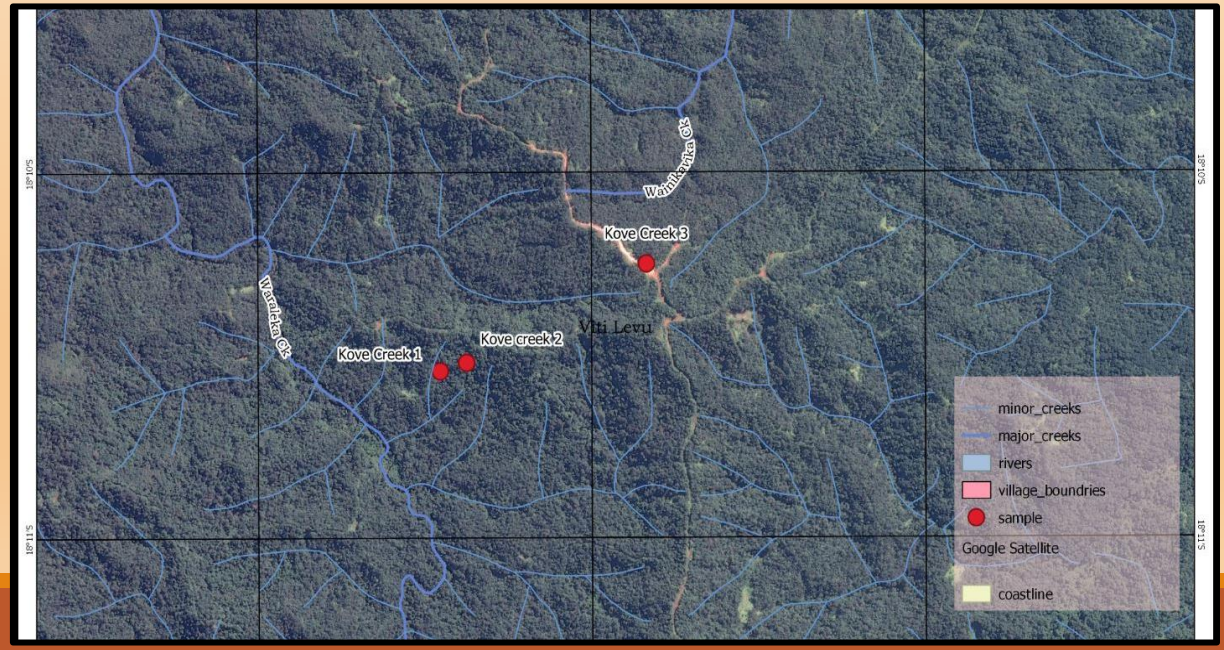
Output: Approved boundary is adjusted to exclude the RAMSAR site and other key biodiversity areas (KBAs), in addition to mapping of the all-water sampling points around the boundary.

- Encourage *inter-ministry collaboration* with EIA regulators for proper and accurate data that will support better informed decision making.

Mineral exploration site in the upper Viti Levu area.







- **Data used (Overlay):** Conservation Area
  - Forestry data
  - Rivers & Creeks
  - Contours
  - Sampling locations (monitor discharge of pollutants into waterways)

The impact of Land Slide in a Protected Area

Problem Statement

- To identify the landslide prone areas within the protected area, which could be a threat to endangered species of plants and animals,
- So that appropriate intervention could be identified with the communities and find ways to address the issue.

Information Demand

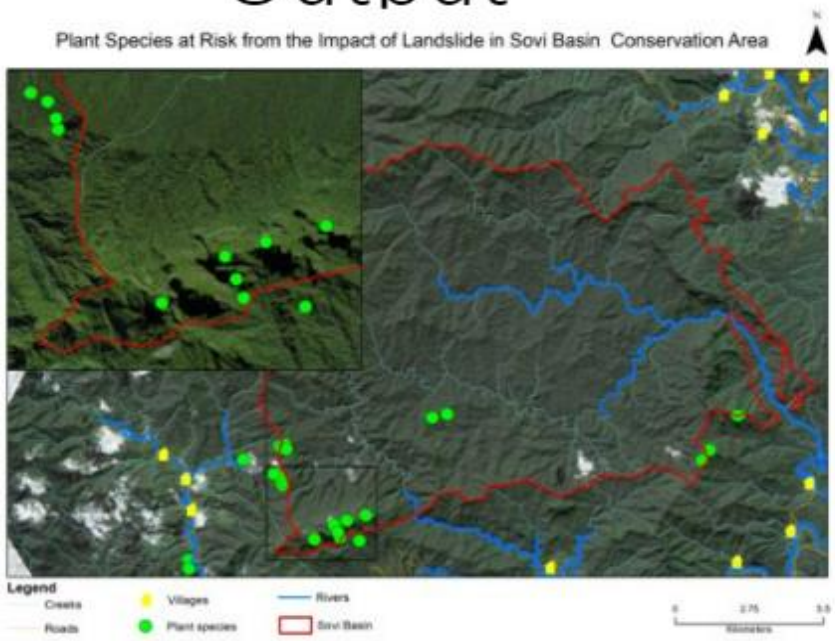
- Landslide hazard zones
- Plant Species information
- Species exposure to different hazard zones

Data

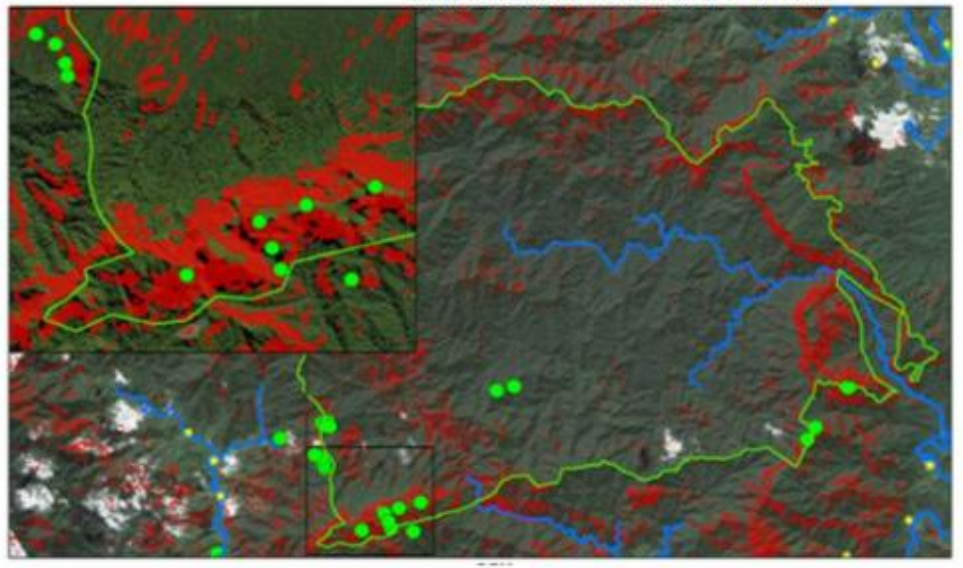
- Protected Area Boundary
- Digital elevation model
- Soil type
- Rainfall
- Species distribution
- Forest cover
- Cultural and natural heritage sites
- Roads, Rivers, Villages, Creeks

Unique Biodiversity

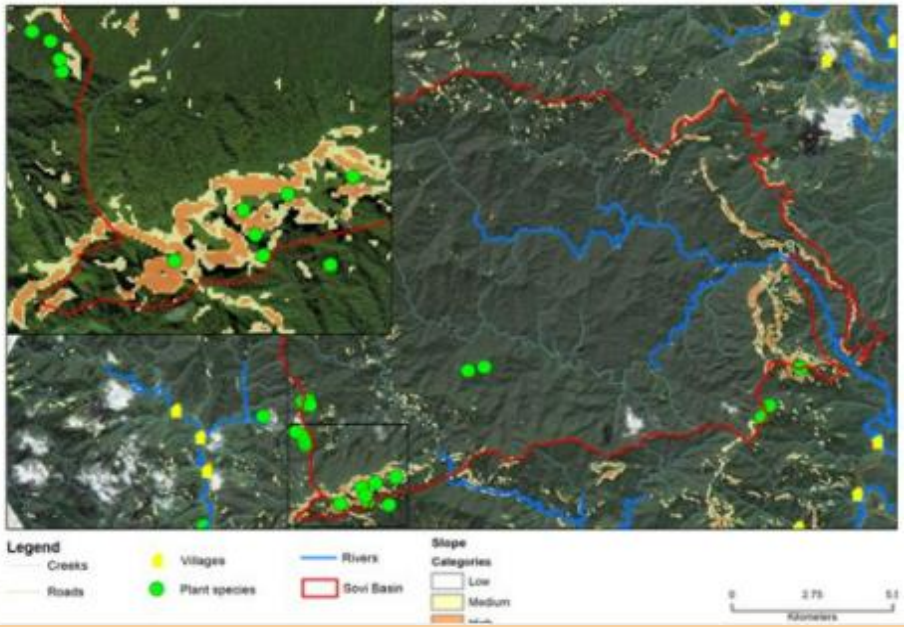
Output



Landslide Prone Area



Land slide categories



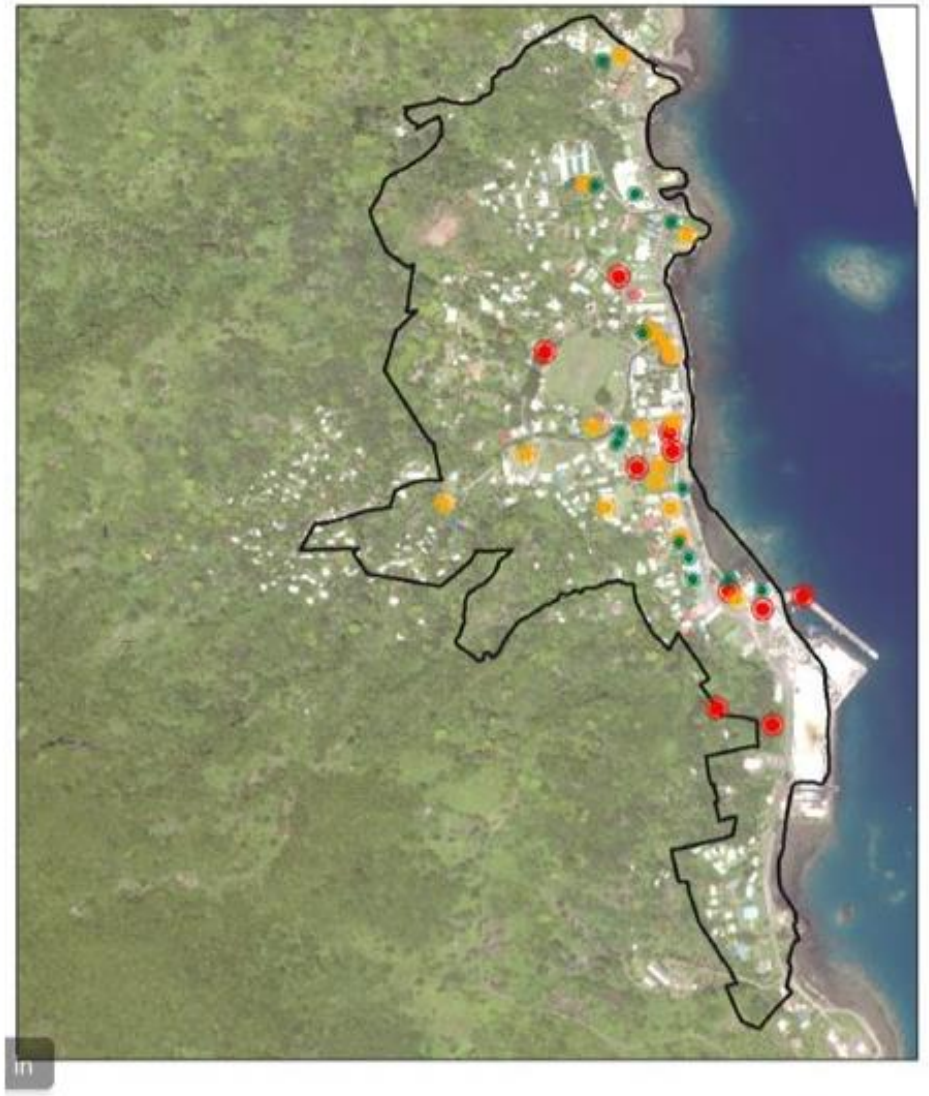
Assessing risks and vulnerability of Heritage Buildings

Problem Statement

- Heritage buildings may be vulnerable to hazards given its location and rugged topography?
- Develop DRM plan to guide the protection of this significant Town.

Main layer to be assessed.
Prioritized based on

- Vulnerability from damages sustained during TC Winston.
- Potential impact that may arise from future disasters.



REHABILITATION CATEGORIES

Critical Buildings
Immediate need to rectify damages preventing further detereoration.
Medium Range
Important but not as critical as above.
Minor Issues
Require minor repairs.

0 0.175 0.35 0.7 Kilometers

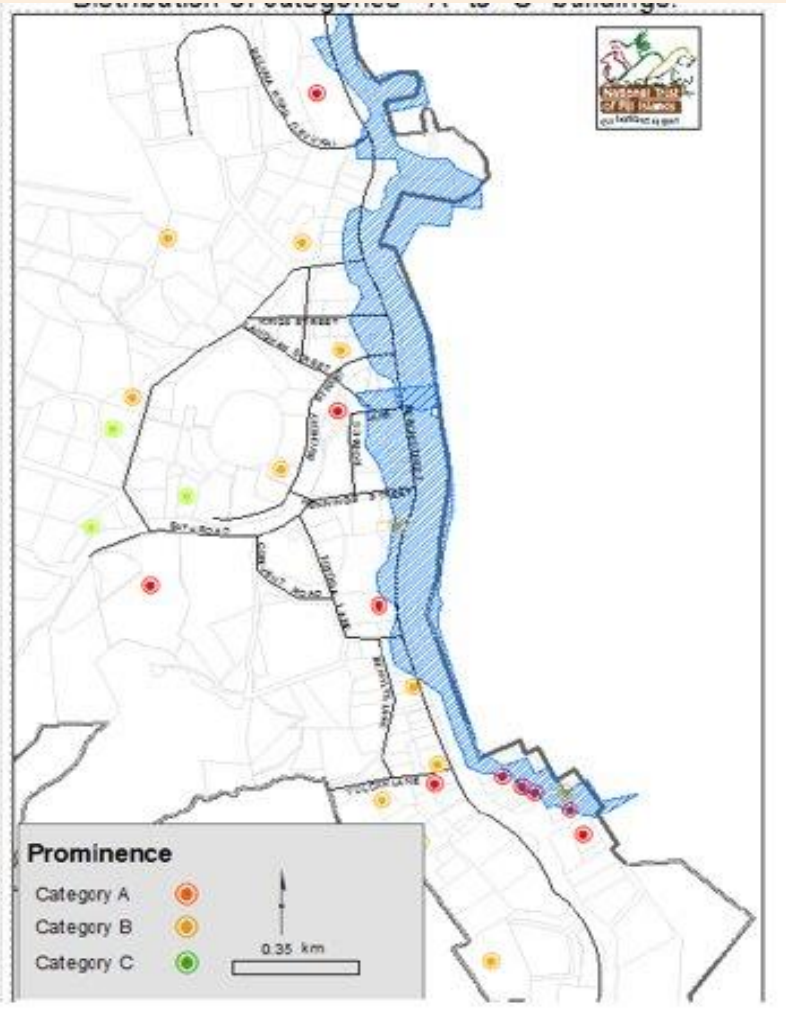
Risk Data

Landslides

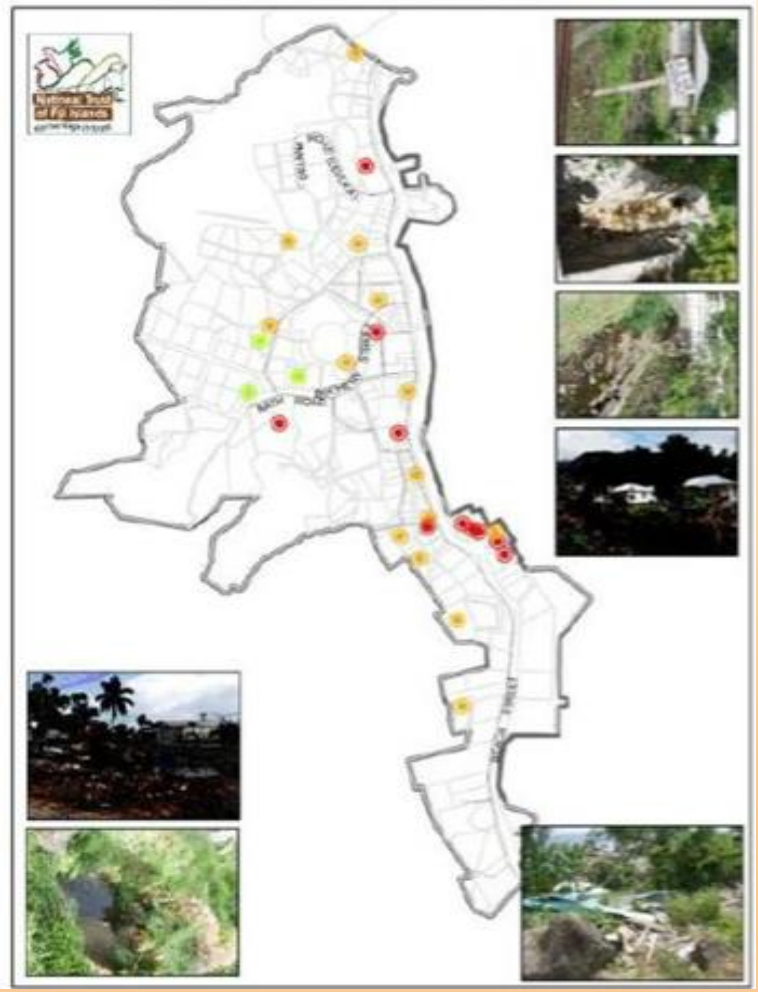
Flooding

Inundation from Storm Surges.

- **Inundation from storm surges**

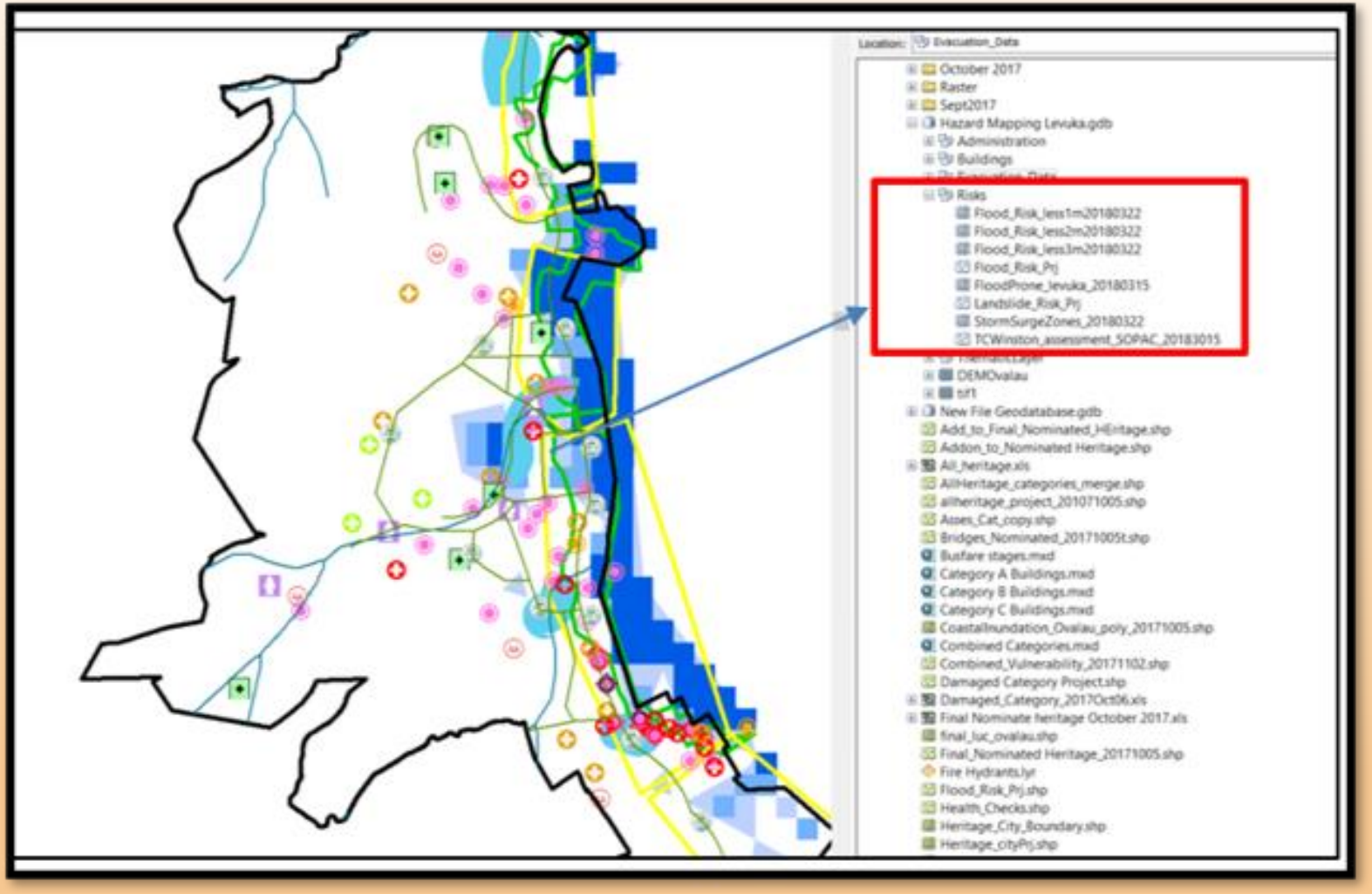


- **Environmental Hazards**



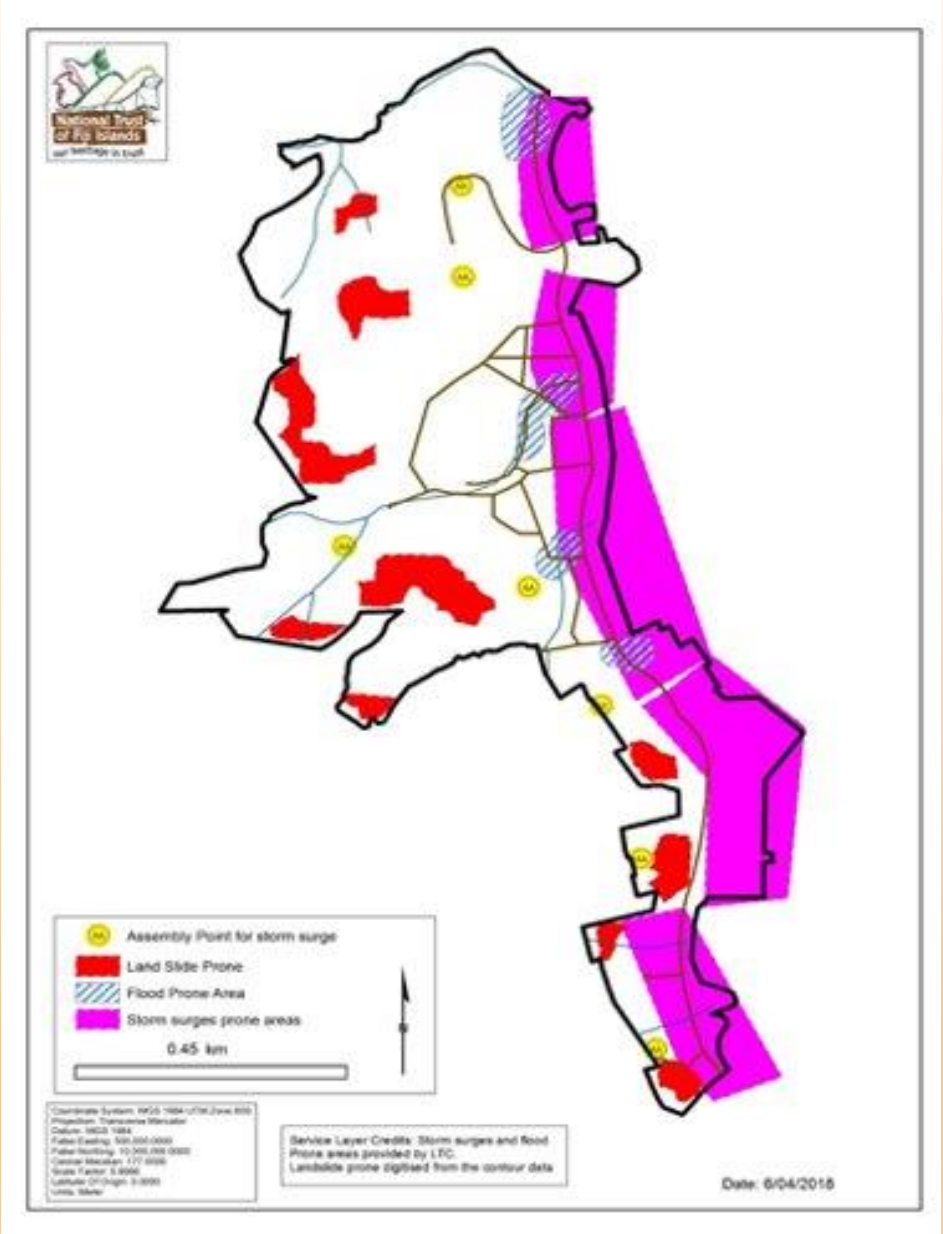
Risk Prone Areas

- Layers from different sources. i.e: LTC – hazard mapping.
- The inundation extent is the distance that the wave travel inland.,
- Other layers derived through GIS modelling.



Hazard Map

- Hotspots/for landslides, flooding and storm surges.
- The land slide hotspots are sites with very steep slope degrees of greater than 25.
- The moderately steep soil types and non-arable classes, makes it more vulnerable to impacts of landslides.

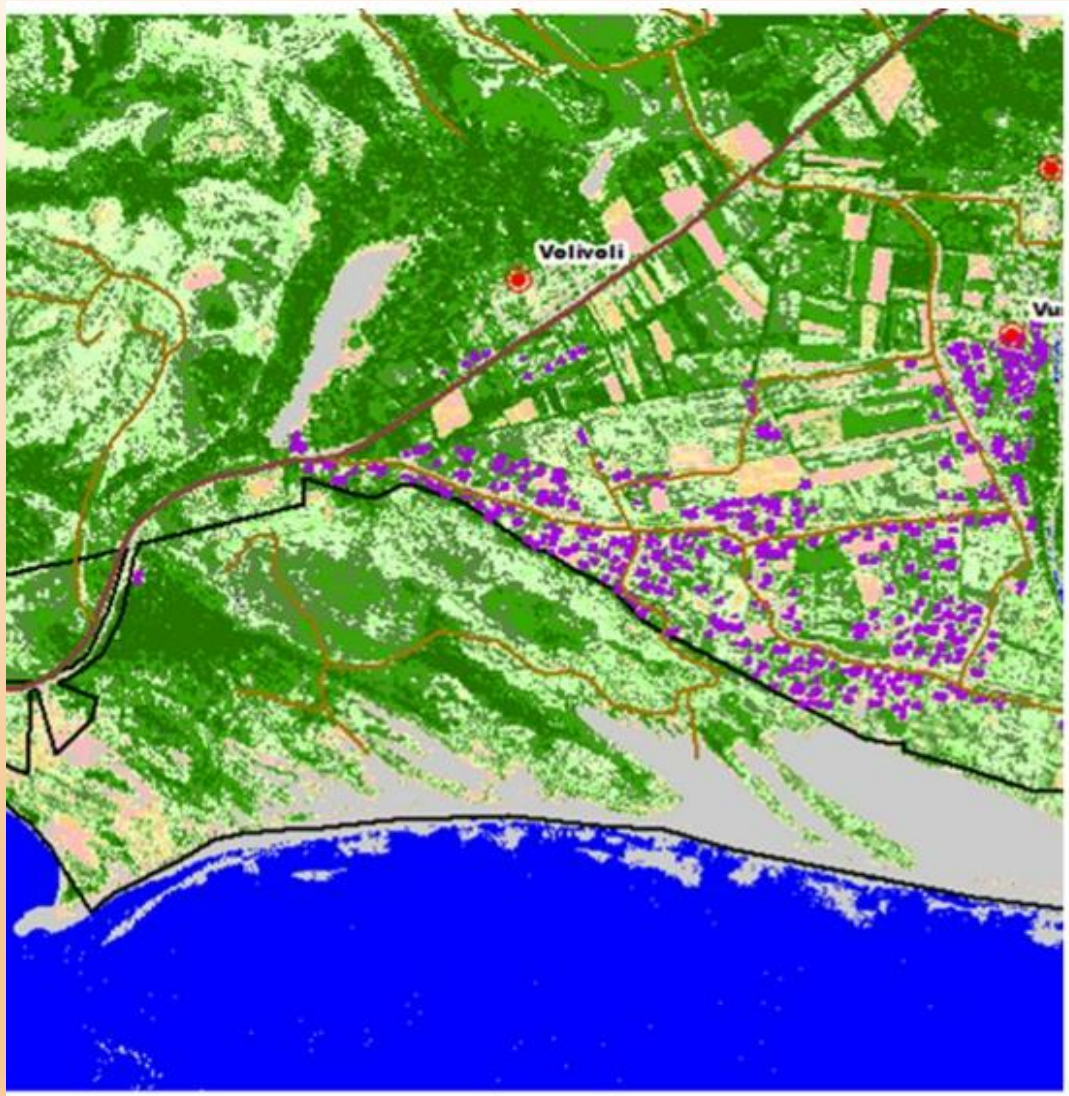


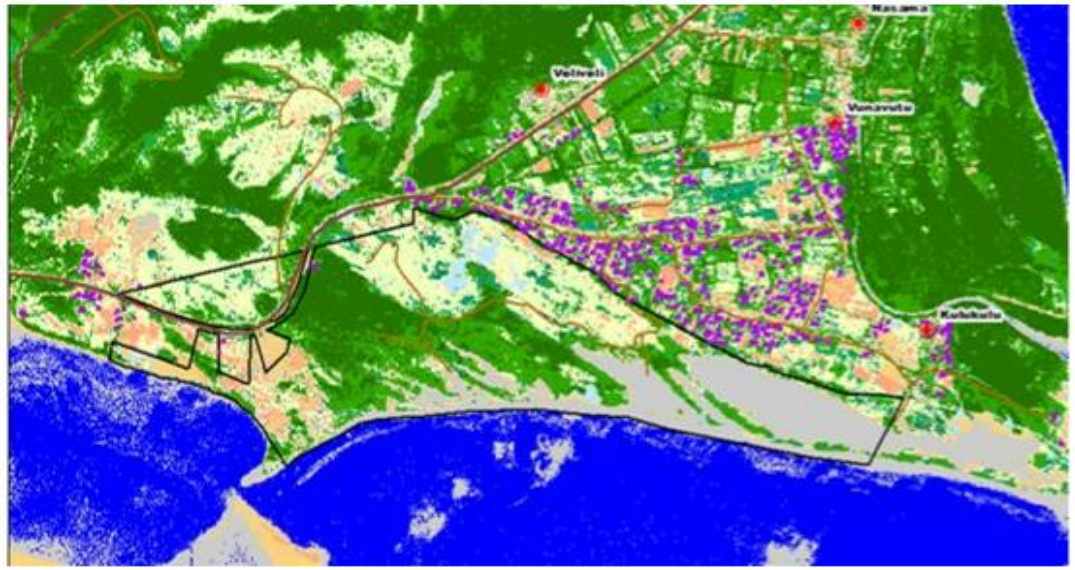
Assessing Change Detection at the Sigatoka Sand Dunes National Park(SSDNP)

Problem Statement

- The increase threat to the loss of biodiversity at the park due to Illegal Sand Extraction.
- The aim of this case study is to investigate the changes that has have occurred in the span of ten years in Sigatoka and to ascertain determine whether there are any visible changes to the sand dunes and its surrounding environment.
- This will be conducted using a land use land cover change detection on the area of interest for 2010, 2015 and 2020.

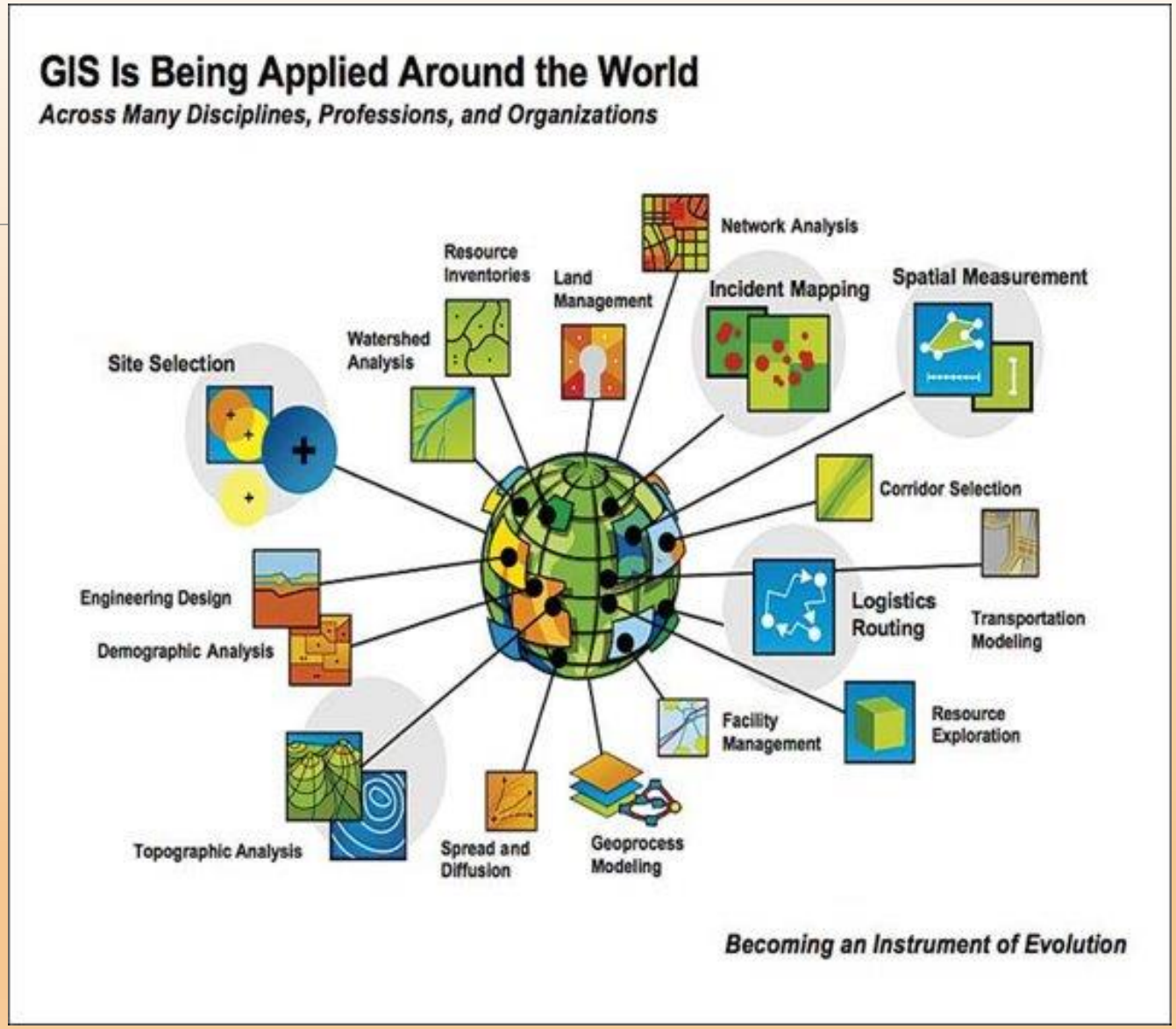
Land Cover Change along the SSDNP





Conclusion

- GIS can assist EIA regulators organize existing data for use in:
  - Planning, management and monitoring of natural resources.
  - Analysis of data to understand trends over time.
- GIS can support the verification process whether the project meets the requirements for it to be environmentally friendly.
- Today GIS is being applied around the world to virtually all the problems that we face.
- GIS assist in providing decisions that are well informed by providing data coupled with analysis
- Overall, GIS is becoming an amazing tool for improving human understanding based on changes happening around us through better informed decision making



Take home message…..

GIS is a powerful tool.

Data is an important component, if properly analyzed can produced useful output.

That can assist and support in project planning, management and decision making.

Would greatly assist in your work in terms of processing data that you may already have to make informed decisions on EIA.

Vinaka, Faa’fetai Lava, Thank You !!

Are there any questions!!