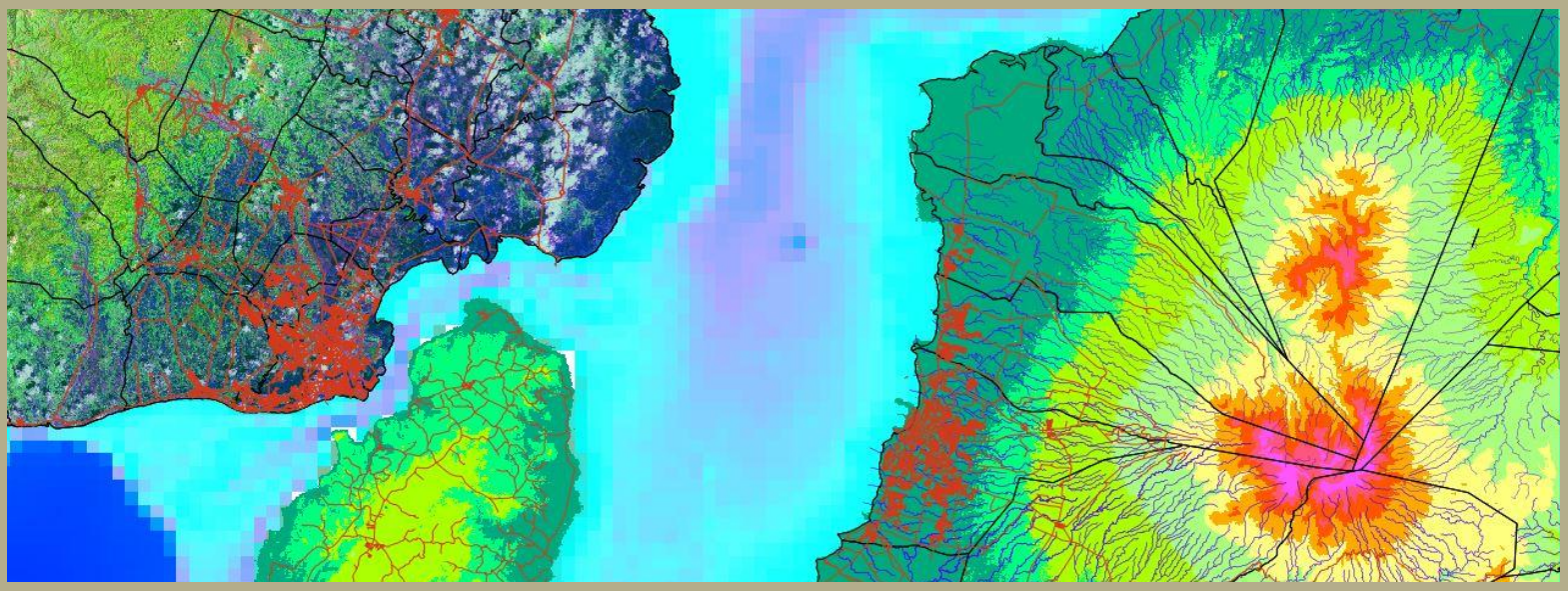
Module

11



Module Subject:

Geographic Information Systems (GIS) for Planning

Deutsche Gesellschaft
für Internationale
Zusammernarbeit (GIZ) GmbH

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Geographic Information Systems (GIS) for Planning

Module Contents

Lecture Points

11.2.1: What is GIS?
11.2.2: Elements of GIS
11.2.3: GIS as a Tool
11.2.4: Confusion
11.2.5: GIS software
11.2.6: How GIS works
11.2.7: The Connection Between Map and Database

11.3.1: Installing Manifold System GIS
11.3.2: The User Interface
11.3.3: Adding Data into Manifold System
11.3.4: Create Overlays of Components (Images, Drawings)

11.4.1: What is GPS?
11.4.2: Importing GPS Data Into Manifold System
11.4.3: Coordinate Reference Systems
11.4.4: Map Georegistration
11.4.5: Data sources in the Philippines

11.5.1: Editing of Maps
11.5.2: Merging Map Layers
11.5.3: Creating New symbols

11.6.1: Description
11.6.2: Advanced Selection: Using SQL
11.6.3: Analysis Using the Transformation Toolbar
11.6.4: Preparation of a Barangay Base Map
11.6.5: Analytical Maps

11.7.1: Formatting Drawings
11.7.2: Preparing a Layout in Manifold System
11.7.3: Creating a layout
11.7.4: Preparing for a Large Scale Print

11.8.1: New Developments in GNSS
11.8.2: Depth Sounders and Coastal Zone Mapping

Geographic Information System (GIS) in the Context of SIMPLE

OVERVIEW

Land use and development planning plays a critical role in the development and implementation of Sustainable Integrated Management and Planning of Local Government Ecosystems (SIMPLE). From the creation and establishment of the Trainer Pool up to the management and implementation of the zoning ordinance and annual investment plan and budget, physical and development planning figures prominently from both ends of the planning and management spectrum, clearly indicating the importance of this tool in the context of the local planning and development process. The formation of the provincial trainer pool for instance involves the enhancement of knowledge and skills of selected key individuals and even institutions in the areas of land and water use and development planning, including such cross cutting issues as climate change, protected area management, conflicts, and disaster risks, to name a few. This intends to build up capacities of the trainer pool as a technical service provider for municipalities and cities relative to the implementation of the SIMPLE planning framework.

Undertaking a land use and development planning initiative requires however an intensive use of Geographic Information System (GIS) as a tool for processing varied forms of spatial and planning information. While SIMPLE heavily employs participatory approaches and processes in most stages of the planning framework, it still depends on computer-based information system to be able to gather, process, and analyse information more efficiently for local decision making. With GIS, key stakeholders and development actors are provided with strategic and issue-focused information that could facilitate productive discussion and generate informed decision.

OBJECTIVES

At the end of this module, the participants shall be able to:

i. Understand and further appreciate SIMPLE as an integrated ecosystem and management framework designed to help local government units manage effectively their entire territory;
ii. Highlight the importance of the use of Geographic Information System (GIS) as a tool for informed decision making; and
iii. Identify and appreciate the importance of GIS as a tool relative to the implementation of SIMPE at varied phases and levels of planning scales.

DURATION

At most, two (2) hours.

CONTENT AND ACTIVITY PLAN

Topics to be covered:

- SIMPLE as a planning and management framework
- GIS as a tool for decision making
- Importance of GIS relative to the implementation of SIMPLE

Procedure:

i. Prepare and present a PowerPoint which provides a detailed but succinct description of SIMPLE as a planning and management framework. It has to be emphasized that some of the participants to the training are most likely technical personnel who have limited exposure to the field of physical and development planning. It therefore follows that care must be taken in the preparation of the PowerPoint presentation and even during lecture discussion that concepts and principles are explained in a way that can easily appreciated by the participants;

ii. This is to be followed by an introduction on Geographic Information System (GIS) and its role in facilitating the process of land and water use planning and development;

iii. A video presentation may follow demonstrating the use of GIS in physical and development planning;

iv. Finally, PowerPoint slides will be presented situating the role of GIS in the entire SIMPLE framework and explaining the types of information that can be processed and generated using GIS.

SUGGESTED METHODOLOGY

PowerPoint Presentation; Video Presentation.
Lecture-Discussion method

RESOURCES NEEDED

- Laptop computer, LCD projector and screen
- Videos on GIS and its sample applications
- Hand-outs and photocopies of printed materials and documents

REFERENCES

Deutsche Gesellschaft fur Internationale Zusammenarbeit (GIZ).2010.Sustainable Integrated Management and Planning for Local Government Ecosystems (SIMPLE). Facilitators Guidebook.Manila.GIZ

Housing and Land Use Regulatory Board.2007.CLUP GIS Guidebook. A Guide to Comprehensive Land Use Data Management. Quezon City. HLURB

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Understanding GIS and Its Role in Land Use and Development Planning

OVERVIEW

The increasing use and application of Geographic Information Systems (GIS) in the field of Land Use and Development Planning emanates from the need to have better and more reliable information for informed decision-making. Planning, in whatever form, scale, and dimension undertaken, requires a significant amount of data and information to support the analysis of the existing situation, formulate development goals, objectives and targets, and identify, evaluate, and select spatial strategies. In addition, land use and development planning also covers other critical aspects aside from the usual plan formulation/making, and these include general development administration and development control and management. These aspects of physical and development planning requires a specific mechanism that would allow for the effective processing, analysis, and visual presentation of information to facilitate active discussions with stakeholders and guide officials in making policy decisions. These mechanisms fall within the ambit of GIS. GIS is considered as one of those formalized computer based information systems that has the inherent capability to process a multitude of data from various sources in order to provide strategic information for decision-making.

OBJECTIVES

By the end of this session, the participants shall be able to:

i. Understand the rationale and the objectives of undertaking land use and development planning by the local government units;
ii. Appreciate the history of the development of GIS and its close relationship with physical and development planning;
iii. Take cognizance of the use of GIS as a support system for land use and development planning; and
iv. Recognize the many dimensions, functions, scales, sectors, and stages of land use and development planning and the role that GIS plays in each of these aspects;
v. have insight in the role of maps in planning

DURATION

At most, two (2) hours.

CONTENT AND ACTIVITY PLAN

Topics to be covered:

i. Nature, rationale, and basis of land use and development planning
ii. Use and functions of GIS in support of land use and development planning; and
iii. Role of GIS in the different dimensions and functions of land use and development planning.

Procedure:

i. Prepare PowerPoint presentation providing a brief and basic information on the basis of land use and development planning. Information may be culled from the 1991 Local Government Code including an elaboration of the dual role of LGUs as a body politic and body corporate. From these information, one can easily generate the primary goals and objectives of land use and development planning;
ii. Discuss GIS and its contribution to the development of the physical and development planning field. Describe the practice of planning prior to the onset of computer-based information system, particularly the use of paper maps in depicting base and thematic maps for land use planning. Explain also the process of land use and suitability analysis using the hand drawn map overlay technique and how the process has evolved into a computer-based geographic information system;
iii. Present and explain the different functions and technical contributions of GIS in local development planning. These include spatial tool-box for physical planning and database management. GIS as a spatial tool box provides planners and local technical staff to undertake spatial analysis functions such as map overlay analysis, connectivity, and buffer. Database management function allows for the storage of spatial and attribute data and links these two vital information sources using geo-relational models;
iv. The final part of the presentation centers on the role of GIS vis-à-vis dimensions and functions of land use and development planning. GIS and its various functionalities are relevant not only in terms of its contribution to the formulation of the plan itself but also in the areas of general development administration and development control. Examples include management of land use records, building permit application, land use monitoring, locational clearance application, land availability, etc.

SUGGESTED METHODOLOGY

- PowerPoint Presentation
- Lecture-Discussion

RESOURCES NEEDED

- Laptop/desktop computer, LCD projector and screen;
- Hand-outs and photocopies of printed materials and documents.

REFERENCES

Housing and Land Use Regulatory Board.2007.CLUP GIS Guidebook. A Guide to Comprehensive Land Use Data Management. Quezon City.

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Galido-Isorena, Trina (2009) -Mapping Guidebook 1: Guidelines in Preparing and Analyzing Maps for Forest Land Use Plan. Published with assistance from the American people through the U.S. Agency for International Development's (USAID) Philippine Environmental Governance (EcoGov) project.

Wikipedia – Geographic Information System
http://en.wikipedia.org/wiki/Geographic_information_system

What is Geographic Information System (GIS)?

OVERVIEW

This Session will give you a theoretical background of GIS and therefore you may call this "GIS minus the computer". This background will help you in better understanding the concepts of GIS and by that you will be able to use the system to it full capacities. Since you will not be using the computer for now, there will be no difficulty as in having to know and remember specific commands and instructions from the software.

There will be exercises that will focus on the core principles of GIS that when taken apart and discussed one by one, are actually not that complex. If you have an understanding of these principles then it will be easier for you to design your own GIS analysis and know what you can do, and what you cannot do with your data.

This Session will start with a short introduction on what GIS is and will continue with the different elements of GIS.

OBJECTIVES

At the end of the session, the participants are able to:

1. describe a GIS in conceptual terms and can define the different elements of GIS;
2. describe the difference between confusing terms such as GIS, GPS, CAD and RS;
3. draw insight in the most important data types in GIS;
4. obtain insight in some of the most used GIS packages;
5. gain insight in possible uses of GIS in LGU's worldwide;
6. know how a GIS works through the layer model,
7. describe the most important data types of GIS data, raster, vector, surface image
8. know the difference between geographic and attribute data and have knowledge on the importance of the connection between these

CONTENT AND ACTIVITY PLAN

1. Introduction: Getting to know each other
2. Expectations
3. Movie
4. Topics for discussion:
   - What is GIS?

- Elements of GIS
- GIS as a Tool
- Confusion
- GIS software
- How GIS works
- The Connection between map and Database
- Summary

5. Wrap-up and Synthesis

What is GIS?

What is GIS?

GIS stands for **Geographic Information System** or a program that can combine a variety of mapping and editing functions together with database capability. Although for many people, GIS appears to be new, GIS has been around for about thirty years, but only recently have GIS applications appeared on desktop machines. Manifold® System was deliberately created to focus exclusively on Wintel (Windows – Intel) PCs and laptops, to leverage mass-market standards like Microsoft scripting languages and Windows interfaces, and to attack sleepy traditional markets with a mix of very high performance and very low cost.

A GIS can be seen as a word processor for maps in the same way you can use Microsoft Office Word to create elaborate text documents. In both cases, you can create new items, you can edit existing items, and you can import items already created from other documents. A GIS allows us to:

- Import existing maps from many different file formats.
- Create new maps, and edit existing maps. This includes adding new items to a blank map, or to change the shape and position of items already in the map or delete items from a map.
- Change the appearance of items in a map by changing their formatting.

You can also do more with GIS such as:

- You can specify the geographic location of the map and the items in it.
- Link the items in the map to a database table. This allows the graphics in the map to act like visual "handles" to reach into the database.
- Process the data and visual items in a map to create new items or to analyse the data. For example, you might create a "buffer zone" that shows all regions within 100 meters of a road or stream, or you might automatically add up populations of a given species of tree within a set of tree stands in a forestry application.

Because you can link the items on the map to the database, you can create intelligent maps and have them positioned at the exact right location of the earth. For example, you can imagine that you have a map with streets which is linked to a database which has for each street a record in a database table that would have fields storing the name of the street,

when it was last paved, what paving material was used and so on. Now, using our GIS, with you could find all streets within a mile of a given location that have been repaved in the last three months and then you could sort the database records for those streets by which street was most recently repaved. You could use Standard Query Language (SQL) to find all the streets in the map that were last paved with concrete and highlight them in the drawing. You could automatically calculate our costs for different time periods when paving will be necessary in the future. Once the system has a handle on both visual appearance and shape, location and database information the possibilities are virtually endless.

A GIS can work with many different maps. Just as you can use Microsoft Office Word to open any document in a file format understood by Word, you can use GIS to open maps saved in any file format understood by the GIS. You can create our own maps and you can save them for later use or you can use maps created by others. This is a very good thing since the whole process of creating maps from scratch can be a big and expensive project. In many cases you will find that the maps you need may exist somewhere else, in the internet or with other organizations. You can then use GIS to change that map, format it with the standard colours, add new features, combine it with other maps, or cut and paste features from the map into other maps. Editing and cutting and pasting are a lot easier than creating something from scratch.

An atlas is a collection of maps; usually of the earth or a region of earth and they are usually into book form but today many atlases are in multimedia formats as well. In addition to presenting geographic features and political boundaries, many atlases often feature geopolitical, social, religious and economic statistics. They also have information about the map and places in it. (Wikipedia). In an atlas all maps are static. They have their set colours, coding themes etc. which, as a user, you can see, but not alter. In contrast, a GIS can be used to view many different maps from many different sources and create entirely new maps or to edit and combine existing ones. GIS is an active system. This is one of the major differences between a true GIS program and an atlas program.

There is an increasing trend to use the term geospatial instead of GIS. What is the difference between geospatial and GIS? Although some may use the terms geospatial and GIS interchangeably, there is a distinctive difference between the two. GIS refers more narrowly to the traditional definition of using layers of geographic data to produce spatial analysis and derivative maps. Geospatial is more broadly use to refer to all technologies and applications of geographic data. For example social media sites such as Facebook allow us to "check-in" at specific places, or, that allow us to geographically tag their statuses. While those

applications are considered to be geospatial, they don't fall under the stricter GIS definition.

Other quotes to answer "*What is GIS*?"

"In the strictest sense, a GIS is a computer system capable of assembling, storing, manipulating, and displaying geographically referenced information, i.e. data identified according to their locations. Practitioners also regard the total GIS as including operating personnel and the data that go into the system." USGS

“A geographic information system (GIS) is a computer-based tool for mapping and analysing things that exist and events that happen on earth. GIS technology integrates common database operations such as query and statistical analysis with the unique visualization and geographic analysis benefits offered by maps." ESRI

"GIS is an integrated system of computer hardware, software, and trained personnel linking topographic, demographic, utility, facility, image and other resource data that is geographically referenced." NASA

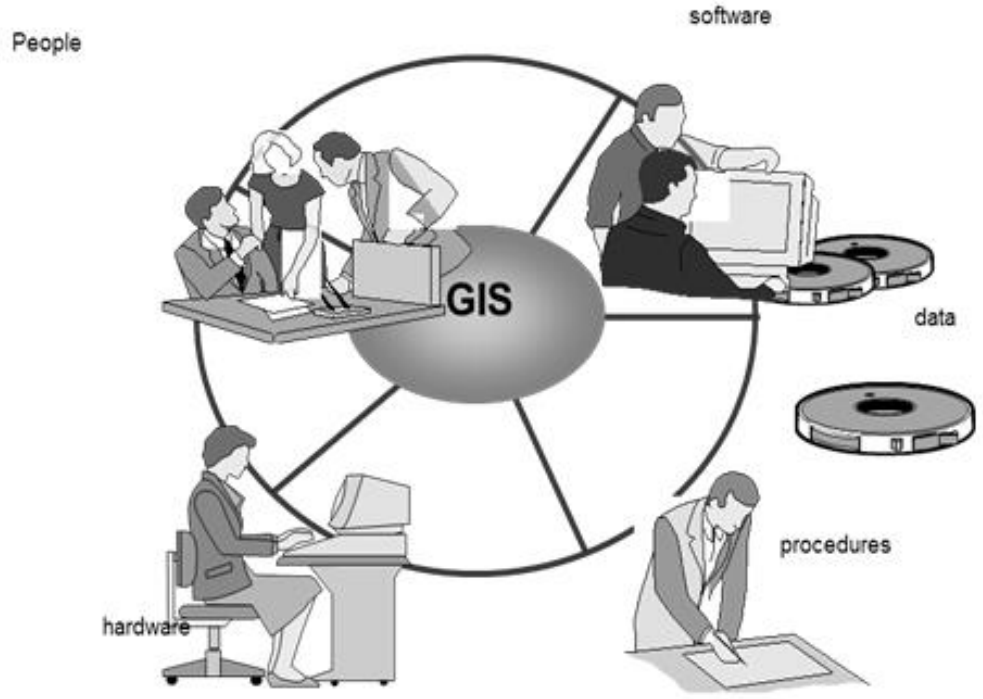
Elements of GIS

Elements of GIS

The next step in understanding GIS is to look at each area of GIS and how they work together. These components are:

- Hardware
- Software
- Data
- People
- Procedures

Together these elements form a working network that can be called GIS. In the following picture this is symbolized where GIS forms the core of the wheel and the different elements form the spokes that enable the wheel to function. If one or more of these elements are under developed (or not present), the GIS wheel will have a hard time in turning. The elements of a successful GIS will be described in the following paragraphs.



Hardware

Hardware comprises the equipment needed to support the many activities of GIS ranging from data collection to data analysis. The central piece of equipment is the workstation, which runs the GIS software and is the attachment point for ancillary equipment. Data collection efforts can also require the use of a digitizer or a scanner for conversion of hard

copy data to digital data and a GPS unit to collect data in the field. The use of handheld field technology is also becoming an important data collection tool in GIS.

Software

Different types of software are important for GIS. Central to this is the GIS application. Such software is essential for creating, editing and analysing spatial and attributes data; therefore these packages contain a myriad of GIS functions. Extensions or add-ons are software components that extend the capabilities of the GIS software package. Component GIS software is the opposite of application software. Component GIS seeks to build software applications that meet a specific purpose and thus are limited in their spatial analysis capabilities. Utilities are either stand-alone programs or plug-ins that performs a specific function. For example, a file format utility that converts from on type of GIS file to another. There is also web based GIS software that helps serve data and interactive maps through Internet browsers.

Data

Data is the core of any GIS. There are two primary types of spatial data that are used in GIS: vector and raster data. Vector data is spatial data represented as points, lines and polygons. Raster data is cell-based data such as aerial imagery and digital elevation models. Coupled with this data is usually data known as attribute data. Attribute data generally defined as additional information about each spatial feature housed in tabular format. The spatial data describe where the feature is located while the attribute data describe what it is. Documentation of GIS datasets is known as metadata. Metadata contains such information as the coordinate system, when the data was created, when it was last updated, who created it and how to contact them and definitions for any of the attribute data.

People

Well-trained GIS professionals knowledgeable in spatial analysis and skilled in using GIS software are essential to the GIS process. There are three factors to the people component: education, career path, and networking. The right education is the key; taking the right combination of classes. Selecting the right type of GIS job is important. A person highly skilled in GIS analysis should not seek a job as a GIS developer if they haven't taken the necessary programming classes. Finally, continuous networking with other GIS professionals is essential for the exchange of ideas as well as a support community.

Procedures

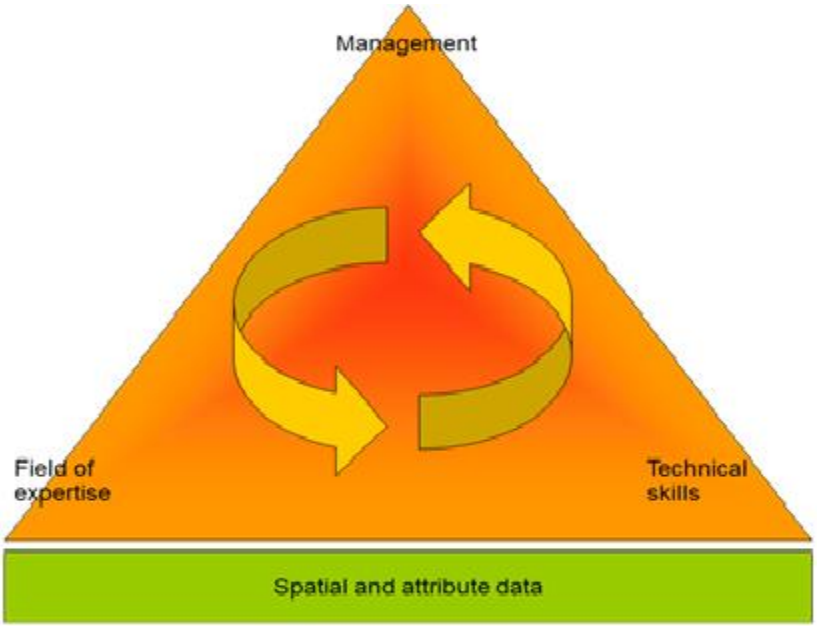
In every organization there are procedures which should be followed to ensure the quality and the status of the work done. GIS is not different in this. Also at points where this is not apparent at first, it is important to describe procedures and stick to them. For instance we would like to follow the same procedures and classify the same elements when doing

a survey of features in a barangay. If all barangays will be surveyed in a different way, the results may vary greatly within one municipality. Also for data that may have legal or financial consequences (CLUP, tax mapping) procedures may be of great help.

GIS as a Tool

GIS as a Tool

In most of our work, GIS is not a goal in itself, but a tool to be used to solve problems with a spatial content. Since the problems on our world are often complex, a GIS user needs to be able to combine his or her field of expertise with the technical skills of GIS, both software and concepts. These skills should be founded on a solid understanding of geographical and attribute data. Additional value can be obtained if the GIS expert is able to translate problems, proposals and policies into a step by step GIS approach and present the answers (or elements for discussion) using maps, tables and graphs. This process can be visualized as follows:



As with all skills, these are best learned by doing, so therefore we propose to have a number of exercises and examples in the toolkit which range from step by step exercises to more complex questions where only an approach and necessary data will be given.

With this in mind, typical GIS questions can be defined in terms of their location on our earth:

Using a GIS you can find do many things related to the space around us:

- Find geographic features. You can search a GIS database to find point, line, area, and surface features by their descriptions or measurements and then you can measure them based on their lengths, widths, areas, and volumes, and compare sizes from one feature to another.

- Group geographic features and define their distributions based on how much space they use, how close they are to each other, and where they are relative to other features.

- Calculate all sorts of statistics on your geographic features from the simplest descriptive statistics (for example, mean, median, and mode) to very complex spatial statistics in order to report on the features.

- Find routes based on time, distance, or other factors. You can route buses to reach the maximum number of people and use this population density information to locate stores near your customers.

- Compare map layers. You can compare the locations of features from one map layer (or theme) to another. This powerful feature helps you overlay the layers, and shows you the relative location of features from one layer to another.

Confusion

When we are talking about geographic data and planning, there is sometimes some confusion with respect to terms as GIS and GPS (Global Positioning System), RS (or Remote Sensing) and CAD (Computer Aided Design). Some characteristics of these terms will be explained in the following paragraphs.

GPS

The Global Positioning System (GPS) is a space-based satellite navigation system that provides location and time information in all weather, anywhere on or near the Earth, where there is an unobstructed line of sight to four or more GPS satellites. It is maintained by the United States government and is freely accessible to anyone with a GPS receiver. The GPS program provides critical capabilities to military, civil and commercial users around the world. In addition, GPS is the backbone for modernizing the global air traffic system.

In addition to GPS, other systems are in use or under development. The Russian Global Navigation Satellite System (GLONASS) was in use by only the Russian military, until it was made fully available to civilians in 2007. There are also the planned European Union Galileo positioning system, Chinese COMPASS navigation system, and Indian Regional Navigational Satellite System (IRNS). More on GPS will be given in Session 3.

Remote Sensing

Remote Sensing (RS) is the acquisition of information about an object or phenomenon, without making physical contact with the object. In modern usage, the term generally refers to the use of aerial sensor technologies to detect and classify objects on Earth (both on the surface, and in the atmosphere and oceans) by means of propagated signals (e.g. electromagnetic radiation emitted from aircraft or satellites).

There are two main types of remote sensing: passive remote sensing and active remote sensing. Passive sensors detect natural radiation that is emitted or reflected by the object or surrounding areas. Reflected sunlight is the most common source of radiation measured by passive sensors. Examples of passive remote sensors include film photography, infrared, charge-coupled devices, and radiometers.

Active collection, on the other hand, emits energy in order to scan objects and areas whereupon a sensor then detects and measures the radiation that is reflected or backscattered from the target. RADAR and LiDAR are

examples of active remote sensing where the time delay between emission and return is measured - establishing the location, height, speed, and direction of an object.

CAD

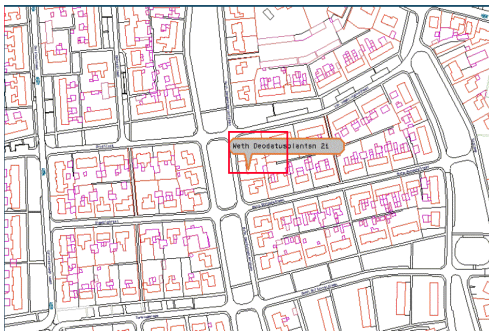
Computer Aided Design (CAD), also known as computer-aided design and drafting (CADD), is the use of computer systems to assist in the creation, modification, analysis, or optimization of a design. Computer-aided design describes the process of creating a technical drawing with the use of computer software. CAD software is used to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and to create a database for manufacturing. CAD output is often in the form of electronic files for print or machining operations. CAD software uses either vector based graphics to depict the objects of traditional drafting, or may also produce raster graphics showing the overall appearance of designed objects. CAD often involves more than just shapes. As in the manual drafting of technical and engineering drawings, the output of CAD must convey information, such as materials, processes, dimensions, and tolerances, according to application-specific conventions. CAD may be used to design curves and figures in two-dimensional (2D) space; or curves, surfaces, and solids in three-dimensional (3D) space. (Wikipedia)

Traditionally CAD is strong in design, but not so strong in analysis which is strength of GIS. However with recent developments in software and databases these differences are getting smaller. In normal use a GIS will be used to an analysis (for instance building site selection) and then CAD will be used to design the building.

GIS examples all over the world:

Example Increasing Government Revenues

In most countries there is a tension between the government that wishes to collect the right amount of real property tax and the owners of properties who would like to expand their properties without the added burden of paying more tax and/or applying for the correct permits. This example from the Netherlands will demonstrate how the use of GIS and aerial images can be used to monitor where there are undocumented extensions to buildings.

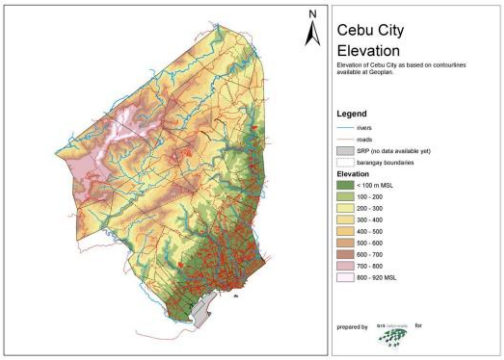


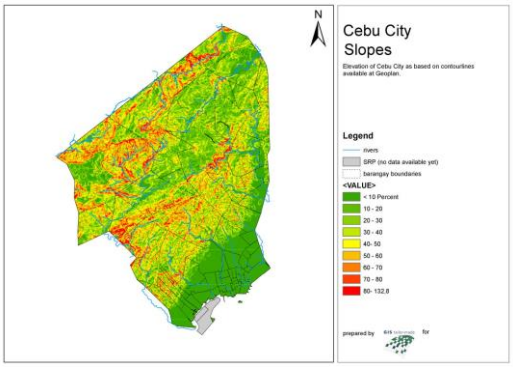
The start is a city base map which shows the buildings and lots in purple and orange and municipal properties (roads, sidewalks) in black. When this map is overlaid with a high resolution aerial photograph, it shows the extent of the building footprint (as known by the Office of the Building Official), in combination with the actual size of the building. Using these two images, the situation can be compared (the building footprints have been made yellow for better visibility). The extent of the undocumented expansion to the building is now measured and since the owner of the property is known, records in City hall can be checked and if desired, the owner will be invited to offer an explanation and may be requested to pay additional taxes.

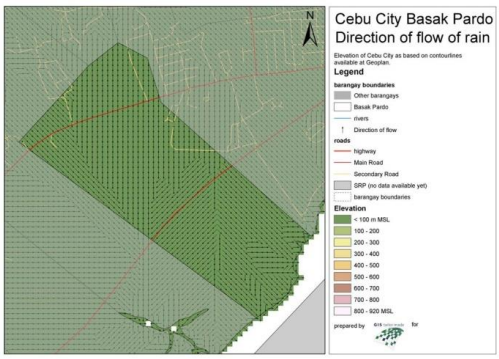
Even though this example comes from the Netherlands and focuses on the building footprints. The same method can be used in the Philippines to determine where people are encroaching on government property or, especially in subdivisions, see where people have been improving their property without the right permits.

Example terrain modelling

For Cebu City the elevations are known as they are digitized from the topographic maps. The first image shows the elevation of the City, low lying at the coastal zone and high in the mountains. IF the elevations are known and available in raster format, then a GIS can also calculate the slope at each given location.







The second image gives an indication of the steepness of the slopes. The steepness is indicated from green (flat) to red (very steep). Steep and very steep slopes can pose a hazard for development and habitation. Sadly enough, in a highly urbanized area these areas are also intensively used and accidents happen. It should be considered whether or not these areas are suitable for development and if so, under which conditions. After calculating the slope, it is also possible to calculate the orientation of the slope (north, east etc.). With these two data combined, it is possible to derive the natural flow of rain water down the slopes as is shown with the small areas in the third picture. These natural flow paths give a good indication of flood hazard

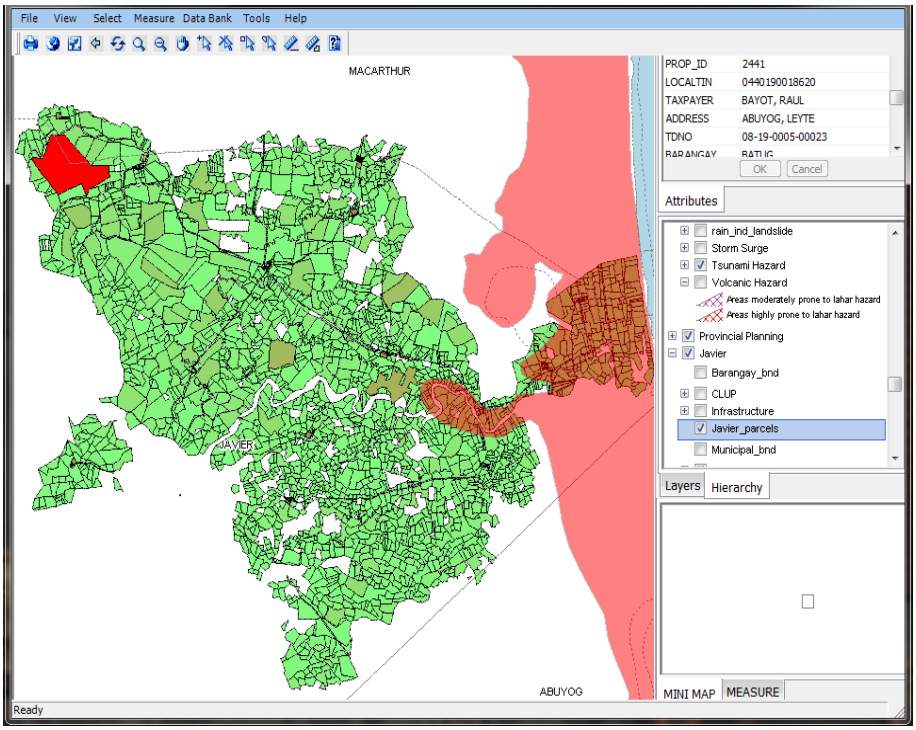
Example fire hazard mapping

In many urban areas in the Philippines there is a recurring hazard of fires, especially in urban poor areas. These areas are often characterized by the use of light, highly flammable materials and the absence of wide roads. This means that in case of fire, the fire trucks often do not have access to all the areas to put out the fires. In this example we assume that the fire trucks are limited to the main roads (red) and that they have an operational reach of 50 meters.

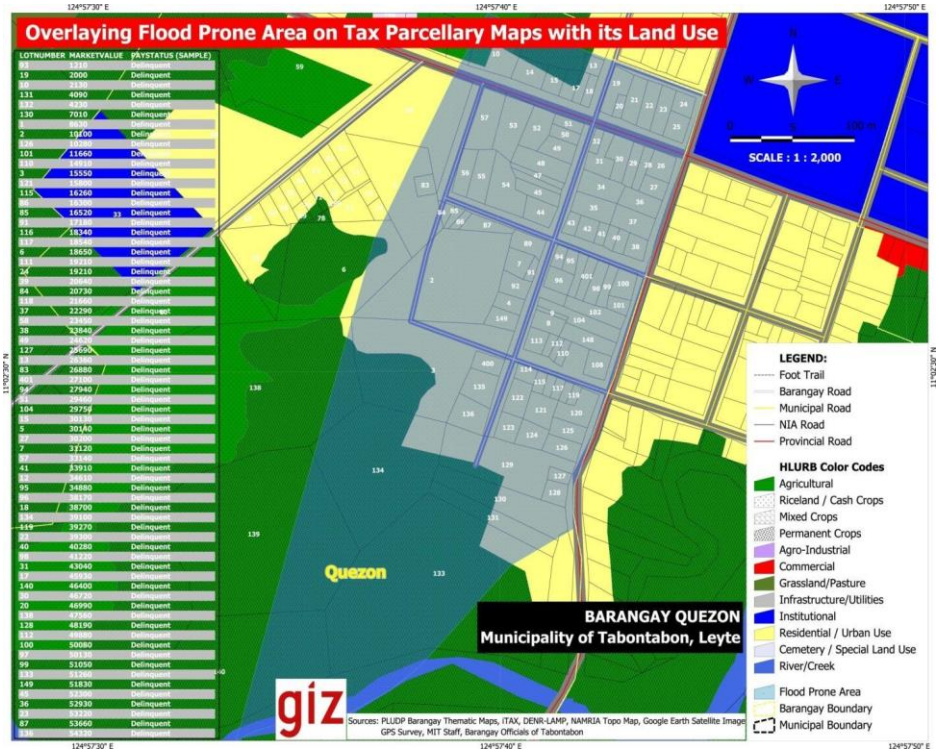
The yellow zones show those areas where a fire can be put out from the main roads. The other areas cannot be reached and other measures (like fire hydrants) are necessary.

Example hazard mitigation

This example shows how real property data can be overlaid with natural hazard maps to give an indication for the susceptibility to natural hazards. The image from the Provincial Map Viewer shows the assessed market values (test data) in combination with the tsunami hazard. This gives the City planner an indication of the possible economic damage in case of a tsunami

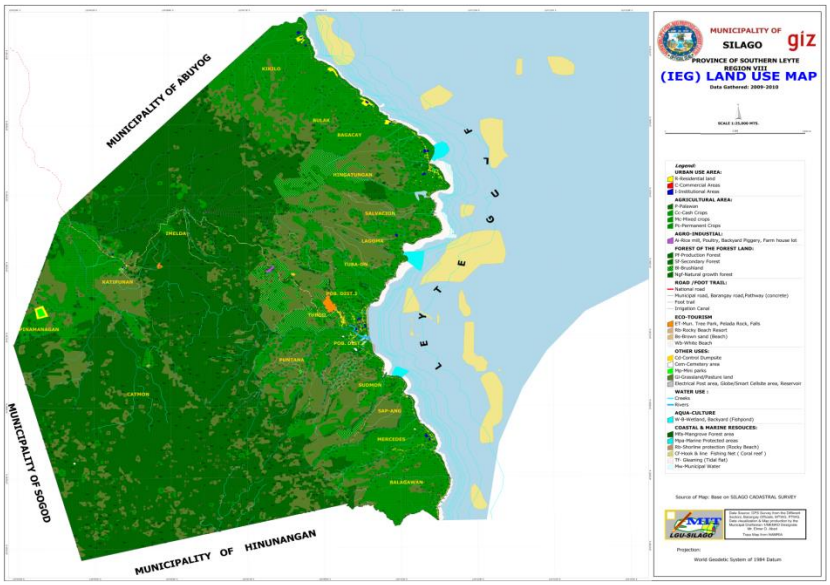


This image gives similar information, but in more detail. Here a parcel map with land use information is combined with a flood map



Example Land use plan

This map shows the comprehensive land use plan for Silago (Southern Leyte)



GIS software

There are many GIS software packages in the world and many of them are used in the Philippines as well. This paragraph wants to give you short background information on some of the most used GIS software.

Arcview 3.x

ArcView 3.x was a geographic information system software product produced by ESRI. It was replaced by ArcGIS in 2000 and is no longer available ArcView started as a graphical program for spatial data and maps made using ESRI's other software products. Over time more and more functionality was added to ArcView and it became a real GIS program capable of complex analysis and data management. Its simple user interface was preferred by many over the less user friendly, more powerful ARC/INFO. Although ArcView was relatively easy to use, it had some limitations as the difficult procedures with projections and its own programming language.

ArcGIS

ArcGIS is the flagship from ESRI, recognized as the leader in GIS software. It's been estimated that about seventy per cent of GIS users use ESRI products. In addition, ESRI has developed plug-ins called extensions which add to the functionality of ArcGIS. Demo and light versions of ESRI software are available for downloading. You can also find free data to use with ESRI products. A big disadvantage of the ESRI products for the Philippines is the pricing of the licenses which is very high. (The price in the U.S. is around USD 1500 for the simplest version)

Manifold System GIS

Manifold System provides affordable comprehensive, professional grade GIS software that includes a very wide array of features. Manifold System imports data from over 80 different GIS formats, including all formats used by Federal government sites for free Internet downloads, and Manifold System allows seamless, simultaneous work with vector drawings, raster images, terrain elevations and raster data sets either as 2D displays or 3D terrain visualizations. Manifold System includes exceptional DBMS

capabilities, full development facilities and includes a built-in Internet Map Server for fast and easy publication of GIS projects to the web without programming. (Manifold can be obtained for USD 295.)

MapWindow GIS

The MapWindow GIS 4.x application is a free open source, extensible geographic information system (GIS) that can be used in many ways:

- As an open-source alternative desktop GIS
- To distribute data to others
- To develop and distribute custom spatial data analysis tools.

MapWindow includes standard GIS data visualization features as well as DBF attribute table editing, editing, and data converters. Dozens of standard GIS formats are supported, including Shapefiles, Geo-TIFF, ESRI Arc-Info ASCII and binary grids. MapWindow is more than just a data viewer. It is an extensible geographic information system. This means that advanced users or developers can write plug-ins to add additional functionality (models, special viewers, hot-link handlers, data editors, etc.) and pass these along to any number of the users clients and end users.

Quantum GIS

Quantum GIS (QGIS) is a powerful and user friendly Open Source Geographic Information System (GIS) that runs on Linux, Unix, Mac OSX, Windows and Android. QGIS supports vector, raster, and database formats. QGIS is licensed under the GNU Public License. It offers. For many of the advanced raster operations it is dependent on the integrated GRASS GIS.

Using plug-ins a whole range of official and community developed extra functionality is available. Customizing of QGIS is done using Python scripts.

Why Manifold System?

All software is subject to changes and development, but at this time GIZ in the Philippines made a choice for Manifold System GIS because:

- It is much cheaper than the ESRI ArcGIS or ArcView products but offers the same or even more GIS functionality;
- Easy to learn and most calculating extensions are already built-in unlike ESRI were you have to order extensions at a very high cost;
- ESRI GIS files can be imported into Manifold System and also GIS files within Manifold System can be exported to any GIS software file type (ex. Shapefiles, CAD drawings, etc.);
- Manifold System can download GPS data directly and does not need third party software to do the downloading task;
- Google Earth data (*.kml / *.kmz) can be imported into Manifold System and also drawings within Manifold System can be exported to Google Earth for visualization and verification of the data;
- Has a built-in query tool that can to certain calculations (for programmers);
- Good database/attribute table capabilities;
- Good in 3D-Modelling for surfaces and terrains;
- The Manifold Project map file contains all data stored, such as drawings, tables, images, queries, scripts, etc.;
- Government agencies as NAMRIA and DENR's Land Administration and Management Project (DENR-LAMP) use Manifold System for data synergy;

How GIS works

The layer model

It is not easy to put our surroundings in a computer. You need to transform the complexity of our environment into a model and a language that computers can comprehend. You can do this by means of spatial data modelling:

"The process of defining and organizing data about the real world into a consistent digital dataset that is useful and reveals information" (Goodchild, 1992)

The model is a simplified representation of only those features that are of importance to the user. For instance in the following picture you see an image of the world that has been organized (or dissected) into layers. Each layer represents a specific type of information about the world that is important to us in our GIS project.

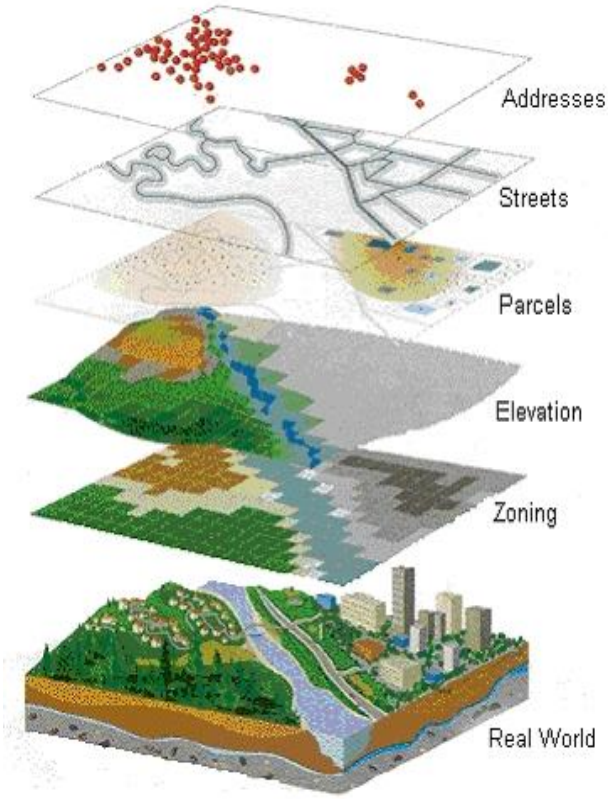


Figure 1: the GIS layer model (ESRI)

In this example you can find information on zones, elevation, parcels, rivers and addresses. Please note that the layers you are not necessary visible in the real world. An example is the zoning information in the example above, but you can also think of barangay and municipal boundaries etc. Within a GIS every description of the environment has two different types of spatial or geographic information attributes (where is the object situated) and non-spatial attributes or descriptive attributes. These attribute data describe the features on the map (the geographic data). Only if both spatial and non-spatial attributes are available, you can perform a useful analysis in a GIS.

The model is a simplified representation of only those features that are of importance to the user

Types of GIS data

Vector and raster are the two basic data structures for storing and manipulating geographic data on a computer.

Vector data comes in the form of points, lines and polygons that are geometrically and mathematically associated. Points are stored using the coordinates, for example, a two-dimensional point is stored as (x, y). Lines are stored as a series of point pairs, where each pair represents a straight line segment, for example, (x1, y1) and (x2, y2) indicating a line from (x1, y1) to (x2, y2).

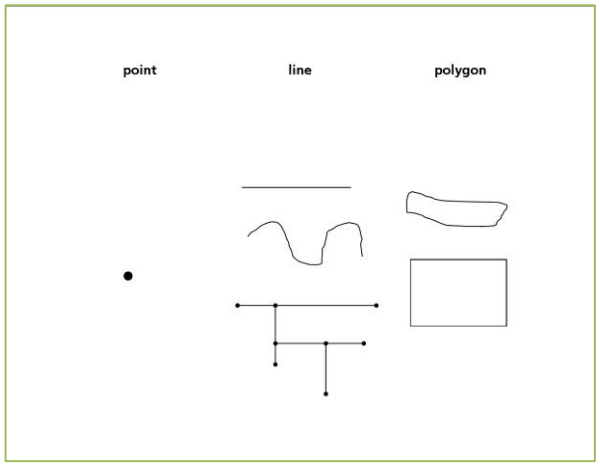
Raster images come in the form of individual pixels, and each spatial location or resolution element has a pixel associated where the pixel value indicates the attribute, such as colour, elevation, or an ID number. Each pixel or cell also has a specific size. When increasing the spatial resolution by 2 times, the total size of a two-dimensional raster image will increase by 4 times because the number of pixels is doubled in both X and Y dimensions. The same is true when a larger area is to be covered when using same spatial resolution.

In general, vector data structure produces smaller file size than raster image because a raster image needs space for all pixels while only point coordinates are stored in vector representation. This is particularly true in the case when the graphics or images have large homogenous regions and the boundaries and shapes are the primary interest. Vector data is also easier to handle on a computer because it has fewer data items and it is more flexible to be adjusted for different scale, for example, a projection system in mapping application. This makes vector data structure the apparent choice for most mapping applications. For many data entry processes (scanning, Remote Sensing etc.), raster data are the prime solution, so in a GIS we have to work with both.

Point

The first thing you need to realize when talking about point features is that what you describe as a point in GIS is a matter of opinion, and often dependent on scale. Let's look at cities for example. If you have a small scale map (which covers a large area), it makes sense to represent a city using a point feature. However as you zoom in to the map (moving towards a larger scale) it makes more sense to show the city limits as a polygon which has an area.

When you choose to use points to represent a feature is mostly a matter of scale (how far away are you from the feature), convenience (it takes less time and effort to create point features than polygon features), and the type of feature (some things like electricity posts just don't make sense to be stored as polygons).



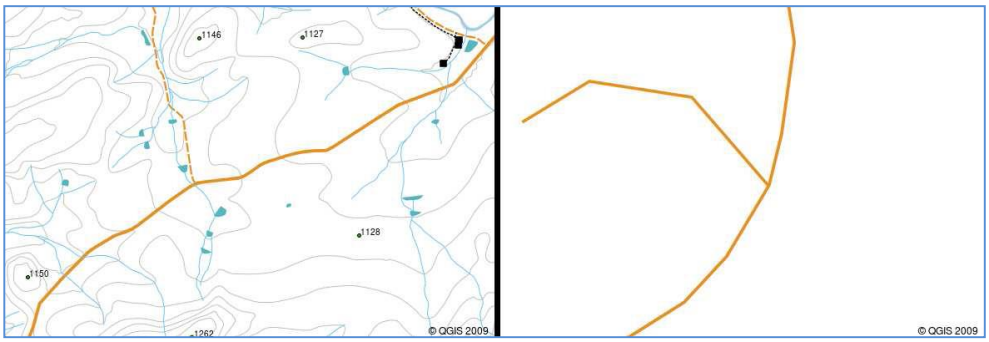
As shown in the Illustration above, a point feature has an X, Y and optionally, Z value. The X and Y values will depend on the **Coordinate Reference System** (CRS) being used. You are going to go into more detail about Coordinate Reference Systems in Session 3. For now let's simply say that a CRS is a way to accurately describe where a particular place is on the earth's surface. One of the most common reference systems is **Longitude and Latitude**. Lines of Longitude run from the North Pole to the South Pole. Lines of Latitude run from the East to West. You can describe precisely where you are at any place on the earth by giving someone your Longitude (X) and Latitude (Y). If you make a similar measurement for a tree or a telephone pole and marked it on a map, you will have created a point feature. Since you know the earth is not flat, it is often useful to add a Z value to a point feature. This describes how high above sea level you are (or for instance how high a telephone post is).

Line

Where a point feature is a single vertex, **a line has two or more vertices**. The line is a continuous path drawn through each vertex, as shown in Illustration 3 above). When two vertices are joined, a line is created. When more than two are joined, they form a 'line of lines', or **line**. A line is used to show the geometry of **linear features** such as roads, rivers, contours, footpaths, flight paths and so on. Sometimes you have special rules for lines in addition to their basic geometry. For example contour lines may touch (e.g. at a cliff face) but should never cross over each other. Similarly, lines used to store a road network should be connected at intersections. In some GIS applications you can set these special rules for a feature type (e.g. roads) and the GIS will ensure that these lines always comply with these rules. If a curved line has very large distances between vertices, it may appear **angular** or jagged depending on the scale at which it is viewed (see the figure below). Because of this it is important that lines are digitized (captured into the computer) with distances between vertices that are small enough for the scale at which you want to use the data.

The **attributes** of a line describe its properties or characteristics. For example a road line may have attributes that describe whether

it is surfaced with concrete or asphalt, how many lanes it has, whether it is a one way street, and so on. Manifold System can use these attributes to display the line feature with a suitable colour or line style.



From QGIs: an easy introduction into GIS

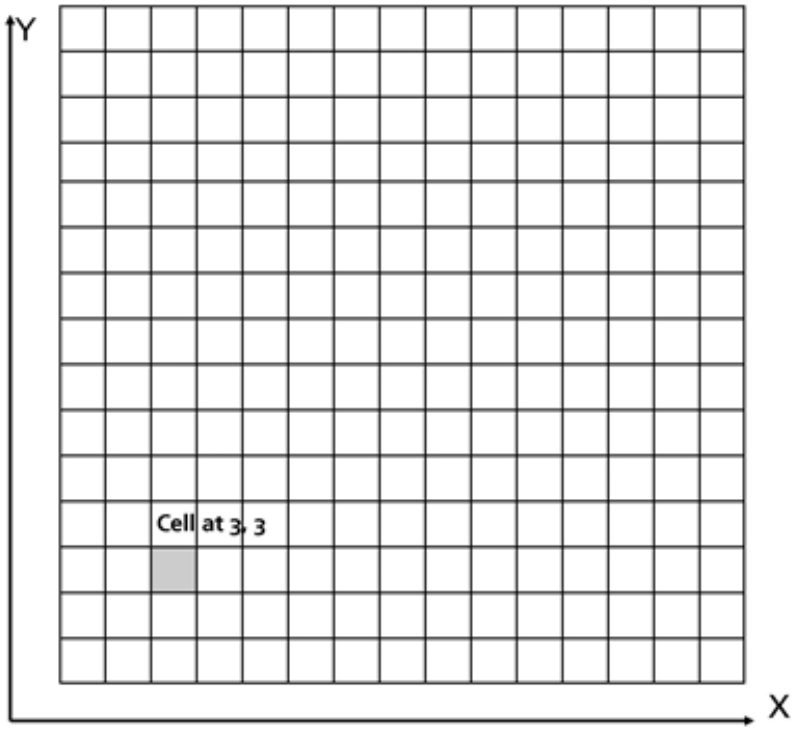
Polygon

Polygon features are enclosed areas like lakes, islands, administrative boundaries and so on. Like line features, polygons are created from a series of vertices that are connected with a continuous line. However because a polygon always describes an enclosed area, the first and last vertices should always be at the same place! This has also as consequence that you can calculate and use the area and perimeter of polygons. Points have (by definition) no dimensions and from lines you can only calculate the length. Polygons often have shared geometry - boundaries that are in common with a neighbouring polygon. If you look at real property maps, one part of the polygon is the boundary of both its own as well as its neighbouring lot.

In Manifold System you have the capability to ensure that the boundaries of neighbouring polygons exactly coincide. You will explore this later in Session 4. As with points and lines, polygons have attributes to describe each polygon. For example a map with barangay boundaries may have attributes for its name, population, etc.

Raster

In the previous paragraphs you have taken a closer look at vector data. While vector features use geometry (points, lines and polygons) to represent the real world, raster data takes a different approach. Rasters are made up of a matrix of pixels (also called cells), each containing a value that represents the conditions for the area covered by that cell (see Figure on next page). Every cell has the same size. In this topic you are going to take a closer look at raster data, when it is useful and when it makes more sense to use vector data.



A raster dataset is composed of rows (running across) and columns (running down) of pixels (also known as cells). Each pixel represents a geographical region, and the value in that pixel represents some characteristic of that region.

Raster data is used in a GIS application when you want to display information that is continuous across an area and cannot easily be divided into vector features. In exercise 1.1 we showed you a Google map image and asked you to identify Point, line and polygon features. There are however other features that have no clear boundaries and these are difficult to map put in discrete units. Think for instance on elevations. On a slope every millimetre may have a different height. Drawing a boundary around this is very difficult. You can draw a line around a single elevation (for instance between 10 and 20 meters MSL) but all the info on elevation in between would be lost in the process of simplifying the features to a single polygon. This is because when you give a vector feature attribute values, they apply to the whole feature, so vectors aren't very good at representing features that are not homogeneous (entirely the same) all over or that do not have discreet boundaries. Another approach you could take is to digitize every small variation of height and cover as a separate polygon. The problem with that approach is that it will take a huge amount of work in order to create a good vector dataset.

Using raster data is a solution to these problems. Many people use raster data as a backdrop to be used behind vector layers in order to provide more meaning to the vector information. The human eye is very good at interpreting images and so using an image behind vector layers, results in maps with a lot more meaning. Raster data is not only good for images that depict the real world surface (e.g.

satellite images and aerial photographs); they are also good for representing more abstract ideas.

For example, rasters can be used to show rainfall trends over an area, or to symbolize the fire risk on a landscape. In these kinds of applications, each cell in the raster represents a different value e.g. fire hazard on a scale of one to ten.

An issue with rasters is that the more you zoom in, the more difficult the image will be to interpret (same as if you zoom in too much in your digital photo).

Similar as to the vector data, raster data comes in many forms and shapes and under different names. For instance an image, usually used as a digital photo or element from Remote Sensing, is basically a raster dataset

Exercise 1.1

The layer principle and line, point, and polygon data

Summary

At times it can be confusing when to use vector and when to use raster data. There may be instances when there is no choice. If satellite images are purchased or a paper map is scanned,, the data are always in raster form. These can be used as basis for tracing and drawing vector data. Also Manifold System has options to convert vector to raster and vice-versa.

Method	Advantages	Disadvantages
Raster	• Simple data structure • Compatible with remotely sensed or scanned data • Simple spatial analysis procedures	• Requires greater storage space on computer • Depending on pixel size, graphical output may be less pleasing • Projection transformations are more difficult • More difficult to represent topological relationships
Vector	• Requires less disk storage space • Topological relationships are readily maintained • Graphical output more closely resembles hand-drawn maps	• More complex data structure • Not as compatible with remotely sensed data • Software and hardware are often more expensive • Some spatial analysis procedures may be more difficult • Overlaying multiple vector maps is often time consuming

The Connection between map and Database

Attributes for a vector feature are stored in a table. A table is like a spread sheet. Each column in the table is called a field. Each row in the table is a record. Table 4 shows a simple example of how an attribute table looks in a GIS. The records in the attribute table in a GIS each correspond to one feature. Usually, the information in the attribute table is stored in some kind of database. The GIS application links the attribute records with the feature geometry so that you can find records in the table by selecting features on the map, and find features on the map by selecting features in the table.

Table 4: An attribute table has fields (columns) and records (in rows)

Records/fields	YearBuilt	RoofColor	Terrace
Record 1	1998	Red	no
Record 2	2000	Red	no
Record 3	1984	Brown	yes

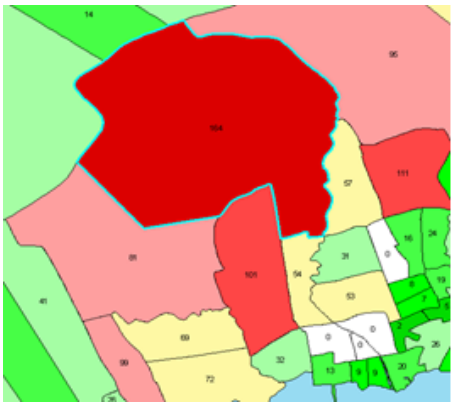
Each field in the attribute table contains a specific type of data - text, numeric or date. Deciding what attributes to use for a feature requires some thought and planning. In the house example earlier on in this topic, roof colour, presence of a terrace and year of construction as attributes of interest were chosen. Just as easily, any of the following could have been chosen:

- number of levels
- number of rooms
- number of occupants
- type of house (row house, city house, bahay kubo etc.)
- market value of the property
- area of floor space in the house
- and so on....

With so many options available, how does one make a good choice as to what attributes are needed for a feature? It usually boils down to what you plan to do with the data. If you want to produce a colour coded map showing houses by age, it will make sense to have a 'Year Built' attribute for your feature. If you know for sure you will never use this type of map, it is better to not store the information. Collecting and storing unnecessary information is not efficient because of the cost and the time that is required to research and capture the information. Very often, vector data is obtained from companies, friends or the government. In these cases it is usually not possible to request specific attributes and one has to make do with what is available.

In a GIS, the table is always stored in a database which can be, relatively simple to very complex. The advantage of this is that items in the table can be used to design the colours and look and feel of the map layer. Alternatively, one can also select a geographic element (on the map) and study the records of the database. You can also do this in reverse, select specific features in the database and present them in the map. This is one of the main features of the GIS.

This principle is demonstrated again in the following image where the corresponding elements in the map and database are colored blue



MUNIPOLS	BRGYPOLS	CITIES	ZIPCODE	Z997	Z998	Z999
Cebu City	Mambaling	Cebu City	6000	25	69	23
Cebu City	Sirao	Cebu City	6000	0	42	1
Cebu City	Sinsin	Cebu City	6000	8	0	0
Cebu City	Sapangdaku	Cebu City	6000	2	8	5
Cebu City	Pamutan	Cebu City	6000	0	3	0
Cebu City	Buot-taup	Cebu City	6000	1	4	0
Cebu City	Budla-an	Cebu City	6000	2	6	0
Cebu City	Buhisan	Cebu City	6000	8	10	7
Cebu City	Toong	Cebu City	6000	1	0	1
Cebu City	Guadalupe	Cebu City	6000	111	194	76
Cebu City	Bulacao	Cebu City	6000	52	27	18
Cebu City	Pardo (Pob)	Cebu City	6000	23	30	19
Cebu City	Inayawan	Cebu City	6000	29	54	14
Cebu City	San Nicolas	Cebu City	6000	0	0	0
Cebu City	Calamba	Cebu City	6000	11	42	7
Cebu City	Sambag II	Cebu City	6000	19	52	17
Cebu City	Sambag I	Cebu City	6000	22	35	7

The element in the map with the blue outline is described in the database as barangay Guadalupe in Cebu City with zip code 6000 and vice versa (the record in the database is located in the map at the exact location of the blue outline. The barangay is colored red because in 1998 it has a big amount of dengue cases which are represented per barangay from white (no dengue, via yellow, green and pink) to red, many cases of dengue.

Exercise 1.2

Geographic and attribute data

Summary

In this Session we have presented a number of principles of GIS. As a Geographic Information System it is a combination of hard- and software which is operated by people that use data and procedures to work with geographic data. Geographic data are simplifications of the world in which we live and depending on your needs and insights the real world can be divided into many different map layers, each describing a specific element of the world. These data can come in many forms and shapes but two most important types for our work are the vector and raster data. We have presented some of the most used GIS software packages in the Philippines and described the difference between sometimes confusing terms as GIS, GPS, CAD and RS. The maps in our GIS present the location of a feature on the earth where the attribute data describe this feature. Using the information in the attribute table (or database) we can again format and display our map.

In the following Session we will discuss Manifold System as a tool to use, prepare and present maps for planning.

Introduction to Manifold System

OVERVIEW

Manifold System is a Geographic Information System (**GIS**) software package. A GIS package is different than an "atlas" package, such as Microsoft's Streets and Trips that can display only one, built-in, read-only map. A GIS can work with many different maps and can be used to create new maps, to edit maps and to combine maps with database information.

Manifold System is a "word processor for maps" that will let you create new maps or edit existing maps. It is also a "database system for maps" that will allow you to embed database information into a map so that the map can be used as a visual interface into the data. Anyone can use Manifold System interactively to create new maps or to explore database information displayed within a map. In the hands of experienced users with programming skills, Manifold System may be used to create new applications to work with maps, images, surfaces and databases.

OBJECTIVES

After this Session you will:

1. Have a basic knowledge of the Manifold System functionality
2. Know how to add drawings and images and how to change the colours of the drawings
3. Know how to create maps and add labels
4. Have insight in the main components of Manifold System as panes, toolbars and the status bar

DURATION

6 hours

CONTENT AND ACTIVITY PLAN

Topics to be covered:

1. Installing Manifold System GIS
2. The user interface
3. Adding Data into Manifold System
4. Create overlays of components (Images, Drawings)

SUGGESTED METHODOLOGY

- Presentations
- Exercises
- Demonstrations

RESOURCES NEEDED

For this session you need a computer with a working Manifold System license and the data for the exercises from the DVD. In order to have no problem with read/write access to the data, please copy the exercises from Lesson 2 to a place on your computer. The exercises from this Lesson are described in the exercise manual.

REFERENCES

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Existing PowerPoint and documents on Manifold GIS trainings, mostly compiled by Jay-ar Ragub and Jerson Sala

MANIFOLD System GIS Help,

MANIFOLD System GIS User manual, accessed on: http://www.georeference.org/doc/whnjs.htm

Geerling, Gertjan, - Draft Manifold Hands-on Manual, not published

Installing Manifold System GIS

If Manifold System is not yet installed in your computer, this needs to be installed . This session contains the steps to install the software. For users who are using Microsoft Vista or newer, a true administrator rights to install or activate Manifold System is needed.

Some versions of Vista make it difficult for users to login with true Administrator rights. However, that can be bypassed sometimes by running programs using a "Run as Administrator" option. Here is a shortcut that works in most cases.

TO INSTALL MANIFOLD SYSTEM:

Right-click on the Manifold System .msi installation file and choose "Run as Administrator."

For example, suppose after downloading Manifold System from the Product Downloads page and unzipping the zip file you have an installation file called Manifold System-8.0.12.msi. [Note that depending upon your Windows Explorer settings Vista may or may not show you the three letter ".msi" extension.] With your mouse, right click onto the Manifold System-8.0.12.msi file and choose Run as Administrator from the context menu that pops up. This will cause the Manifold System installation to be run with true Administrator privileges.

To activate Manifold System:

Launch Manifold System by right clicking on the Manifold System icon and choose "Run as Administrator."

Suppose you have installed Manifold System by using the shortcut above. Now it's time to launch Manifold System with true Administrator privileges so you can provide your serial number and, optionally, activate the installation. The default Manifold System installation places a Manifold System program icon on your desktop. With your mouse, right click onto the Manifold System program icon and choose Run as Administrator from the context menu that pops up. This will launch Manifold System with true Administrator privileges. The Activation dialog will pop open and you can now add a serial number and optionally get an Activation key and activate Manifold System with true Administrator privileges.

Important: If your Windows system has been altered from defaults, the above shortcuts might not work. In that case you'll have to use the full procedure as given at this website: http://www.ManifoldSystem.net/tech/vista_admin.shtml.

Entering the Serial Number and Activation Key

All Manifold System licenses are copy protected using one of two mechanisms:

- Authorization using a Serial number and Activation keys that locks each license to a single computer system. Manifold System licenses acquired in small quantities or acquired for use on portable devices use this mechanism.
- Authorization of floating licenses using a License Server. Manifold System licenses acquired in larger quantities will frequently use this mechanism, which requires licensing of the Manifold System License Server product. See the Manifold System License Server topic for discussion of License Servers.

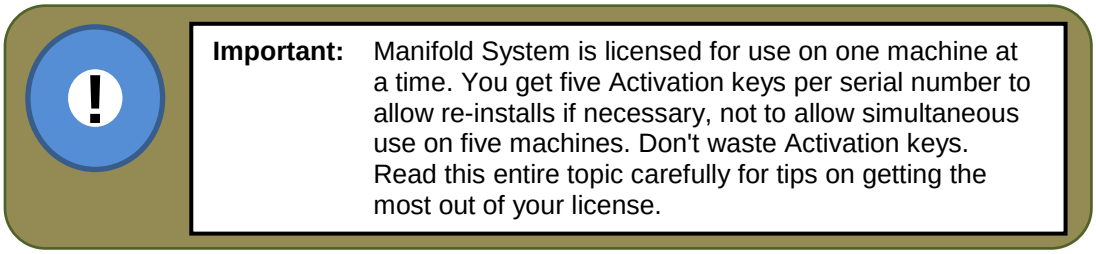
In most cases, the first option will be relevant for use.

Login as **Administrator (or alternatively run as Administrator).** Install Manifold System and then launch Manifold System. In the **Activation** dialog that pops open, provide the serial number emailed to you for the Manifold System edition you have licensed. Copy the serial number from the original serial number email message and paste it into the dialog.

For the first 30 days after your serial number was issued, you can run on the serial number alone. After 30 days you will have to get an Activation key as well. When the **Activation** dialog launches, enter your serial number and then press the **Get Activation Key via the Web** button and then press **Accept**. Getting an Activation key terminates any return privileges you may have.

If you have licensed Business Tools, Geocoding Tools or Surface Tools extensions: launch Manifold System and choose **Help - Activate Extension**. Enter the serial number for the extension. Get an Activation key if it is more than 30 days since the serial number was issued. Press **Accept**. Do this for each extension that you have. If you have licensed Universal Edition or Ultimate Edition, all three extensions get turned on automatically when you activate your main Manifold System serial number. No need to use the

Help - Activate Extension dialog with Universal Edition or Ultimate Edition.



Important: Manifold System is licensed for use on one machine at a time. You get five Activation keys per serial number to allow re-installs if necessary, not to allow simultaneous use on five machines. Don't waste Activation keys. Read this entire topic carefully for tips on getting the most out of your license.

If any problem is encounterd,please refer to this webpage http://www.Manifold System.net/tech/activation_troubleshooting.shtml.

The user interface

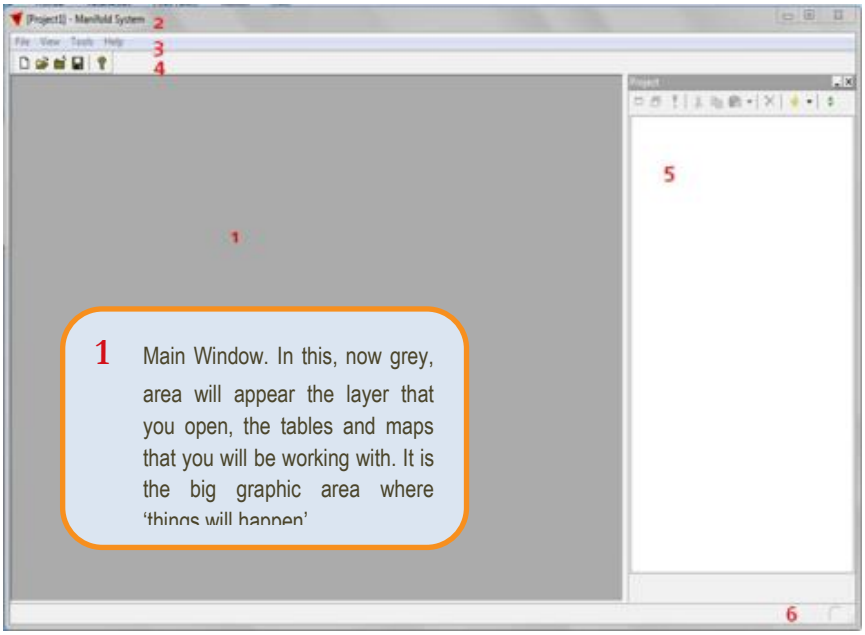
After starting the MANIFOLD SYSTEM, either from the desktop computer, or through start -> all programs -> Manifold System systems -> Manifold System 8.xxx (where xxx stands for the version number of your Manifold System License), the start-up screen will appear, as shown below::

3 The menu bar shows the available menu items for your project. The amount of menu items and which items are shown at a specific moment is dependent on your Manifold System version and with what kind of data or activities you are working. The menu will only show the options that are available to you at that specific moment.

Please take note of the help menu item. The Manifold System Help is elaborate and very well organized. You can get help on technical issues, all features of Manifold System and on GIS concepts as well. The help is indexed and can be both browsed and searched. The help can also be activated using the "F1"button.

2 The name bar which also shows the name of the project you are working with.

4 The button bar adds functionality which is sensitive to the context where you are working with. The amount and which buttons show is therefore variable and different if you are working with layers, tables etc. You can influence which button bars are shown using the menu option tools – customize.



1 Main Window. In this, now grey, area will appear the layer that you open, the tables and maps that you will be working with. It is the big graphic area where 'things will happen'

5 The project pane shows all components we have in our project. Open/close the project pane with **SHIFT-ALT-P** or with View - Panes - Project. In the default hierarchical view used for the project pane, components that are linked to other components will be shown indented below their parent component. Drawings, for example, always are linked to a table that contains the data fields for the objects in the drawing. Images that are palette images will have a palette linked to the image. Surfaces will have a terrain component created by default for the surface and may have one or more subsidiary terrain components.

Names of components are marked with an asterisk * if they have been added to the project or changed since the last Save command. Manifold System works with only one project at a time. To work with different projects (say, for example, to copy and paste data between projects) we can launch two Manifold System programs and switch between them. More details on the project components will be given in the following paragraph.

6 System Activity Indicator. The System Activity indicator in the status bar at the lower right hand of the screen changes shape whenever Manifold System is busy executing a command. When the system is busy it will show a 3D "bump". If desired, un-checking the Quiet system activity indicator in the Tools - Options User Interface page will change the indicator to use colors.

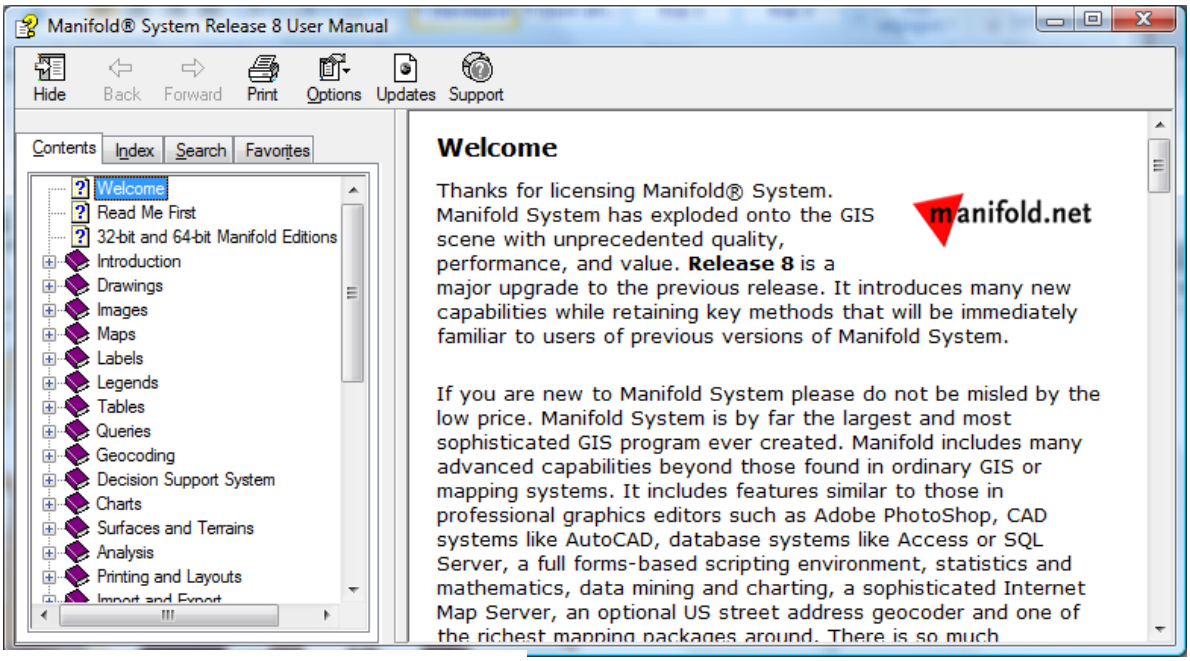
Hint Sometimes you don’t need all the panes, but you would like to have more space to work with the layers or tables. In that case, Manifold System GIS has the option for View - Full Screen Display main Manifold System window using the entire monitor screen, eliminating the title bar and menu bar. Press F11 to enter full screen mode. Press F11 again to exit full screen mode. If toolbars are hidden using Tools - Customize and a window is maximized the result is a "full screen" display.

The Help function

The help function is very important to be able to work with Manifold System and many other GIS packages have such a vast array of functions, that it is almost impossible to remember the exact workings of all of them. It is common that the user has an idea of what he/she wants to do and needs manuals or help files to find the correct procedure.

By pressing **F1**, or going to menu **Help** > **Contents**, the help window opens. Help can be accessed in three ways by clicking on the tabs **contents**, **index** and **search** that are located in the top left of the help window. Should more information about a topic discussed in this manual is needed, remember that help on all the words printed in **Bold** can be found by typing that word in the **Index** tab.

Contents tab	Information is grouped according to topic, for example all about drawings can be found in topic drawings.
Index tab	Index allows you to type an index keyword. For example the name of a button or a function you encounter in a menu, pane or toolbar. This takes you directly to its description, similar to the index of a book.
Search tab	Search allows you to search for all keywords, like using Google on the internet. All help texts containing the search term are shown as a result. Sometimes this can give a lot of results and is therefore not always useful.



The help window.

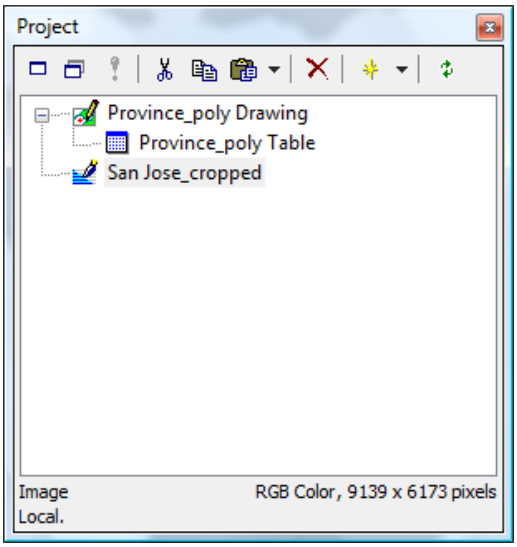
Exercise 2.1

The Manifold GIS help functions

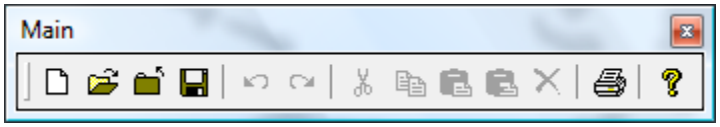
Panes and Toolbars

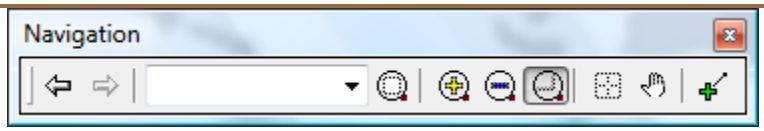
Many controls of Manifold System are accessed through Panes and Toolbars. **Panes** are windows that give information about something. For example the 'Project Pane' in the figure below. It gives information about what components are available in the project.

The 'Project pane'.



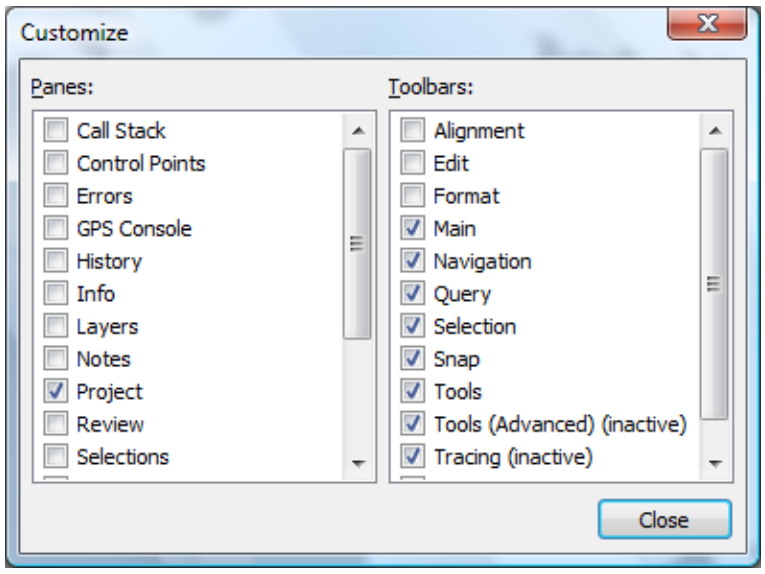
Toolbars are small windows that contain buttons linked to tools. Depending on what type of data window is active (like drawings, tables or images) different toolbars are visible. Examples of toolbars are shown below.





Examples of toolbars.

To show or hide panes and toolbars you can go to menu item **Tools** > **Customize**. Here you can select which panes and toolbars are shown (see figure above). You can select and deselect items to let them appear and disappear (just try!). The functions of the different panes and toolbars will be gradually explained throughout this manual.



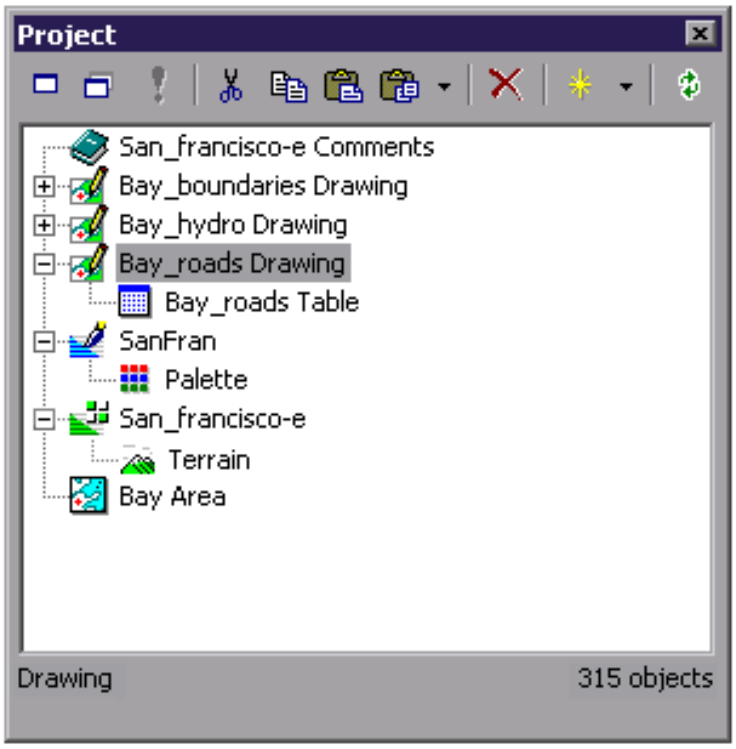
The customize windows (from the Tools > Customize menu).

All panes and toolbars can be docked or floating. Figure above shows docked (to the sides) and floating panes and toolbars. To move a pane, drag it by clicking on or just next to its name, you will see the mouse pointer change into an arrowed cross. When dropped in the middle or outside the main window, it will float. When dropped close to an edge of the main window, it will dock again. To move a toolbar, just click on the small vertical bar on the left and move the toolbar. When you want to dock it again, drag it in next to another toolbar and drop it.

Remember, when you close it by pressing the [x] in the top right corner, you can open it again through the menu item **Tools** > **Customize**!

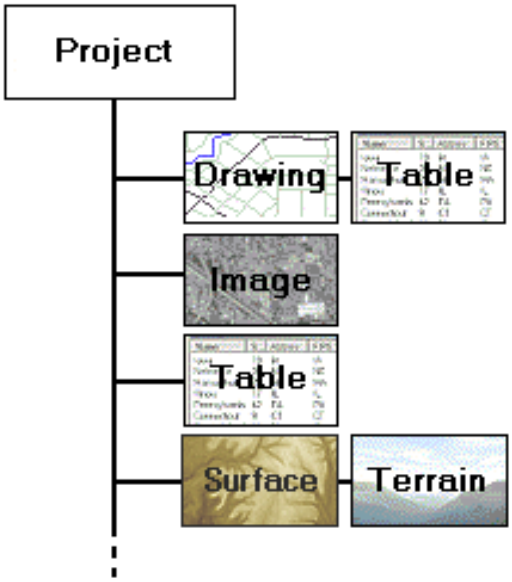
Projects

Manifold System's main documents are **projects**, which use Manifold System **.map** project file format ("**.map**" = **Manifold System Project**). Within Manifold System the standard Windows menu items **File→New**, **File→Open** and **File→Save** commands will create, open and save **.map** project files. Projects contain a portfolio of **components**. Components are **images**, **drawings**, **tables**, **labels**, **charts**, **maps** and other items.



The 'Project pane'.

Some components always have subsidiary components. Whenever a drawing is added to a project a subsidiary table for the drawing will also be automatically created. The table stores data fields for objects in that drawing. Surfaces will be created by default with a subsidiary terrain. The terrain shows the contents of the surface in a 3D window.



The Project Tree.

Names of components are marked with an asterisk ***** if they have been added to the project or changed since the last **Save** command. Manifold System works with only one project at a time. To work with different projects (say, for example, to copy and paste data between projects) we can launch the Manifold System program two times and switch between them.

Project components

A project may consist of several components, and it is saved as a map file. Components can be, for example, drawings of roads, rivers, administrative borders, but also tables, excel data or a layout.

The following will give an overview of the most used components:

Drawings

Drawings are made up of objects that may be points, lines or areas based on specific coordinates (see also Lesson 1). Every Manifold System drawing is linked to a table. Every object in the drawing corresponds to one record in the table. Manifold System can import drawings from a vast array of different GIS and CAD formats. Drawings that are automatically created from database tables are called linked drawings and are shown using an icon that includes a yellow "database" cylinder.

Themes

Themes are displays of a drawing shown using different formatting. Manipulating a theme is just the same as manipulating its parent drawing. Themes make it possible to show drawings colored or presented in different ways without having to duplicate the drawing.

Images

Images are composed of pixels arranged in orderly rows and are often referred to as rasters in older GIS systems. Most of us know images as the familiar pixel-based images we edit in Microsoft Paint or so. Images in Manifold System can also be multi-channel raster data as well as visual images. Images are normally imported into a Manifold System project. One special type of images, compressed images, may be linked into a Manifold System project from external files or compressed image servers. Linked images may also be created from queries and database tables as well as from image servers such as TerraServer or OGC WMS servers, in which case they are indicated with an icon that incorporates a "database" cylinder.

Tables

Database tables may be included either within a project or linked from external database providers so that the data they contain is fetched "on the fly" as it is needed. Tables linked from external sources are shown with an icon that includes a yellow "database" cylinder. Manifold System includes an immense array of database capabilities that work with tables and which may be used for database manipulation of tables from almost any database

management system.

Labels

Labels components show text labels that are either entered manually or are automatically created from data fields linked to drawings. Labels components may be created in a variety of ways, such as making a Copy of drawing objects and then Paste As a Labels component.

Maps

Maps show drawings, images and labels as layers in a map window. An important function of maps is showing the data they contain in projected form, where the native coordinates of drawings are transformed into a desired geographic or other projection and where images are referenced into the desired coordinate system and shown in projected form. Map windows are the main user interfaces within Manifold System. Maps are used not only for geographic presentation but also for working with non-geographic images and drawings in many layers.

Surfaces

Surfaces are raster data sets that contain data values, such as elevations, for each location. They are almost exactly analogous to images except that instead of a colour value for each "pixel" they contain a data value. The default way to show a surface is as a shaded relief 2D image. Surfaces are called "grids" in some GIS packages. Surfaces may also be linked from queries or tables, in which case they are indicated with an icon that incorporates a "database" cylinder.

Terrains

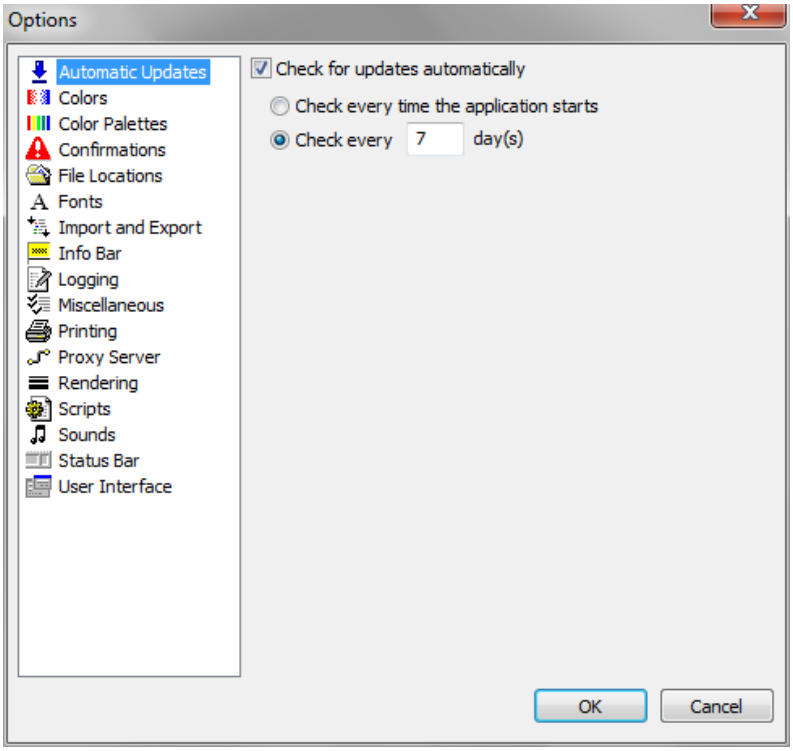
Terrains are surfaces shown in three-dimensional views. Every terrain has a parent surface. Terrains are most often used to show 3D views of the surface of the Earth based on terrain elevation data; however, they may also be used to see abstract data such as population gradients, temperatures or other data as 3D surfaces. Each surface can have an unlimited number of terrain views created for it.

Exercise 2.2

Get familiar with Manifold System

Customizing Manifold System

As with most software, Manifold System GIS has a number of options to customize the application so that it fits more to the needs of the user. In order to do this, go to **Tools - > Options** and the following menu appears:



The following are important features:

Automatic updates:

Manifold System can be set to check the internet for automatic updates or after a specific amount of days. This can be switched off to prevent any re-installation issues. Locations to be used by default for files can be specified in **File Locations**. Locations that may be specified include those of many Manifold System features (take care when changing these) and the default locations of your projects.

For a complete overview of the functions, please go to **Help→Index and type "options"**

If the default location of GIS data is changed, it may be useful to prepare a folder structure in the project that may help in storing and organizing the data. One option is to use the same structure as Manifold System does for its project components. There are however more options for this and, select one that is functional for one's own needs.

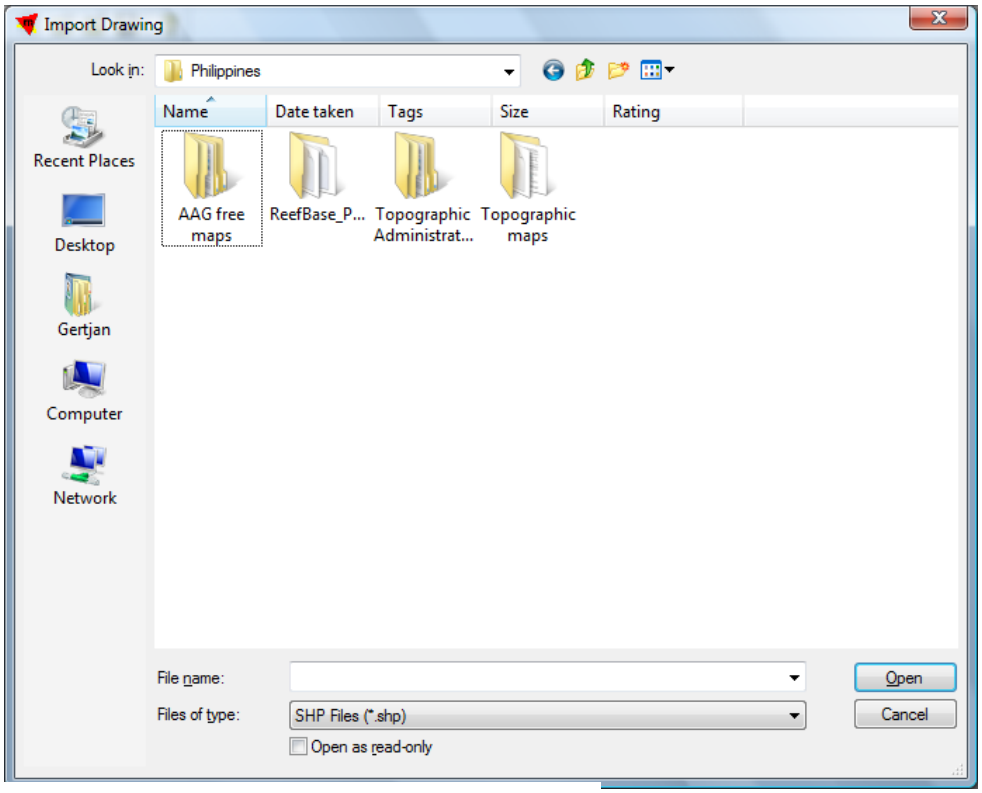
Below is a suggestion of folders that can be created. These are borne out of tested practices:

- **Admin** - this is where project documents etc. are stored

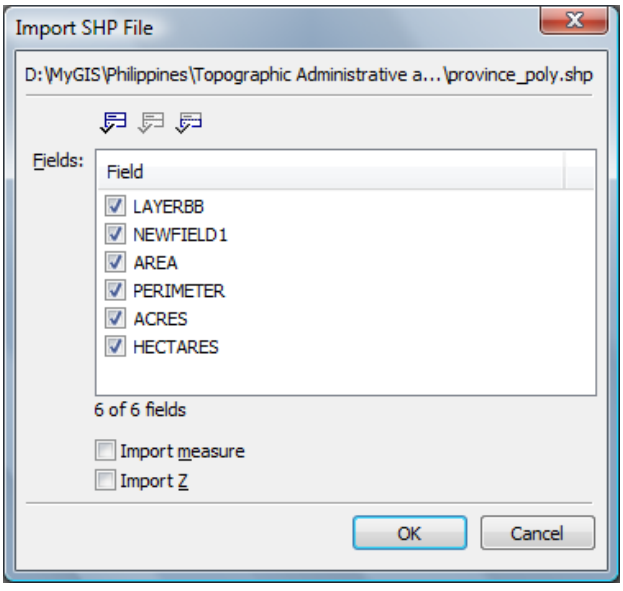
- **Base data** – All original data is placed in the same projection etc. These data can be used for backgrounds etc., but not for editing
- **Final**: contains all the final finished products
- **Original** – stores the data in its original form as received and has not in any way been edited.
- **Tmp** – stores all temporary data
- **Work** –place the data currently being worked on . Completed work is transferred to to the folder, final data
- **Reports** – where documentation and reports are kept

Adding Data into Manifold System

Through clicking on the menu items **File** > **Import** > **Drawing** the import windows opens, see figure below.



Example of Import Drawing

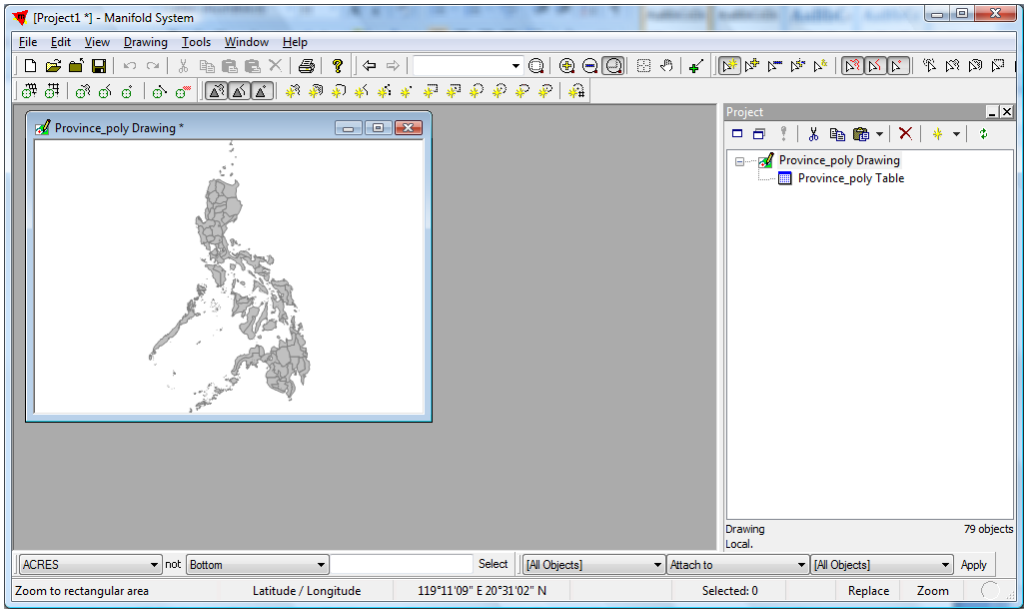


Import SHP File, field selection.

Navigate through the map (directory) containing the drawing. Be sure to select the correct file type in the drop-down menu **Files of type** located in the bottom of the window. In this case SHP Files (*.shp) is selected. When a drawing is opened, choose what 'fields' from the attribute table will be imported (left figure). Fields contain the properties of the drawing elements, such as names, length, surface area, or any database entry thinkable.

After the drawing has been imported, it appears as **component** in the **project** pane. The drawing consists of the drawing itself and the connected table that contains the fields (See Project Pane on

the left in *Import SHP File* Figure). By right clicking on the component's entry in the project pane and choosing **Open** (or double clicking on the component) the data becomes visible on the main screen. Just as in normal windows, the drawing can be moved and resizes using the normal window controls.

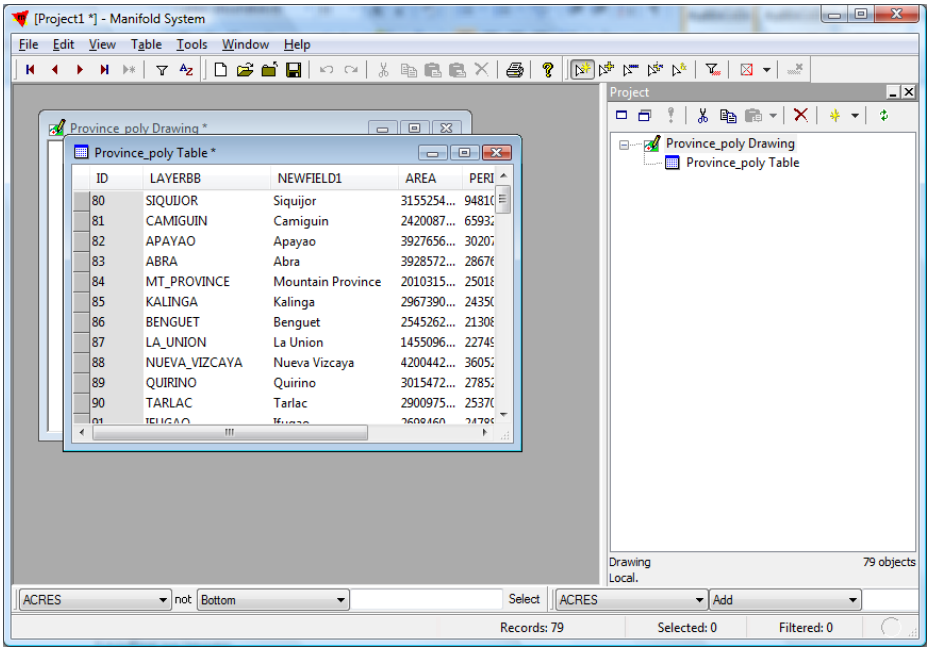


Active component (drawing) in window.

In Manifold System, the toolbars and available menu items vary according to what type of component is active. Notice that after opening the drawing, several 'toolbars' with buttons to access functions appears and the menu items changes. Now go to the 'project pane' and press the '+' sign in front of the drawing ( ). You should see the table appear. Double click on the table icon ( ). The table appears in the main window, like figure1-6. Notice again that the menu items and toolbars have changed!

To close a component window, just press the red cross ( ) in the corner to close the window. To see how many windows are open, choose menu item **window→ windows (F12)** or press **F12**.

To delete a drawing from the project: Select it in the **Project** pane, right click it and choose **Delete** or press the **Delete** button in the Project Pane ( ).



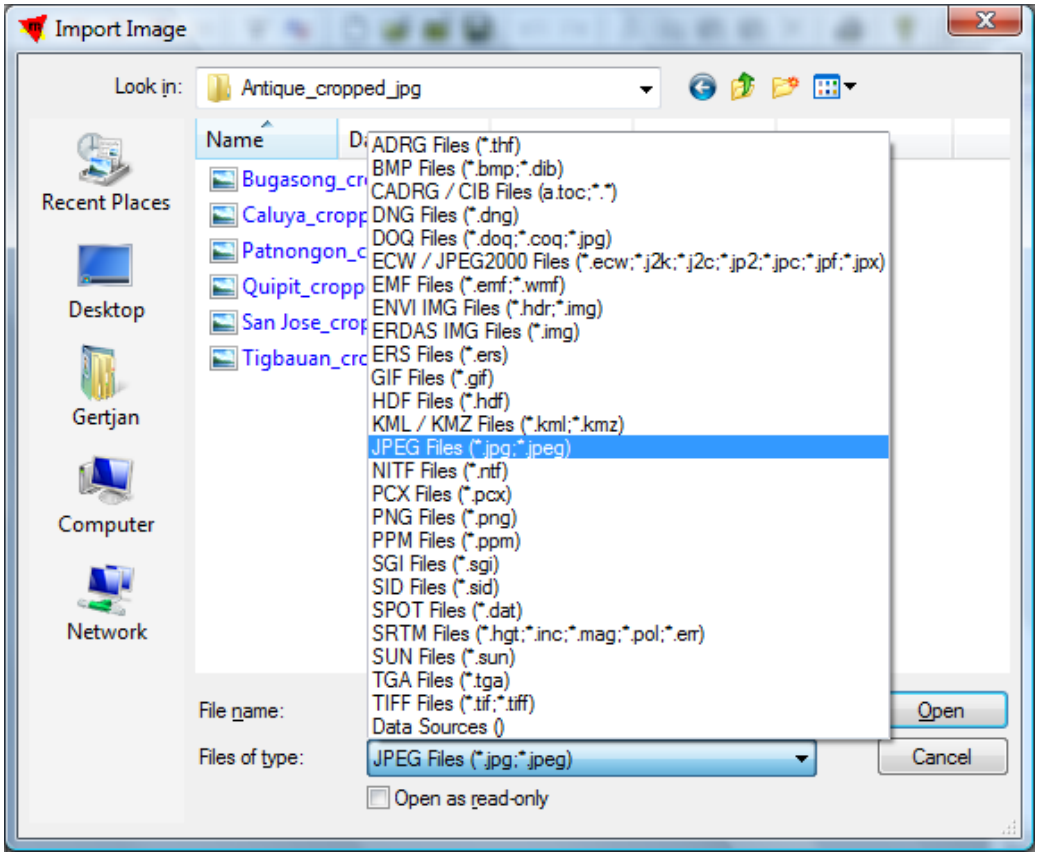
Showing a drawing's table.

Loading and deleting an image

Similar to loading a drawing, an image can be loaded. Now not every step is shown in pictures. Do the following steps:

1. Go to **file > import > image**
2. Locate the file; remember to choose the right file type in the bottom of the window! (*See figure below*).
3. Press **open** or double click the file. It can take some time to load an image.
4. The file should appear in the project pane having this ( ) icon.
5. Right-click and choose open or double click on the image to show it.
6. Press the red cross ( ) in the corner to close the window.

Notice again that the menu items and toolbars have changed.



Showing a drawing's table.

To delete an Image from the project. Select it in the **Project** pane, right click it and choose **Delete** or press the **Delete** button in the Project Pane ( ).

Exercise 2.3

Import drawings and observe map and database

Exporting data

All data in the project pane can be exported to be kept as separate files outside a project. You can export all components such as tables to excel files, Images, Drawings to various kinds of output files.

1. Open the component to export by double clicking it in the **project** pane.
2. Go to **File** > **Export,** choose the export type.
3. The Export window opens. Browse to the location you want to save to file to.
4. Select the desired file type in the **Save as type** list box and specify a name
5. Press **save**.

Important: In contrast to some other GIS software, Drawings in Manifold System can contain points, lines and areas (polygons) at the same time. When such a drawing is exported to for example Manifold System shape, one drawing is exported as 3 separate shape files, one containing points, one lines and one areas.

Exercise 2.4

Saving and sharing your data

Create overlays of components (Images, Drawings)

Map windows are the most frequently used windows in Manifold System. A map is a projected view that contains layers. Each layer is a separate drawing, image, surface or labels component. Maps are the only view windows in Manifold System with layers. They are used to see drawings, images, surfaces and labels components in combined, layered views.

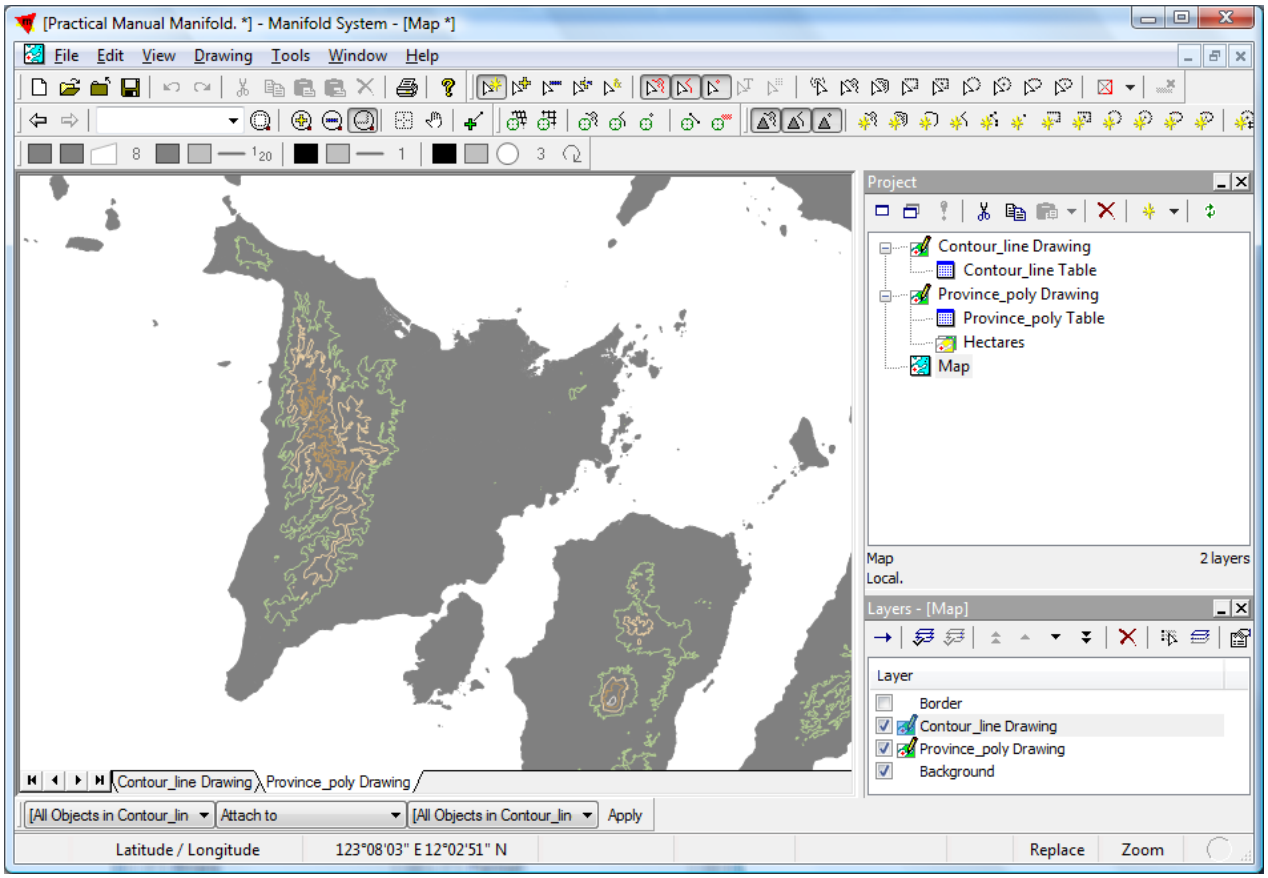
Creating a New Map

We can create a new map using whatever source materials we like:

1. Create a new project using **File** > **New**. This opens a project view window.
2. Using **File** > **Import**, import any drawings or other components into the project the new map will use.
3. Create a new map in the project using **File** > **Create** > **Map**. We must specify the name of at least one drawing or image this map will use. In the Create Map dialog, check all the drawings or images from the project you would like to appear in this map.
4. Double-click on the new map in the project view window to open it in a map view.
5. Drag and drop any additional components from the project view window into the map view window. This adds them to the map.
6. If images (or any other components) are not already georegistered, they must first be georegistered so that they appear in the proper geographic location at the correct size. See session 3: Map projections and Transformations.
7. If desired, use **Edit** > **Assign Projection** to change the projection used by the map.
8. By activating **View** > **Panes** and choosing the **Layers** pane, one can see what layers are present and which are active using the tick box, see the **Layers** pane in the lower right corner of figure in next page.
9. **Option**: To change the order of the layers you click on the layer's tab and drag it past another layer's tab. Remember that points or lines can easily be hidden behind areas.
10. **Option**: By right clicking a layer's tab a lot of functions become available: You can **delete** the layer from the map. Or **Zoom** to the layer.

11. Very useful is the **Opacity** option by which for example images such as map scans can become see-through to show underlying layers. This is often used to combine elevation maps (called **surfaces** in Manifold System) with other data.

12. Maps are also used to create (digitize) and edit drawings and images by using multiple layers for edits.

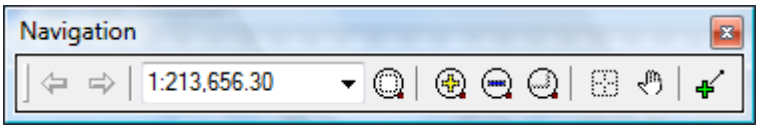


Example of a map view

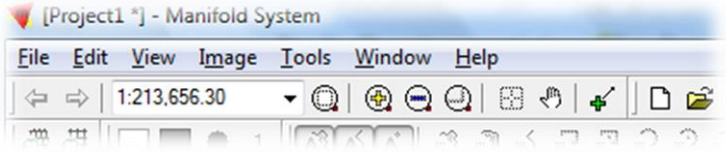
Navigation toolbar

The navigation toolbar (*figure below*) is used to navigate in geographical data, such as drawings or images. This is only active when the geographical data window is open. Normally it is 'docked' in the main window of Manifold System looking like

.



Navigation toolbar.



Docked navigation toolbar.

Hint When you hover your mouse arrow above the buttons without clicking, the function of the button appears in a text bar. The scale indicates the current scale, when it is empty you should check the projection of the active window (see further in Map projections and transformations).

Below the functions of the buttons are summarised, you activate a button (function) by clicking it once; by clicking it again you turn it off. Try them after you have imported and opened a drawing or image.

Back - Go back one view in the current component window.

Forward - Go forward one view in the current component window.

Zoom scale combo - Choose a zoom scale from a variety of even zoom scales, or enter the scale

you want.

Zoom To Fit - Zoom so that the component fits within the current window size.

Zoom In - Magnify the view as if seen from a closer distance.

Zoom Out - Reduce the view as if seen from farther away.

Zoom Box - Zoom to the size of the cursor box drawn with the mouse.

Center Point - Pan the view so that the spot clicked is centred.

Grabber - Interactive pan: click and drag with the grabber hand. The scene will be panned so that the initial point is moved to the spot where the drag is released.

Tracker - Provides interactive distance and area measurements.

Hint The saved map file contains the data of all the components except for the linked components such as Google earth data. Therefore by copying the.map file only, you can take or email your work to another place

Important: In contrast to some other GIS software, Drawings in Manifold System can contain points, lines and areas (polygons) at the same time. When such a drawing is exported to for example Manifold System shape, one drawing is exported as 3 separate shape files, one containing points, one lines and one areas.

Formatting a component

Once a drawing has been imported and opened, we can change the way it looks using the format toolbar. Used with drawings or drawing layers in maps, the Format toolbar controls the colour, style and size of areas, lines and points. Used with text components the Format toolbar controls the

colour and appearance of text labels in that layer. Used with images, the Format toolbar controls the colour, style and size of painting tools. Note that the contents of this toolbar depend on what component window or map layer is active.

For drawings the following options are available:

Areas Format - Foreground / background colours, Style and size for all areas in this drawing.

Area Borders Format - Foreground / background colours, Style and size for all area borders in this drawing. While the 1/20th of a point value for border size works well for screen display it is wise to increase the thickness of area borders for printed materials since 1/20th of a point results in lines that are too thin for good visibility with most printers.

Lines Format - Foreground / background colours, Style and size for all lines in this drawing.

Points Format - Foreground / background colours, Style and size for all points in this drawing

Foreground Colour

The colour of solid points and lines and the foreground colour of two-colour area styles or of two-colour area border styles. Choosing a transparent colour for foreground colour for an area will turn off display of that area. This is a short-cut way of turning off areas when desired.

Background Colour

The fill colour in most styles used for points, lines, areas and area borders.

Style

The pattern or icon used to draw points, lines, areas or area borders.

Size

The relative size to use for patterns used to draw points, lines, areas and area borders. Does not apply to bitmapped images used for points.

Rotation Angle

Allows rotating the symbols used for points to a given angle.

Exercise 2.5

Change the colors of drawings

Exercise 2.6

Prepare a map and change look and feel

Summary

In this Lesson you have set your first steps in working with Manifold System GIS. We have discussed the main panes and toolbars and you now know how to import your data and change the colours of your drawings. More advanced colouring options will be presented in the Lesson on making and printing layout. One of the most important components in Manifold System is the map where you can combine drawings and images into a more complex presentation where then there are also more and different options available. This Lesson focuses on working with existing data. The next Lesson will focus on collecting and preparing your own maps.

Data Entry

OVERVIEW

In starting to use GIS, one will find that in many cases, the data needed are not available, or if they are, not in the shape or format that are usable. In this case, one has to come up with ways of preparing its own data. This session presents, the three ways of collecting baseline data for a project. These are, conducting GPS survey, georegistration, and using data from tables. In many cases these data may be based on different geographical reference systems or projections and working with the wrong projection may cause errors in data or in analysis. This session provides an overview of how to work with the GPS and how to download data into Manifold System. Using these data and a scanned image, this session will deal with how to correctly position the said image on the world so by using GIS.. This will also give an insight into coordinate systems and where in the Philippines the GIS data may be obtained

OBJECTIVES

After this lesson you will have:

- Insight in and experience with the working of a GPS
- Gained experience in doing a GPS survey
- Know how to transfer the data from a GPS unit into Manifold System
- obtained insight in and working knowledge of coordinate systems
- Know how to geo-register a paper map or (scanned) image
- insight in possible other data sources in the Philippines

DURATION

1 day (8 hours) mostly depending on the line needed for a GPS survey

CONTENT AND ACTIVITY PLAN

Topics to be covered:

1. What is GPS?
2. Importing GPS data into Manifold System
3. Coordinate Reference Systems

4. Map Georegistration
5. Data sources in the Philippines

SUGGESTED METHODOLOGY

- Presentations, demonstrations, exercises, movie

RESOURCES NEEDED

- Laptop/desktop computer, LCD projector and screen;
- Hand-outs and photocopies of printed materials and documents.
- GPS unit & cables

REFERENCES

DENR – Mines and geosciences bureau – GIS website http://gdis.denrr.gov.ph/mgbviewer

DNRGPS - http://www.dnr.state.mn.us/mis/gis/DNRGPS/DNRGPS.html, Minnesota Department of Natural Resources

DOST – PhilVocs – http://www.philvocs.dost.gov.ph

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Existing PowerPoint and documents on Manifold GIS trainings, mostly compiled by Jay-ar Ragub and Jerson Sala

Garmin – About GPS – http://www8.garmin.com/aboutGPS/

Garmin – Etrex Vista HCx Owner's Manual

Garmin – GPSmap 76CsX Owner's manual

HLURB - Housing Land Use Regulatory Board Cookbook - http://www.cookbook.hlurb.gov.ph

MANIFOLD System GIS Help,

MANIFOLD System GIS User manual, accessed on: http://www.georeference.org/doc/whnjs.htm

McNamara, Joel McNamara (2008) GPS for dummies

Namria Website – http://www.namria.gov.ph

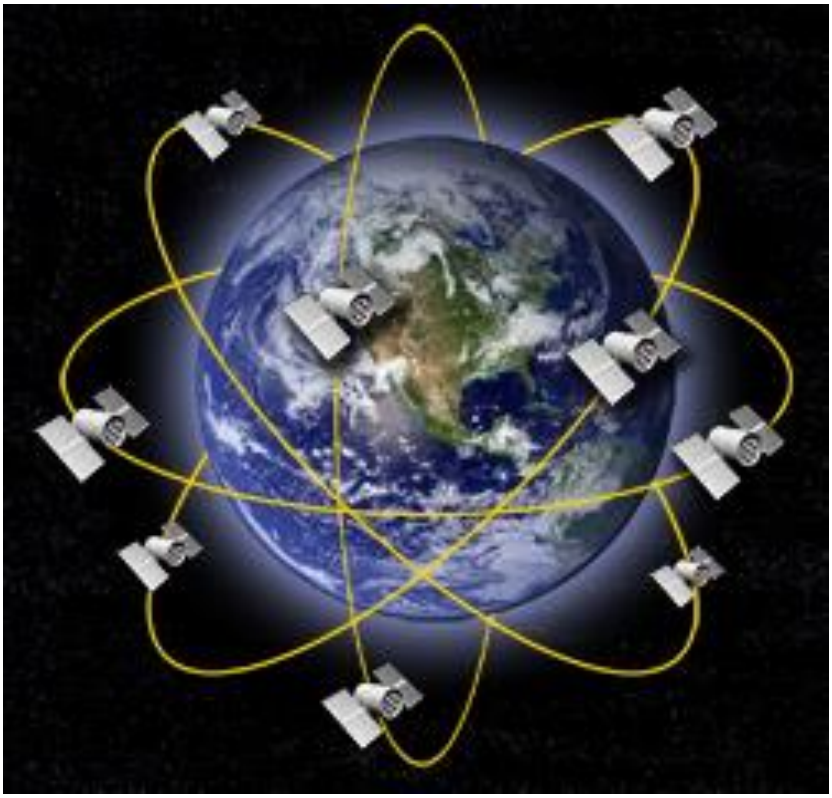
Open Street Map Philippines – http://www.openstreetmap.org

Roadguide Philippines – http//www.roasdguide.ph

WIKIPEDIA – GPS - http://nl.wikipedia.org/wiki/Global_positioning_system

What is GPS?

The Global Positioning System (GPS) is a space-based satellite navigation system that provides location and time information in all weather, anywhere on or near the earth, where there is an unobstructed line of sight to four or more GPS satellites. It is maintained by the United States government and is freely accessible to anyone with a GPS receiver. The GPS program provides critical capabilities to military, civil and commercial users around the world. In addition, GPS is the backbone for modernizing the global air traffic system.



The GPS system is a satellite-based navigation system made up of a network of 24 satellites placed into orbit by the U.S. Department of Defence. GPS was originally intended for military applications, but in the 1980s, the government made the system available for civilian use. GPS works in any weather conditions, anywhere in the world, 24 hours a day. There are no subscription fees or setup charges to use GPS.

A GPS system consists of three elements:

1. The space segment consists of the satellites circling the earth and emitting signals to the earth
2. The control segment is responsible for the quality management of the system by constantly monitoring satellite health, signal integrity and orbital configuration from the ground.
3. The user segment consists of the user and the GPS unit to collect the signal from the satellites and use it for your purposes. Four satellites are required to compute the four dimensions of X, Y, Z (position) and Time.

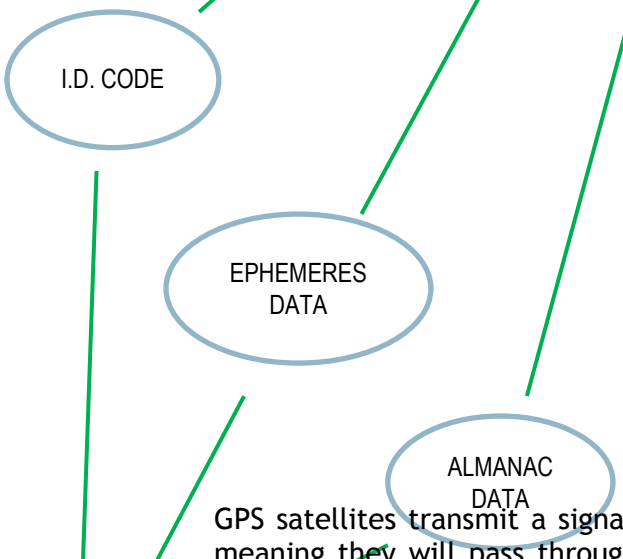
GPS satellites circle the earth twice a day in a very precise orbit and transmit signal information to earth. GPS receivers take this information and use trilateration (a three dimensional process of triangulation) to calculate the user's exact location. Essentially, the GPS receiver compares the time a signal was transmitted by a

satellite with the time it was received. Since we know the speed in which the signal travels, the time difference tells the GPS receiver how far away the satellite is.

Distance = Velocity * Time (radio waves travel at the speed of light, roughly 186,000 miles/second. If it takes 0.06 seconds for a GPS unit to receive a signal then the distance is 186,000*0.06=11,160 miles)

Now, with distance measurements from a few more satellites, the receiver can determine the user's position and display it on the unit's electronic map. The 24 satellites that make up the GPS space segment are orbiting the earth about 12,000 miles above us. They are constantly moving, making two complete orbits in less than 24 hours. These satellites are travelling at speeds of roughly 7,000 miles an hour. GPS satellites are powered by solar energy and have backup batteries to keep them running in the event of a solar eclipse, when there's no solar power or where the sun's solar radiation is blocked by the earth if the satellites are located behind it. Small rocket boosters on each satellite keep them flying in the correct path.

A GPS receiver must be locked on to the signal of at least three satellites to calculate a 2D position (latitude and longitude) and track movement. With four or more satellites in view, the receiver can determine the user's 3D position (latitude, longitude and altitude). Once the user's position has been determined, the GPS unit can calculate other information, such as speed, bearing, track, trip distance, distance to destination, sunrise and sunset time and more.



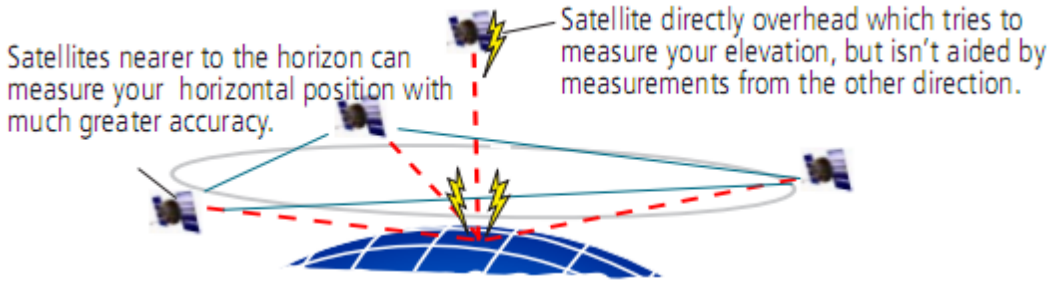
GPS satellites transmit a signal which will travel by line of sight, meaning they will pass through clouds, glass and plastic but will not go through most solid objects such as buildings, mountains and dense foliage. A GPS signal contains three different bits of information - an I.D. code, ephemeris data and almanac data.

1. The **I.D. code** identifies which satellite is transmitting information. You can view this number on your Garmin GPS unit's satellite page, as it identifies which satellites it's receiving.
2. **Ephemeris data**, contains important information about the status of the satellite (healthy or unhealthy), current date and time. This part of the signal is essential for determining a position.

3. The **almanac data** tells the GPS receiver where each GPS satellite should be at any time throughout the day. Each satellite transmits almanac data showing the orbital information for that satellite and for every other satellite in the system.

There are factors that can degrade the GPS signal and thus affect accuracy. The most important are:

- Ionosphere and troposphere delays - The satellite signal slows as it passes through the atmosphere. The GPS system uses a built-in model that calculates an average amount of delay to partially correct for this type of error.
- Signal multipath - This occurs when the GPS signal is reflected off objects such as tall buildings or large rock surfaces before it reaches the receiver. This increases the travel time of the signal, thereby causing errors.
- Receiver clock errors - A receiver's built-in clock is not as accurate as the atomic clocks on board the GPS satellites. Therefore, it may have slight timing errors.
- Orbital errors - Also known as ephemeris errors, these are inaccuracies of the satellite's reported location.
- Number of satellites visible - The more satellites a GPS receiver can "see," the better the accuracy. Buildings, terrain, electronic interference, or sometimes even dense foliage can block signal reception, causing position errors or possibly no position reading at all. GPS units typically will not work indoors, underwater or underground.
- Satellite geometry/shading - This refers to the relative position of the satellites at any given time. Ideal satellite geometry exists when the satellites are located at wide angles relative to each other. Poor geometry results when the satellites are located in a line or in a tight grouping.



- Intentional degradation of the satellite signal - Selective Availability (SA) is an intentional degradation of the signal once imposed by the U.S. Department of Defence. SA was intended to prevent military adversaries from using the highly accurate GPS signals. The U.S. Government turned off SA in May 2000, which significantly improved the accuracy of civilian GPS receivers.

With a GPS unit we always know where we are on the earth with an accuracy of usually up to 2 meters. Since it is basically also a small computer, we can also save the location of any point of interest and use it in GIS. This makes GPS a very valuable tool for collecting data on site that we can use in many GIS applications. In the following paragraphs you will be given hands on experience with location or the use of GPS, survey and how to import the data into Manifold System.

Functions of the GPS

For a hands-on demo and exercises to work with your GPS, please refer to the exercises manual. The description in this paragraph is based on the Garmin 76CsX GPS unit. A short manual on this unit and the Garmin eTrex Vista HCX are given on the DVD. For other units, please refer to the manual of your GPS. The principles will be the same, but the locations and appearance of buttons and functions may differ.

A GPS has many options, ranging from playing games to doing a survey or checking optimal times for fishing or hunting. With respect to this toolkit, the following options are important, so please read this before we start with the exercises.

GPS settings

1. After switching on your GPS unit, go to the **Main Menu** page. The Main Menu page is accessible from any page by pressing **Menu button** twice.
2. Select **Setup** 

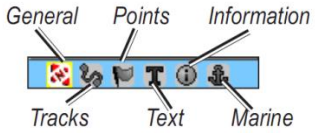
. Navigate to the **Setup** until it is highlighted using the **Rocker Key** 
3. From the **Setup** Menu select **Units**. The following tabs will be displayed: Position Format, Map Datum, Distance/Speed, Elevation, Depth, and Temperature. From the **Position Format** tab, adjust the format by highlighting the proper format. By default the format is hdd.ddd (decimal degrees), try to use the **hdd mm ss.ss (degrees minutes seconds)** format. Then press **Enter** 

key after selecting the proper format.
4. Navigate to the **Map Datum** tab. By default if the **GPS is new**, the datum would be WGS 84 (World Geographic System of 1984), change the datum to **Luzon Philippines** if you are navigating using a **NAMRIA Topographic Map**. But for this exercise we will just keep it as default the **WGS 84 datum**. Then press Enter key. For the Distance/Speed, Depth, and Temperature try to change the units to the Metric System (meters/kilometres, etc.).

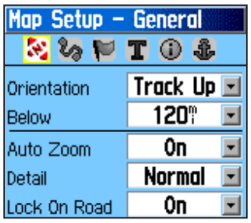
Setting up the Map Page

By default the Map Page is setup to its factory setting: every time you navigate using the GPS, the Map Page turns and orients to where the navigator is heading.

1. In the **Map Page**, press **Menu** > **Setup Map**. The top of the page contains icons for each setup page. Use the **Rocker key** to select a **page and** move up and down the feature fields of each page.



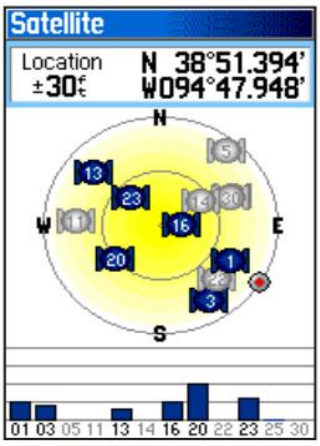
2. With the **Map Setup feature** selected, press **Enter key** to show the list of options for that feature. Each page has a sub-menu of general options. To access this menu, press **Menu** with the preferred setup page displayed.
3. For our purpose, we will just set up the **General tab** in the Map Setup page. The General tab contains the setting for Orientation, Below, Auto Zoom, Detail, and Lock on Road.
4. Use the **Rocker key** to select the **Orientation** and press



Enter > **North Up**. This will always show the Map page oriented to north as you travel or do your survey. Press **Quit button to Exit**.

Starting the GPS

When you start the **GPS** unit, **the first** activity will be that the GPS will search the sky for available satellites and will try to **make fix** (connect to available satellites). This is shown in the satellite screen. This screen provides a lot of information.



Satellite Page

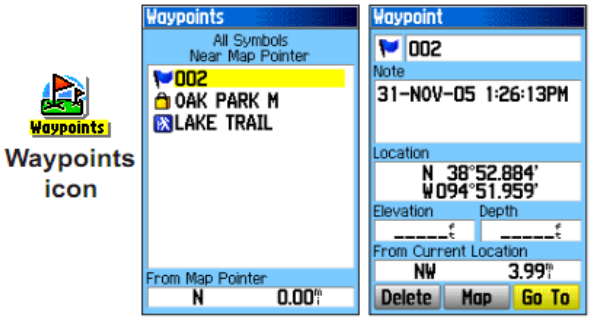
The centre of the screen is a representation of the sky around with the location of the available satellites. These are marked with their name (number) and location in the sky. The outer circle represents the horizon and the inner circle represents the sky at a 45 degree angle.

At the bottom of the screen are the names (number) of the available satellites. The longer the bar, the stronger the signal of this satellite is, if the bar is white, the satellite has been found, but a fix has not yet been computed. If a fix has been made, then the top part of the screen shows the current location and the accuracy of the GPS measure in meters. Once a fix has been made, the GPS is ready to use.

Please note the indication of the accuracy of the GPS position in the top right corner. Under good condition, this should be 5m or less.

Waypoints

Waypoints (also known as Point of Interest or POI) are specific locations that have been marked with a GPS and can be found back using your GPS. A waypoint can be anything you want, a house, a well, a barangay hall, a road intersection, etc. Using a GPS we can mark a specific location and save it as a waypoint. The GPS then stores the coordinates of the location and some other data (time, elevation etc.).



Using a separate logbook or notebook you can note down any other relevant characteristics and combine these later in your GIS. Once a waypoint has been saved, we can also use the GPS to find back the exact location, even if there are no specific landmarks in the area.

If you make a mistake by placing a waypoint at a wrong location, instead of editing it, you can also just delete it.

1. From the Waypoints page, select the waypoint you want to delete > DELETE.

   OR

2. If you want to delete all waypoints stored in the GPS: on the Waypoints page press Menu > Delete by Symbol (this will delete waypoints of the same symbol), then press DELETE.

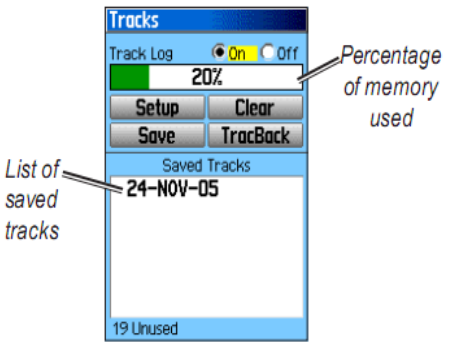
Note:

Be careful in deleting waypoints, especially if they have not been downloaded to the computer. Deleted waypoints cannot be recovered from the GPS unit.

Tracks

The track feature creates an electronic bread crumb trail or "track log" on the Map page as you travel. The track log contains information about points along its path, including time, location elevation, and bearing (direction). The track log starts recording as soon as the unit gets a location fix. The percentage of memory used by the current track log appears at the top of the Tracks page.

The track features can be used if surveying line features like roads, trails, or rivers. It can also be used to calculate the approximate area of a certain field (ex. Area of a rice field, coconut area, abaca, marine sanctuary, or a settlement area) on site, a feature that is very useful in Land Use Mapping. Take note that the GPS must be clear of any track log data.



Tracks Page

The process is simple; just take note that your starting point must also be your end point of the survey to close the area. You can also calculate the area later after processing in your GIS

Navigate to a location

Using a GPS we can navigate to a known location or coordinate

that has been stored in the GPS. Proper Map Datum must be set and the exercise will involve editing of waypoints.

Note: You can input or edit waypoints even in "GPS Off" mode.

1. Press and hold the Enter/ Mark key to capture a waypoint.
2. Do not press Enter again just in the conventional capturing of waypoint. We have to edit first the values of the waypoint.
3. Move the Rocker key up and down, left or right to highlight the desired values to be edited. This will take a while to learn but just think of it as learning how to use a new gadget (a new cell phone).
4. Always press Enter key if you are done in editing a certain value.
5. Input the desired coordinates and name of the waypoints that the trainers will give.
6. Press OK if you are done editing to save the coordinate.
7. Now you are ready to navigate.

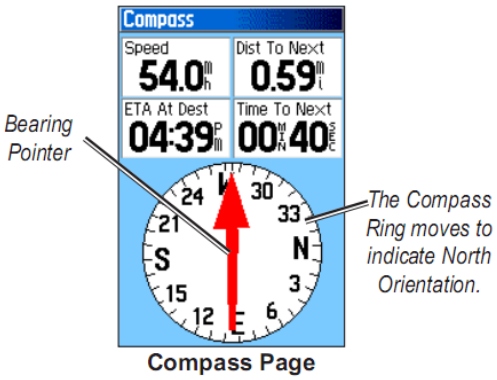
Navigating:
Go outside where there are no overhead obstructions (an open field) and turn the GPS unit **On**. Hold the GPS unit i**n** a proper way that the receiver will not be blocked so as to have an accurate GPS satellite signal. Once you have GPS satellites signal displayed on the Satellite page and a good accuracy (<10 meters), press **Find key** > **Waypoints**. The Waypoints list page will be displayed, select the waypoint that has been saved earlier. Highlight Go To**.**

Hint Many GPS units have a 'proximity' option. This feature sets an alarm when you are nearing a selected waypoint. Very useful in finding back features.

1. Try to use the other GPS pages that can be very helpful in navigating: the **Compass page,** the **Map page** and the **Highway page** (the **Highway page** is automatically activated once you are navigating to a location).

2. Depending on your actual and derived location and transport, select either on road (GPS will navigate over road in your map) or off-road (as the bird flies).

The compass page guides you to your destination with a graphic compass and a bearing course pointer. The rotating compass ring indicates the direction you are heading. You may choose between the **bearing pointer** and **course pointer**. The bearing pointer indicates the direction to your destination, and the course pointer indicates your relationship to a course line leading to the destination. To select between bearing pointer and course pointer, while in the **Compass page** press **MENU** -> highlight the bearing or course pointer option and press **ENTER** to start. Using the boon in your GPS you can get a warning (beep) when you are nearing a location that you want to find back. To turn off the navigation, while in the Compass page, Map page, or Satellite page, press **Menu** -> **Stop Navigation**.



Compass Page

Doing a GPS Survey

(after HLURB Cookbook at http://www.cookbook.hlurb.gov.ph)

Know your receiver

A GPS receiver is a new device for many people and you should familiarize yourself with it. This can save time, resolve problems in operation, and prevent accidental data loss. Read the manual. Know the specifications of the GPS model, set-up, functions, usage, and the limitations of the gadget. Find out what operations would result in data loss (reset, delete, clear track records, etc.), in order to prevent accidental data loss. Take time to practice using the receiver before conducting an actual survey. Practice set-up procedures, data collection, transfer and deletion. Observe battery life of the GPS receiver. This is important in planning the survey and in case there are no available spare batteries for the unit.

Plan the survey

A GPS survey will consume time and resources (gasoline for the vehicle, manpower, etc.). Here are some things to do in planning the survey.

1. Prepare a map of the area to be surveyed and have it printed in a size that can be easy to write on and read while in a moving car or outside the field.
2. Find source persons (local guides or coordinate with the LGU) for the places to be surveyed if you are not familiar with the places and plan the survey routes on the map together.
3. If working in teams, assign which areas to cover and alternate areas to survey in case the survey is completed early or if problems arise for primary areas.
4. Consider hazards and risks that may be encountered in the survey areas (flash flood areas, road conditions, etc.) to avoid delays and prevent any untoward incidents from happening.
5. Plan who to bring with the team, what type of vehicle to use in certain areas (model, marked or unmarked,

etc.) to avoid physical (rough road) and social (presence of insurgents or areas controlled by rival political parties) constraints. Bring along a resource person for the areas during the survey if possible.

6. Plan which information you also need to collect aside from the location (item like description, size, land use, building type, etc.)

Prepare materials before conducting the Survey

- Prepare data sheets for the GPS readings. This serves as the backup for the data and a much easier way to write down notes. Use a clipboard folder for writing data in the field. An example of a GPS data capture sheet is found in session 6.04 of the HLURB GIS Cookbook. (see http://www.cookbook.hlurb.gov.ph)
- Bring spare batteries; otherwise make sure to fully charge the battery before going to the field.
- Bring a digital camera if available and take pictures of the areas being surveyed.

Before leaving for the survey

- Check the weather if GPS survey is possible.
- Check if all materials are good and ready to go to avoid any delays.
- Initialize and set-up the instrument before going out to the field
- Turn on the GPS receiver and apply appropriate settings. Find an open space with a good view of the sky and wait for the GPS to set-up. Once the GPS is set-up, take some test readings. Take note of the accuracy of the test readings. This will serve as an estimate for the next readings.

Getting the readings

- Locate an open area on the area to be surveyed. If the area is a small building (less than or equal to two floors), find an area near the structure that will still have a good view of the sky. Note that thick canopy for trees are also contributing to the low GPS signal strength.
- Get GPS readings on the area and observe the accuracy. Wait for the accuracy to stabilize, at least to a meter level and take note of the highest accuracy level possible. Many GPS devices have an option for averaging (AVG). This feature takes many readings from one location and by doing so improves the accuracy of your reading. Save the reading when the accuracy is within

the highest stable reading possible.

- Record the readings on the data sheet and the point number recorded in the GPS.
- Take pictures of the area using a digital camera and record the photo number/s in the data sheet for the corresponding point.

Notes

- Be consistent in what you mark: take readings from the same area per feature type. (e.g., flagpole for all schools, front of building for all Barangay Halls).
- Stay away from tall buildings and sources of strong electrical current or interference (e.g., transmission lines, substations, electrical generators, cell sites);
- Track reading is a feature common to GPS receivers. It records the route of the survey as points that can also be downloaded into the computer. Turn this feature on whenever available. Clear track readings in the receiver whenever starting a new day for survey but before doing so, make sure it is already downloaded and saved in a computer.
- Take note that track readings (called 'track logs' in some models) is different from point readings ('waypoints' in some GPS models) to prevent any accidental deletion of other data stored;
- Set-up the GPS using the above procedure whenever it is turned off (e.g. lunch break);
- Download the readings (points and tracks) to a computer after a day's work.
- If you are doing a big survey, it may be good to let the GPS take care of the numbering of your waypoints. Do not change these since the GPS will automatically increment and add unique numbers. In your log file or datasheet you can add descriptive information on the waypoints (attribute data).
- Make sure that you collect all the information you need in one lesson since going back to collect additional information is bothersome, expensive and time consuming.
- The compass page also is activated during navigation, but you must be in motion to let the GPS satellites calculate where you are heading to give you the bearing towards the desired location.

Hint Your GPS unit comes with some free data from the Philippines. However, this free data is low in quality and completeness. In order to receive a good base map of the Philippines (for Garmin users), you can join the free GPS mapping project Roadguide Philippines at http://www.roadguide.ph/. After registration you can download a good GPS map of the Philippines. Using MapSource you can upload it to your device. You are also invited to contribute your own data. If you do that you can place your municipality on the map (and stimulate tourism because suddenly GPS users can find roads, restaurants, resorts etc.) and in return you can download an even better map. A win-win situation!

Another source of update for your internal base map of your GPS device is through this link http://esambale.wikispaces.com/osmphil_garmin. This site provides the road data from openstreetmaps - a free worldwide map, created by people like you. The data is free to download and use under its open license. You can create a free account if you register to http://www.openstreetmap.org/ and start adding your own data set to map out your area. The site regularly updates its data so it is better to check from time to time if there is one.

Now it's time to go outside for a demo and do a number of GPS exercises:

- Check the GPS settings
- Mark a location with a waypoint
- Change the characteristics of a waypoint
- Set up a track
- Find back a location
- Delete a waypoint
- Collect waypoints for georeferencing

Exercise 2.1

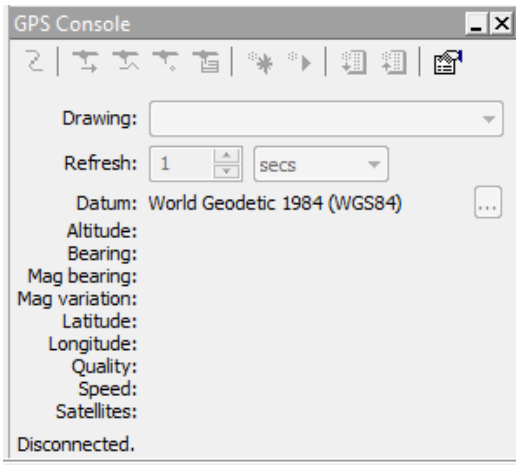
Introduction to GPS

Importing GPS data into Manifold System

There are a number of ways to import data from the GPS into the GIS and with developing technologies and insights these methods are changing. This manual will describe two different methods. These methods are necessary since not in all cases does Manifold System GIS recognize the GPS if it is connected to a computer. The first method is by directly importing data from the GPS into Manifold System GIS, the second one is by using a free support program called DNRGPS.

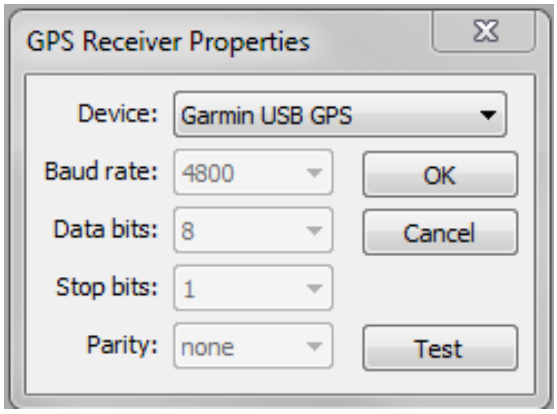
Working method using Manifold System GIS

To use the data collected with our GPS in Manifold System, they have to be imported. In order to do this we have to open the GPS pane using **tools→customize→GPS console. The following pane will appear**



Next connect the USB unit to the computer using the USB cable and switch on the GPS.

When the GPS is connected, use the first button  to connect to the GPS (or to disconnect). If the GPS unit does not automatically appear, then press the properties button  and change the settings

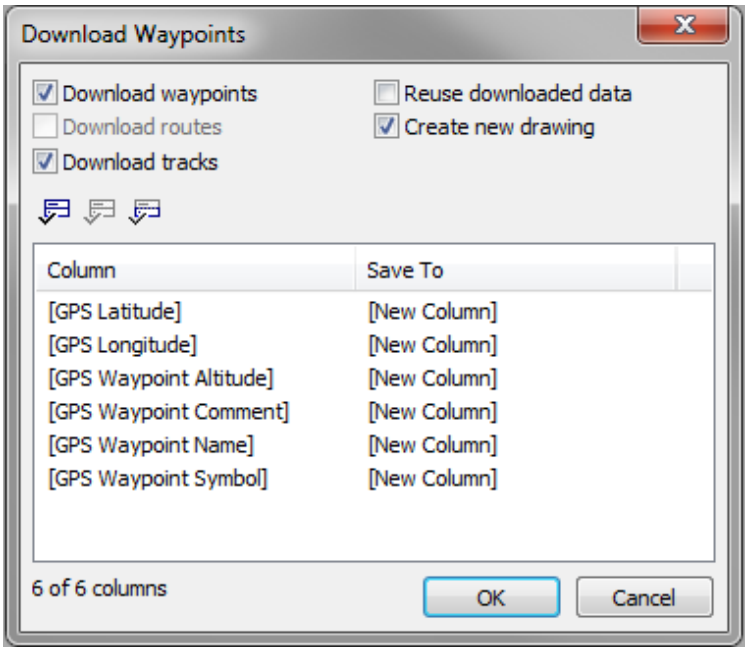


Make sure to select the right device (GARMIN USB GPS) (for other brands these settings may change. Please refer in those cases to the Manifold System help on how to connect a

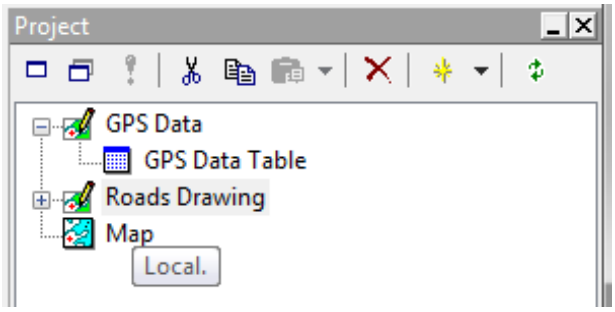
GPS).

Hint If your Garmin GPS unit is not automatically discovered by Manifold System, make sure that you have the correct USB drivers installed. Please refer to the CD with the Garmin software for those drivers. Alternatively, if you install Map Source from Garmin, the correct USB drivers will be installed.

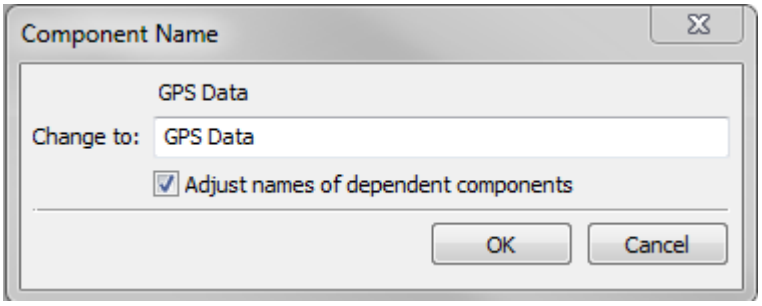
If the GPS is connected, download the survey data using the download waypoints button . The following menu appears:



Check all (download waypoints, routes and tracks) and click **OK**. Wait until the DATA DOWNLOAD is complete and automatically your GPS Data will be on the Project Pane. Then press the connect/disconnect button to safely remove your GPS device and then switch OFF the GPS to conserve battery. Press the connect/disconnect button before physically disconnecting the unit to avoid data corruption and error to your device.

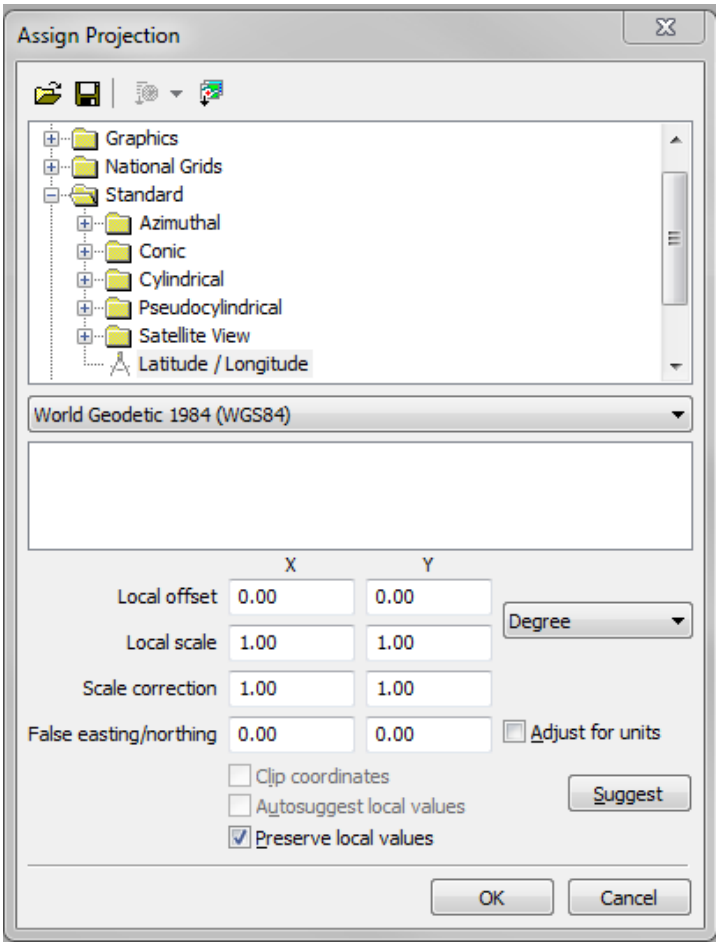


In the project pane, there is a new Drawing component named GPS Data and if desired, this can be renamed to a more logical name. To rename the dataset use the right mouse button on the component and select Rename



Make sure that the box for "Adjust names of dependent components" is checked so that the renaming is done consistently for all components. After this, it is good practice to make sure that the data are set in the right coordinate system (more on that in Lesson 4). In Manifold System this is a two-step process. First make sure that the current projection is assigned correctly the next step is to change it into a new one.

1. To do so, again right mouse click on the name of the component in the project pane, and select Assign Projection.



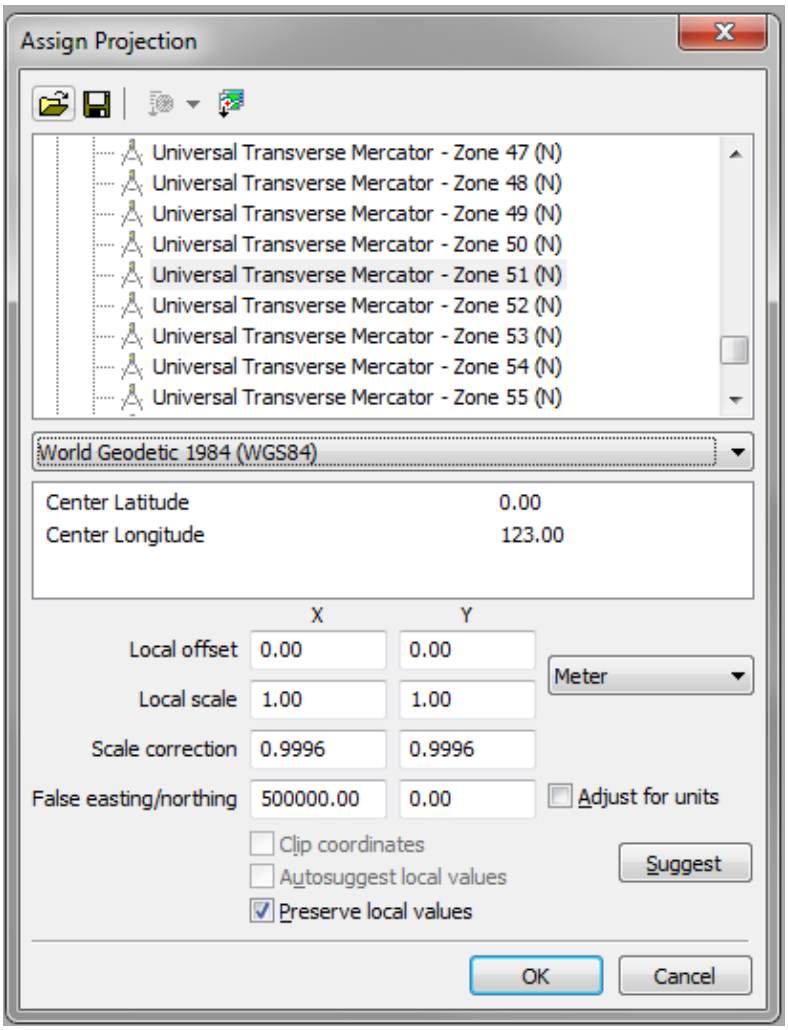
2. Click **Ok** to assign the projection and then right click again on the name of the component in the Project pane, but now select **Change Projection**. Change from the current Latitude/Longitude to UTM (Universal Transverse Mercator).

3. Click on the checkbox in front of **standard** to close this tab and open the tab for **Universal Transverse Mercator**

4. **Navigate to** Universal Transverse Mercator – Zone 51 (N)

5. In the field underneath Just leave the Datum as is, **World Geodetic 1984 (WGS84)**

6. It should look like this (*see next page)*:



And click **OK**

To finalize the Projection: Right click again GPS Data, then click **Assign Projection**…and click **OK**.

Your drawing with GPS data is now ready for use.

Depending on the data of the survey it may contain the following data:

- Waypoints (as points)
- Tracks (as lines)
- Routes (as lines)

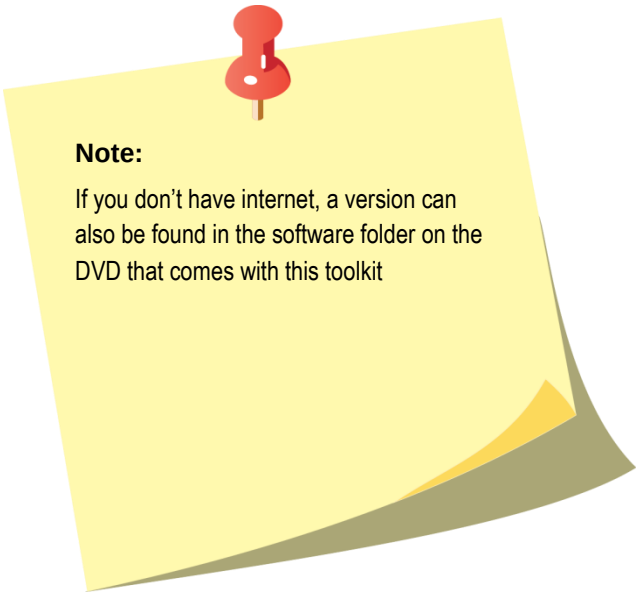
Exercise 2.2

Import GPS data into Manifold

Working method using DNRGPS

DNRGPS is an Open Source program that provides users with the ability to transfer data between handheld GPS receivers and GIS software. DNRGPS: accommodates newer GPS models; and is available for the Open Source community to modify and share. The program can be downloaded here:

http://www.dnr.state.mn.us/mis/gis/DNRGPS/DNRGPS.html



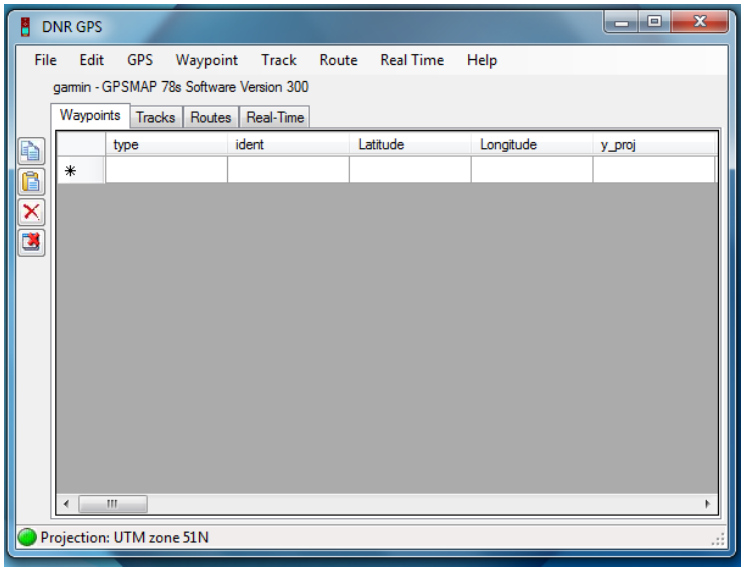
Installation is simple: DNRGPS is a self-contained program which means it can be run from anywhere – a hard drive, an usb drive, a network location. Simply unzip the DNRGPS folder and place in the location of your choice.

The working procedures are as follows:

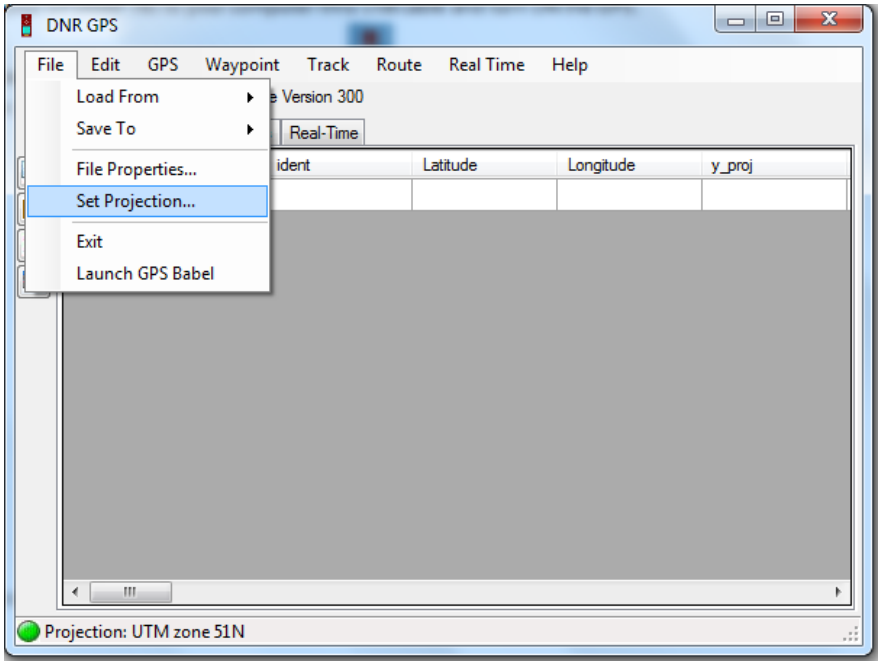
1. Connect your GPS unit to the computer through a USB cable and turn the GPS unit **ON**.

2. On your desktop shortcut icons, double click the 

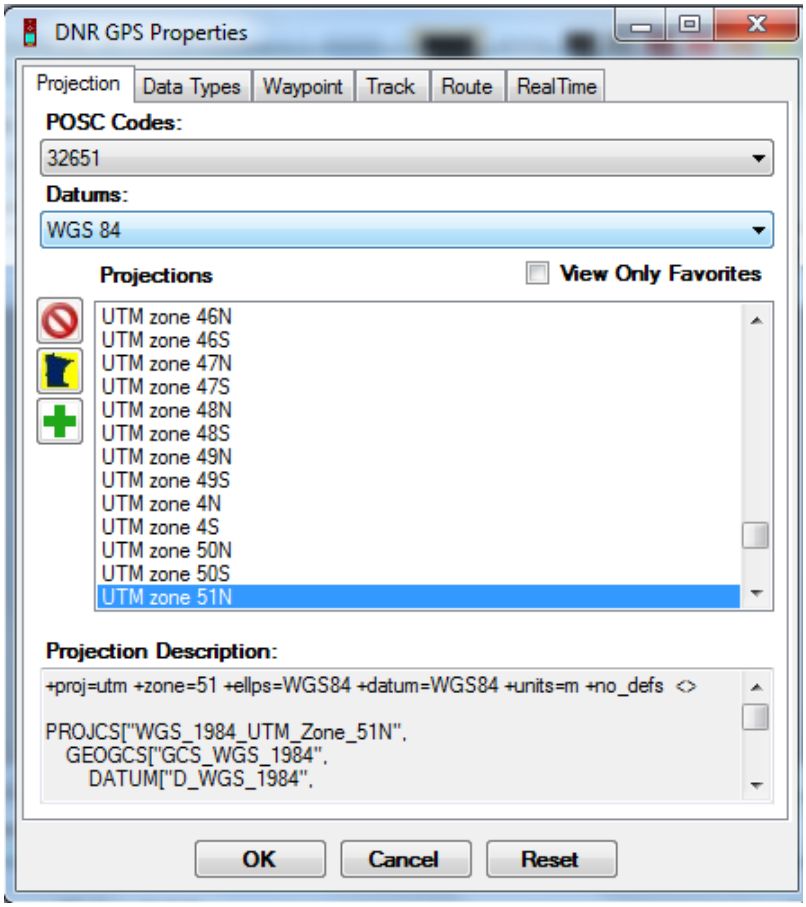
dnrgps program which is installed in your computer.



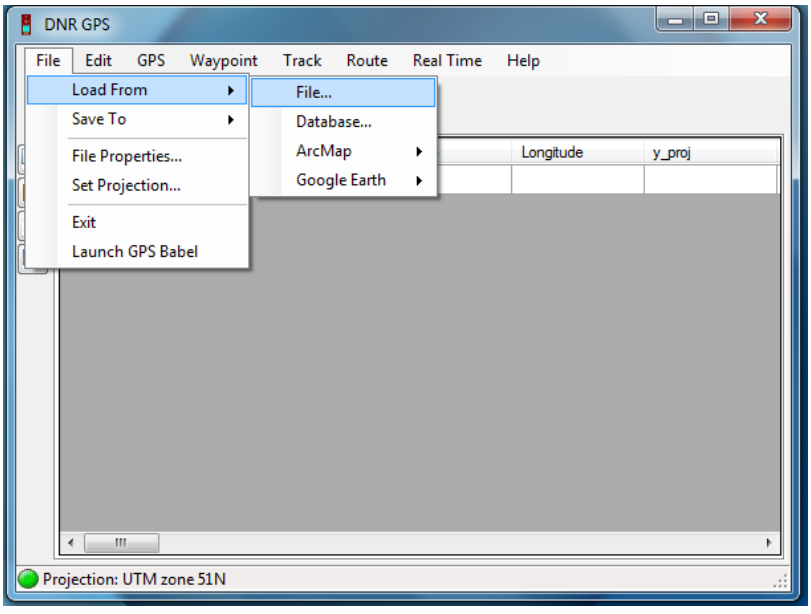
3. The DNR GPS program will open; click **File** → **Set Projection…**



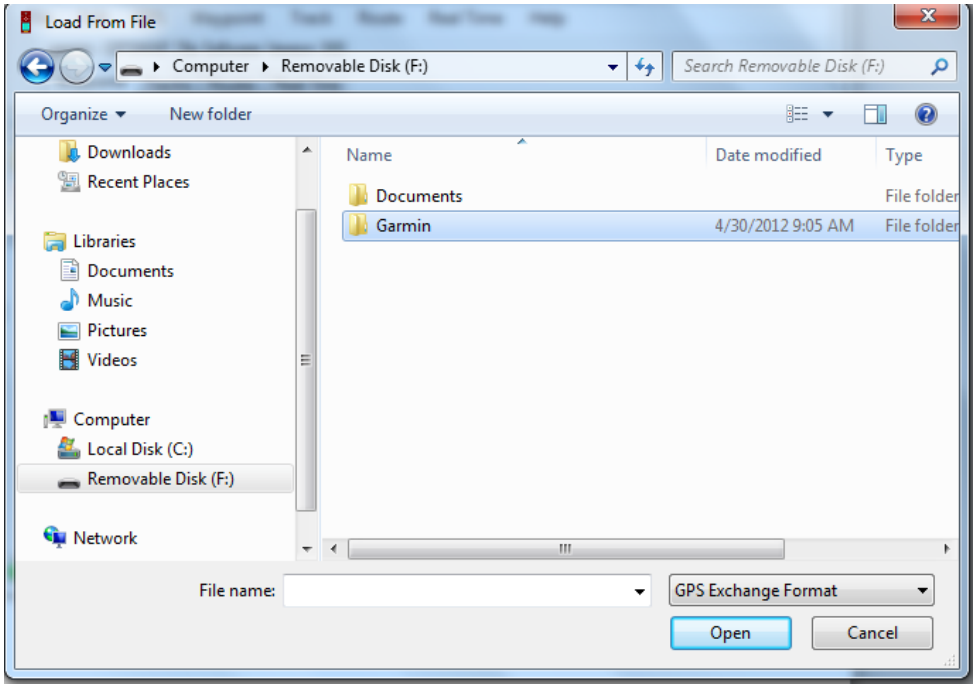
4. The **DNR GPS Properties** window will appear. Select **WGS 84** as Datum and **UTM zone 51N** as Projection.



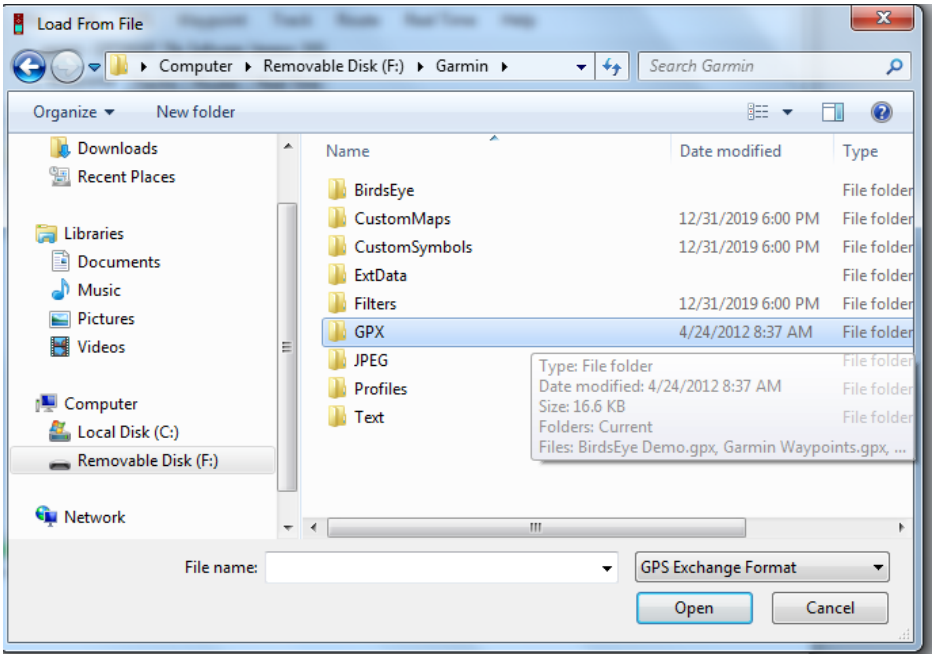
5. Close the DNR GPS Properties window. Click **File** again → **Load From** → **File…** to browse your GPS data.



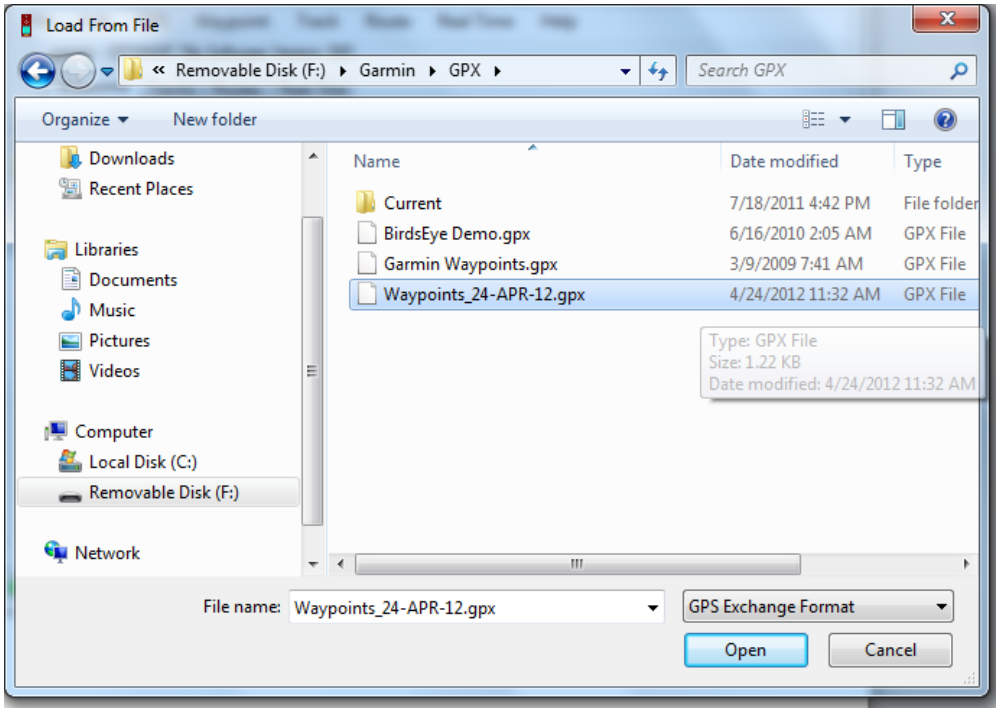
6. The **Load From File** window will appear, go to **Removable Disk** which is your GPS internal memory, click on the **dropdown arrow** at the right side lower part and select **GPS Exchange Format** (*.gpx) as the default file format of the GPSMAP 78s, then find the **Garmin** folder and double click to Open.



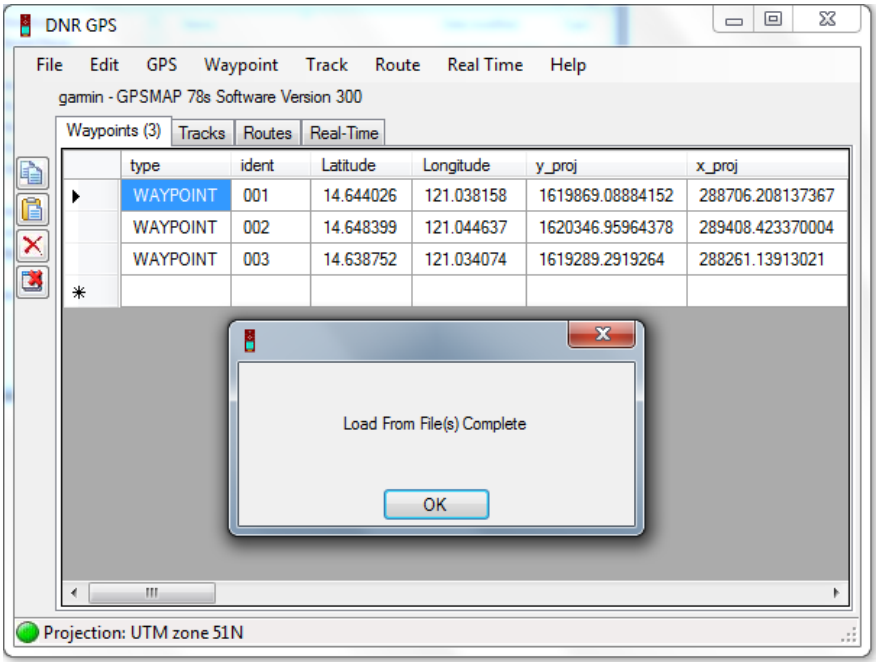
7. Under Garmin folder, double click **GPX** folder to Open.



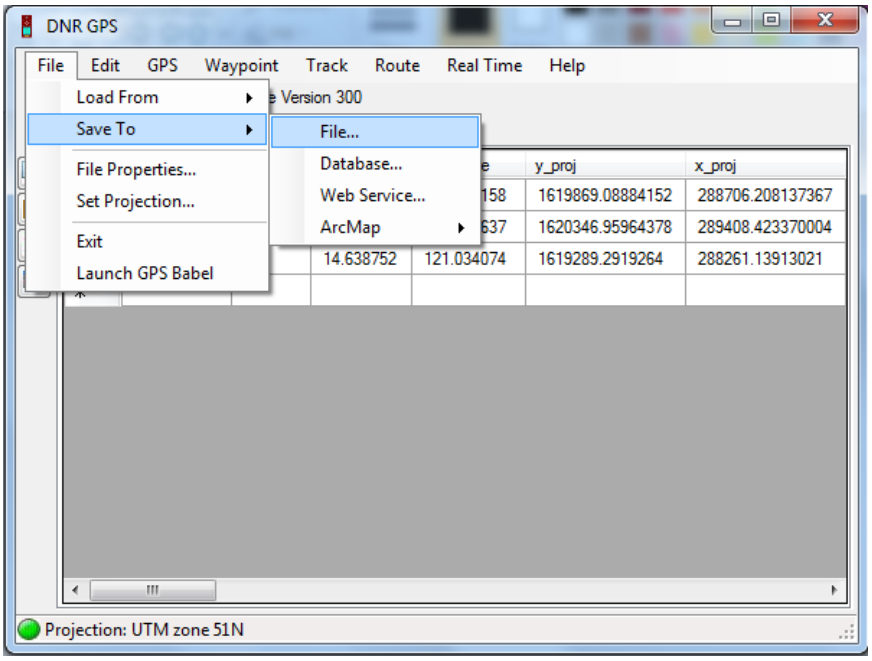
8. Now, the saved data are in this folder from the GPS unit indicating the dates being modified. For example, select **Waypoints_24-APR-12.gpx** as the latest GPS waypoint data and click OPEN button.



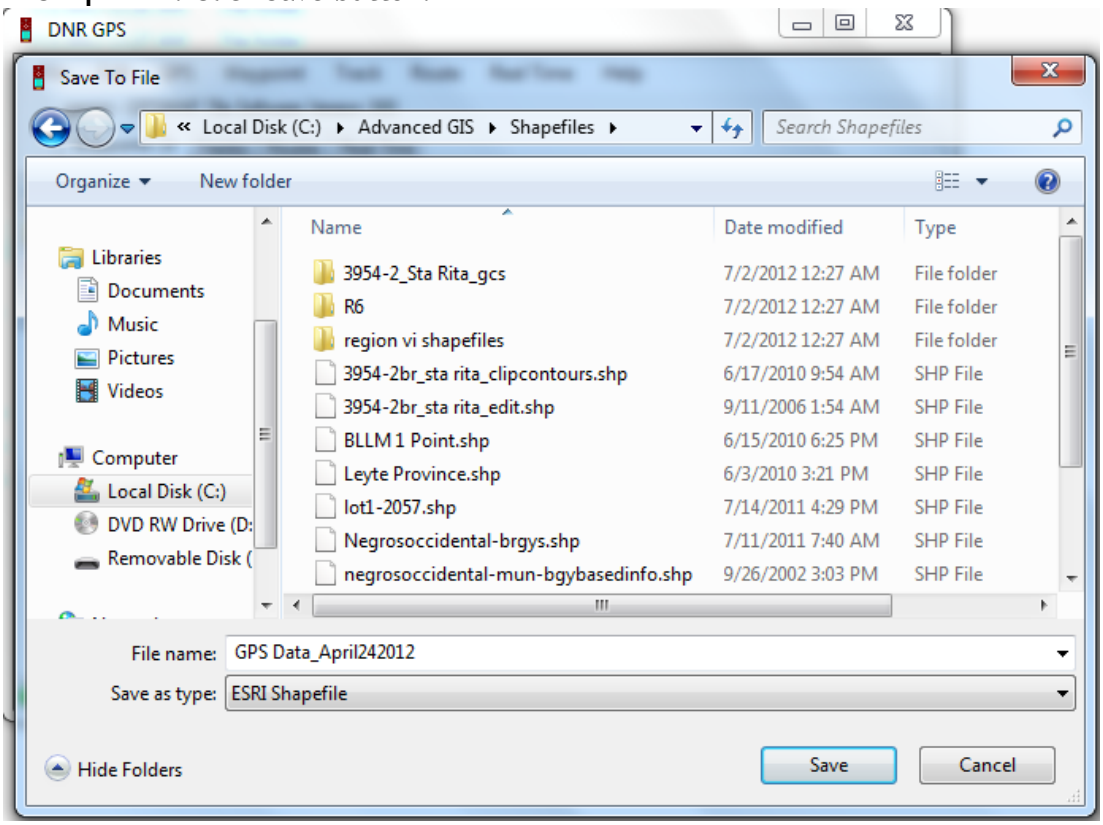
9. The **Load From File(s) Complete** dialogue box will appear. Click OK.



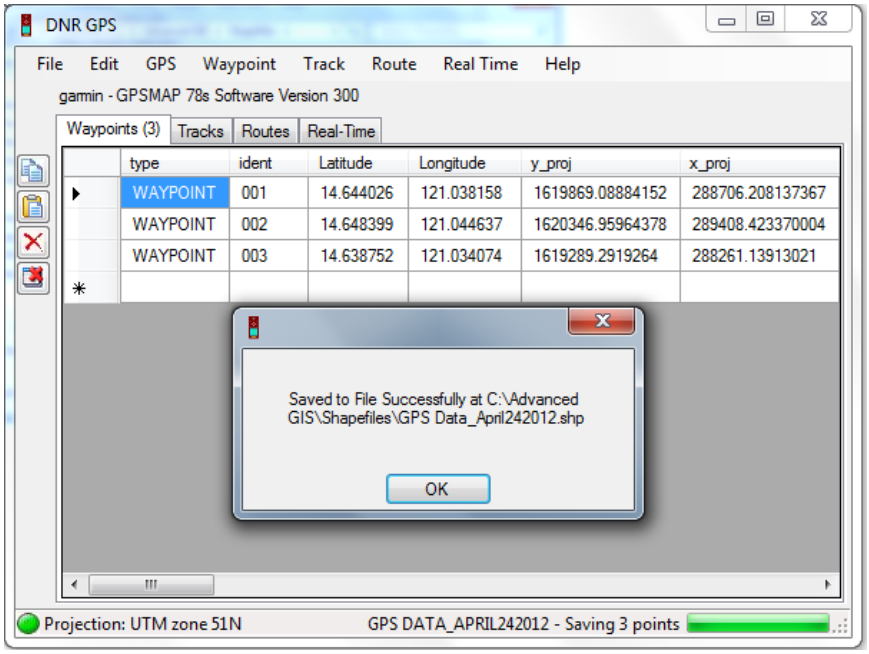
10. Click **File** again → **Save To** → **File…**



11. The **Save to File** window will appear, navigate to the desired directory for saving from gpx converted to shape file data. Then put a File name e.g. **GPS Data_April242012_Waypoints**, and the Save as type: must be **ESRI Shape file**. Click Save button.



12. The **Save to File successfully**...dialogue box will appear, click OK.



The downloading of tracks and routes can be done in a similar way as the waypoints.

Exercise 2.3

Import data using DNRGPS

Hint Both Manifold GIS and DNRGPS can also be used to upload your GPS Roads to be checked and location to be visited can be prepared in GIS and used in your GPS

Possible errors

When GPS points don't align with GIS Data:

It's most likely a projection issue if:

- There are huge errors…data points do not overlay
- Features could be displayed in wrong state or hemisphere!

It's most likely a datum issue if:

- GPS data overlays with GIS data, but off by several meters
- Differences between Luzon 1911 and WGS 84 can be as much as 200 meters

This creates problems when doing analysis especially with Land Use and Parcellary information.

Coordinate Reference System

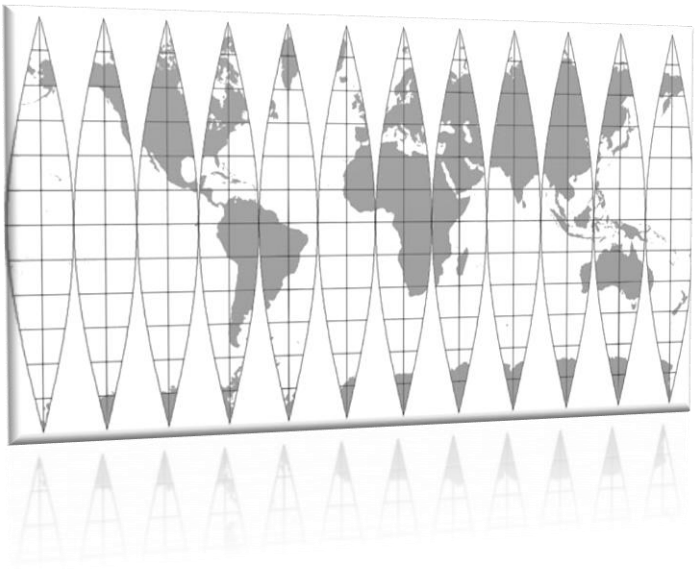
Drawings and images can be utilized in Manifold System from many different sources. Drawings come in many different sizes using different scales. Images can be everything from a photograph scanned on a desktop scanner at 1200 DPI, where one pixel is less than a thousandth of an inch in size, to a data set acquired by satellite where every pixel is representing a square kilometre of the Earth's surface. It may be clear that if we want to use different drawings or images together in a map we will often ask the system to enlarge or reduce them in some way so their scales match up. If we want to use drawings or images together in a map, we will also need some way of specifying the desired geographic position of the images so that Manifold System can draw them correctly aligned together with drawings or other images in a map window.

Drawings are for the most part simply lists of the X, Y coordinates needed to draw the objects they contain. If we make a drawing on a piece of graphing paper with a fine grid, we could measure the X, Y coordinate of every corner point of every rectangle by counting the little boxes from the origin in the lower left corner of the paper, just like we do with graphs. This means that every location in our map can be described with a pair of X and Y coordinates.

The list of coordinates will allow us to reproduce the drawing in the future, but it does not tell us the size of the paper used or what each "unit" is intended to represent in real life. For example, if we originally used a graphing paper with a one millimetre mesh to measure coordinates and then one day re-created our drawing using graph paper that had a 1/8-th inch mesh the two drawings would not be the same size. Likewise, it makes a big difference if each unit is supposed to represent one inch or one centimetre.

We could add some **metadata** ("data about the data") to the drawing by writing in a note: "one drawing unit equals one inch" to tell us the scale. This would allow us to make measurements in our drawing and to compare those measurements to real life. "Smart" drawing formats used to save digital drawings will save the intended scale together with the lists of coordinates. This allows programs that read such formats to automatically have the correct scale into account. Surprisingly many formats fail to take this simple step. We can specify which way our drawing faces in "real life" by assuming that North is always up in the drawing. By doing this, we can assume that Y coordinates going in the positive direction are headed North and that positive X coordinates are headed East. We could also add metadata that specify where the drawing is located on the Earth. Such a metadata is called a projection.

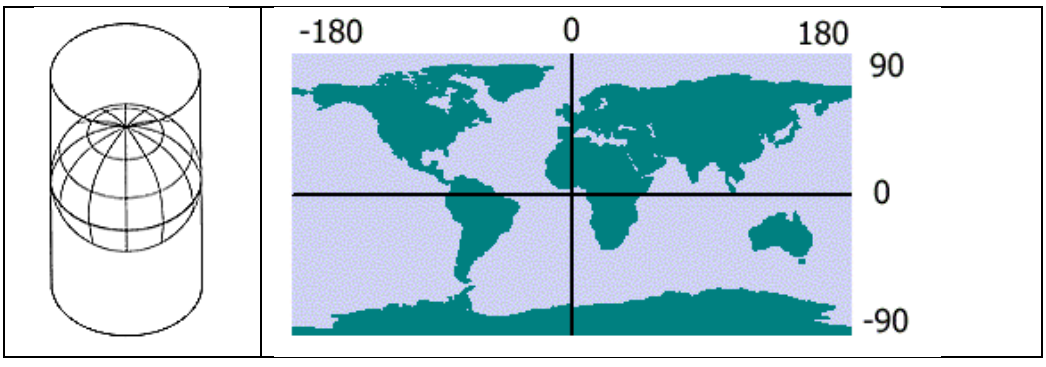
Geographic projections are a way of showing the curved surface of the Earth on a flat surface like a piece of paper or a computer monitor. Imagine we make a globe out of a flexible material with a world map painted onto the material. Now, let's cut the material and try to flatten it. If you've ever tried to flatten a deflated ball you know this is not possible to do without stretching the flexible material in some areas and compressing it in others. If we deform the peeled "skin" of our atlas globe in this way to make it flat we will end up changing the shape of continents and other items illustrated in our world map.



The earth (as a globe) peeled to present as a flat area (from nonprofitgis.org)

There is no single way of projecting the curved surface of the Earth onto a flat sheet that does not cause some distortion, and there is no one projection that is suitable for all purposes for which people use maps. However, for virtually every usage there are projections that minimize distortions of importance for that task. For example, if one needs to measure areas in a flat map there are projections that will guarantee the area contained by various shapes is correct even if the shapes of the objects shown appear quite differently than they do on a globe. Other projections do a good job of showing continents in a shape similar to that seen on a globe even though they do not allow for accurate measurement of areas.

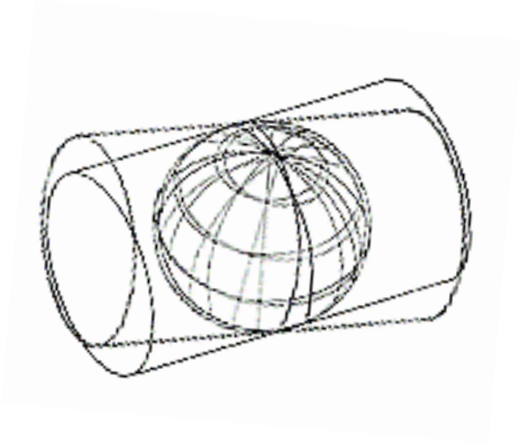
Any shape that is curved in only one direction can be unrolled into a flat map without distorting the appearance of objects drawn on it. For example if we take a cylinder and cut it lengthwise we can unroll the cylinder into a flat map. The trick to any elementary projection is to place the Earth within such a shape and to "project" lines out from the Earth onto the shape to show where to draw the projected outlines of items on the globe. We can then "unroll" the shape and see our projected map on a flat surface.



The first and most obvious such projection to use is a simple **Cylindrical Projection**. Place the Earth inside a big cylinder that touches the Equator and then transfer points on the globe to the cylinder. The simplest way to do this is to imagine the cylinder is graph paper with 360 boxes in circumference and 180 boxes up and down. If we use the longitude and latitude coordinates in degrees of a place on the sphere and transfer it to our cylindrical roll of graphing paper, we end up with a map like the above (*above figure*). Since one

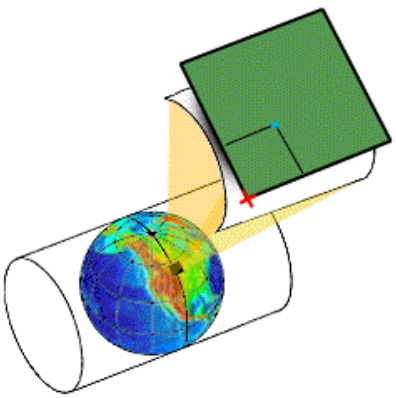
point needs to be the centre of the unrolled cylinder, nearly universal usage is to use the intersection of the Equator with the zero Meridian running through Greenwich, England. We can then count degrees plus and minus 180 degrees in longitude and plus and minus 90 degrees in latitude. This is called the **Geographic** or **Latitude / Longitude** projection. We can think of it as our default projection. It produces a good effect in areas near the Equator, but results in immense distortion close as measurements approaches the poles.

There are other ways of transferring points from the surface of the globe onto an enclosing cylinder. Most of these, such as the **Mercator Projection**, use some mathematical formula to alter the ratio between degrees of latitude on the globe and vertical measurements on the cylinder. What they all have in common is that accuracy is good near the Equator where the cylinder is very close to the globe. To a greater or lesser degree all cylindrical projections centred on the Equator fall off in accuracy as distance from the Equator increases. If we wish to make maps of places along the Equator we could use a cylindrical projection and just show those regions. What would be shown in those maps would be relatively free of distortion. One problem with this is that the Equator for the most part lies over water whereas the greatest demand for maps is in populated zones. A quick glance at a world map shows that most populated zones occur in a North-South direction.



Turning the cylinder so that it is tangent to the Earth along a meridian (longitude line) instead of tangent to the Equator results in what is called a **Transverse Cylindrical Projection**. We can now make local maps anywhere along the darker, North-South line of tangency and if the maps are not too big they will be relatively free of distortion. However, this only works along the line of tangency. If we pick a North-South line running through Athens we can make maps all the way from Scandinavia down the length of Africa, but any maps using this projection in North and South America would be hopelessly distorted.

One possible solution is to use not one projection, but many transverse cylindrical projections with the cylinder rotated slightly along the Equator. In fact, one scheme of mapping the Earth called the **Universal Transverse Mercator (UTM)** does exactly this. UTM maps the Earth with a transverse cylinder projection using 60 different lines, each of which is a standard "UTM Zone". By rotating the cylinder in 60 steps (six degrees per step) UTM assures that all spots on the Earth will be within 3 degrees of the centre, tangent line of one of the 60 cylindrical projections. To map any spot on Earth in UTM, one picks the UTM Zone centreline that is closest to it and then makes a map using that cylindrical projection.



The illustration above shows a small section of the earth near the tangent line projected onto the cylinder, and then the cylinder being unrolled into a flat sheet. If we want to save the X, Y locations of points on our flat sheet we can now measure them as though the flat sheet were graph paper and use the resulting coordinates in a digital, flat map.

There are many more projections in the world, but for this manual, we will not discuss them. The Manifold System Help Menu has more information on these projections.

Apart from the projection, we also need a Datum in our GIS to make sure our maps are an accurate representation of the world. While a projection is used in mapping to define the earth on a flat surface, a datum is used to describe the actual shape of the earth in mathematical terms.

Datums in the Philippines

Where the projection describes the way the round earth is transformed on a flat or two dimensional medium, these parameters are valid for the whole earth or large parts of it. In order to make this model fit better to the real world at a specific location, we need to add detail and this is done using a datum. A datum is a model of the earth that is used in mapping. The datum consists of a series of numbers that define the shape and size of the ellipsoid and it's orientation in space. A datum is chosen to give the best possible fit to the true shape of the Earth. There are a large number of datum in use. Many of them are optimized for use in one particular part of the world. An example, familiar to GPS users, is the WGS-84 datum. WGS-84 is an example of a datum that is used globally, but there are many locally or nationwide used datums as well.

Latitude and longitude are commonly used to refer to a specific location on the surface of the Earth. It is important to keep in mind that latitude and longitude are always specified in terms of a datum. The latitude and longitude of your current position are different for different datums.

However, some information has been provided. Please see Modules 2 for integration of climate change adaptation into local development planning, 3 for disaster risk reduction and management, 8.1 for integrating FLUP into CLUP and CDP, and 8.2 for CFRM-CLUP integration.

There are four common datums that are widely used in the Philippines:

Luzon 1911 is the most commonly used in the Philippines and most of the maps produced by NAMRIA are in this datum. It uses the Uses Clarke 1866 ellipsoid and its origin is located just south of Luzon at Balanacan, Marinduque Island.

Luzon Philippines, uses the baseline data as Luzon 1911, but is also adapted for use with GPS.

Luzon Philippines (excluding Mindanao), Luzon-Mindanao is not a separate datum; it is the Luzon 1911 datum with different WGS84 transformation parameters. Extreme care should be taken to ensure the use of the correct transformation. Since a point from the Luzon (sometimes called Luzon-Philippines) datum transformation will be approximately 10 meters north and 1 meter west of the same point transformed using the Luzon-Mindanao transformation. Some software programs identify Luzon-Mindanao as a

separate datum. This is incorrect.

WGS 84 is a commonly used worldwide datum and it has been developed from satellite measurements of the earth. Since satellite images are often published using this datum and the growing use of GPS, it is rapidly becoming the preferred datum around the world. Unlike most datums, the origin for WGS84 is the centre of the earth. Transformation parameters to convert from most national or local datums to WGS84 are published and can often be found in GIS software.

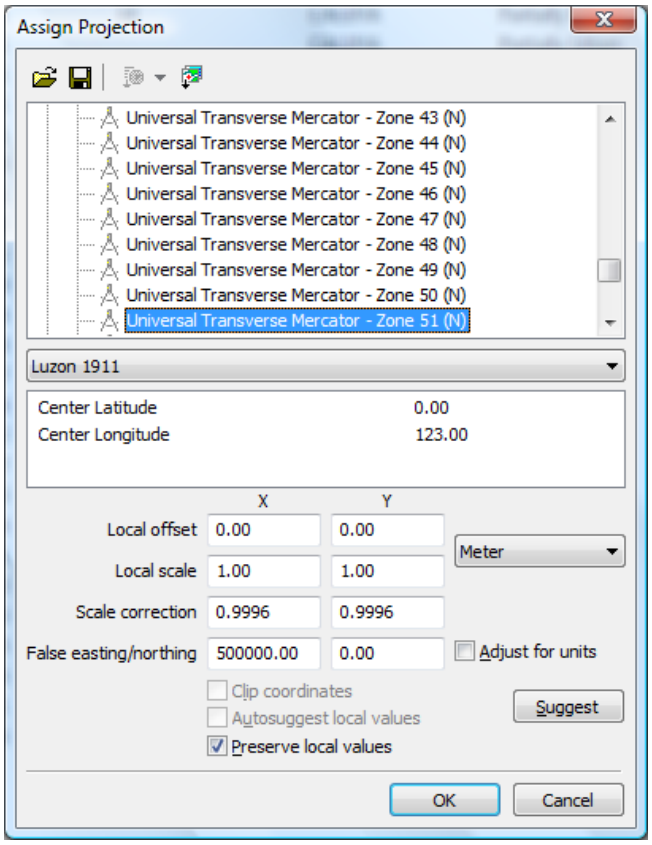
Apart from this there is the **Philippine Reference Datum of 1992** or **PRS92.** This was developed in 1992 by NAMRIA and it is not technically a new datum but an adjustment of the Luzon datum. PRS92 uses a total of 467 GPS locations, of which 330 are first order accuracy. The Luzon datum location network consists of survey data of second order accuracy or below. NAMRIA has published transformation parameters for PRS92 to WGS84 but there is no published accuracy assessment. This datum is gaining in popularity in the Philippines and the PRS92 can be installed in MANIFOLD SYSTEM GIS using the data in the DVD with additional information. The parameters and instructions have been downloaded from the NAMRIA website.

Projection Transformation/ Changing Projections

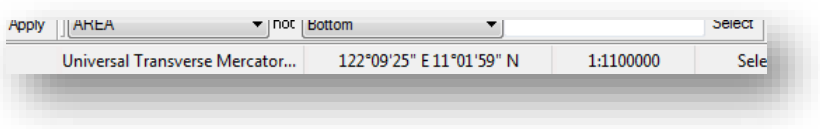
When a drawing or image is loaded that does not contain projection information, the software always asks to verify the original projection. After this, Manifold System is able to combine images and drawings having different projections in one map component "on the fly" – that is, the GIS software will automatically translate the internal drawing or image coordinates into whatever Projection is being assigned to the Map component without the need in changing the component's actual Projection.

To verify the original projection:

1. Right click the component in the **Project** pane, choose **Assign projection**.
2. The assign projection window opens:



3. Choose the original projection from the list. Press **OK**.
4. Be sure to verify if the coordinates make sense after assigning another projection. Check the coordinates of the mouse pointer in the Status bar portion which is located at bottom of the main Manifold System window. In the figure below it is in degrees minutes seconds.



When desired, the projection of the source data can also be changed after the original project has been verified.

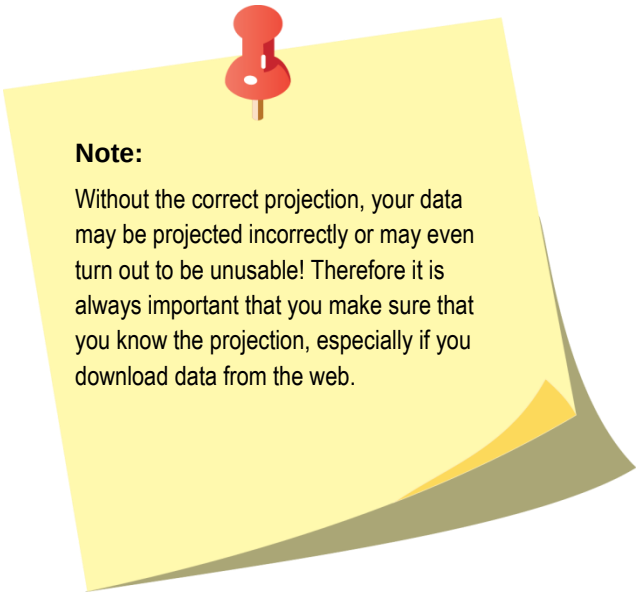
1. Right click the component in the **Project** pane, choose **Change projection**.
2. The assign projection window opens and then choose the target projection.
3. Press OK.

More information can be found in the help files:

Help > **Index** > type *georegistration*

Information on projections can be found on:

Help > **Index** > type *Projections Tutorial*



Note:

Without the correct projection, your data may be projected incorrectly or may even turn out to be unusable! Therefore it is always important that you make sure that you know the projection, especially if you download data from the web.

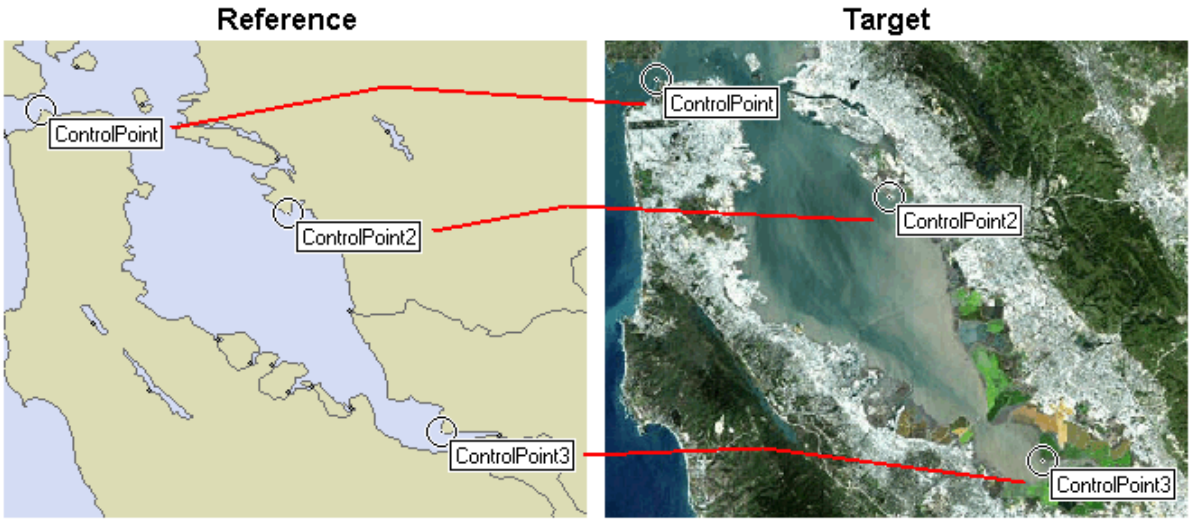
Exercise 3.4

Change the projection of a drawing.

Map Georegistration

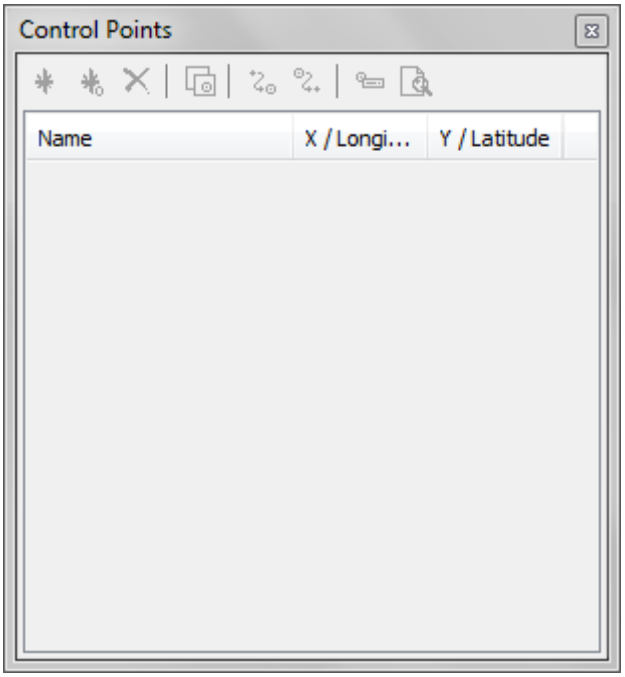
When we obtain a dataset that we want to use in GIS, we have to make sure that it is located at the right location of the earth and that it is in the right coordinate system. In some cases (purchased data) this will be the case, but in others we have to do this ourselves. For instance if we want to use scanned paper maps, data exported from AutoCAD and screen captures from the PC. The process to fix these data on the earth is called geo referencing or georegistration and can be described as the process of adjusting one drawing or image to the geographic location of a "known good" reference drawing, image, surface or map. For a quick discussion, this topic and other georegistration topics use images as examples. However, the same procedures apply when georegistering other components such as drawings or surfaces.

The drawing, image, surface or map being used as a reference is called the **reference component**. The drawing, image or surface being adjusted is called the **target component**. The example below shows the general idea.



Control points are used geo-register images, surfaces, drawings and labels components. During geo-registration the target image will be re-projected to match the reference drawing using the control points as a guide. The image above shows conceptually how control points in a reference drawing are matched up with equivalent control points in a target image.

Use the Control Points pane to add new control points to a drawing, image or map. Control points are used to georegister a target image or drawing to the same geographic location and projection used by a reference image or drawing. The Control Points pane can be opened with Tools -> Customize - > Control Points. When opened, it looks like this:



The Control Points pane always shows a list of control points defined for the active image or drawing together with their coordinates. When we click on a different window the Control Points pane will switch context to show any control points defined for the active window. The Control Points pane is also used to rename control points or to change their location by changing their coordinates. We can click into the Name field to change the name from the defaults, if desired. To change the coordinates of a control point we click into their X / Longitude or Y / Latitude fields.

The following are the main options in the Control Points Pane

	New Control Point - Add a control point by clicking with the mouse in the component window. A new control point will be added in the Control Points pane.
	New Control Point - Add a control point by clicking with the mouse in the component window. A new control point will be added in the Control Points pane.
	New Control Point - Add a control point by clicking with the mouse in the component window. A new control point will be added in the Control Points pane.
	New Control Point - Add a control point by clicking with the mouse in the component window. A new control point will be added in the Control Points pane.

For more information, please use the **help** *and search for* **Control Points**

Control points are matched by their name. For example, the spot marked by a control point named "ControlPoint2" in the reference drawing will be matched to the location in the target image marked by a control point that is also named "ControlPoint2." Control points may be called by any names so long as the names used for control points within the reference component or target component correspond to the same location. For example, we could use the name "Church entrance" for control points in both the reference component and the target component. These two points with the same name will be matched during the geo-registration process. The choice of names is free. Some users prefer long, descriptive names while others prefer short names.

Adding a Control Point to a Component using the Mouse:

1. Import both the image to be geo-registered (target component) and the reference (either drawing or image).
2. Then go to **View**-> **Panes**-> **Control Points**. This opens the **Control point** pane.
3. Open one of the components. Zoom into the location where the control point is to be located if greater accuracy is required. Use the Navigation toolbar for these OR the wheel mouse button for faster zooming.
4. Click on the **New Control Point** button () in the Control Points pane's toolbar.
5. Click the location in the component where the control point should be. It will appear in the drawing and a new control point row with coordinates will appear in the Control Points pane.
6. If the name assigned to the control point by default is not logical, double click onto the name to change it.
7. Now do this alternately for both the source and the target component until you have at least 3 (more is better) matching points. Best is to scatter the points across the image and around all the borders.
8. When enough points have been entered, press the registration button () and the **Georegistration Dialog** opens. Enter: **Reference** - The name of the drawing or image to be used as a source of control points to be used as reference points.
9. **Method** – Choose the algorithmic method used for triangulation: Affine (triangulation), Affine (scale, shift, rotate), Simple (scale, shift) or Numeric (polynomial). For less distorted mass Affine (scale, shift, rotate) is normally sufficient. In case it does not give good results try numeric (polynomial) with **order** 2.
10. Press **OK** or refer to **Help**-> **Index**-> type *control points* for more advanced settings.
11. The image is being registered, this can take a while.
12. It will assume the coordinate system of the reference image/drawing.

Exercise 3.5

Georeference a map to GPS obtained coordinate points.

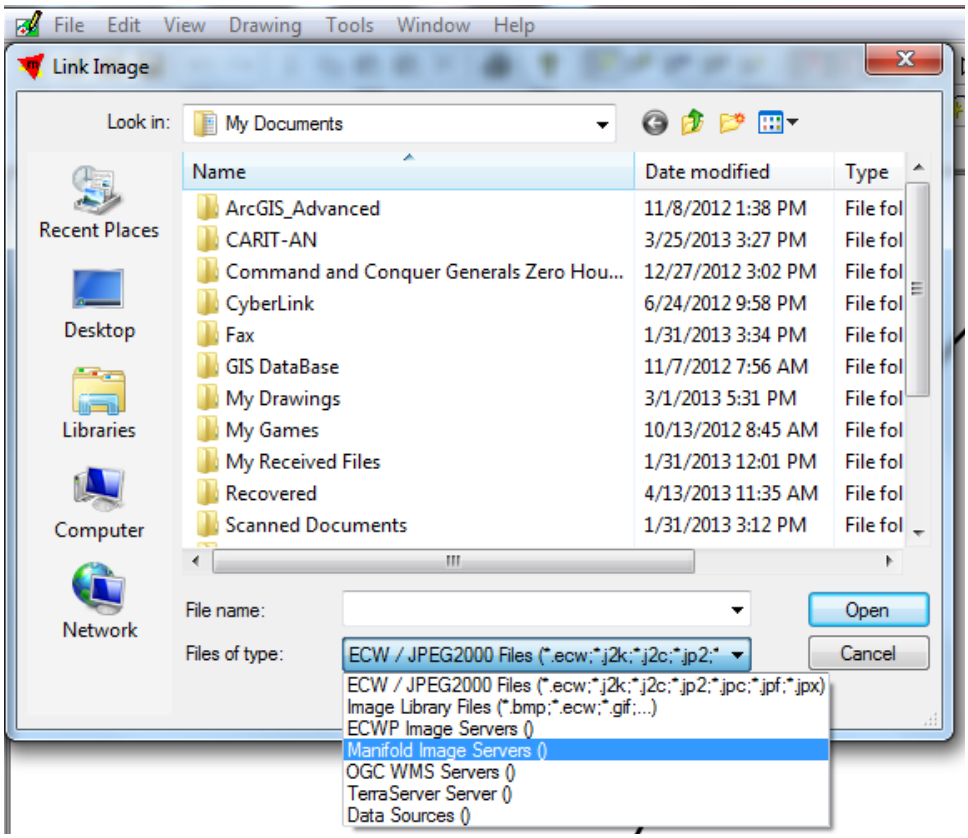
Exercise 3.6

Georeference a scanned (or downloaded) topographic map using known coordinates.

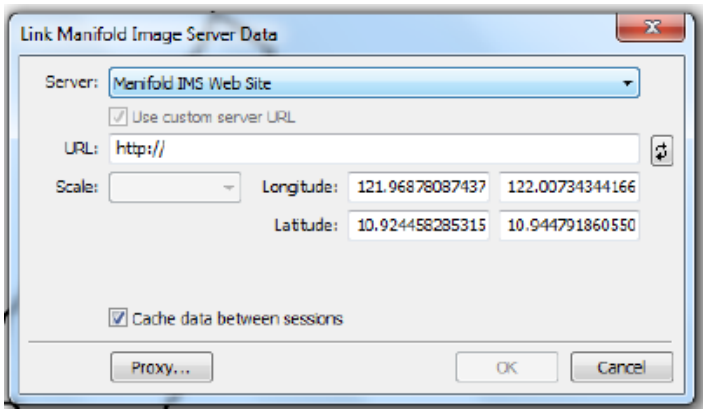
Adding online images in Manifold

With the growth of online images like Google Earth and Bing Maps, there are now also options to have a live connection with these services in Manifold System. The relevant data can even be saved and used as background image when you are not on-line.

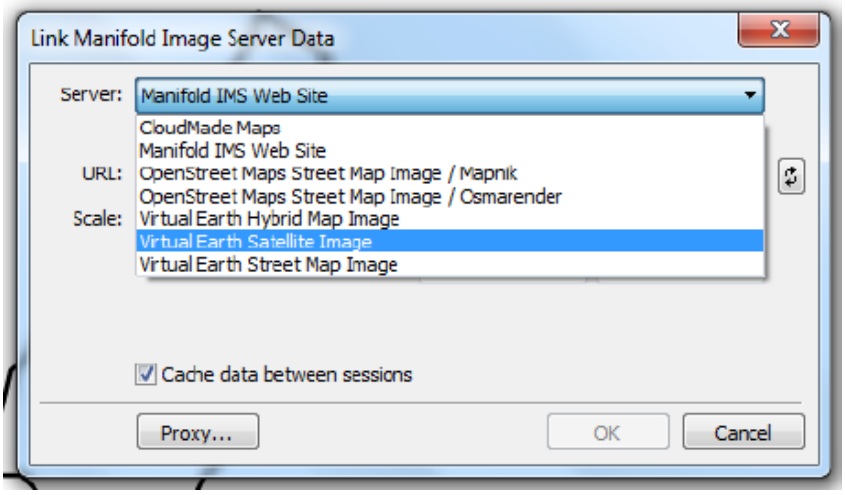
1. Open a drawing of the area
2. Change the scale to a relative large scale (i.e. from 1:8,000 to 1:15,000) in order to prevent too long loading times
3. Select file→link→image from the menu. A Link Image window will open. From the Files of type box select Manifold Image Servers:



4. A *Link Manifold Image Server Data* dialog box will open showing the latitude and longitude of map image that will be downloaded. *Note: the values of longitude and latitude can be changed.*

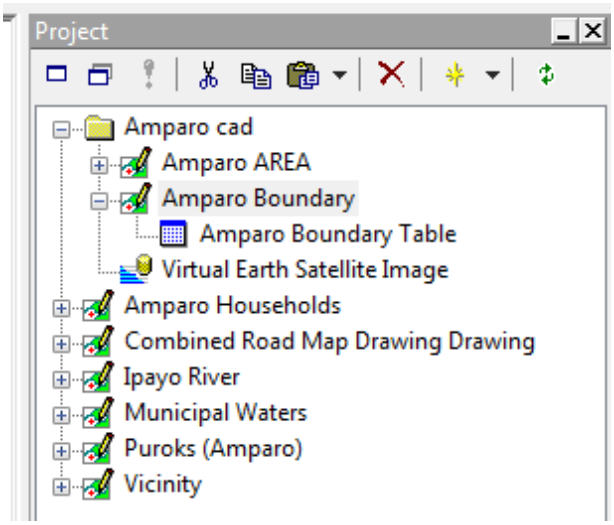


5. Under the *Server* box select *Virtual Earth Satellite Image* or any other server of preference:



6. Press the refresh button at the far right of the box and wait until the connection to the internet server is established.

7. When the connection is complete press OK tab. The linked image layer (named Virtual Earth Satellite Image) will appear in the project pane. Double click the linked image layer (Virtual Earth Satellite Image) to view the image. Note: The linked image below is non-editable, however can still be used for overlays. The projection is fixed to Mercator with WGS84 datum.

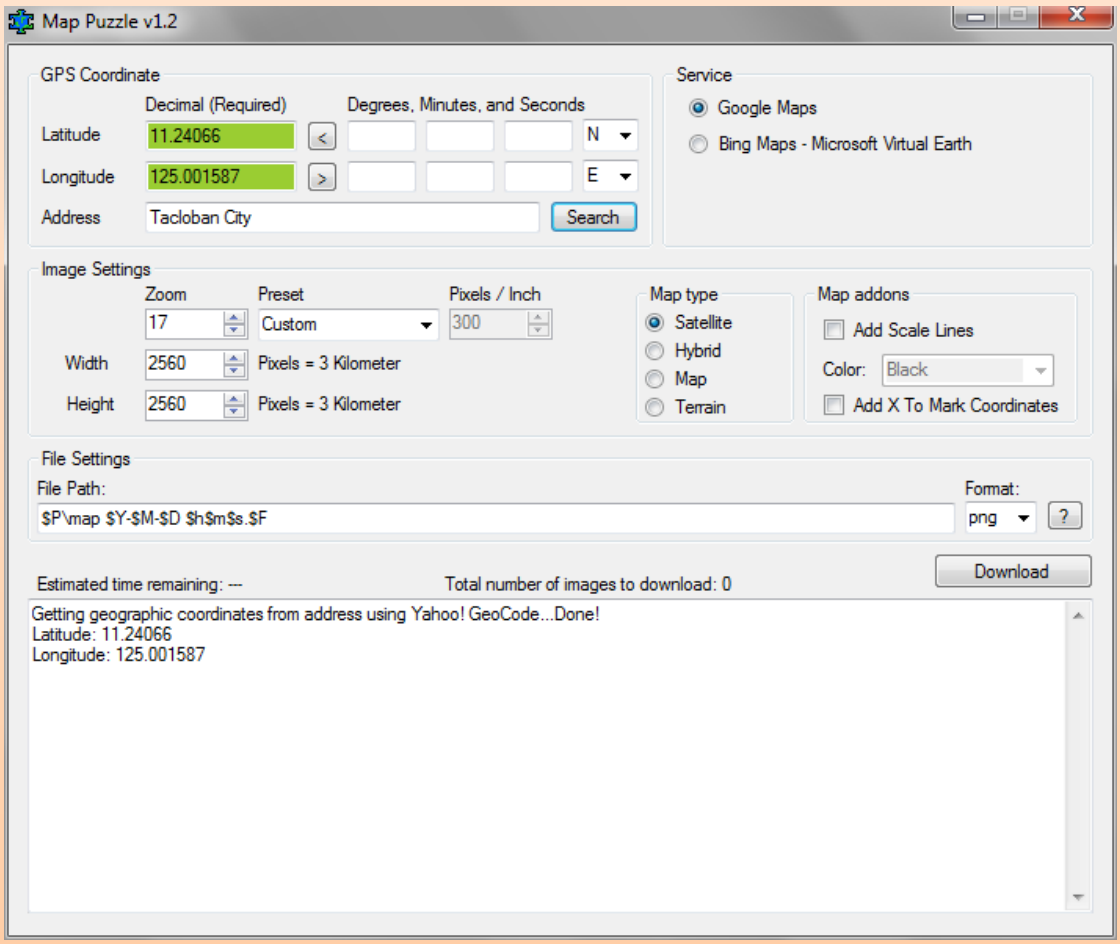


8. Zoom-in a small area of the image to increase its resolution and Pan around the image to increase its overall resolution.

In order to create an offline copy of the image, you can copy the image (in the project panel, right mouse click on the layer and select save as and then past as image). An editable image will appear named Virtual Earth Satellite Image 2. Note: Change the projection and datum of the image to match that of the drawing layers.

Sideline:

When collecting data from sources on the internet like Google maps, Yahoo Maps or Bing Maps, in many cases you end up with many screen captures that need to be combined. To prevent this you can use a tool like Mappuzzle where you can give coordinates of a centre point and a level of detail and it automatically gives you the Image that can be directly used. It is even possible to search can even give the name of a city (although that often leads to errors). It looks then like this:



Mappuzzle can be downloaded here:
http://www.softpedia.com/get/Multimedia/Graphic/Graphic-Others/Map-Puzzle.shtml

The disadvantage is that Mappuzzle only downloads rectangular areas. If a more flexible area is needed, than stitching the images together is the only option. The following makes use of Microsoft Image Composite Editor as an example. Microsoft ICE can be downloaded free from the following link:
http://research.microsoft.com/en-us/um/redmond/groups/ivm/ice/.

Microsoft Image Composite Editor is an advanced panoramic image stitcher. Given a set of overlapping photographs of a scene shot from a single camera location, the application creates a high resolution panorama that seamlessly combines the original images. Microsoft ICE is available for both 32- and 64-bit Windows Operating Systems.

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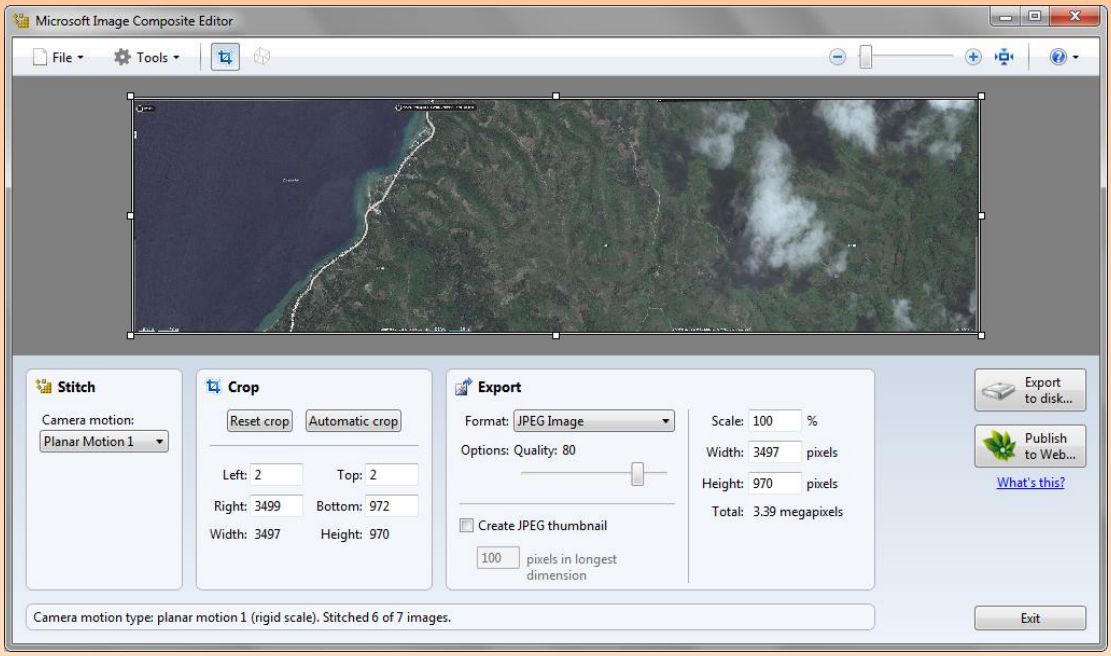
In Microsoft Image Composite Editor either drag and drop all of the four (4) scans OR click on File ▫ New Panorama to select all four (4) scans and combine it automatically into one (1) single image. To do it, follow these steps:

1. In Microsoft ICE , Click on **File -> New Panorama** and select the 4 scans as shown in the picture below



Click on Open button and instantly, the software will merge/stitch the scans together.

This will take a while in merging the scans together depending on your computer's performance.

2. After the process, a new file will be displayed in the screen. Note that this is not yet permanently saved; please save this merged image so you can access it later in other applications. Otherwise, repeat the process of Merging/Stitching. In the Export portion set the slider bar to 100 so that the image quality will remain as how it has been scanned.

3. Save the new merged image by clicking the Export to Disk button located in the right portion of the Microsoft ICE window.

Data sources in the Philippines

Even though the use of GIS is growing strongly in the Philippines, lack of quality data is big hindrance for the further development of the field. This means that in almost all cases a GIS project starts with the collection and processing of the data. Many of the data that are needed for a CLUP need to come from different Government Agencies and more often than not, more than one trip to these Agencies is needed to collect the relevant data. For this reason it is important to have knowledge of those agencies where GIS data can be obtained GIS data. The succeeding discussion will give a short introduction to those organizations, but we would like to emphasize that the GIS field is growing fast and this data may be outdated relatively soon.

There is not (yet) a standard GIS data warehouse in the Philippines although steps are now being taken. This means for now that the sharing of data (and therefore also the data collection) is not yet standardized. It may therefore payoff to ask around with co-workers and other GIS users if they have data available before venturing into expensive trips and requests. Most GIS users are willing to share data and knowledge! Please check the extras on the DVD for an article of the development of a GIS clearing house in the Philippines.

General data

NAMRIA

The National Mapping and Resource Information Authority (NAMRIA) surveys and maps the land and water resources of the Philippines. One of its major mandates is to provide both the public and private sectors with mapmaking services as well as geographic and resource information. Apart from the topographic map, NAMRIA is also a source for satellite images and all kinds of different maps such as elevation maps, land cover maps and nautical charts. An overview of maps and services can be found in their catalogue on their website (http://www.namria.gov.ph/). NAMRIA also provides trainings and a number of services with respect to GPS and surveying. The NAMRIA topographic maps can be downloaded as high quality JPG from
http://www.namria.gov.ph/topo50Index.aspx.
By using the coordinate information on the corners of the map and the projection which is defined in the legend, they can easily be georegistered them. For practical use, it may be wise to use a photo editing program to cut off the borders of the map so that only the actual map areas remain.

Natural Hazards

DENR - Mines and Geosciences Bureau

The DENR-MGB, as steward of the country's mineral resources, is committed to the promotion of sustainable mineral resources development, aware of its contribution to national economic growth and countryside community development. The DENR-MGB is maintaining a GIS based website where a number of natural hazard maps for the whole country http://gdis.denr.gov.ph/mgbviewer/ can be reviewed.

Below are the Maps that are included in the Geological Database Information System, and the Layers that are included in each.

Barangay Point

- Barangay Points

Index

- 1:50,000 scale Geohazard Map Index
- 1:50,000 scale Geological Map Index

Index Labels

- Geohazard Map Index Labels
- Geological Map Index Labels

Geohazard

- Flooding
- Landslides

Geology

- Geological Map of the Philippines
- Drains
- Roads
- Shoreline
- Water bodies
- Mining Tenement Map
- Mineral Resources

From (the MGB viewer manual, http://gdis.denr.gov.ph/mgbviewer/MapViewerManual.aspx)

The Maps can be downloaded, but as a bitmap or image and for use in GIS, these needs to be georegistered and then traced. It is advisable to contact your regional MGB office first to see if the GIS data are available.

PHIVOLCS

The Philippine Institute of Volcanology and Seismology (PHIVOLCS) is a service institute of the Department of Science and Technology (DOST) that is principally mandated to mitigate disasters that may arise from volcanic eruptions, earthquakes, tsunami and other related geotectonic phenomena. From the main page of the website from PhilVocs, there is a tab where for reviewing and downloading maps with natural hazard data. As with the MGB, these data are not yet in GIS format, but need to be geo registered and traced. Also here, please contact your regional office first for the availability of these maps in GIS format. The website (http://www.phivolcs.dost.gov.ph/) contains the following maps:

- Philippine Fault Zone Maps
- Active Faults and Trenches
- Earthquake-Induced Landslide
- Liquefaction Susceptibility Map
- Tsunami Prone Areas

Standards

HLURB (http://www.cookbook.hlurb.gov.ph). The Housing and Land Use Regulatory Board has prepared a cook book for Local Government Units which can be considered a manual on how to create Comprehensive Land Use Plans. It also describes some standards for the use of colours in maps. Even though the standard is not complete we strongly advice to adhere to these standards. The SIMPLE procedures also adhere to the guidelines as set by HLURB.

Other Data Sources

Most of the national government agencies are now using GIS and have data that are needed or useful with respect to the preparation of Comprehensive land use plans. Please contact the NGA in your region for details and availability of data. Many of these data are prepared for use at provincial or regional level and therefore may also be available at or through the PPDO in your province.

Also the internet is a source of many GIS (related) data and a Google search on GIS data Philippines may reveal many sources of data. However useful (and in many cases free), the quality of these data is in many cases revealed by their price. For instance many free datasets of the Philippines show a rail road in Cebu which is no longer operational since the 2nd World War. These data from the internet can therefore be only considered for reference purposes and in no way as correct.

NAMRIA and DENR have taken the lead in preparing a proposal for a National Spatial Data Infrastructure (NDSI). The Philippines' National Spatial Data Infrastructure (NSDI) is a national initiative to provide better access for all Filipinos to essential geographic information. The primary objective of the NSDI is to ensure that users of geographic information, who require a national coverage, will be able to acquire complete and consistent datasets to meet their requirements, even though the data is collected and maintained by different agencies. The National Spatial Data Infrastructure helps ensure all such agencies concern themselves with the national interest, thereby maximizing government's return on investment in data collection and maintenance. The NSDI will help achieve better outcomes for the country through better economic, social and environmental decision-making. If this project pushes through it would be a huge boost in stimulating GIS through improved data availability.

For now, the FLUP Mapping Guide Book by Galido-Isorena at al. gives the following overview of possible data sources when starting a GIS based CLUP:

Data/Map Name	Source	Scale	Date	Key features
Sub watershed & Drainage Map				
Topographic map	NAMRIA office in Fort Bonifacio and sales offices at selected DENR offices	1:50,000	Reprints of 1950s aerial photographs with some of its features updated	Elevation, river, roads, political boundaries, location of towns, name of barangays
Bigger Watershed Map				
Topographic map	NAMRIA	1:250,000		Elevation, river, roads, political boundaries, location of towns, name of barangays
Administrative Map				
Proclamations or Republic Acts creating new municipalities or provinces	Philippine Gazette Copies from Congress or Malacañang archives	Various scale		The boundaries are indicated as technical description. Only a few of these proclamation or RAs have accompanying maps
Provincial and regional maps	NAMRIA		Most printed in the 1990s	Political boundaries, location of town centers and barangays
Land Classification Map				
Land classification	NAMRIA Land Classification Division	Scale ranging from 1:20,000, 1:50,000 and 1:250,000	Depending on the date of Ground survey	Extent of alienable and disposable (A&D) and the forestlands (FL)
	Project control map of the Community Environment and Natural Resources Office (CENRO) and Provincial Environment and Natural Resources Office (PENRO) of respective areas	1:50,000 1:100,000		
Land cover				
Map from SPOT satellite images classified by SSC (Swedish Space Corp.)	NAMRIA	1:250,000	1988	The two maps from the SSC and JAFTA show about 20 land cover categories; however, the two map data cannot be directly compared because they

Data/Map Name	Source	Scale	Date	Key features
				do not have similar categories
Map from 1993 Landsat (produced by JAFTA (Japan Forest Technology Association)	NAMRIA (available only for Luzon and Visayas	1:100,000	1993	This map is a colour composite of bands of Landsat images used for land cover assessment and are not presented as classified polygons
Vegetative cover map for Mindanao	EcoGov2 Project Mindanao Maps (available also in digital form)	1:50,000, 1:100,000 and 1:250,000	2004	Land cover categories used by EcoGov are largely based on the SSC map although some of the categories were aggregated
Land allocation and tenure				
Protected Areas proclamation or Republic Acts	Copies from Congress or Malacañang archives • Websites of law resources in the internet • Protected Area Wildlife Bureau (PAWB) office • Philippine Gazette	Various Scales		The boundaries are indicated as technical description, sometimes accompanied by maps.
CADC/CADT areas	• Certificate of Ancestral Domain Titles (CADTs) are available at the National Commission for Indigenous Peoples (NCIP) central office or its provincial offices • Certificate of Ancestral Domain Claim (CADC) issued under DENR could be found also in the project control • maps of CENROs and PENROs • Digital copy also available from the Philippine Association for • Intercultural	Various scales		

Data/Map Name	Source	Scale	Date	Key features
	Development • Project control maps in the CENRO and PENRO offices			
DENR issued tenure			Updated by the CENRO and PENRO offices yearly or when new tenure is issued	
Settlements				
Topographic map	NAMRIA	1:50.000	Reprints of 1950s interpretation of aerial photographs, some features are updated in the reprints	Individual houses are shown as small black box symbols
Existing Community maps or spot maps	• Community maps that are produced • from other development projects in the area • The Barangay Health Center of the • city/municipal LGUs also map the location of settlements as part of their annual census update	• Usually done per barangay		Community maps usually represent the settlement areas by individually drawing the houses
Community Management and Development Plan (CMBP)	Part of the requirements of the CMBP is to conduct community mapping			
Infrastructure				
Roads	Namria	1:50,000	Reprints of 1950s interpretation of aerial photographs, some roads are updated in the reprints	Most of the national highways and provincial roads are indicated
Municipal and barangay roads and other social infrastructure	LGU physical and socioeconomic profile in their CLUPs	Prepared in varied scales		

Data/Map Name	Source	Scale	Date	Key features
Water Permits Issued	List is updated by the National Water Resource Board (NWRB)			Coordinates of water permits locations is available from the list which includes name of permittee, permit type, charges etc.
Irrigation related infrastructure and irrigated areas	Data from the reports of National Irrigation Administration (NIA) and Department of Agriculture (DA)			
Elevation				
Topographic Map	Namria	1:50,000	Reprints of 1950s interpretation of aerial photographs, some roads are updated in the reprints	Elevation data are represented every 20 meter contour interval
Slope				
Slope Map	Bureau of Soils and Water Management (BSWM)	1:250,000		Slope categorized into 0-3, 3-8. 8-18, 18-30, 30-50 and 50% and above
Geohazards				
GeoHazards	Mines and Geosciences Bureau			
Mining Rights and Claims				
Mining tenements	Mines and GeoSciences Bureau (MGB) and in the land management services office in the Regional, PENRO or CENRO offices	Prepared in varied scales	Updated as the need arises	Indicate extent and the name of the claim holder

Online sources for GIS data are:

1. Philippine GIS Data Clearinghouse - http://www.philgis.org/
2. GEOFABRIK for road data http://www.geofabrik.de/
3. Consultative Group on International Agricultural Research Consortium for Spatial Information (CGIARCSI) for updated version of SRTM http://www.cgiar-csi.org/
4. Global Administrative Boundaries - http://www.gadm.org/
5. Perry-Castañeda Library Map Collection of University of Texas at Austin for Historical Maps - http://www.lib.utexas.edu/maps/
6. Environmental Science for Social Change (ESSC) for the same Geohazard Map that is available from MGB - http://geohazard.essc.org.ph/
7. Department of Social Welfare and Development (DSWD) Map Viewer for KML data of their programs and projects, health facilities of DOH, and School Facilities of DepEd - http://m.dswd.gov.ph/
8. Not strictly GIS, but many government websites contain information on a barangay, municipal, or provincial level. This data can easily be copied into a spread sheet or a table and then combined with GIS map to create new data sets.

Summary

In this lesson you have learned the steps needed to collect the data you need for the CLUP based on your own survey, paper maps or the data from the Lot Data Computation. For a good understanding of the GIS data, we have described the most important coordinate reference systems and map datum of the Philippines and possible other data sources where data can be obtained. This step is a first step, since most (if not all) cases you will need to edit these data. The editing of the data, both geographic and attribute data will be the topic for the next lesson.

Editing

OVERVIEW

The data we create during our surveys or those that we purchase or get from others are rarely exactly what we want. In many cases we may want to add, change or modify these data. For instance, you may want to use a geo-registered image to create a new drawing of roads or buildings. Not only the geographical data (the map), but also the attribute data may be subject to change. In this Session we will describe ways how to create new, or edit existing datasets.

To do this correctly, this Session also deals with the way spatial data are stored in GIS. You will have a close look at the basis of data storage, which is accomplished by means of tables. You will view, create and fill tables. In addition you will also join and relate tables. The first part deals with data storage in a vector model environment. The second part deals with storage in a raster environment. In addition, you will digitize points as a method of data capture. Digitizing is the process of using a mouse to automate the locations of geographic features by converting their map positions to series of x, y coordinates stored in computer files.

OBJECTIVES

After this Session, you will:

1. Have insight in and experience with the process of editing drawings
2. Know how to create new drawings
3. Know how to modify existing drawings
4. Know tips and tricks with respect to editing
5. Have experience with and insight in working with tabular data
6. Have gained practical experience by combining these elements using realistic exercises

DURATION

6 hours

CONTENT AND ACTIVITY PLAN

Topics to be covered:

1. Editing of maps
2. Working with tabular data
3. Merging Map layers

SUGGESTED METHODOLOGY

- Presentations
- Exercises
- demonstrations
- group discussions

RESOURCES NEEDED

For this Session we assume that you have a working version of Manifold System installed on a computer and that you have insight in the basics of Manifold Systems presented in Session 1. Experience with the data collection as presented in Session 3 is an advantage, but not necessary. The necessary data for the exercises can be found on the DVD.

REFERENCES

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Existing PowerPoint and documents on Manifold GIS trainings, mostly compiled by Jay-ar Ragub and Jerson Sala

Geerling, Gertjan, - Draft Manifold Hands-on Manual, not published

MANIFOLD System GIS Help,

MANIFOLD System GIS User manual, accessed on: http://www.georeference.org/doc/whnjs.htm

Ragub, Jay-ar (2012), Manifold System Manual for iTAX Digital Parcellary Mapping, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH http://www.methodfinder.net/example87_1.html

Editing of maps

Tracing or digitizing is the process of creating drawings from images. By using the pixels of an image as a guide we can trace over the image and create points, lines and areas in a drawing. The tracing process is like laying a sheet of tracing paper onto a photograph and then drawing lines with a pen to outline what is seen in the photo. The photo image is thus converted into a line drawing. To trace an image we use a map where the drawing layer in which objects are created appears about the image layer. We can then see both the drawing as well as the image being traced. There are two main methods of tracing within Manifold System:

- Freehand Tracing: At any time we can draw points, lines and areas freehand using the pixels within an image as a guide.
- Tracing Tools: Tracing tools use pixels in the image layer as a guide to create objects in the drawing layer semi-automatically. For example, the Trace Point command will create a point at the centre of a pixel cloud.

When tracing an image we will usually use a combination of the above methods. When working with compressed images we can use freehand tracing only, since compressed images do not allow any manipulation as is necessary with tracing tools.

SIDELINE

In a GIS we see a MAP as a combination of a table with a map. One of the most used formats for this is the shape file. While the term "shapefile" is quite common, a "shapefile" is actually a set of several files. Three individual files are mandatory to store the core data that comprises a shapefile: ".shp", ".shx", ".dbf", and other extensions on a common prefix name (e.g., "lakes.*"). The actual shapefile relates specifically to files with the ".shp" extension, but alone is incomplete for distribution, as the other supporting files are required.

There are a further eight optional files which store primarily index data to improve performance. Each individual file should conform to the MS DOS 8.3 filename convention (8 character filename prefix, period, 3 character filename suffix such as shapefil.shp) in order to be compatible with past applications that handle shapefiles, though many recent software applications accept files with longer names. For this same reason, all files should be located in the same folder.

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Mandatory files:

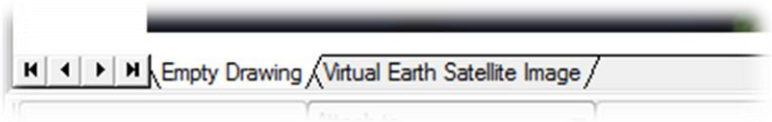
- .shp — shape format; the feature geometry itself
- .shx — shape index format; a positional index of the feature geometry to allow seeking forwards and backwards quickly
- .dbf — attribute format; columnar attributes for each shape, in dBase IV format
- Optional files:
- .prj — projection format; the coordinate system and projection information, a plain text file describing the projection using well-known text format
- .sbn and .sbx — a spatial index of the features
- .fbn and .fbx — a spatial index of the features for shapefiles that are read-only
- .ain and .aih — an attribute index of the active fields in a table or a theme's attribute table
- .ixs — a geocoding index for read-write shapefiles
- .mxs — a geocoding index for read-write shapefiles (ODB format)
- .atx — an attribute index for the .dbf file in the form of shapefile.columnname.atx (ArcGIS 8 and later)
- .shp.xml — geospatial metadata in XML format, such as ISO 19115 or other schemas
- .cpg — used to specify the code page (only for .dbf) for identifying the character encoding to be used

(from Wikipedia)

Individual GIS software packages may add more files and extensions to the shapefile. For this reason, always make sure you copy all the files if you want to share GIS data (or safe them in a Manifold System project file).

Creating Drawings and digitize

Make a new empty drawing through **File** > **Create** > **Drawing**. Give it a name and it will appear in the **project** pane. Import or Link base data set to be digitized. This could be the Google Earth/Virtual Earth data or scanned maps etc. Be sure to check the projection of the scanned map; register (i.e. georeference) the map first if needed. Create a Map: **File** > **Create** > **Map** and add the empty drawing and the base data. Make sure the drawing is on top by dragging its tab to the left side, see figure below.



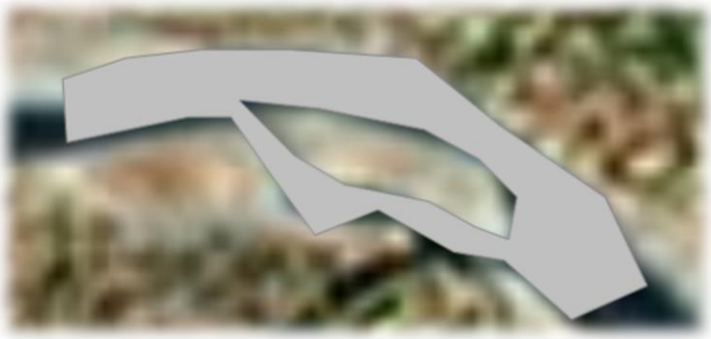
Switch on the appropriate button in the tools toolbar to create points, lines or areas. In the figure below, the create lines and the insert lines buttons are switched on. See **Help** > **Index** and type *Tool toolbars* for detailed information on the functions of the buttons.

For inserting lines, the line starts at the first click. At every click an additional node (also called vertex) is placed. A right click ends the current line sequence.

For inserting areas, click **create areas** in the **Tools** Toolbar. Click Insert Area. The Tools buttons should look like in the figure.

The area is formed by subsequent clicking. Right clicking finishes the area.

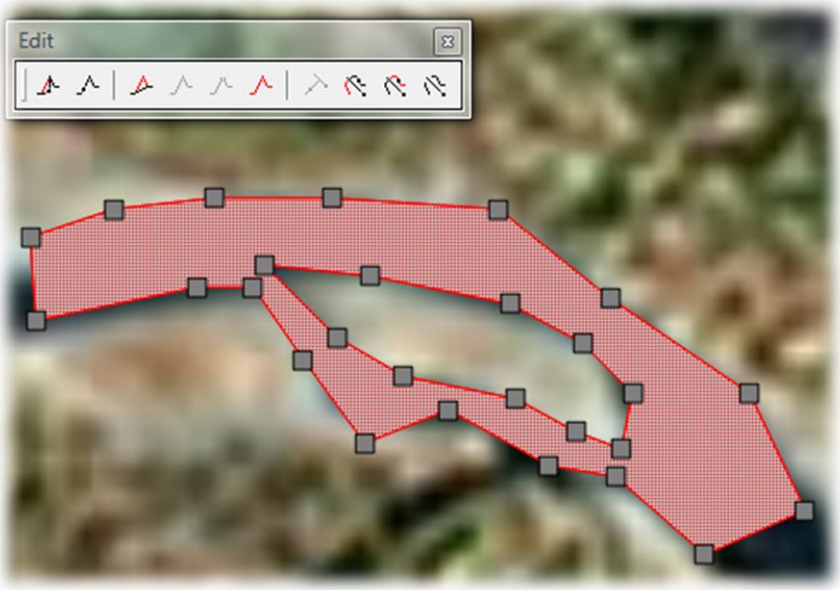
If **CTRL** is hold during the last click, the area is not finished but can be continued starting with the first left click. A normal right click finishes the area definitively. This method can be used to create islands in areas, such as in the example below.



Important: In contrast to some other GIS software, Drawings in Manifold System can contain points, lines and areas (polygons) at the same time. When such a drawing is exported to for example Manifold System shape, one drawing is exported as 3 separate shape files, one containing points, one lines and one areas.

NOTES

- pressing **Esc** quits drawing the current object.
- A useful tool is **auto complete with ALT**. When editing maps we often would like to create a new area that fits exactly into an existing area. Manifold System provides an autocomplete capability within the Insert Area and Insert Line tool to make this easy. See **Help** > **Index** type *autocomplete*.
- When points, lines or areas have to be changed, you can use the Edit Toolbar. The **Edit Toolbar** provides commands for editing objects in drawings. If not already displayed, the edit toolbar will appear when an object is selected for editing with a **CTRL-ALT** clicking the object. The figure below shows the Edit Toolbar and an area clicked while pressing **CTRL-ALT**. See **Help** > **Index** and type *Edit Toolbar* for more information on its use.



Hint When you are editing, you may find that you need to look up and get an overview of the bigger picture or just zoom in for more detail. A good way to do this is to use the **+** and **-** keyboard keys to zoom in and out even in the middle of the **Insert Areas** command. Pressing **+** on the keyboard will cause a zoom in. Using the **+** and **-** keys we can zoom in where greater precision is required and then zoom out where less precision is required. Another option is to use a mouse with a scroll wheel to zoom in and out. This works even in the middle of commands such as the edit toolbar editing commands. By default the zoom will be centered on the mouse position. Holding the **CTRL** key while operating the scroll wheel will force the zoom to be near the center of the opened window.

Note: In order to create holes in polygons (as the island in the above picture), Such areas are called branched or complex areas. To create such areas in Manifold System, use a CTRL-click between several sequences of boundary line clicks. We would then click once at a new starting point and click to the first position to change direction. Just as before, as we click our way around the periphery of the "hole" the boundary preview line will "rubber band" from the starting position to the current mouse position.

Manifold System knows that after the CTRL click we have drawn a figure within a figure, so it knows this is to be a hole or an island and creates the complex area accordingly. Had we drawn the second figure outside the first figure, it would have been drawn as an "island." In fact, we can draw complex overlapping figures by CTRL clicking between them to create new areas of great topological complexity. Note: to keep things reasonably obvious it is usually best to create complex areas with holes or islands but not with complex internal overlaps.

Digitizing using snap tools

For precise drawing, the Snap Tools are useful. When snapping is turned on, the cursor snaps to the nearest item defined as snap-to-item. This ensures seamless continuation of the digitized object.

Snap Tools can be turned on through menu **Edit** > **Snap to**. One can choose to snap to Graticule, Grid, Areas, Lines, and Points. Additionally the snapping can be limited to segments and selection. Once the **Edit** > **Snap to** menu is activated, the **Snap Toolbar** appears. Facilitating access to the tools.

Example of use

In the practise of digitizing long lines, you may want to continue a line exactly at the same spot the last one ends. We use snap to lines and snap to segments, as can be seen in the figure above.

Turn on snapping of lines through **Edit** > **Snap to** > **Lines**. In the toolbar click on **snap to segments**. Now the cursor is fixed to the closest line, moving the mouse results in a moving cursor along the line. See figure.

When we click the new line will start on the old line. To move beyond the old line, we can press SPACE to turn snapping off temporarily. Pressing SPACE again turns snapping on, if we want to continue another line later.

More information in the help file: **Help** > **Index** > type *snap to*

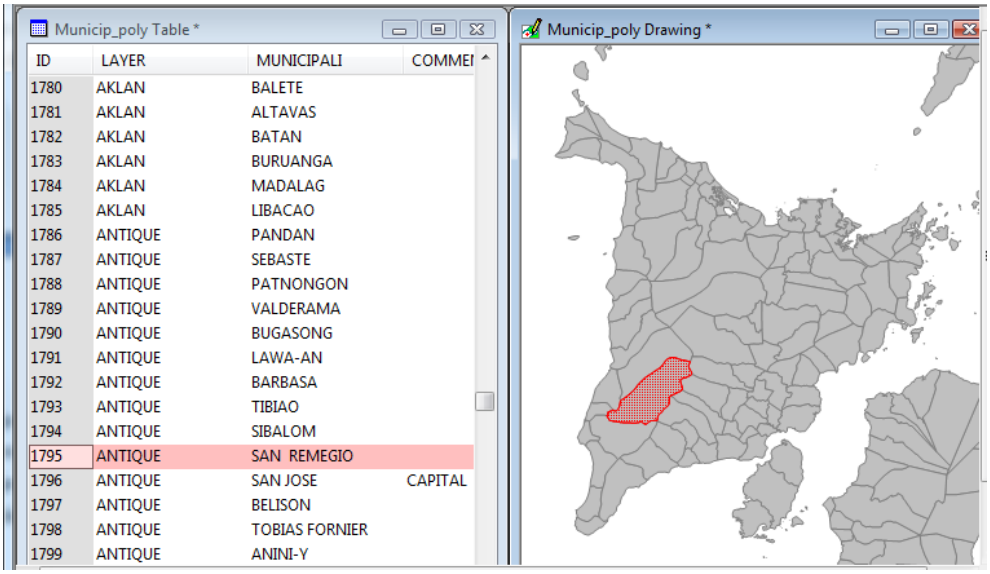
Exercise 4.1

Editing a new drawing.

Attributes and Tables

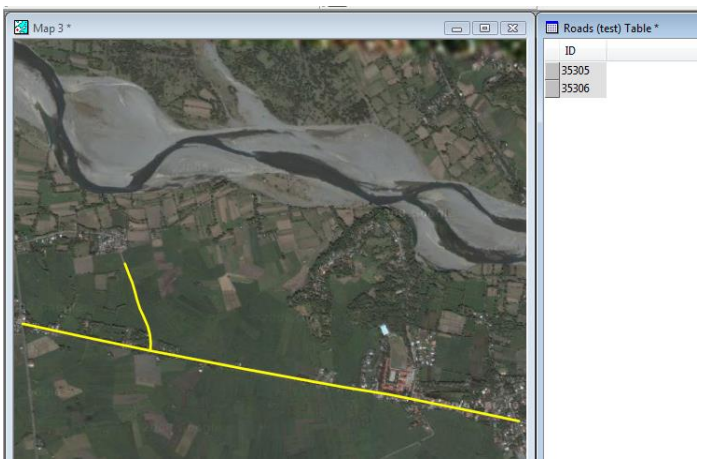
Table show data organized into rows and columns. Every record is linked to an element in the drawing and every field describes a specific part of that element. Every row in a table is a record. Every column in a table is a field. We will use the words "row" and "record" interchangeably. We will also use the words "column" and "field" interchangeably. Column and Fields of drawings describe attributes of that drawing, such as the length or area of features, names, etc.

Every drawing in Manifold System has a table associated with it. Each object in the drawing (that is, every point, line or area object in the drawing) is linked to a row in the table. Drawings have a table even if there is no data saved for each object. In that case, the drawing's table is mostly empty. It has only one field, the object ID field, for each row. The object ID field is used to link each row to its associated object and cannot be edited. It is indicated as the key field with a small key icon in the column name. Deleting an object in a drawing will delete the object's record in the drawing's table. Deleting a record in a drawing's table will delete the associated object in the drawing, see figure for a selected municipality in the map and the associated table.

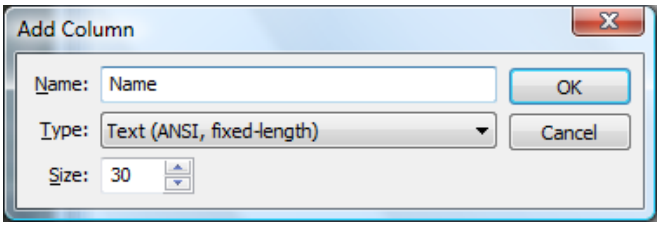


ID	LAYER	MUNICIPALI	COMMEI
1780	AKLAN	BALETE	
1781	AKLAN	ALTAVAS	
1782	AKLAN	BATAN	
1783	AKLAN	BURUANGA	
1784	AKLAN	MADALAG	
1785	AKLAN	LIBACAO	
1786	ANTIQUE	PANDAN	
1787	ANTIQUE	SEBASTE	
1788	ANTIQUE	PATNONGON	
1789	ANTIQUE	VALDERAMA	
1790	ANTIQUE	BUGASONG	
1791	ANTIQUE	LAWA-AN	
1792	ANTIQUE	BARBASA	
1793	ANTIQUE	TIBIAO	
1794	ANTIQUE	SIBALOM	
1795	ANTIQUE	SAN REMEGIO	
1796	ANTIQUE	SAN JOSE	CAPITAL
1797	ANTIQUE	BELISON	
1798	ANTIQUE	TOBIAS FORNIER	
1799	ANTIQUE	ANINI-Y	

In the following example 2 parts of a road have been digitized as lines. The two lines show up in the table, see figure below. Next we would like to add a column for their names.



1. To add a column for inputting their names go to **Table** > **Add** > **Column**.

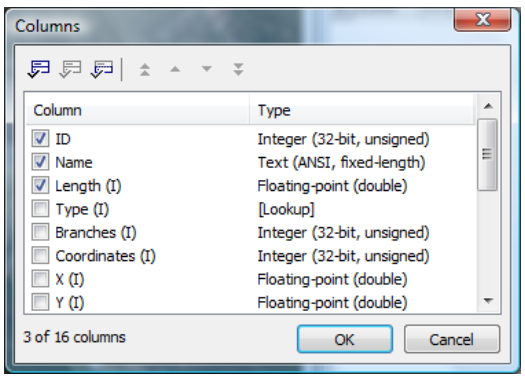


2. Type the **name**, in this case type *Name* for road name. Choose the **Type**, depending on your needs, in this case **Text (ANSI, fixed length)** and give the expected length of the longest name. Alternatively you can choose **Text (ANSI, variable length)** as **Type**. For an overview and description of all the **Field types** in Manifold System go to **Help** -> **Index** and type *field types*
3. Press **OK**.
4. Now the Field is added to the table, you can double click on it and type to input data.
5. **Option**: to delete a column / field, right click on the Field name and choose **Delete**.

Calculating length and surface area of items in drawings

Tables from Drawings have intrinsic fields which store basic data on the objects of that drawing. These intrinsic fields are prepared by and maintained by Manifold System and as a user you cannot change, edit or alter these. If you want to use them in calculations, then copy the field into a new one and use this new field in your calculations. Length and Area are two of those intrinsic fields. To show the length or area of lines or areas, go to **View** > **Columns** and click **Length (I)** in the popup window, see figure below. Now the Length will appear in the table. The same procedure can be followed for **Area (I)**.

Changing values in tables can be done using the transformation toolbar, through active columns and through Viewbots. From all three options an example is given in the following paragraphs.



Exercise 4.2

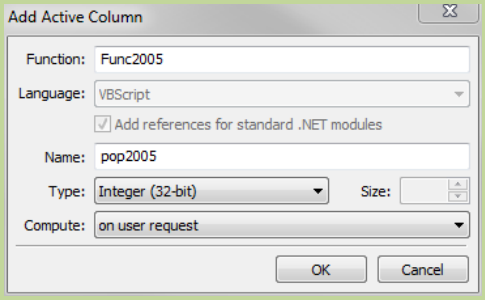
Working with tables.

Computing using fields of tables (active columns)

To compute new fields using existing fields of tables, similar to formulas in MS excel, Manifold System uses Active Columns. Functions have to be written in a scripting language. In the following example we will use an active column to automatically calculate the population data in a barangay for 2005 based on the population from 2000. For this example we just assume a uniform growth of 5%.

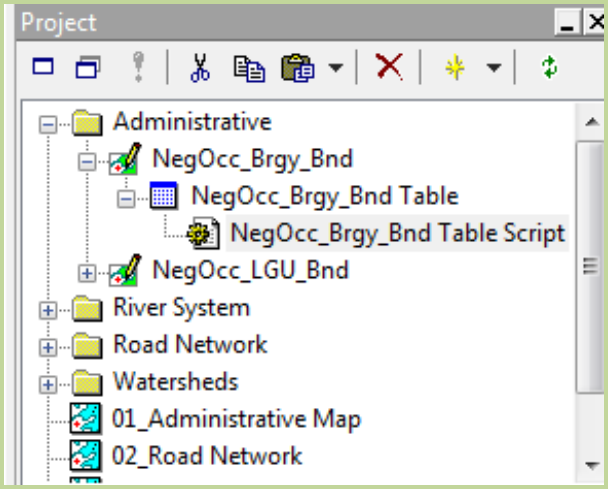
TO CREATE AN ACTIVE COLUMN:

1. **Open** the table.
2. Right click on a column head and choose **Add** > **Active Column** or choose **Table** > **Add** > **Active Column** from the main menu.
3. Specify the **function** name, the name to appear on the column head and the data **type** returned by the function, see figure below. Set **Language** to **VBScript**. The data type requires special attention. If you expect decimals (smaller than 1), be sure to select **floating-point (single)** or **floating-point (double)**. Single or Double refers to the amount of decimals. In case of doubt refer to **Help** > **Index** and type *field types*.



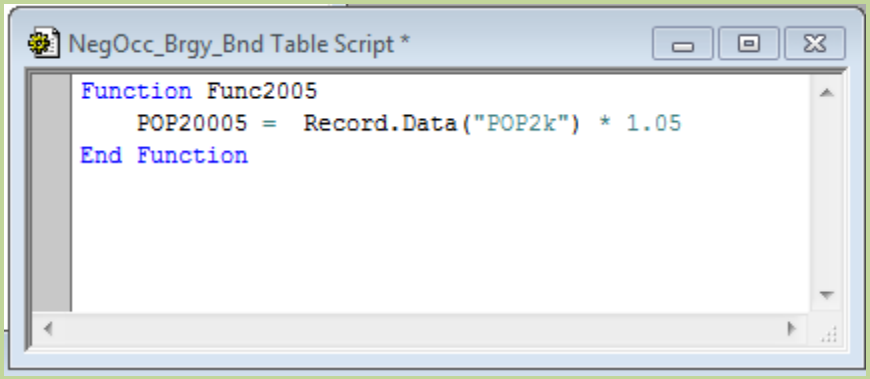
In the example above a function with the name Func2005 has been created and this is used in the active column with name pop2005.

4. Make sure the **Compute** option is set to **on user request**. Press **OK**.
5. A script component will be created and opened for editing; the script appears in the **Project** pane linked to the table.



6. Write the function to be used by the Active Column. In the following example the population of 2000 (field POP2k) will be added with 5% (or multiplied with a factor 1.05)

```
Function Func2005
 POP20005 = Record.Data("POP2k") * 1.05
End Function
```



Another example: to divide two columns (named Column1 and Column2) use the following code

```
Function Divide
    Divide = Record.Data("Column1") /
Record.Data("Column2")
End Function
```

7. Verify the script by right-clicking on the column header and pressing **recompute**. The column should be filled with values.
8. In case the script works and you want to recompute automatically, set the computation mode to **on the fly**. To do this, **open** the table; right click the header of the active column and choose **edit**. Use of on the fly mode will prevent most script editing operations in the script window, therefore to change the script again, reset the **compute** option to **on user request**.

Active Columns can contain programs written in any ActiveX scripting language or any .NET language available in your system. Mostly the standard setting of Visual Basic Script (VBScript) will do. More information **help** > **index** > type *active columns or look at the following example on the internet for automatically calculating the area in acres for parcels* : *http://www.georeference.org/doc/show_area_of_a_parcel_in_acres.htm*

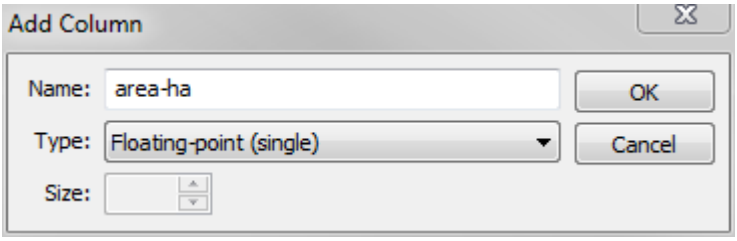
Exercise 4.3

Active Column

Computing using fields of tables (transformation toolbar)

Another way to calculate values in fields is to use the transformation toolbar. If you open the table of a drawing, the transformation toolbar also opens. We can use this to do many calculations. For instance if I have a drawing with municipalities and that has the area in square meters, but I want to have the area in hectares, I will take the following steps:

1. Open the table
2. From the menu select table - > Add Column. Name it area-Ha and make sure it has a floating format



3. Next in the table open the transformation toolbar and add the areas from the field area into the new column:

This will have the effect that the areas (still in m^2) are copied in the new column. In the second step we will divide them by 10.000 in order to generate hectares. This is done again in the transformation toolbar.

The advantage of using the transformation toolbar is that you do not need any programming experience. However if you have many (or frequent) changes, then you need to repeat the calculations after every change where the active column will perform

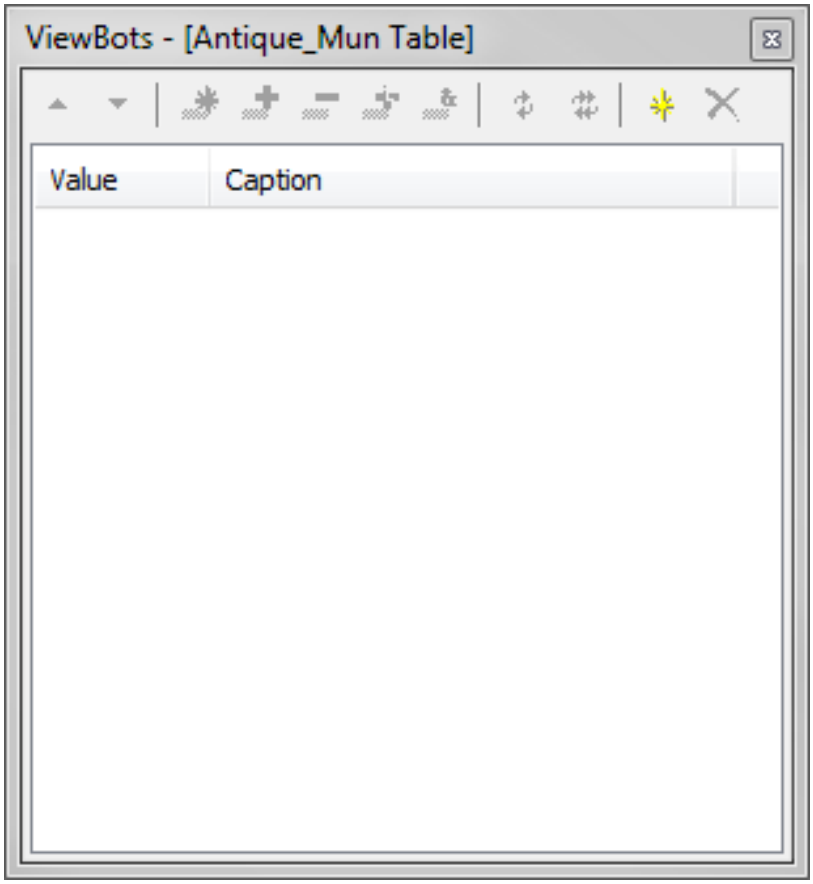
Exercise 4.4

Calculations

Computing using fields of tables (ViewBots)

ViewBots are one-line analytic instruments used to dynamically compute a statistical or comparative measure over a subset of records and are extremely useful for analysing tables. They are one of the most popular functions in Manifold System for experienced users. When a ViewBot is configured for a drawing's table it continues to function when the drawing has the focus. For example, if we configure a ViewBot to show the average of a given field for selected items it will continue reporting the average of the selection whether or not we select items from a drawing's table or by using mouse selection commands to select objects in the drawing.

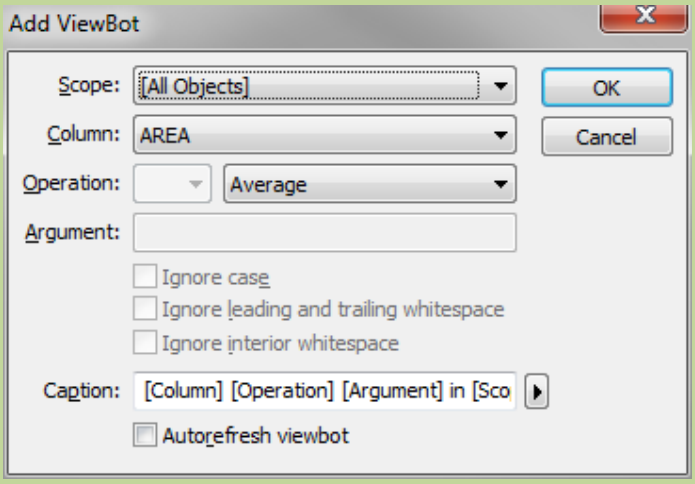
Turn on the ViewBots pane with a **SHIFT-ALT-B** ("B" for "ViewBots") or with a **View - Panes - ViewBots** command.



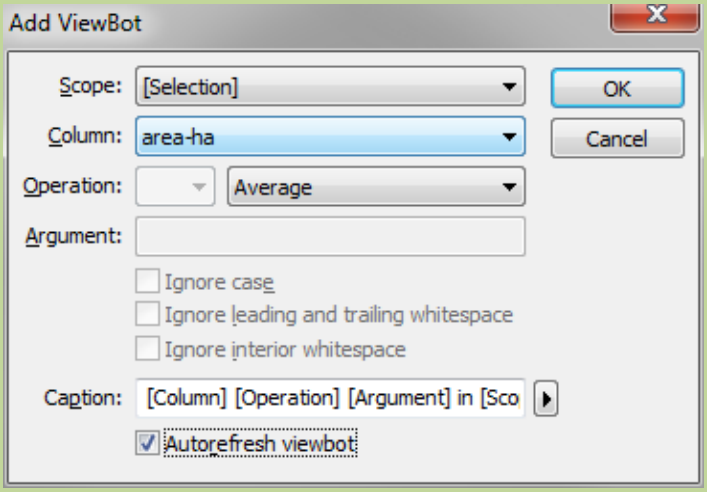
ViewBots are bound to the tables for which they were created. When a drawing window is active, the ViewBots pane will list all ViewBots created for the drawing's table. When a drawing layer in a map is active, the ViewBots pane will list all ViewBots for the active drawing's table.

TO CREATE A VIEWBOT

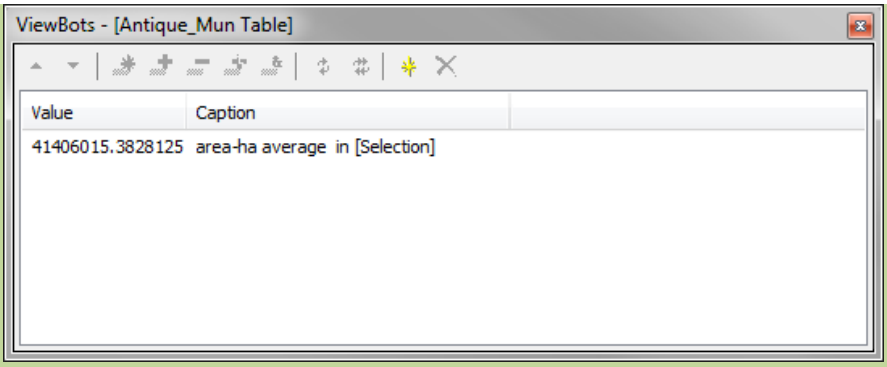
1. Open the ViewBots pane and press the **New ViewBot** button. A new ViewBot line will be added to the ViewBots pane.
2. Double click onto the saved ViewBot fields to choose analytic functions and the scope of the ViewBot.
3. Press the **Refresh** button to update the results in that ViewBot if the ViewBot auto refresh option is not on in **Tools - Options**.
4. For instance if I want to calculate the average area (in hectares) from my (selected) municipalities, I would take the following steps:
5. In the ViewBots pane, select **new viewbot**



6. And in the new window, set the correct parameters:



7. After pressing OK, for every selection of municipalities the average area will be automatically calculated. You can have more than one viewbot for every table!



Exercise 4.5

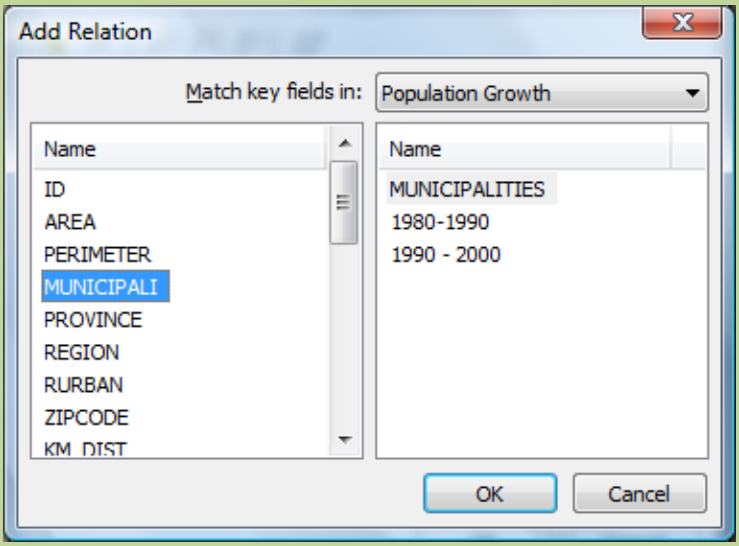
Viewbots

Joining external tables (like MS excel files)

Relations are connections between two tables in a Manifold System project that allow one table to show columns from another table. A relation between tables uses a key field with unique values common to both tables to connect the two tables. This allows data that appears in one table to also appear in another table without having to physically duplicate the data. Most often this is used to add data from external sources such as excel files to an existing (administrative) drawing.

TO FORM A RELATION BETWEEN TWO TABLES

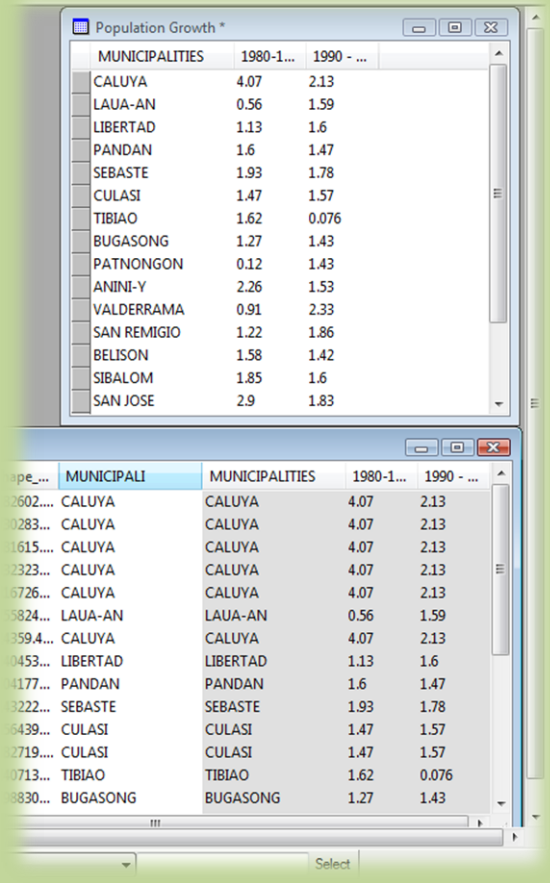
1. If needed use **File** > **Import** > **Table** to import an (excel) table. Be sure to select the right **type** (excel, csv, ..) while looking for the file.
2. **Open** the table that is to display the additional fields and click on **Table** > **Relations**.
3. Click on the **New Relation** button ( ). This launches the **Add Relation** dialog.
4. In the **Add Relation** dialog, choose another table in the list box after **Match Key Fields in:**.
5. In the **Add Relation** dialog, click on one field for each table that will be used to match records and press **OK**. See figure below for an example showing matching fields: MUNICIPALI and MUNICIPALITIES.



6. Back in the **Relations** dialog, check the desired columns to join from the other table. Press **OK**.

   Example: the external table Population Growth is matched to a table from a drawing. As both tables contain names of municipalities (see figure above), they could be matched as shown in the figure below. Important is that the municipal names in both columns are exactly the same (even upper and lower case) otherwise the match doesn't work.

Hint First export the table of the drawing as excel file (**File** > **Export** > **Table**), then remove all columns in excel except the column used for matching. Add all the data columns you want to use in the GIS behind the matching column, and Import the excel file again in Manifold System. (**File** > **Import** > **Table**).



Columns that are "borrowed" from another table will appear in the table with grey background colour to indicate they are imported. They may be used like any other column, for example, for sorting, filtering or within formulas or thematic formatting. Tables may have more than one relation with more than one other table. If you want to edit a grey column or unlink the relation, just right click on the column and Flatten All or Flatten on a specific field

Hint If you did a GPS survey and have entered a lot of data in your field notes about all the waypoints, then this process is an easy way of adding that info to your GIS data. Just make sure that you encode your field notes into excel and that you have a matching id between the waypoints and your data. Also, do not use any layout options in your excel data since this usually complicates issues. Good practise is to have the records (waypoints) in rows and the attribute data in columns. The first row is then reserved for the name of the field.

For more information see: **Help** > **Index** and type *relations*

Exercise 4.6

Importing and Joining tables.

Merging Map layers

There are a number of ways and a number of reasons for merging maps. One of the most obvious of these reasons may be the fact that our CLUP is based on maps from all the barangays. In order to make a municipal map, we have to combine these maps into one new map. The easiest way to do this is to copy and paste the items into a new drawing.

First create a new empty drawing (Create drawing in the project pane) and then copy those elements from existing drawings into the new drawing. In order to copy these, open the source drawing, use **Edit-> Select all** (or a conditional selection) and then paste them into the new drawing. There are two options to paste the drawing elements: (1) **Paste** Pastes contents of the Windows Clipboard into the active component. Edit – (2) **Paste Append** appears in components such as drawings, tables or comments, where data may be appended onto existing text or records. ***When copying objects from one drawing and pasting into another the*** **Paste Objects** ***dialog appears to allow control of how fields are pasted.***

	Select All - Paste all columns.
	Select None - Do not paste any columns except ID.
	Select Inverse - Do not paste all current Paste As columns and paste all other columns. A fast way to use all but one column: click Select None, specify a Paste As choice for the one column not desired and then click Select Inverse.
	Autoselect - Paste existing fields to compatible columns where the names are the same and otherwise create a new field as necessary.
column	Column This column lists fields in the source drawing.
Paste As	Paste As How the field should be pasted into the destination drawing. Double-click into a Paste As cell to define how the paste should take place

In order to facilitate this process, it is good to make a template of the map layer you need. This map layer should contain the attribute structure needed for all maps and then facilitates the work for all layers. For instance for a map layer containing structures in a barangay (points with the location of wells, barangay hall, schools, etc.) could be based on a template structure-template which contains already the field definitions you need. A copy can be used for all barangays and the easily be combined into one municipal map.

Physically merging map layers is only necessary if you need the different layers to be into one file, for instance to create a municipal map or to share the data with other GIS users who do not use Manifold System. In many cases creating a map containing the different map layers is just as easy as merging the map layers.

Exercise 4.7

Merging map layers.

Creating New symbols

Manifold System has many options to symbolize points, however the symbols for point features are not that exhaustive. Luckily for us it is not too difficult to make our own symbols. We can use either symbols from the fonts in Windows (like windings or webdings) or we can create icons or find them on the internet. Manifold System can use point styles from four different sources:

- Point styles that are built into Manifold System.
- Point styles that are created from True Type fonts installed in Windows.
- Point styles created from image files.
- Point styles created from custom scalable styles.

This topic discusses the first three methods of customizing point styles. For use of custom scalable styles see the **Custom Scalable Styles for Points, Lines, Areas and Labels** topic at http://www.georeference.org

Point styles that are created from True Type fonts or images are loaded into Manifold System based upon directions specified within **.xml** files found in the **Config** folder. When Manifold System launches it reads any **.xml** files that are placed in the **Config** folder and then opens True Type fonts or image files they mention to create new point styles. If an **.xml** file mentions a True Type font or image file that is not available in the Windows system, the point style thus specified will not be available and will be displayed as the default circle point style.

For example, an **.xml** file adding all characters in the particular font could be provided to customize the Manifold System installation. This **.xml** file tells Manifold System to create point styles based on the characters in the given font. If for some reason the specified font is not installed in Windows, the point styles created from this **.xml** file will not be available. Note: A description of the XML language is not part of this manual. For adding styles, please follow the exact descriptions and changes in the files as described.

Point styles created from image files

Point styles created from images may be used just like any point style, except that they are not resizable (and so may result in unexpected scaling effects when size on the monitor or on printed pages is compared) and do not use either foreground or background formatting colours. In addition, point styles created from images will not be shown in selection colour when selected.

Users can add their own point styles from images by installing a desired image file (one image per file) and then creating an **.xml** file in the following pattern:

```
<xml>
  <style>
    <name>Name for this style</name>
      <file> images\filename.png</file>
  <type>point</type>
  </style>
</xml>
```

Rules

- There can be any number of **<style>** … **</style>** entries within a single **XML** file between the **<xml>** tag at the beginning of the file and the **</xml>** tag at the end of the file.
- The name string supplied in the **<name>** attribute is mandatory and must be unique.
- The path string in the **<file>** attribute is mandatory. It specifies the path to the image file from the configuration directory. In the pattern shown above a **filename.png** image file must be within an **images** directory that is in the **Config** directory.
- Image files may be in any of the following formats: BMP, GIF, JPG, PNG, TIFF, EXIF, WMF and EMF. Each image file contains one image, corresponding to one point style.
- The value in the **<type>** attribute is mandatory and must be "**point**".

Place the new or modified **.xml** file containing the image point style specifications into the **Config** folder for Manifold System (normally **C:\Program Files\Manifold System Professional\Config**) and restart Manifold System. When Manifold System launches, the system will scan all **.xml** files in the **Config** folder. Any **<style>** … **</style>** entries of **<type>** "**point**" found in any of those **.xml** files that correspond to image files will be loaded as a new point style. Images can contain pixels in transparent colour. **.png** format is a good format to use to save images that contain invisible pixels (transparent colour). **.png** is fast and efficient and a good choice overall for iconic images.

Point styles created from Fonts (Webdings)

Point styles that are created from True Type fonts or images are loaded into Manifold System based upon directions specified within **.xml** files found in the **Config** folder. When Manifold System launches it reads any **.xml** files that are placed in the **Config** folder and then opens True Type fonts or image files they mention to create new point styles. If an **.xml** file mentions a True Type font or image file that is not available in the Windows system, the point style thus specified will not be available and will be displayed as the default circle point style.

For example, an **.xml** file adding all characters in the particular font could be provided to customize the Manifold System installation. This **.xml** file tells Manifold System to create point styles based on the characters in the given font. If for some reason the specified font is not installed in Windows, the point styles created from this **.xml** file will not be available.

Point styles created from True Type fonts may be used just like any point style, except that they are always created using the foreground colour only. Users can add their own point styles from True Type fonts by installing a desired True Type font and then creating an **.xml** file in the following pattern:

```
<xml>
    <style>
        <name>Name for this style</name>
        <font>Windows font name</font>
        <symbol>64</symbol>
        <type>point</type>
    </style>
</xml>
```

Rules

There can be any number of **<style>** … **</style>** entries within a single **XML** file between the **<xml>** tag at the beginning of the file and the **</xml>** tag at the end of the file.

- The name string supplied in the **<name>** attribute is mandatory and must be unique. Many users will construct a unique name by appending the symbol number to the name of the font.
- The font name string supplied in the **<font>** attribute is mandatory and must be one of the font names installed in Windows.
- The number in the **<symbol>** attribute is mandatory and must be a number that corresponds to a valid character, either in decimal notation or in hexadecimal (hexadecimal numbers must be preceded by a **#** character).
- The value in the **<type>** attribute is mandatory and must be "**point**".

Place the new or modified **.xml** file containing the point styles into the **Config** folder for Manifold System (normally **C:\Program Files\Manifold System Professional\Config**) and restart Manifold System. When Manifold System launches, the system will scan all **.xml** files in the **Config** folder. Any **<style>** … **</style>** entries of **<type>** "**point**" found in any of those **.xml** files that

correspond to characters in installed Windows fonts will be loaded into the system as an available point style.

Exercise 4.8

Creating a new point style.

More information on creating custom styles can be found in:
http://www.georeference.org/doc/custom_point_styles.htm

Summary

In this Session you have learned how to edit the data you have prepared, be it as drawing or as table. We have also shown you how you can add data from two more different sources: excel and lot data computations. These examples are not conclusive, but they give you a very good idea how GIS can be used to collect and combine data from a broad array of sources. In the next Session we will be showing you how to use these new data in the analysis you might want to do.

Analysis

OVERVIEW

This Lesson will show how to analyse your data. The first steps are to use structured selections that will help you to get more out of your data. In the next step we will combine different layers in the analysis and make selections based on the spatial relationships in your data. This Lesson concludes with the step by step procedure on how to make a number of maps for your CLUP.

OBJECTIVES

After this Session, you will:

1. Obtain insight on how to design and deliver spatial analysis
2. Know the value of different selection tools as part of the analysis process
3. Appreciate the tools to generate new map layers as part of the analysis tools
4. Have gained practical experience in combining these elements using realistic exercises

DURATION

1 day

CONTENT AND ACTIVITY PLAN

Topics to be covered:

1. Basic Selections
2. Advanced selection
3. Analysis using the transformation toolbar
4. Conflict Maps

SUGGESTED METHODOLOGY

- Presentations
- Demonstrations

- Exercises
- Group Discussions

RESOURCES NEEDED

A basic understanding of GIS and GIS data and awareness of the basic operations in Manifold GIS.

REFERENCES

Chang, Kang-Tsung (2006) - Introduction to Geographic Information Systems, McGraw-Hill Higher Education

de Smith, Goodchild, Longley (2013) Geospatial Analysis - A comprehensive guide, http://www.spatialanalysisonline.com/HTML/index.html

Geerling, Gertjan, - Draft Manifold Hands-on Manual, not published

MANIFOLD System GIS Help,

MANIFOLD System GIS User manual, accessed on: http://www.georeference.org/doc/whnjs.htm

Pakes, Ubo – GIS analysis PowerPoint and Training materials, GIS tailor-made Inc

Queries

Introduction

This Lesson deals with querying data from a GIS database. Queries represent processes of selecting information from a GIS database by asking questions. Queries can be divided into geometric, thematic and topologic queries.

- ***Geometric*** queries are based on location, for example 'how many buildings are located within 5 km from the road?' Here the key factor is 'within 5 km', indication a geometric question.
- ***Thematic*** queries are based on attributes of the spatial data, like 'what is the average age of people in each province?'The drawing 'provinces' should contain attribute data on average age in its table.
- ***Topologic*** queries are based on for example networks or common boundaries, like 'what is the shortest distance to the next town by road?' Here, the road is the network and the computer must know which roads connect to each other and which don't (for example from a fly-over you cannot turn left). Another example could be, 'what municipalities share the same coastline?'In this case, the coastline is the common boundary.

You can perform a variety of queries in Manifold, from pointing at features on a map (e.g., to identify them) to analysing spatial relationships between different phenomena (e.g., to find out how they might influence each other).

The formal structure of a query is:

```
Find the data of attribute T
    of the database S
        that fulfils condition C
            and carry out operation O.
```

An example of a thematic query is: Which municipalities have less than 10,000 inhabitants?

T = Inhabitants

S = Municipalities

C = less than 10,000 (<10,000)

O = Show the result (or save to new table, print, etc.)

Identifying features with the mouse

In a drawing:

1. Open a drawing from the project pane.
2. Right click on the object (like an area or line) and choose **Fields**.
3. The Object Fields window appears containing the Object's attributes. These are taken from the table connected to the drawing.
4. Refer to **Help**-> **Index**-> type *object fields* for more information.

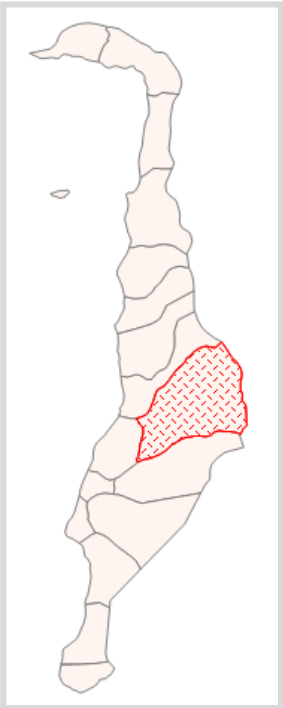
As with many things in GIS, there is another way to do this. If you open the **info pane** from the View → Panes → Info, a pane opens showing the fields from the selected object.

Manual selection of objects and show attributes

To get the attributes of specific objects in a drawing and then work with them, it is best to select the objects on the view and then open the drawings' attribute table to see their attributes. When you select objects on a view, they are highlighted to show that they are selected.

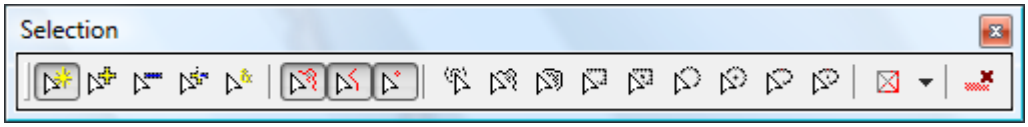
There are various ways to select features in Manifold System. First, we will look at how to select features on a view with the mouse and use the theme's attribute table to get information about these features.

1. First open the drawing of which objects are to be selected.
2. Go to **Edit**-> **Select mode**-> **Replace**
3. Go to **Edit**-> **Select Objects** and choose your type of object to be selected. Often all types (points, lines, areas) are turned on. If you have only one type in your drawing, you can leave all types on.
4. Then click on one of the objects in the drawing, it should be highlighted. See Figure below for an example of a selected area.
5. If you click on another object, the first is deselected.
6. If you open the drawing's table, you will see that one of the records is selected. If the table is large i.e. contain many records, you can use menu **View**-> **Selection filter** to show the selected records only.



Selection Toolbar

When a drawing is shown, quick access to menu items **View**-> **Select mode** and **View**-> **Select objects** is provided by the **Selection** toolbar, see below. If you can't find it go to **Tools**-> **Customize** and switch it on.



REFINING THE SELECTION WITH THE MOUSE

Manifold provides several options to achieve the same in case of selections. In case the selection toolbar looks as above, and none of the select type buttons () is switched on. Then:

1. Select an object by clicking it; add another to the selection by holding SHIFT or CTRL at the same time.
2. Deselect an object by holding CTRL and clicking it.

Selection toolbar

1. Choose your selection method:

   Select Replace - Replace the existing selection with whatever is now selected.

   Select Add - Add whatever is now selected to the existing selection.

   Select Subtract - Subtract whatever is now selected from the existing selection.

   Select Invert - Deselect whatever is now selected that was already in the existing selection and otherwise add what has just been selected.

2. Choose what type of objects you want to select, i.e. areas, lines, points, pixels in case of an image or text. Which options are given depends on the active component (drawing, image, layout). Multiple selections are possible.

3. Choose how you want to select. Most common are listed below, for descriptions of others options see **Help**-> **Index** type *Selection Toolbar*
4.  **Select Touch** - Click to select pixels like the one clicked, give or take the tolerance that may be set in **Tools** – **Options**
5.  **Select Shape** - Select objects within a region defined by a series of clicks followed by a right click.
    **Select Box** - Click and drag to select items within a rectangular selection box

Stop selecting and clearing the selection

The last buttons on the Selection toolbar are:

 Disable selecting, or choose how selection appear

 Clear selections

Saving Selections

By opening the Selections pane using **View**-> **Panes**-> **Selections** you can save selections and use them later. It works in table view or geographical view.

- Press  to save the current selection.
- By double clicking you can apply the saved selection.
- By pressing  and click on a saved selection once you can preview a selection (the selection appears in blue on the view screen.

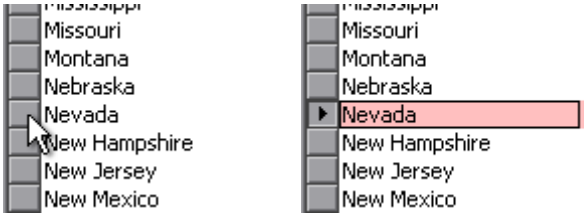
Optional: The **Viewbots** pane (**View**-> **Panes**-> **Viewbots**) can be used to dynamically summarize field data from selected objects, like showing the average of a particular field for the selected objects. When the selection changes, the viewbot automatically updates the values for the new selection. This topic has been discussed in Session 4; or see **Help**-> **Index** and type *viewbots* for more information.

Exercise 5.1

Selection

Manual Selections in tables

When a table is open, you can view selections made in a drawing or you can make selections in the table by clicking the area before the first column. The options **Edit**-> **Select mode**-> **Replace** and **View**-> **Selection filter** are also available in tables.



Sorting attributes

By sorting an attribute table you can list the features in order of importance:

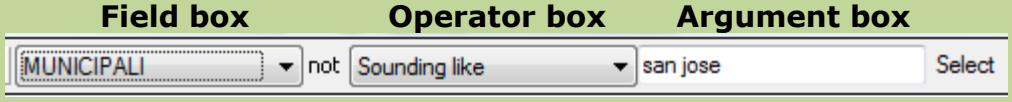
1. In the attribute table, right-click the name of the field (attribute) you wish to sort the attribute values.
2. Click the Sort Ascending or Sort Descending button to sort the attribute values.

Finding features by using a query (thematical)

Queries are used to find features according to their attributes, in order to discover which features meet particular criteria. A query expression is a precise definition of what you want to select. Building a query expression is a powerful way to select features because an expression can include multiple attributes, operators and calculations. Before building the query you have to specify the query criteria.

The Query toolbar

Using the **Query toolbar** you can build simple queries, see figure below. If you cannot find the Query toolbar, go to **Tools**-> **Customize** and activate the Query toolbar.



HOW TO OPERATE THE QUERY TOOLBAR:

1. Open the table or drawing to select from
2. Choose the search field from the **Field** box left
3. Turn **NOT** button **on** or **off** by clicking. Using not you can inverse the

selection

4. Choose your operator from the **Operator** box, such as **sounding like**, or **less than**.
5. Type the argument, in the example “san José”
6. Press **Select**.

For a description of the complete list of operators see **Help**-> **Index** and type *Query toolbar*. The available operators vary with the type of component you have opened (Drawing, Table or Image/Surface). Some examples are given below:

TOP operator: By using Area (I) as Field, the **Top** as operator and for example 5 as argument, you get the top 5 of areas.

The **Matching**, **Containing Match**, **Ending with Match** and **Starting with Match** operators use Visual Basic style regular expressions. Examples (taken from a Mexican drawing):

- Using *DURANGO* as the argument, selects one record ("DURANGO")
- Using *CHI.+* as the argument, selects all records starting with CHI ("CHIHUAHUA" and "CHIAPAS")
- Using operator **Starting With Match** and *BA. +* as argument, selects all records starting with "BA".
- Using operator **Starting With Match** and argument *[F-H]* selects three records ("HIDALGO", "GUANAJUATO" and "GUERRERO"). In effect selects everything between alphabetical order F and H.

Saving Selections

By opening the Selections pane using **View**-> **Panes**-> **Selections** you can save selections and use them later.

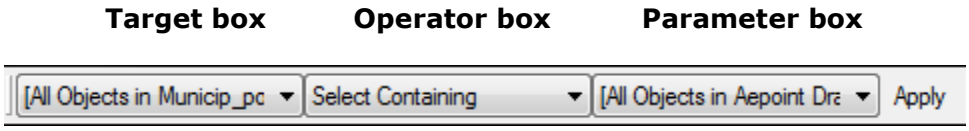
- Press  to save the current selection.
- By double clicking you can apply the saved selection.
- By pressing  and click on a saved selection once you can preview a selection (the selection appears in blue on the view screen.

Exercise 5.2

Queries

Geometrical and topological selections

In Manifold System, geometrical and topological selections are done using the **Transform toolbar**. See figure below. The toolbar is divided into a target box, operator box and parameter box. It is not designed for selections only; you will find a lot of operator functions in the operator box. The table below shows a part of the possible operators for making selections.



The Transform toolbar

Table: Part of the Selection operators in Transform toolbar (except network based selections).

T	Select Adjacent to	Select all objects in the target set that are adjacent to any object in the source / argument box set. Objects are adjacent if they have one or more boundary coordinates in common with no other overlaps.
T	Select Contained within	Select all objects in the target set that are entirely contained within an object in the source / argument box set
T	Select Containing	Select all objects in the target set that completely contain any object in the source / argument box set.
T	Select Intersecting	Select all objects in the target set that intersect any object in the source / argument box set. Objects intersect if they have any parts in common excluding intersections consisting of common boundary coordinates only.
T	Select Line Coverage	Select a minimal set of lines so that each line from the source set touches at least one line from the result set.
T	Select Touching	Select all objects in the target set that touch any object in the source / argument box set. Objects touch if they either intersect or are adjacent to each other.
G	Select Euclidean Point Coverage	Select a minimal set of points so that each point from the source set is within the given distance (in the drawing's native measurement units) to at least one point of the result set.

T = Topological; **G** = Geometrical

Some examples of use

Select adjacent to: Suppose you work for a city council that wants to inform owners of land adjacent to the city border that a new hospital will be built. You can use "**Select adjacent to**" to find those land parcels that are adjacent to the city border.

1. Create a Map (**File**-> **Create**-> **Map**) and add a city border drawing and land owners drawing. Open the Map.
2. In the Choose [All objects in land owners] as target in **Target box**.
3. Choose **Select adjacent to** in **Operator box**.
4. Choose [All objects in city border] in the **Parameter box**.
5. Press **Apply**.

Select Intersecting: Suppose you want to know in how many municipalities one single highway is located. You can use Select Intersecting to select all these municipalities.

1. Create a Map containing a Highway drawing (lines or areas) and a Municipality drawing (areas). Open it.
2. Select the highway in question by clicking it with the mouse or selecting it using the select toolbar.
3. Choose [All objects in Municipalities] in the **Target** box.
4. Choose **Select Intersecting**.
5. Choose [Selection in Highway] and press **Apply**.

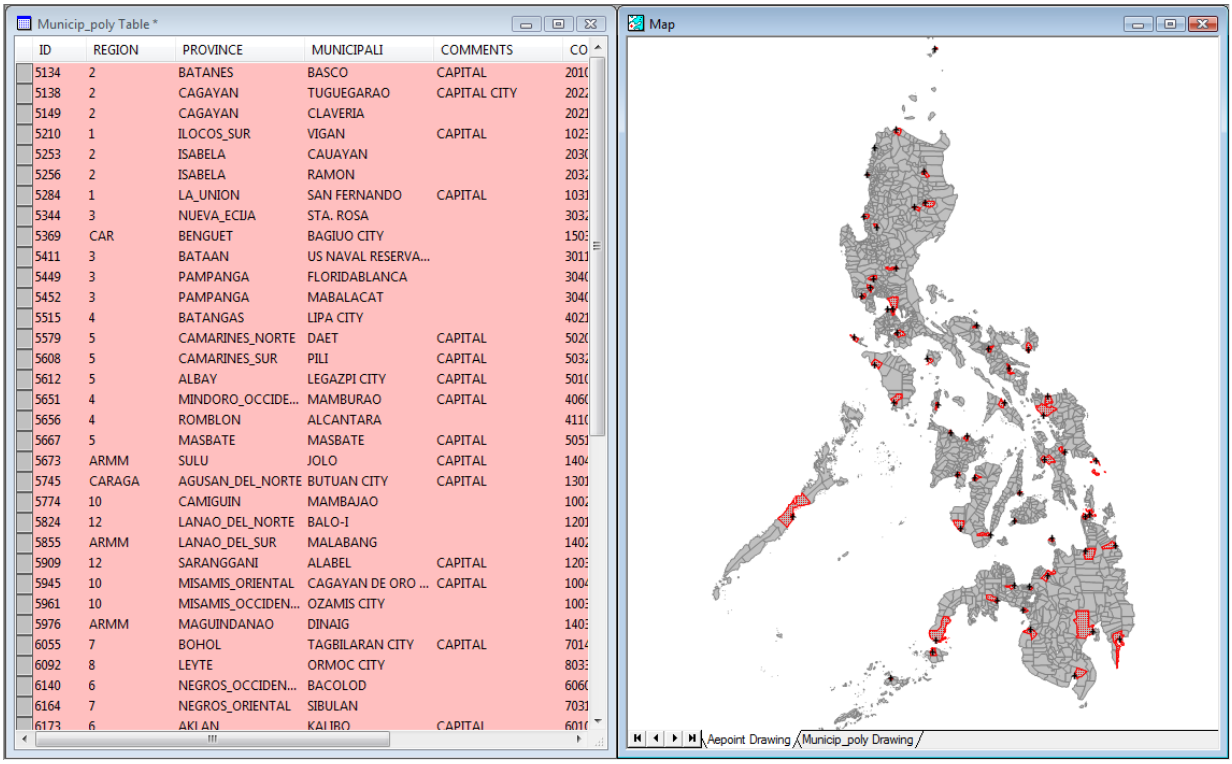
This also shows you can use a previous selection in the operation. Selections made in the single drawings can be used as well as saved selections from the **Selection** pane.

Select Containing: Suppose you have a point drawing of all the airports in the country, but you want to know in which municipality they are located. Fortunately you have a municipality drawing containing the municipal areas. With select containing you can select the municipalities (areas) containing the Airports (points). You can export that list.

1. Create a map with both drawings.
2. Target = [All objects in Municipalities]
3. Operator = Select containing
4. Parameter = [All objects in Airports]

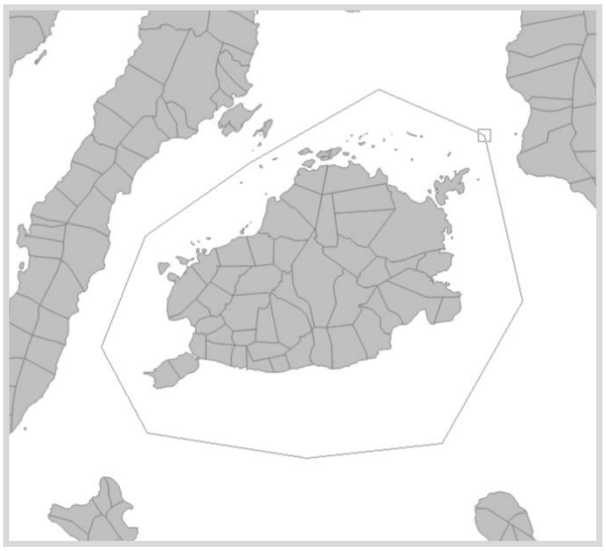
5. Click **Apply**

The result can look like this, in the drawing and table all municipalities are selected (red) that have an airport.



Finding features inside manually drawn shapes (topologic)

Use selection using freehand, box, circle or areas from the selection toolbar, see example for a manually drawn area around an island. See paragraph on manual selection with the mouse in this chapter or refer to **Help**-> **Index** and type *Selection toolbar*.



Exercise 5.3

Geographic and Topologic Selection

Transferring attributes to another drawing based on location (topologic)

Suppose you have a point and an area drawing and you want to transfer the attributes (table entries) of the points to the areas, you use **Drawing**-> **Spatial Overlay**. First, the procedure needs you to select which fields should be transferred and how. You do this using the **Transfer Rules**.

To specify a transfer rule for a column:

1. Open the drawing's table.
2. Right click on the column and choose **Transfer rules**.
3. In the **Transfer Rules** dialog, specify the transfer method to be used for one to many (1 to N) operators. The **Proportional methods** available for numeric fields also require specification of a second numeric field.
4. Specify the transfer method to be used for many to one (N to 1) operators.
5. For text fields, choose any desired options to ignore

case or whitespace.

6. Press OK.

You can do this for as much columns you need, more information in **Help**-> **Index** type *Transfer rules*.

Then, to use Spatial overlay:

1. Open the Map containing the two drawings to overlay. Or at least one drawing containing two kinds of objects, i.e. points, lines and/or areas.
2. Go to **Drawing**-> **Spatial Overlay**
3. Box **Source:** Choose an object set to be the source of data. Choices will include the selection, all saved selections, and objects in drawing layers when launched from a map. The source set may contain only objects of one type (that is, all areas, all lines or all points).
4. Box **Target**: Choose an object set to receive the transferred data. Choices will include the selection, all saved selections, and objects in drawing layers when launched from a map. The target set may contain only objects of one type (that is, all areas, all lines or all points).
5. Box **Method**: Choose a transfer method. Only those operations that make sense for the objects in the source and target sets will be presented. If the source or target set do not contain all objects of one type the method box will not be enabled.

The methods for overlay pertain to objects inside other objects, next to other objects, intersecting other objects, touching other objects and neighbouring other objects. Depending on the types of objects present in the drawings, not all possibilities are shown in the **Spatial Overlay** window.

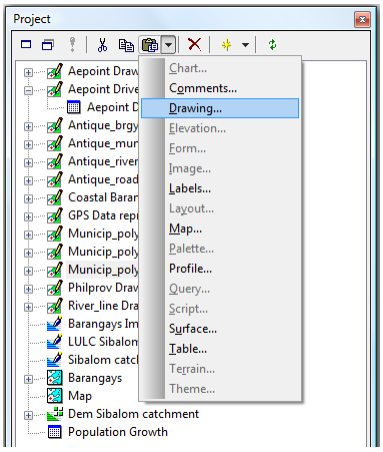
An overview of the **spatial overlay methods** is given in: **Help**-> **Index** type *Spatial Overlay*

Exercise 5.4

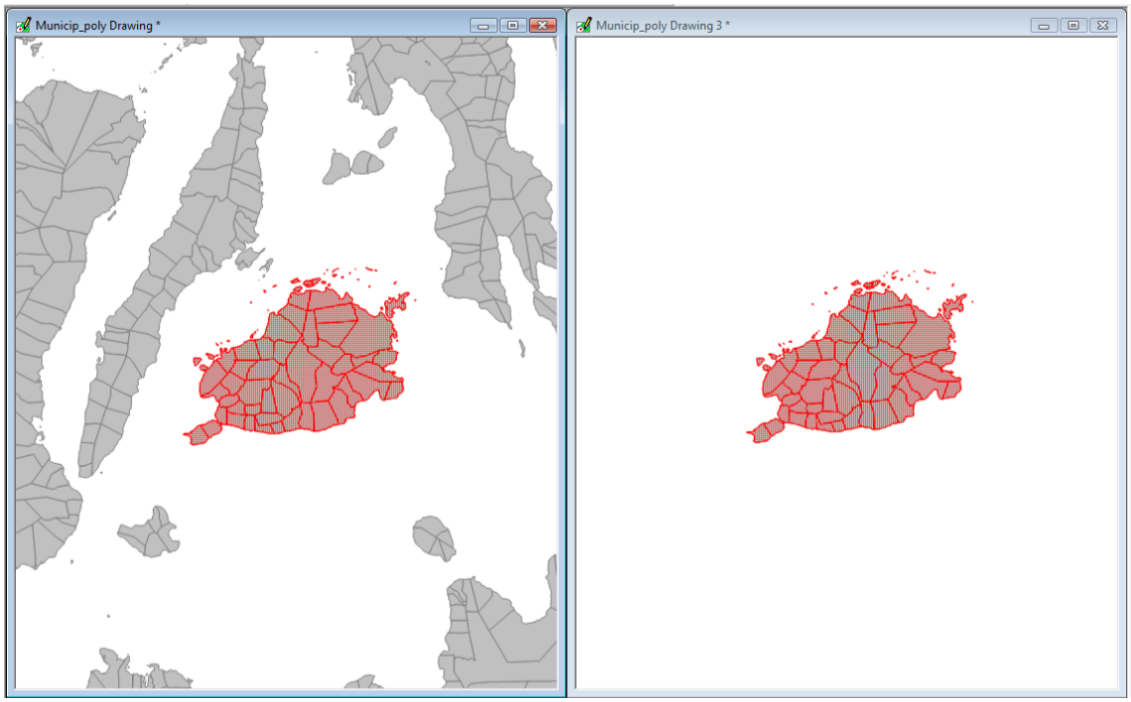
Spatial Overlay

Changing your selection into a new table or drawing (copy and paste)

To extract your selection from a drawing or table, just use **Edit**-> **Copy**. Then go to an empty area in the Project pane and press right-click **paste as**-> **drawing** or press the **paste as-> drawing** button, see figure below.



The result will be a new drawing containing only the selected objects, including the associated attribute table.



Exercise 5.3

Geographic and Topologic Selection

Advanced selection: using SQL

In Manifold queries can be built using a SQL language, exactly like the formal form of a query as shown in the introduction. An example of a SQL query is:

```
SELECT * FROM [Antique_mun Drawing Table] WHERE [MUNICIPALI] LIKE "SAN JOSE";
```

Meaning: Select all records from the table 'Antique_mun Drawing' in which the field 'Municipali' is like 'SAN JOSE'.

To make a query:

1. **File**-> **Create**-> **Query** (or press right-click in the **project** pane and choose **Create**-> **Query**)
2. Give the name of your Query and press **OK**.
3. It will appear in the project pane.
4. Now you can enter your query

In building a query, it is important to know what type of field you are querying, usually it is text based or numeric (integer or floating). To find out, open the table, right-click the Field header and choose **Format**.

Examples for numeric or text based queries:

```
SELECT * FROM [MUNICIPALITIES Table] WHERE [POPULATION] < 2000;

SELECT * FROM [MUNICIPALITIES Table] WHERE [HOTELS] < 30 OR [HOTELS]-> 40;

SELECT * FROM [MUNICIPALITIES Table] WHERE [MUNICIPALI] = "SAN JOSE";
```

Keyboard shortcuts:

- When pressing the [key in query building gives you a list of tables and fields to choose from to facilitate writing the right key.
- Pressing CTRL + SPACE or CTRL+J gives you an available list of queries.

For standard examples look in **Help**-> **Index** and type *Query Templates* for all expressions refer to Help-> Index-> type *SQL Reserved Words / Index*

Analysis using the transformation toolbar

The Transform toolbar is loaded with operators that can accomplish "one step" editing and transformation of the contents of the active window. The transform toolbar's operators box will be loaded with the applicable operators for whatever type of window is active (drawing, image, etc.). The transform toolbar is also used to make spatial selections using commands such as Select Touching or Select Contained within that work between sets of objects. Because transform operators are highly specific to the type of window that is active, the transform toolbar is covered in detail within topics for each different component that has transform toolbar operators:

- Transform Toolbar - Drawings
- Transform Toolbar - Images
- Transform Toolbar - Tables

The transform toolbar uses the same general interface in all cases. We can consider the transform toolbar for drawings as an example. The transform toolbar makes changes throughout the entire drawing using the specified operators. Transform operators can create new objects, delete objects, change objects (for example, splitting them) and select objects using various algorithms such as the location of a shortest path.

The Transform toolbar consists of three boxes, from left to right: a target box, the operator box, and a parameter box.

Target box

Also known as the scope box. The objects that will be affected, altered or which will control the operation. Choices in the target box will be [All Objects], [Selection] or the names of any saved selections that have been saved in the Selections pane. The illustration above shows that the operator will be applied to all objects in the drawing.

Operator box

Gives the function to be applied. The operator box is context sensitive and will show only those operations that make sense for drawings. The example shows we will add border buffer zones.

Parameter box

The value to be used. Depending on the operator, this may be another object set or a value entered by the user. Many operators, such as Boundaries do not require a parameter. The parameter box will not be enabled for such operators. In the example above we use 10000 for the size of the border buffer zones, the size being specified in the native units of the drawing.

Using the Transform toolbar

1. Click on the map layer or drawing that contains the target objects.
2. Make a selection if the operation is to be applied just to the selection.
3. Choose the desired operator in the operator box.
4. Choose or specify a value in the parameter box, if this operation requires it.
5. Press Apply.

Some operators create new objects. Any new objects created will be created in the active drawing/layer and will now be the Selection. Move the Selection to a new layer/drawing if you wish to keep these objects organized separately from the original objects in the drawing (almost always a good idea).

Themes and Toolbars

Themes can be used in the Query and transform toolbars. Object sets defined on themes will always use the name of the theme's parent drawing. For example, if there are selected objects in a theme named T whose parent is a drawing named D the selection choice will appear in the query or transform toolbar boxes as Selection in D. This is done so that it is immediately clear that modifying a theme will modify the parent drawing (and thus all other themes bound to that drawing).

Much used tools

The following are a selection of much used tools in the transformation toolbar

- **Boundaries** – Create lines in the shape of the periphery for each area in the target set. Will create duplicate boundary lines in places where the edges of areas coincide.
- **Bounded Areas** – Create areas within regions enclosed by lines in the target set
- **Buffers** – Create a buffer zone for each object extending outward by the given distance. For areas, this is an outer buffer zone.

- **Clip with (Intersect)** – Use the areas in the source / argument box set to "cookie cutter" objects in the target set and leave only those items inside the cookie cutter.
- **Clip with (Subtract)** – Use the areas in the source / argument box set to "cookie cutter" objects in the target set and remove those items inside the cookie cutter.
- **Decompose** – Split branched objects into simple (non-branched) objects. For example, a single, branched area object composed of three "islands" will be split into three separate area objects
- **Explode** – Explode lines into multiple line objects where each line segment from the original line becomes a separate line object. No effect on areas or points (like naming the streets individually)
- **Intersect lines** – Explode lines into multiple line objects where each line segment from the original line becomes a separate line object. No effect on areas or points
- **Join Lines** – Join lines with coinciding ends into a new, single line object. Redistribute any data attribute fields according to (Precision)
- **Points** – Create points at all coordinates defining the shape of lines and areas in the target set. Avoids making duplicate points in places where the edges of two areas coincide
- **Spline** – Create points at all coordinates defining the shape of lines and areas in the target set. Avoids making duplicate points in places where the edges of two areas coincide
- **Split With** – Split target areas and lines using a given set of lines.
- **Union** – Combine all areas in the target set into one area object

An overview of the **tools** is given in: **Help**-> **Index** type *Transform Toolbar*

Exercise 5.6

Hazard analysis using the transformation toolbar

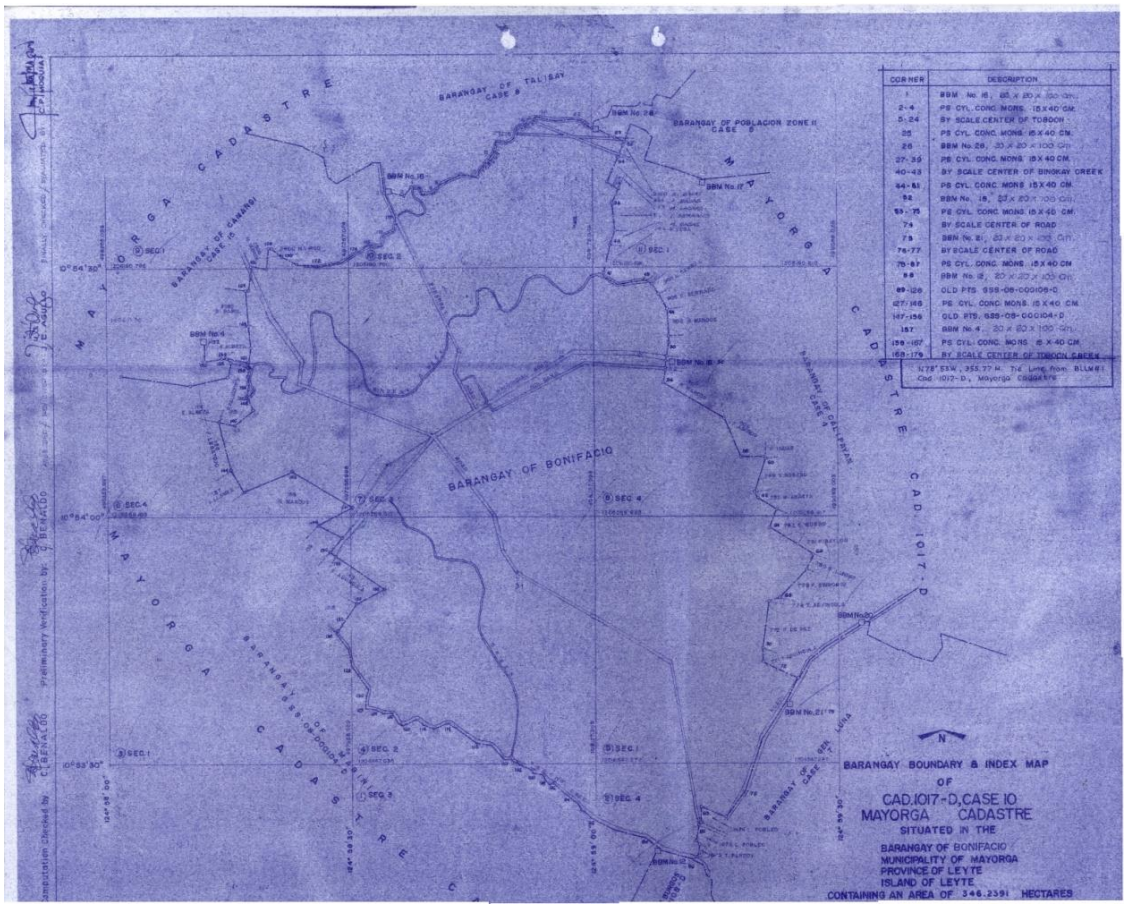
Preparation of a Barangay Base Map

One of the first steps in preparing the CLUP is the preparation of the base maps for the barangays. The base map will be used in next steps to prepare all the thematic maps needed for the barangay.

In order to prepare a barangay base map, please follow the next steps:

1. Secure the highest detail cadastral map you can get. Usually this will be the barangay cadastral map from DENR-LMS;

2. Scan the blueprint cadastral maps. If you only have a small scanner (A3 or A4); then you may need to scan the map in parts and stitch the different parts together again into one image. Make sure that you have enough overlap when scanning. An example of a blueprint cadastral map given is given below:



Barangay blue print from barangay Bonifacio, Mayorga, Leyte

3. For the stitching, you may use the procedures mentioned in the sideline in the session on georeferencing.

4. Use the coordinates on the map for geo registering the map. Since the map may be old, folded and maybe deformed due to weather, storage and so, use many control points and make sure that the control points are evenly distributed over the map. Please refer to session 3 for georegistration. In most cases, the coordinate system used in these maps will be Luzon 1911, so please use that. After georeferencing and digitizing (see the next step), you can change the projection to PRS92 or any other if needed.

5. After georeferencing, trace or digitize the barangay boundary and other important features. Please refer to session 4 for the digitizing process

To do a visual check on the process, you may export the newly digitized barangay boundaries to google Earth and check if the digitized data are located correctly. If this is not the case, please check your georeferencing and coordinate system.

To export to google Earth, right Click on the drawing in the **project pane** and select **export.** Make sure that in the "save as type"field, you select kml /kmz files. In the next menu you can enter a name and description field if desired. After clicking Ok, a KML file will be exported which can be opened in google Earth. For more information on the export to Google Earth please select **help > Search > Export Kml.**

To import this data into Google Earth, start Google Earth (a working internet connection is needed) and select **file > open**. Navigate to your KML file and google earth will automatically navigate to your location.

Analytical Maps

Depending on your area of work and the type of land use planning you are working with there are a number of (national) policies regulating the land use. The following chapters give an overview of these rules and regulations for CLUP and FLUP. Since these rules and regulations can be changed or updated in political processes and since there may be provincial or local regulations on top of these, please do not consider the following lists as complete and final, but always check with the responsible offices for changes and updates.

Comprehensive Land Use Maps

Within the process of creating a CLUP you may find that there are a number of conflicts between the existing land use and preferred land use or between land use and laws and regulations. ***There are generally 3 types of land use conflicts:***

1) land use vs. protected area (e.g. coastal easement zone),
2) land use vs. hazard areas (e.g. flood prone area), and
3) land use vs. land tenure (e.g. CLOA, A&D, Timberland, CBFMA, etc.).

These maps (and especially the decisions based on these maps) directly affect the lives of those who are affected and therefore we have to be careful in preparing the maps. There are legal procedures to be followed, but that process is too extensive to describe in this technical manual. See Modules 2 for integration of climate change adaptation into local development planning, 3 for disaster risk reduction and management, 8.1 for integrating FLUP into CLUP and CDP, and 8.2 for CFRM-CLUP integration However, the legal framework also gives us settings and conditions which should be applied within our GIS. Please find in the following a (non comprehensive) overview of Laws, Policies and Rules.

Please find in the following a (non-comprehensive) overview of Laws, Policies and Rules.

- Lands Administrative Order No. 8-3, S. 1936 (as amended)
- DENR Administrative Order No. 34-99
- PD 1067 (Water Code)

- RA 9397, amending RA 7279 (Urban Development and Housing Act of 1992)
- RA 7160 (LGC), CLUP and LGU Zoning Ordinance
- RA 8368 (Anti-Squatting Repeal Act of 1997); dismissing all pending cases against squatting under PD 772 (1975 Decree Penalizing Squatting and Similar Acts; Sec 27 of RA 7279 (UDHA) against professional squatters and squatting syndicates is not affected by RA 8368.
- RA 7279 (UDHA): eviction and demolition allowed if persons occupy danger areas and public places
- RA 7160: LGUs mandated to formulate CLUP and zoning ordinances
- RA 9397 (amended UDHA): HUDCC designs registration of qualified socialized housing program beneficiaries; LGU identifies beneficiaries
- Lands Administrative Order No. 8-3: riparian owner adjoining shore or marshy lands or lands bordering shores or banks of navigable lakes or rivers may apply for foreshore lease (if such land is not needed for public service)
- DENR AO 34-99: lessee may not assign, encumber or sublet rights without prior consent of PENRO
- PD 1067 (Water Code): no person allowed to stay in banks of rivers and streams, shores of lakes and seas within 3 meters (if urban), within 20 meters (if agricultural) and within 40 meters (if forest)
- Based on RA 7279 (UDHA): subject to summary eviction are new squatter families whose structures were built after the effectivity of RA 7279 and squatters identified by the LGU in cooperation with the PCUP and accredited urban poor organizations
- Eviction and demolition allowed if persons or entities occupy danger areas such as esteros, railroad tracks, garbage dumps, riverbanks, shorelines, waterways and other public places such as sidewalks, roads, parks and playgrounds

Forest Land Use Plans

The following table is provided by Provincial Forestland Assistance Team (PFAT) in September 2012.

	Policy	Stipulation
Two main categories of forestlands PROTECTION an PRODUCTION	EO 318 Section 2.1.1.	State forestlands shall be identified, classified and delineated/demarcated on the ground and shall constitute the permanent forest estate unless otherwise stipulated by Congress; the same shall be categorized and managed either as primarily for production or as primarily for protection purposes, and in both cases, placed under a formal management scheme.

Protection Area	Policy	Stipulation
Slopes steeper than 50%	DAO 24-1991	Prohibits logging
Protection Area	PD 705	
Slopes steeper than 50% Above 1,000m asl	Section 15.	Cannot be used as grazing land
	DAO 1995-15 Section 3. Definition of terms	Protection Forest forestlands outside NIPAS obtained essentially for their beneficial influence on soil and water in particular and the environment in general. These are areas **above 50% in slope** and more than 1,000 meters in elevation. Includes the critical watersheds, mossy forest, strips of specified width bordering rivers, streams, shoreline and reservoir, and steep, rocky areas and other naturally unproductive lands.
	DAO 24-1991	Prohibits logging
	DAO 1995-15 Section 3. Definition of terms	Protection Forest forestlands outside NIPAS obtained essentially for their beneficial influence on soil and water in particular and the environment in general. These are areas above 50% in slope and **more than 1,000 meters** in elevation. Includes the critical watersheds, mossy forest, strips of specified width bordering rivers, streams, shoreline and reservoir, and steep, rocky areas and other naturally unproductive lands.
Old growth forest	DAO 24-1991	Prohibits logging
Natural and residual forests, and naturally grown trees	EO 23	1.2 Natural and Residual Forests- are forests composed of indigenous trees, not planted by man. Section 2. Moratorium on the Cutting and Harvesting of Timber in the National Forests – A moratorium on the cutting and harvesting of timber in the natural and residual forests of the entire country is hereby declared unless lifted after the effectively of this Executive Order.
Mangrove	R.A. 7161 Section 4. Referring to Sec. 71. In PD 705	"Sec. 71. Charges on Firewood, Branches and Other Recoverable Wood Wastes of Timber. - **Except for all mangrove species whose cutting shall be banned**, there shall be collected forest charges on each cubic meter of firewood cut in forestland, branches and other recoverable wood wastes of

Protection Area	Policy	Stipulation
		timber, such as timber ends, tops and stumps, when used as raw materials for the manufacture of finished products, Ten pesos (P10.00).
Water Production	R.A. 8435 (AFMA (1997)	SEC. 12. Protection of Watershed Areas. - All watersheds that are sources of water for existing and potential irrigable areas and recharge areas of major aquifers identified by the Department of Agriculture and the Department of Environment and Natural resources shall be preserved as such at all times.
River easement	PD 1067 1976	**Article 51.** The banks of rivers and streams and the shores of the seas and lakes throughout their entire length and within a zone of three (3) meters in urban areas, twenty (20) meters in agricultural areas and forty (40) meters in forest areas, along their margins are subject to the easement of public use in the interest of recreation, navigation, floatage, fishing and salvage. No person shall be allowed to stay in this zone longer than what is necessary for recreation, navigation, floatage, fishing or salvage or to build structures of any kind.
	CA 141 Public Land Act 1915	Section 90. (i) That the applicant agrees that a strip of forty meters wide starting from the bank on each side of any river or stream that may be found on the land applied for shall be demarcated and preserved as permanent timberland **to be planted exclusively to trees** of known economic value, and that he shall not make any clearing thereon **or utilize the same for ordinary farming purposes** even after patent shall have been issued to him or a contract lease shall have been executive in his favour.
Hazard and risk areas	RA 10121	LGUs are required to prepare LDRRMP and define the hazard and risk areas, these have to be considered in FLUP. Can include water security concern

What does this mean for GIS?

We can prepare maps to identify land uses which are in conflict with the current use of the land – like for example, agricultural areas within protected areas (coastal easement zone) which is by law not allowed. So by overlaying the existing land use data with that of data for the protection areas, the you can identify which land use type are in conflict with actions of the LGU for the protection of their locality.

Land Use conflict between other fields also follows the same process but there are some issues which have to be respected according to administrative orders and regulations. Examples are that it is not legal to practice exhaustive agriculture applications to slopes greater than 18% but restrictive agro forestry uses are allowed (I forgot what regulation this is but this is with DENR) or slopes greater than 50% should be considered as protection areas because these are prone to erosion and landslides.

In order to prepare these maps, we will combine different layers. There are two specific tools in the transformation toolbar that are very useful for this:

Clip with subtract or clip with intersect: The Clip with operators in the Transform toolbar for drawings use one or more areas to "clip" other objects, leaving only those parts of the other objects that lie within the areas (Intersect) or removing those parts of the other objects that lie inside the areas (Subtract). For more information and examples please check the help and search for Clip with subtract. We will be applying these tools with exercises on the following examples:

In the following table we will give a number of examples on how to use these functions and on which data in order to prepare the data.

Map	Input drawings	GIS function	Short description
Riparian conflict map (urban)	Open water; Settlements	Buffer Clip with intersect or Select containing	Prepare a 3 m. buffer around the rivers Select the settlements within this buffer area
Riparian conflict map (agriculture)	Open water; Settlements	Buffer Clip with intersect or Select containing	Prepare a 20 m buffer around the rivers Select the settlements within this buffer area
Riparian conflict map (forest)	Open water; Settlements	Buffer Clip with intersect or Select containing	Prepare a 40 m. buffer around the rivers Select the settlements within this buffer area
Settlements in protected areas	Protected areas; Settlements	Clip with intersect or Select containing	(if needed) select the right type of protected area (watershed, natural park, forest etc.) Select the settlements within this area.

The conflict maps that are created in this process will be used to prepare proposed land use maps. This means that you have be able to recognize the affected areas and that you will have to be able to suggest measures and proposed land use. Remember that one specific area can be part of more than one land use conflict. Using the attribute table, you can organize these data. For instance you can add columns in the table:

- *Rip_conflict* - riparian conflict area (yes or no)
- *Cur_landuse* - current land use
- *Rip_measure* - proposed measure/intervention with respect to riparian conflict
- *Pro landuse* - proposed land use after the measure has taken place

You can use these fields again to make selections, calculate areas etc.

Exercise 5.7

Examples of land use conflict Map

Land use conflicts

Areas where the present land use is in conflict with one (or more) of the regulations.

Residential area conflicts

Similar to the land use conflicts, but restricted to residential or urban areas but with the enclosure of the upland towards the coastal environment.

Intervention map

After identifying the different land use conflict areas, there has to be categorization since there may be redundancy of data overlay (same areas containing multiple conflicts), the LGU has to identify what kind of environmental intervention they need to address to these areas. For example when there is a clearly identified conflict with cultivated (agriculture) area within slopes above 18% then the LGU needs to decide

what they plan in doing about it. For instance they can identify it later as

1. agro forestry area or
2. as reforestation area or
3. remain as agriculture area for status quo.

So the intervention map, talks about how one LGU will handle given all identified conflicts in their jurisdiction which is according to existing administrative orders and regulations or even the law. The actual decision making is not done in GIS, but our maps are a strong tool in facilitating the discussion and presenting and analysing the locations and areas affected and we can present the new situation in a new map. Part of creating this map can be done using the attribute table and classifying the areas there.

Proposed land use map

The proposed land use map is a culmination of the two above prepared maps (and maybe others if other conflicts exist as well). After having identified the different conflicts that they have, the LGU can further decide on what to go about with the existing land use of their locality.

Summary

In this lesson you have seen how you can get more value from your data by performing spatial analysis. A first, strong way of analysing your data is to select the right features in the drawing and study the attribute data, or select features with the right conditions and present these in a drawing. Using the complex selection options of Manifold System, this can be done either in one drawing or between drawings and tables.

The other strong feature is using the transformation toolbar in which more and more complex analysis options are possible and where also new drawing can be made by making smart selections and combinations of drawings. Using exercises from the practice from land use planning in the Philippines you have gained some experience in using the analysis tools.

After steps in collecting and preparing data you have now gained experience in analysing these data. The next step in the GIS process in now to present the data that you have made and that is the topic of the next lesson.

Map Design

OVERVIEW

This Session is the last of the technical Sessions of this training toolkit and manual following the usual workflow in GIS you have collected and edited the necessary data for SIMPLE. After doing the analysis and preparing the necessary maps for the CLUP, it is now time to prepare quality presentations for print or in digital form. In this Session you will gain first a conceptual insight in how we observe and which elements can be placed in a map and what their meaning is. After that we will prepare a lay-out for printing in Manifold System. The Session will finish with some of the standards for data and colours that are set in the Philippines and with instructions on how to prepare a print for a large scale printer.

In this lesson you will learn how to change the colours of a drawing according you your own or specified settings and how to save and reuse these. Once you have the formatting of the drawings set, then you will combine these into a map that is ready for distribution or printing.

OBJECTIVES

After this Session, you will:

1. Gain insight in how men observes and how to communicate with maps
2. describe cartographic elements and how these affect a map
3. Know how to prepare a map layout in Manifold System
4. Have insight in colour standards set by NGA's in the Philippines
5. Have gained practical experience by combining these elements using realistic exercises

DURATION

8 hours

CONTENT AND ACTIVITY PLAN

Topics to be covered:

1. Changing symbology of drawings

2. Preparing a Layout in Manifold System
3. Creating a layout
4. Preparing for a large scale print

SUGGESTED METHODOLOGY

- Presentation
- Group Discussion
- Exercises
- Demonstrations

RESOURCES NEEDED

In order to follow this Session you should have understanding of the principles of Manifold System and how it works with toolbars and panes. You should also know how to combine different layers into a Map component and how to manipulate these layers.

The data for the exercises can be found on the DVD that goes with this toolkit.

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Formatting drawings

Once a drawing has been imported and opened, we can change the way it looks using the format toolbar. Used with drawings or drawing layers in maps, the Format toolbar controls the colour, style and size of areas, lines and points. Used with text components the Format toolbar controls the colour and appearance of text labels in that layer. Used with images, the Format toolbar controls the colour, style and size of painting tools. Note that the contents of this toolbar depend on what component window or map layer is active.

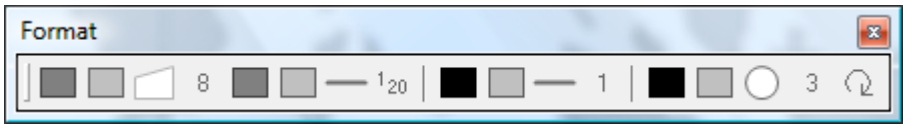
FOR DRAWINGS THE FOLLOWING OPTIONS ARE AVAILABLE:

	Areas Format - Foreground / background colours, Style and size for all areas in this drawing.
	Area Borders Format - Foreground / background colours, Style and size for all area borders in this drawing. While the 1/20th of a point value for border size works well for screen display it is wise to increase the thickness of area borders for printed materials since 1/20th of a point results in lines that are too thin for good visibility with most printers.
	Lines Format - Foreground / background colours, Style and size for all lines in this drawing.
	Points Format - Foreground / background colours, Style and size for all points in this drawing

- *Foreground Colour:* The colour of solid points and lines and the foreground colour of two-colour area styles or of two-colour area border styles. Choosing a transparent colour for foreground colour for an area will turn off display of that area. This is a short-cut way of turning off areas when desired.
- *Background Colour:* The fill colour in most styles used for points, lines, areas and area borders.
- *Style:* The pattern or icon used to draw points, lines, areas or area borders.
- *Size:* The relative size to use for patterns used to draw points, lines, areas and area borders. Does not apply to bitmapped images used for points.
- *Rotation Angle:* Allows rotating the symbols used for points to a given angle.

Below a short introduction is given, more information can be found in the Manifold System help file: look in the menu Help > Index and type thematic formatting.

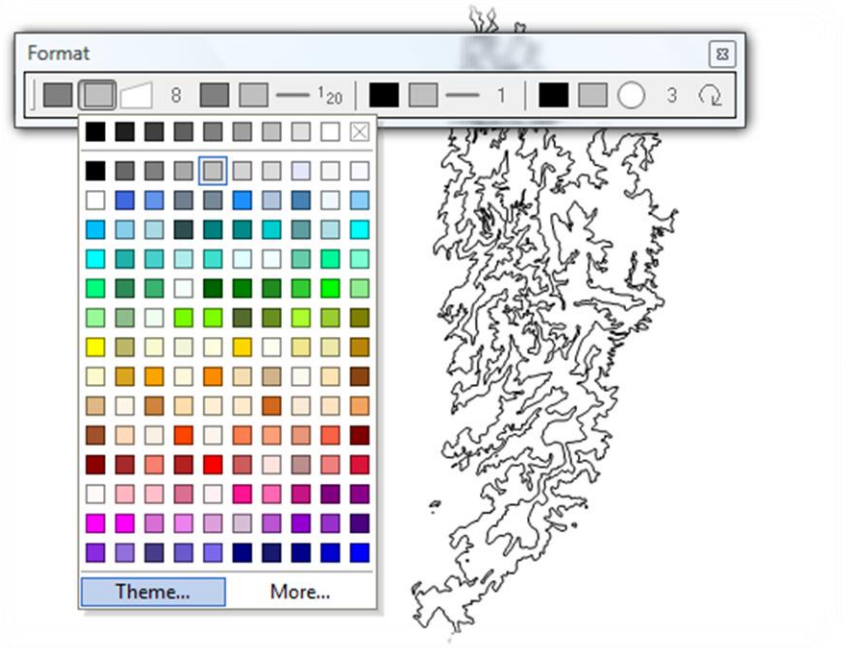
1. First open a project containing a drawing or import a drawing.
2. Have a look at the table and decide what Field to use. Field are sometimes also called column or attribute.
3. Open the drawing (double click on it in the project pane)
4. Locate the 'format' toolbar, see figure 2-1 below.



Format Toolbar

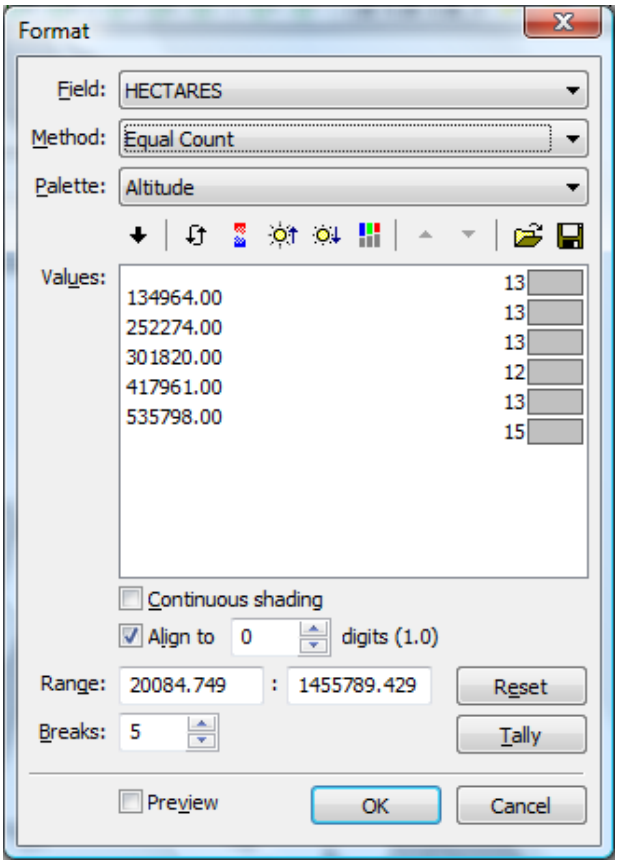
a. For linking *area* fill colour to a Field from a table: click the **area background** button and choose **theme**, see figure below. If you don't know what button to press, just hover your mouse arrow above the buttons and wait for the description to appear.

b. For linking a *line* colour to a Field, click the **line foreground** button. This can be useful for assigning colours to contour lines (elevation lines).



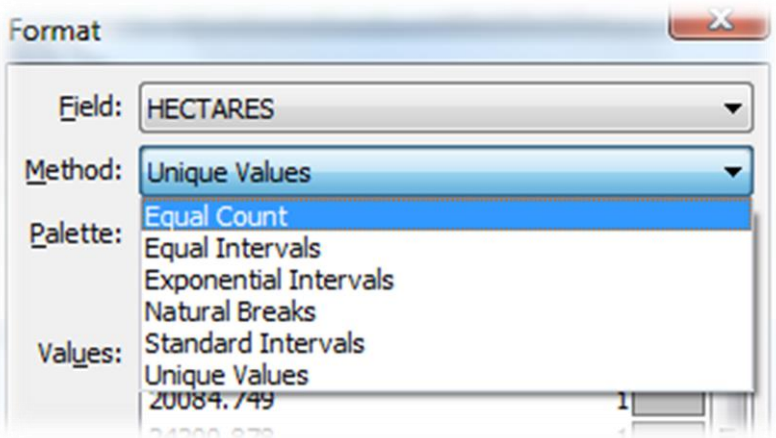
Selection of Theme in Format toolbar

5. Choose the **Field** you want to use from the drop down menu '**Field**'. In the example below, it is 'hectares'.



Formatting options

6. In the '**Method**' drop down menu, choose the **Method** to be used to construct intervals. **Equal Count**, for example, will assign approximately the same number of objects to each interval. Other methods are described in the table below.



Interval method selection

Method	Description
Equal Count	Assign interval values so that each interval contains the same number of objects.
Equal Intervals	Assign interval values so that each interval contains the same range of values.
Exponential Intervals	Assign interval values so that each interval contains an exponentially increasing number of values.
Natural Breaks	Find clusters or groupings of objects by the given field and assign break values so that each cluster is in a different interval.
Standard Intervals	Choose break values so that each interval represents one standard deviation.
Unique Values	Used with text and enumerated fields. Assign a break value for each unique value that occurs in the field.

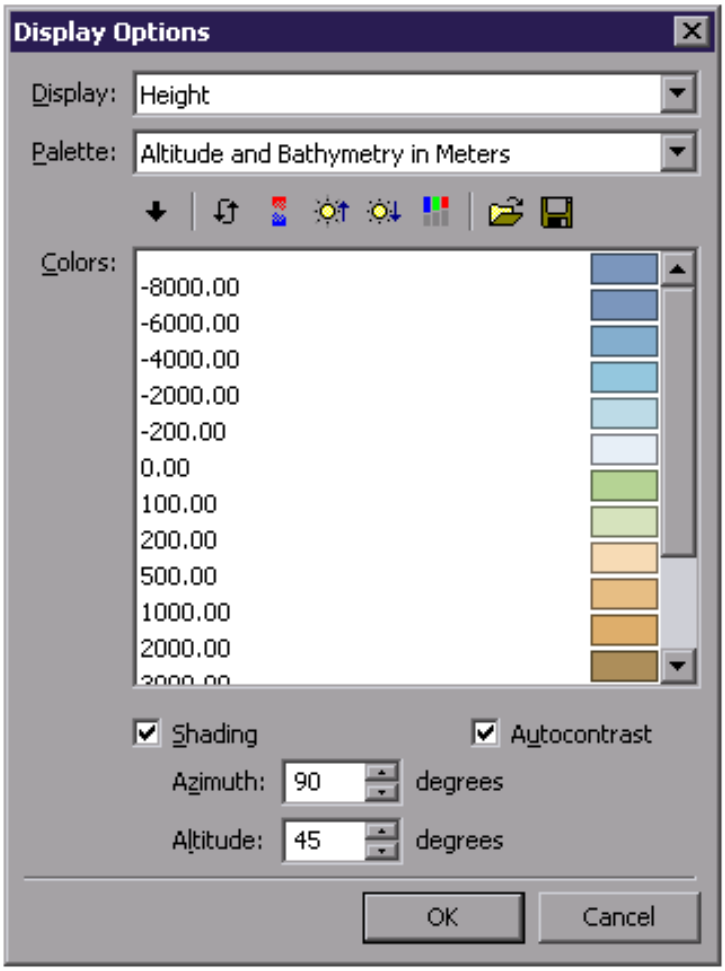
7. Choose the number of **Breaks** between intervals. This specifies the number of intervals as well.
8. Change the **Align to** value if even numbers of tens, hundreds, thousands, etc., values are desired for intervals. Change the **Range** if the default entire range needs to be extended or contracted.
9. Press the **Tally** button to create the given number of intervals. If interval numbers different than those created by the **Method** are desired, double-click into the interval numbers to change them.
10. Either use a pre-set colour **palette** or click into the interval colour boxes to change colours to whatever range is desired. To use a palette, select it in the **Palette** box and press **Apply** ( ) to apply the pre-set to the intervals. Check the Preview box to try out different combinations and see how they look in the drawing without committing the changes.
11. When satisfied, press **OK**.

Note: Not only line and area colours but all the items in the **Navigation** toolbar can be connected to a field. For example, size of points, shape of points, colour of points, size of lines, etc. Just press one of the navigation toolbar buttons, choose **Theme**. The further procedure is similar as described in the text above.

Note: When a drawing contains more than one thematic field and you want to show them at the same time. *Themes* can be used to store different visualisations of the same drawing. For more information look in menu **Help** > **Index** and type *themes*.

Assign colors to raster data (surfaces)

Surfaces appear in a surface window as greyscale images where lighter colours indicate greater heights. The word "Height" is used even though the data values of a surface may convey some other meaning, such as temperature. To change the appearance of a surface window, use **View -> Display Options** to change the settings.



Surface Display Options

By default, surfaces will appear as shaded surface renderings with the colour of each pixel corresponding to the data value at that spot as adjusted for highlights and shadows from a Sun in the East. Other options include display of aspect or slope, or use of shading. Palette controls are similar to those used in Thematic Formatting of drawings.

Exercise 6.1

Assigning colours to surface

Color Standards

Sadly enough there are not yet many standards for the use of colours and symbols in maps of the Philippines. The topographic maps from NAMRIA have standard colours and symbols which can be seen in the legend of the maps. Apart from that, there are not many, so in most cases, you have to create your own symbols. However, if you can avail of paper maps from the map publishing agencies, please use the colours in that map so that you follow that standard as much as possible. Many of the colour standards that are presented in this chapter are not officially standards, but have been defined for the use with the Provincial Map Viewer in 2011.

CLUP

One exemption is the Comprehensive Land Use Plan where the HLURB has set standards. The following standard is given:

No.	DESCRIPTION	COLOR	RGB VALUE			EXAMPLE
1	Residential	yellow	255	255	130	
2	Commercial	red	255	0	0	
3	Infrastructure/utilities	gray	190	190	190	
4	Institutional	blue	0	0	255	
5	Parks/playgrounds	light green	100	225	100	
6	Industrial	violet	140	0	200	
7	Agriculture	Green	0	150	0	
8	Forest and Forest use	dark green	0	100	0	
9	Mining/quarrying	brown	153	51	0	
10	grassland/pasture	olive	90	125	40	
11	Agro-industrial	Light violet	200	150	255	
12	Tourism	orange	255	102	0	
13	Cemeteries	black	0	0	0	
14	Dumpsites/landfills	light grey	205	205	205	
15	Buffer zones/Greenbelts	green yellow	173	55	7	
16	Idle/Vacant land					
17	Reclamation	sienna	142	107	35	
18	Water uses	light blue	175	215	230	

The colour coding in the table above is the one that is used in the development of the provincial Map Viewer for Leyte and Southern Leyte. It deviates from the official HLURB coding by the fact that we have chosen the colour grey for dumpsites and black for cemeteries where the HLURB is not giving colours for those land uses. The land use reclamation area is only to be used for newly reclaimed areas for which no land use is proposed yet. As soon as a land use is proposed (or if it is already in use), then the matching land use class should be used.

If you can avail of real property data in GIS format from iTAX or another GIS based system, then you also have information on the land use as indicated in the taxation info. In that case, we suggest that you use the same colour coding as presented here for the CLUP.

Water uses

For water uses HLURB is also giving colour standards which are colored blue (as in 5.3.1) with a hatch pattern. For the provincial Map Viewer this has been adapted to the following:

code	description	colour
1	Fishpond	
2	Mangrove forest	
3	Wetland	
4	Sea grass area	
5	Coral Reef	
6	Fish Sanctuary	
7	Nipa	
8	Tourism	
9	Fish cages	
10	Seaweed culture	

During the development of the Map Viewer in a discussion with HLURB region 7 it became clear that for the water uses mangrove forest, tourism, nipa also the colours from the 5.3.1 would be accepted.

Classified Slopes

Classified slopes are used in a number of cases to determine possible land uses and or land use conflicts. For the Provincial Map Viewer the following classes and colours are suggested:

CODE	DESCRIPTION	COLOR	RGB VALUE			EXAMPLE
M	Level to nearly level (< 3%)	green	0	255	0	
N	Gently sloping to undulating (3 -8%)	green yellow	173	255	47	
O	Undulating to rolling (8-18%)	yellow	255	255	0	
P	Rolling to moderately steep (18-30%)	yellow orange	255	215	0	
Q	Steep (30-50%)	orange	255	165	0	
R	Very Steep (50-90%)	red	255	0	0	

Natural hazard data

The area for which you are working may be susceptible to one or more natural hazards. For the Provincial Map Viewer the following generic symbology has been defined.

VALUE	DESCRIPTION	COLOR	RGB VALUE			EXAMPLE
1	Not Susceptible	green	124	252	0	
2	Low Susceptibility	yellow	255	255	0	
3	Moderate Susceptibility	violet	208	32	144	
4	High Susceptibility	red	255	0	0	

The description can be made to fit to match the specific natural hazard (High susceptibility to landslide hazard for instance). In case you want to combine more natural hazards into a multi hazard map, you may consider giving the different hazards a different hash marking, while keeping the foreground colour the same and making the background colour transparent. This way you can combine hazards in one map or easily combine them with other data (which parcels are affected by tsunami hazard).

Exercise 6.3

Making the colored maps.

Map Preparation

Displaying data so that you can analyse spatial patterns on a computer screen is usually the first step in your GIS works. The next is often the printing a map for other people to look at. In this case, the basic features you use for your analysis may not be enough and for this Manifold System has a separate option in the project pane for making layouts. Here you can find a set of distinct functions and makes available a series of tools for designing map layouts that you don't need until you are ready to print.

A map is a visual presentation of the data that we think are so important that they should be placed on paper (or on a digital folder). A map is a visual way of communication and with all communication issues we have to think about the message we want to convey and about the target audience (or to whom do we want to convey the message. In order to do this in a regular and organized way there are 12 steps we can take.

The 12 steps are:

1. What purpose does the map serve?
2. What user group is aimed at?
3. What is the title of the map going to be?
4. What components are to be displayed in the legend?
5. What is the hierarchy of the components?
6. What is the attribute scale of these components?
7. How many classes does each component contain?
8. Which graphic symbols can be used?
9. Which graphic attributes have to be included?
10. Do I need a North arrow?
11. Do I need a Scale bar?
12. Should I mention the source of my data?

Map Elements

Map frame

In Manifold System this is the frame with the map that you can place in your lay-out. The Map frame is the actual area on your final product where the map is placed. In many cases this will be an area which is separated from the other map elements, but this is not always the case. For instance if you are making a poster or a map for a colour magazine, the map may be cover the whole page. There are also instances that your final product will have more than one map (frame) for instance if you compare two situations. Your final product will however always have at least one map frame.

Legend

Unless the map clearly speaks for itself, you may have to add a legend. A legend is a small display that provides captions, summarizes formats or otherwise explains what is seen in a window or in a print layout. Legends appear to float over the window and are always on top of other items in the window. Legends may use simple, default styles or they may consist of complex and sophisticated items. Legends will often show object formats for drawings, surface colours by height for surfaces, thematic formats for labels (if present), and colours in images.

Although legends are part of a component like a drawing, they are an accessory item like a north arrow or scale bar associated with that component and are not the same as the actual contents of the component like the points, lines and areas that make up a drawing. Legends are not edited using tools such as painting tools for an image or the various editing tools available for drawings. Instead, legends are edited using settings in the Legend dialog.

Except for layouts, each component has one legend. A component remembers the settings for its legend as part of the properties of that component.

Print layouts may contain multiple legends, including even multiple copies of the legend for each component that appears as an element in the layout. An entire legend or any part of a legend may be composed for us automatically by the system or we can manually specify all or any part of a legend. Automatically-created legend items may be dynamically updated if the information they show, such as thematic formatting, changes. Dynamic and static parts of legends may be mixed, so that part of a legend (such as a title) may be manually specified while other parts, such as the colours and values for thematic formatting, may be dynamically generated by the system.

Before you add a legend to a map or a layout, it is good practice to consider the look and feel of your

map layer first:

- Is the name in the properties pane (that will show in the legend) logical ("Barangay boundaries" vs. "brgy_bnd drawing"
- Are the units in my legend logical and consistent (for instance an automated class may reach from 0 – 4.98. Setting this from 0 – 5 makes a lot more sense)
- Are the colours that I use correct
- Does this element need to be in the legend (the big blue area next to a coastal barangay will be interpreted by almost all people as the sea. Do you then really need it in your legend?)
- It is also good practice to have a hierarchy in the order in which elements in the legend are presented. From top to bottom this would be:
    - Point drawings
    - Line drawings
    - Polygon drawings
    - Surfaces/images

North arrow

The north arrow is (usually) an arrow that points to the North. In Manifold System you have choice of a number of North Arrows that can be used. In Manifold System the components are always displayed "North up" based on the assumption that they have been created that way in a geographic context. Therefore all correctly georegistered components will always be "North up". On rare occasions we may work with drawings or images that are not georegistered, for example, scanned images or designs that have been made in AutoCAD and that are imported using the AutoCAD DXF format. These are usually designed using the front facade and not the north as reference. In such cases and only in such cases if we know the correct orientation for the North Arrow, we can use the Bearing value to provide a North Arrow that is not aligned straight up. Instead, the North Arrow will point to North at whatever Bearing rotation has been specified (with the default 0 degrees pointing straight up).

Scale bar

A scale bar displays the current scale of the map and gives an indication of how long a specific unit of length is. The units in the scale bar can be chosen and will usually be kilometres or meters or miles. When you place a scale bar in your map, make sure that you use logical units for the scales. If a scale bar does not change size when the Display number is changed or if it otherwise misbehaves, consider if the number of units

to display would cause the scale bar to be less than the minimum size specified (an underflow) or larger than the maximum size specified (an overflow).

Supporting text

Supporting texts can take many forms and sizes. One of the most obvious is of course to give your map a relevant title. It is common to use a descriptive title (Overview map of Barangay XX), but also more action directed texts can be used for a title "Municipality is addressing flood problems!". Other texts can be legal disclaimers and more. Also the labels that you can place on your drawings are considered to be texts and should be treated as such. Do not place too much texts and different fonts on your map in order to keep the design easy to read. Italic fonts in maps are usually reserved for water features (names of rivers etc.). Please consider the audience of your map, if the map is used for discussions with the people in a barangay, you may consider using your local language instead of English.

Spelling errors in your maps can be irritating and can keep your audience from focusing on the message of your map. When in doubt, copy your texts into Word or another word processor and use the spell check. You can then copy the correct texts back in your map.

Supporting graphics

Your map can have a number of supporting graphics. These can come in many shapes and sizes. You can think of a photo at the background of your map when you are preparing a poster. You can of course place the logo of your organization, graphs and more. Before placing these graphics, consider their use. Photos of affected areas can strengthen a map with natural hazard zones etc. Too much graphics however can make your map too crowded and difficult to read.

Source/colophon

It is good practice in making maps to add information on the map. Usually this contains the following information;

- The name of maker of the map and information on the organization where the maker is working (name, address, logo etc.)
- Production date
- Production framework (special project, for CLUP etc.)
- Possibly legal information

Grids/graticules

Graticules are lines that are parallel to meridians of longitude and parallels of latitude. Graticule lines will be curved in

geographic projections. Graticules may be shown as system items in the window or may be saved as objects into a drawing. There is a difference between graticules and grids. In Manifold System, selecting the option for the graticules will display the coordinate values in geographic coordinate system, while the grid option will display values in the projected coordinates system (e.g. UTM if that is selected).

They may add additional information to maps that cover a large area, but for non GIS users, adding labels for cities or provinces may be more meaningful. Graticules can be added to your lay-out. Graticules can be added to your map by first defining them in the map element using the View – Graticule command. The next step is to double click on your layout to open the properties menu and switch on the graticules. The matching texts can be set using the options in the border.

Exercise 6.4

Making a map design

Tips and Tricks

Before you start

When making a layout for printing, especially in new or unfamiliar formats, to make first a sketch on paper and add all the elements that should be contained in the map. A quick exercise like this can give you a good indication which elements can be placed where without crowding the layout too much.

Our eyes

The computer screen can display many more colours than our eyes are able to see under normal conditions. For this it is good to limit the number of colours in your map. Please consider the following aspects when you design your map:

The average person can only distinguish 7-8 colours and 3-5 grey shades on a map. Adding more may not really contribute to adding more information, especially if the colours are similar. In these cases, boundaries improve distinction of colours that are close to each other

Red and Yellow are dominant colours and tend to pop out while green and blue tend to vanish. You can also use this for simple maps in the traffic light colours:

- **Red** = warning or not good
- **Orange** = in between or neutral
- **Green** = positive or good

Saving Ink

When you print on a colour ink jet printer there are types of paper that can really soak up so much of your ink. If you don't have the option to use good quality paper, then do not use a solid colour for your areas. If you use a dense dotted or densely hashed pattern, the soaking effect of the paper may just work in your advantage to create a solid fill.

Viewing texts

When you are preparing for a map that it is sometimes difficult to judge if the texts can be read by the audience. In that case, set the viewing scale of the map to 100% (real life size) and if you are making a poster, step back to see if the elements are still clear and can be read.

Transparency

In a map page you can set the transparency of your

drawings and images. Using the transparency is a great way to let your area of interest really stand out. For instance if your area of interest in one barangay in the municipality, then consider adding a drawing of barangays in which all barangays are colored white without an outline. Now set the transparency to 50%. Now if you change the white colour of your barangay to only the outline (no foreground), then it really stands out from the crowd. Make sure that this layer is always on top in your layout or the effects will be less.

Hierarchy of elements

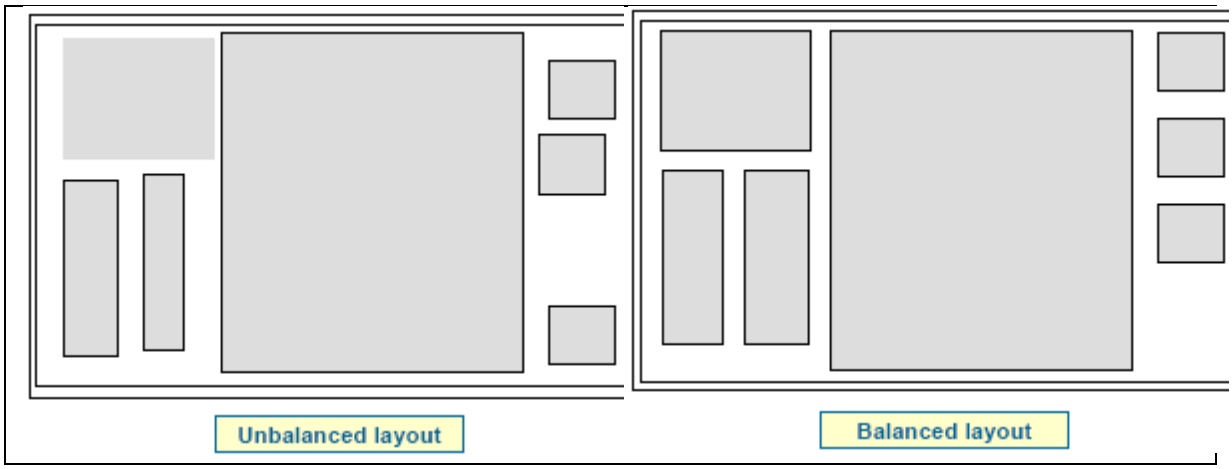
What is the most important in your map should also be most visible in your map. You can achieve this using the size of the element (the map will be bigger than the north arrow), use of colours and colour intensities (primary colours can be stronger then greys or pastels) and by the way you design the layout.

Aligning elements

A good layout is pleasing to the eyes. One of the ways to achieve this is to create balance in the way you place your map elements. In Manifold System, you can easily align your elements so that a more pleasing design is achieved.

Bounding boxes

Also placing boxes on elements creates a sense of unity and if you place a box around a number of elements, then these are visually combined into one element which creates a more balanced look. Look at the following image to see the effect of aligning and placing boxes.



Preparing a Layout in Manifold System

Maps in Manifold System are based on spatial data. Spatial data refer to the geographic location of features on the Earth's surface, along with attribute information describing what these features represent. You can communicate complex information more effectively using maps than tables or lists, because maps take advantage of our natural abilities to distinguish and interpret colors, patterns and spatial relationships.

When you display your data on a map you will see distributions, relationships and trends that you did not see before. Your maps will help you make decisions and solve problems. They will also help to communicate your information and results more effectively to others.

Choosing how to represent your data on a map may well be your most important map-making decision. Symbolizing your data involves choosing the colors and symbols that will represent features. It also involves grouping or classifying features according to their attribute values. Symbolization is a powerful tool for exploring, understanding and analyzing your data.

Laying out and printing maps

You've displayed your data in a data frame. You've chosen the symbology you want to use and you've labelled your data frame with the information you want to include. Now you want to print it out with a title, scale bar, legend, north arrow, descriptive text and some other graphics, like neat lines. To do this you have to create a layout.

A layout lets you assemble all the components you want to appear in a map, arrange them together to get the design you want, and then print it out when it's ready. Layouts make it easy to produce presentation quality maps with Arc map. You can place more than one data frame onto your layout along with any of the charts and tables in your Arc map document. If you change your mind later, you can add, remove, resize and move each element in a layout as required.

Creating a layout

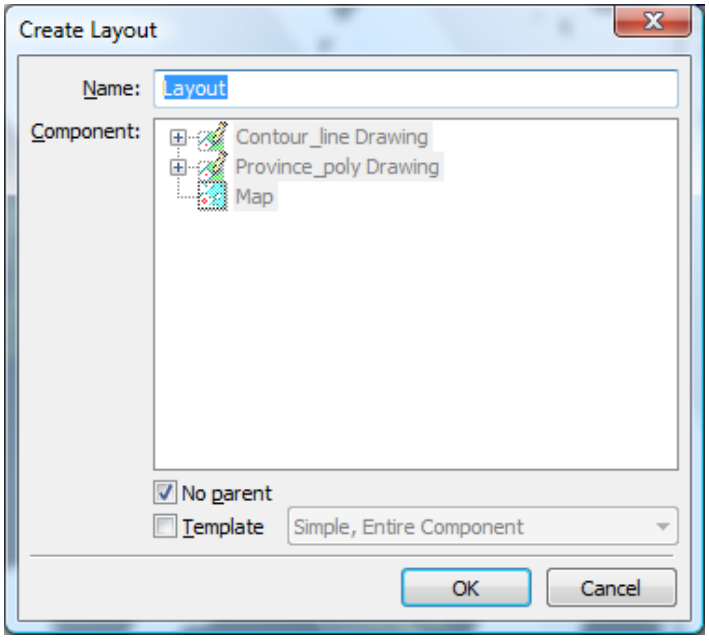
Layouts may be created in two ways. The first way is to create a layout based on a particular component, such as a drawing, and to then add any other components to the layout. The second way is to create a blank layout and to then drag and drop components into the layout.

The first method will automatically scale the component that is used to create the layout to fill an entire page or, in the case of text components like tables or comments, the layout will be expanded to a multipage layout to allow the entire component to be printed. This component will automatically be the main component so that addition of any system generated text expressions will use this component. The first method is convenient when one main component will be the subject of the layout.

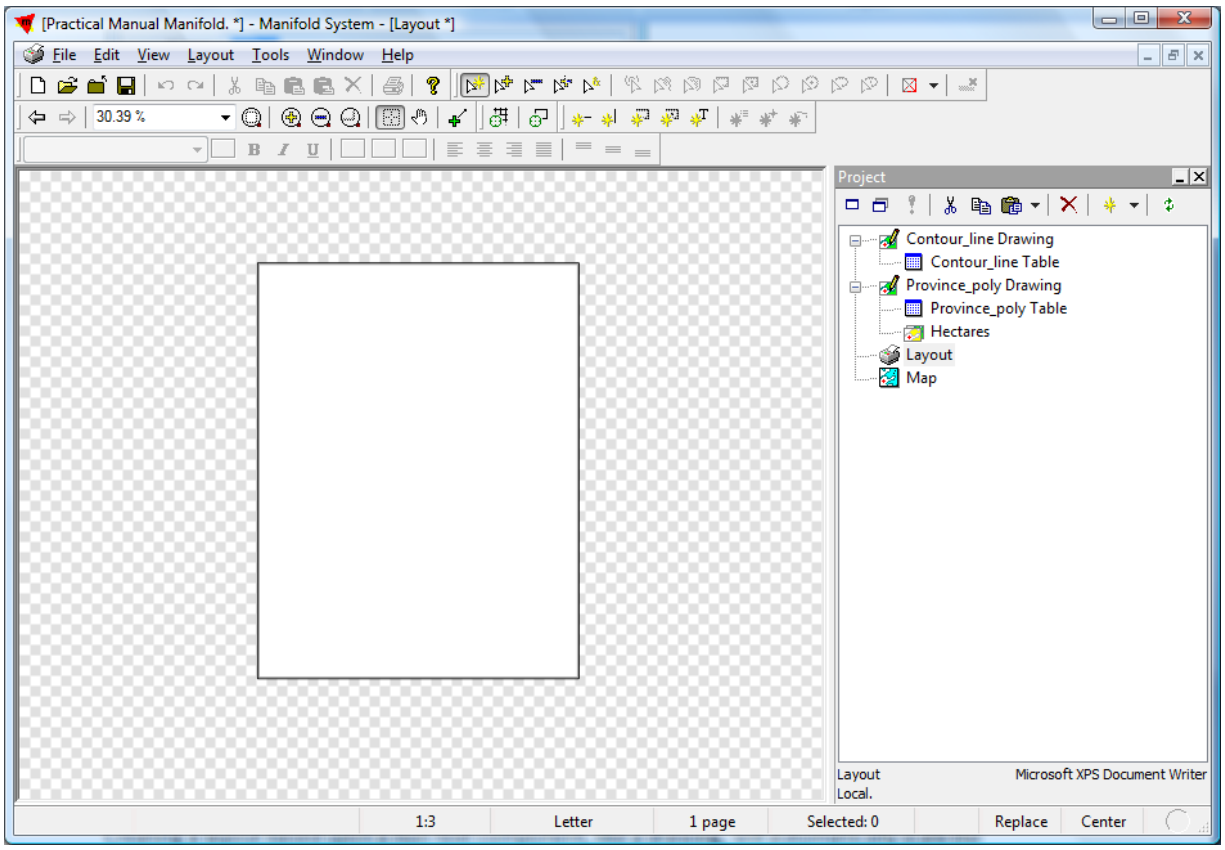
The second method may be more convenient when several components will be the subject of the layout, or when a layout is being created for use as a standard layout with many different projects.

Overview of the Create a Layout procedure

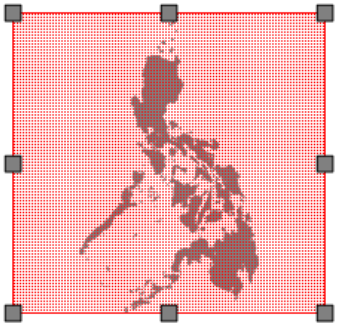
1. Click on the project pane and create a new layout with **File** > **Create** > **Layout**. If the layout is to be based upon a particular component, choose that component in the **Create Layout** dialog.
2. In the **Create Layout** dialog, if a template is to be used check the Template box and choose a template. If the layout is to be blank, check the No parent box and no component will be loaded into the layout by default.



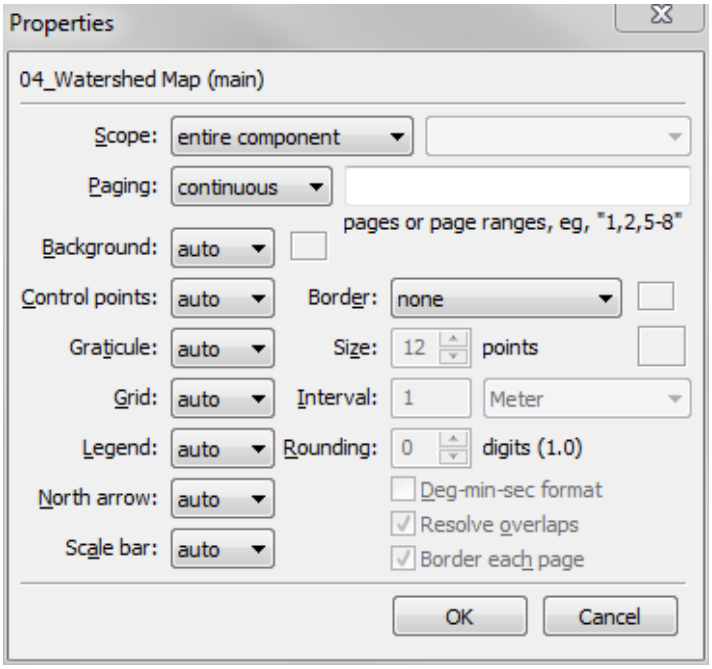
3. Open the new layout (located in the project pane). It should appear as an empty sheet in the window.



4. Verify paper size and other overall options are correctly specified in **File** > **Page Setup**.
5. Drag and drop components that are to appear from the project pane into the layout.
6. Insert any objects such as vertical or horizontal lines, text labels, and north arrow using the buttons from the **Tools** toolbar.
7. Edit the component elements in the layout to change size, position, views to be printed, etc. To resize or move press the **CTRL**+**ALT** keys and click on the items using the mouse. Items will appear as shown below (example of Philippine map), and can be moved or resized by dragging the corner-blocks.



8. Double click on the layout to see and change the properties of the layout. The following menu will show

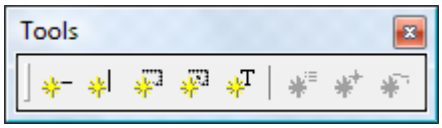


9. Use **File** > **Print** to print the layout.

Creating a layout based upon a non-text component, like a drawing, will automatically scale the component to fit the entire component on a single, full page. Creating a layout based upon a text component such as a table, query, script or comments component will automatically invoke the multipage layout capability to use as many pages as are necessary to show the entire component in the font size that is used.

Using the Tools toolbar

The tools toolbar for layouts allows us to insert additional design elements into a layout. When a layout is the active window, the tools toolbar will change to show tools used with layouts.



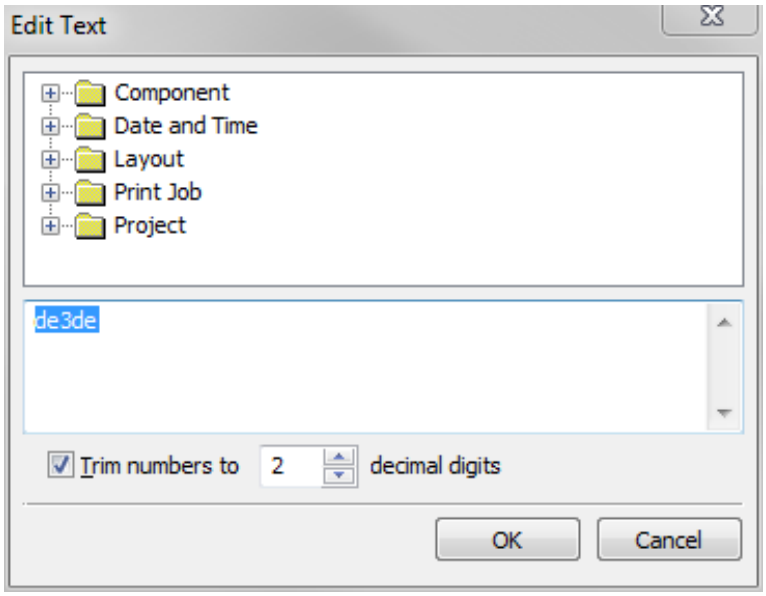
Insert Horizontal Line - Create a horizontal line in the layout. Default line size is 1/20th of a point. You can change the line thickness and colour of the after selecting the line in the format toolbar

Insert Vertical Line - Create a vertical line in the layout. Default line size is 1/20th of a point. You can change the line thickness and colour of the after selecting the line in the format toolbar

Insert Box - Create a rectangular box with a click and a drag. Boxes have foreground and background colour and line thickness that can be set by selecting the box and using the format toolbar. Default line size is 1/20th of a point. You can change the line thickness and colour of the after selecting the line in the format toolbar

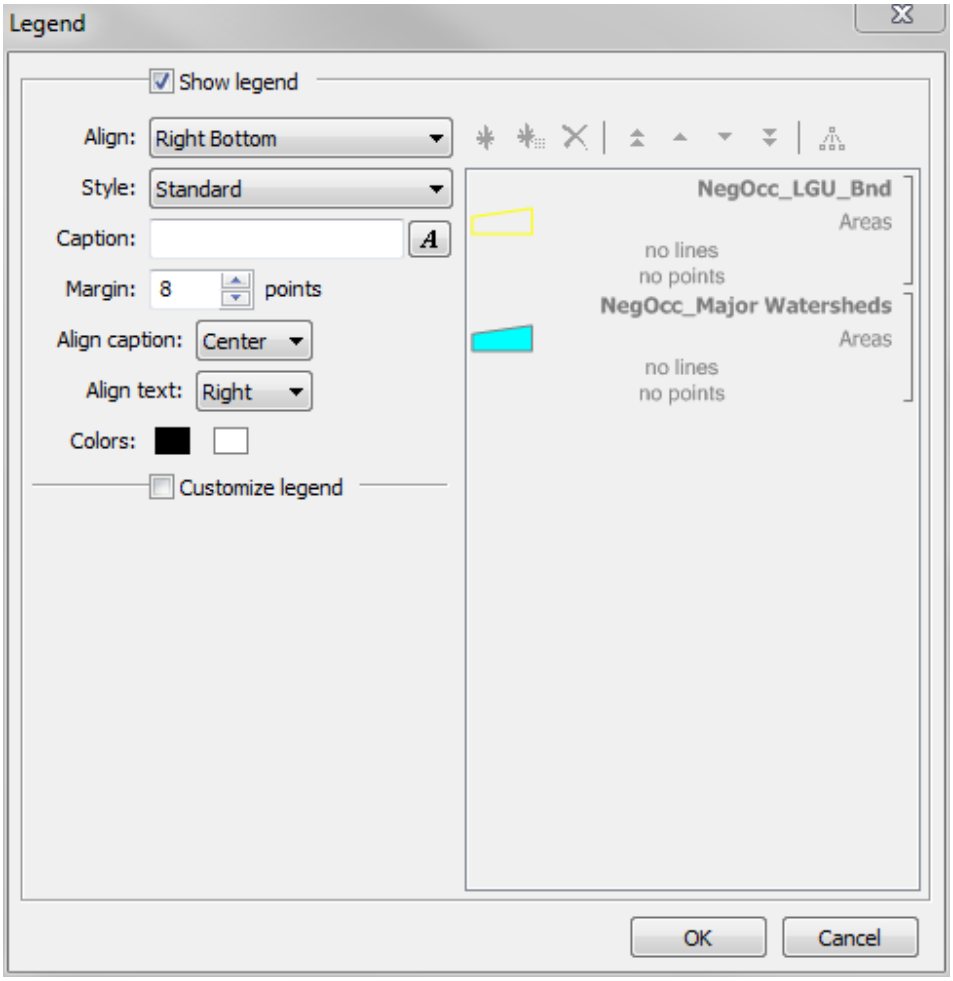
Insert Box on Center - Create a rectangular box centered on initial mouse click. Default line size is 1/20th of a point. You can change the line thickness and colour of the after selecting the line in the format toolbar

Insert Text - Add a text box, such as a caption, copyright notice or title, to the layout. Click on the text box to select it and then use the format toolbar to format the text. Double-click a text box in the layout to edit the text it contains.



As you can see from the menu, you have options for standard, pre-set texts, but you can also enter your own texts. You can change the text and the text box properties in the format toolbar when you select the text box

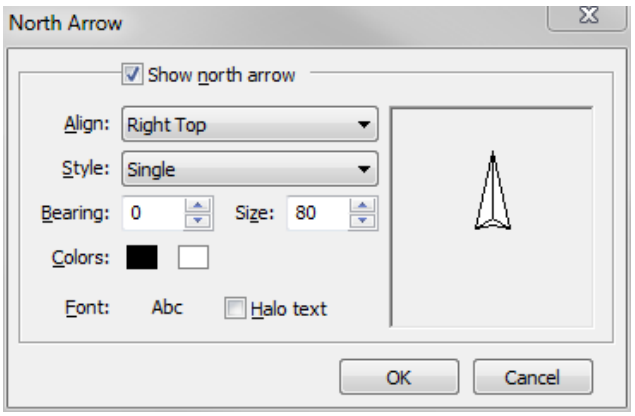
Insert Legend - Add a legend to the layout, based upon a component used in the layout. Inserting a legend will raise a dialog asking upon which component the item is to be based. If the layout does not contain any components for which a legend can be created, these buttons will be disabled. Double clicking on the legend shows a menu in which you can change the settings of the legend (like which map elements to place in the legend and how these should look and feel. Make sure that you have placed a checkbox in the show legend option.



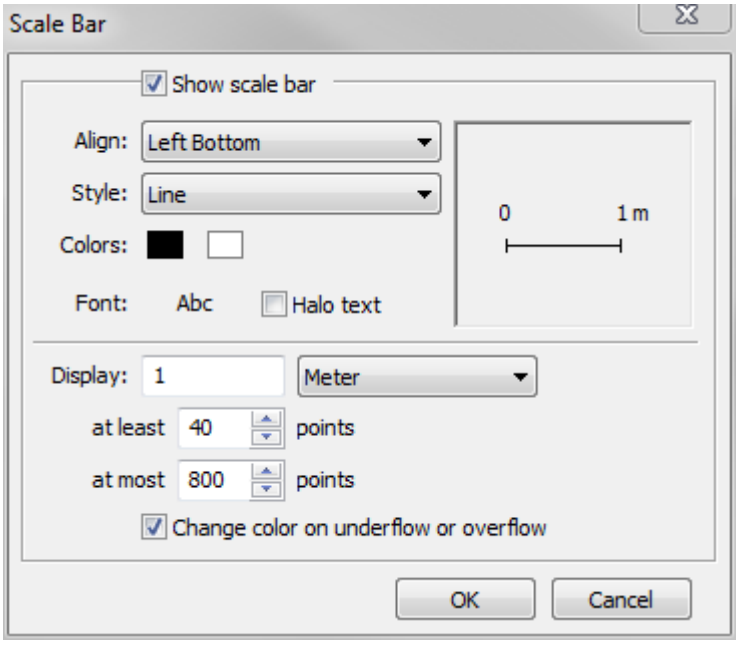
If you are not satisfied with the standard options (and in many cases, you will not be satisfied with these, then check the box besides customize legend. This gives you many more options to tailor the legend to your desire. Keep in mind that formatting the different drawings and images so that the colours look good in your map and legend should be done before you prepare your layout.

Insert North Arrow - Add a North arrow to the layout, based

upon a component used in the layout. Inserting a North arrow will raise a dialog asking upon which component the item is to be based. If the layout does not contain any components for which a North arrow can be created, these buttons will be disabled. If you double click on the north-arrow you have options for the placement of the North Arrow and under the style button there is a huge array of possible North Arrows available for you to use. If your map is not North-South oriented, then you can use the bearing option to make the angle of the North Arrow match that of the layout.



Insert Scale Bar - Add a scale bar to the layout, based upon a component used in the layout. Inserting a scale bar will raise a dialog asking upon which component the item is to be based. If the layout does not contain any components for which a scale bar can be created, these buttons will be disabled. As with the North Arrow and Legend, double clicking will give a menu in which the properties of the scale bar can be set



When inserting horizontal or vertical lines, it is usually best to turn on the grid with View - Grid and to then use Snap to Grid to

position layout element such as vertical and horizontal lines.

Making a good layout may mean that you have to place and move different map elements in order to get a pleasing result. A good tool to help you with is the alignment toolbar which makes it easier to align your elements

When you are working on an area, it may be good to assign one or more views. A view is a specific view of an area that is saved into a window at a given location and zoom level under a specific name. It is possible to create a view for every municipality in a province. By clicking on the view in the views pane, Manifold System will automatically navigate to the predefined area and scale. Note that when a component is projected, saving a view at a given zoom level is really saving a view at a specified scale, the scale at which the view is displayed. For setting and using views, you have to open the Views Pane (tools - options - views).

Exercise 6.5

Make a print layout

Using templates

Layout templates are pre-defined arrangements of layouts that may be invoked when creating a new layout or applied to an existing layout.

To use a template when creating a layout, in the Create Layout dialog check the Template box and choose a template. To apply a template after creating a layout, open the layout and use the Edit - Template - Apply command to use a built-in template or a template added to the system through customization, or use the Edit - Template - Apply File command to apply a template from a file.

To create a new template, create a layout and then use the Edit - Template - Save command to save the layout to a file for use as a template. The Edit - Template - Apply command also allows us to use a layout in our project as a template to be applied to the current layout.

Exercise 6.6

Making a layout and saving it as a template

Preparing for a large scale print

With GIS we will be preparing many maps and some of them will be printed on paper sizes bigger than our normal office printer. Working with paper sizes like that we need to prepare some extra steps in order to make the print work. First of all, make sure that you have the correct printer installed and that your printer drivers are up to date. To show you the steps you need to use, we show here the example of plotting to a HP Designjet 510 (42 Inches), if you have another printer, the details may vary, but the steps are the same.

Printing in the plotter within Manifold System System:

- At the start of creating your layout: make sure the **plotter is on** (or any printer you want to print at).
- Set your page size first before finishing your lay-out. Do this by opening the layout and go to **File>Page Setup**.
- A window will open and click on **Printer button**.
- Select hp designjet 510 42in printer and click on **Properties** button.
- The hp designjet 510 42in properties window will appear, Click on **Custom** button for a custom page size.
- The Custom Page size window will appear and you will now input the desired custom page size. Please see the Print out on the paper sizes to do this. *Commonly base maps will be printed in A0 or A1 paper sizes. Note: be careful in inputting the values here.*
- If you have properly encoded the correct page size, hit **OK** on the Custom Page Size window to close it> hit **OK** on the hp designjet 510 42in properties window to close it > hit **OK** on the Printer Page Setup window> hit **OK** on the Manifold System Page Setup window. Your layout will now automatically adjust to your desired page size.
- If you are done with your layout you can now just click on **Print**. The print settings you made earlier will be carried over when you do your final print out. Oftentimes, the printed map may not be the desired map you want. There may be layers missing, roads or segment of land use not colored properly. This is due to printer drivers setup and hp is a common culprit to this (not unlike Epson, so I suggest if you are planning to purchase a printer in your LGUs to be used in Manifold System, go for Epson).
- If you want to use a PDF printer driver to print to a PDF file for further use, the steps are similar, just make sure that you select the right PDF printer.

Summary

In this Session you have learned some elements of a balanced layout and how to create a layout in Manifold System. A major element of a good map is a good representation of the map elements that are included in the layout. This was the last technical Session on Manifold System GIS. The next Session, Session 7 will focus on a number of new technologies that can change the way how we collect our data.

New Developments

OVERVIEW

This last lesson will allow more insights to be obtained in new developments that may change the way GIS data are collected.

In particular, relatively new tools and approaches are presented in data collection for location specific areas of interests (e.g., Municipality or City). The tools are however not always suitable for everybody or every case (for instance some tools need many people with internet access). The tools and examples presented show in some cases how GIS changing from a tool for experts to location based content in social media and how this can be used to your advantage in collecting data. Some of the other tools show more technological developments which help in collecting either more accurate or new information. As such, this learning session does not provide exercises. Rather, it will provide a number of links in the internet for further readings on the tools or elaboration of cases. This lesson comprises from the following elements:

- ✓ New developments in GPS
- ✓ Depth sounders and coastal zone mapping
- ✓ Tools for participatory data collecting
- ✓ Crowdmap
- ✓ Open Street Map Philippines
- ✓ Collecting data using structured questionnaires in Android
- ✓ Provincial map Viewer

OBJECTIVES

This lesson is envisaged to give broaden one's understanding of new developments in GIS that could be useful for the data collection local planning purposes. After this module, the participants are expected to:

1. Contextualize usefulness of new developments with respect to GPS
2. Gain knowledge on tools and processes for participatory mapping
3. Obtain familiarity in the use of android cell phone based tools for data collection
4. Recognize the possibilities of depth sounders for Marine/Coastal Mapping
5. Appreciate the potentials of using the Provincial Map Viewer for development planning.

DURATION

2 hours

CONTENT AND ACTIVITY PLAN

Topics to be covered:

1. New developments in GNSS
2. Depth Sounders and coastal zone mapping
3. Tools for participatory data collection
4. Open Street Map Philippines
5. Data collection using Android devices
6. Open Data Kit
7. Provincial Map Viewer

SUGGESTED METHODOLOGY

- Presentation
- Self-study
- Demonstration when requested

RESOURCES NEEDED

For this module there are no special requirements needed.

From the earliest history in cave drawings to navigational charts to GPS, people have created and used maps to help them define, order and navigate their worlds. Four hundred years ago, it was cartographers, often working alone, who used the stars, mathematics and early attempts to represent longitude to map the New World. Today, it's crowds, not scholars, who are charting their own world. A combination of the old art of mapping with the relatively new art of crowd sourcing — the open calls for action via the Web — offers the potential to open up a new path for the developing world: helping citizens map their own country's facilities and thereby have a greater say in charting the future. Citizen cartographers can be a powerful force. In the aftermath of the Haiti earthquake, rescue workers used real-time data uploads on Open Street Map, via text and cell phone messages, to help create up-to-date maps of Haiti and find the injured. Engineers from around the globe gathered "virtually" to assess the damage. In the 17th century, imperial cartographers had an advantage over local communities. They could see the big picture. In the 21st century, the tables have turned: Local communities can make the biggest on the ground difference. Crowd sourced citizen cartographers can help make it happen.

(after: Empowering Citizen Cartographers, By CAROLINE ANSTEY, Published: January 13, 2012)

In the following paragraphs we would like to demonstrate to you a number of the tools and resources that may help you in your future projects.

REFERENCES

Anstey, Caroline (2012), Empowering Citizen Cartographers, New York Times

Crowdmap – http://www.crowdmap.com

Harrassmap – http://www.harrassmap.com

Open Data Kit http://www.opendatakit.org

Open Street Map Philippines – http://www.openstreetmap.com

GIS tailor-made Inc – 2012 A GIS viewer for Leyte and Southern Leyte: Functional Design , GIZ ENRD and DP programs Philippines

GIS tailor-made Inc – 2011 A GIS viewer for Leyte and Southern Leyte: Inception report , GIZ ENRD and DP programs Philippines

GIS tailor-made Inc – 2012 A GIS viewer for Leyte and Southern Leyte: Harmonization of data , GIZ ENRD and DP programs Philippines

GIS tailor-made Inc – 2012 A GIS viewer for Leyte and Southern Leyte: user manual , GIZ ENRD and DP programs Philippines

QuantumGIS for Android – http://hub.qgis.org/projects/android/gis

USHAHIDI – http://www.ushahidi.com

Votereport Philippines – http://www.votereport.com

WIKEPEDIA Echo Sounding http://en.wikipedia.org/wiki/Echo_sounding

New developments in Global Navigation Satellite System

GPS

A new generation of American GPS satellites offer an even more accurate determination (two times more accurate) of your position by using an improved atomic clock, better resistance against disturbances of the signal and by having a longer estimated lifespan. The new satellites will be used for both military and civil aviation use and offers more possibilities for search and rescue. The GPS IIF builds on 30 years of experience with the existing 39 satellites.

The GPS IIF satellite is crucial for the keeping the GPS constellation available worldwide for its over one billion users in civil, commercial and military applications.

Galileo

Galileo is a global navigation satellite system (GNSS) currently being built by the European Union (EU) and European Space Agency (ESA). The project is named after the Italian astronomer Galileo Galilei. A major aim of Galileo is to provide a high-precision positioning system upon which European nations can rely, independently from the Russian GLONASS, the US based GPS, and Chinese Compass systems.

Basic navigation services will be free of charge. Galileo is intended to provide horizontal and vertical position measurements within 1meter precision and better positioning services at high latitudes than other positioning systems. As a further feature, Galileo will provide a unique global search and rescue (SAR) function. Satellites will be equipped with a transponder that will relay distress signals from the user's transmitter to the Rescue Co-ordination Centre, which will then initiate the rescue operation. At the same time, the system will provide a signal to the users, informing them that their situation has been detected and that help is on the way. This latter feature is new and is considered a major upgrade compared to the existing GPS and GLONASS navigation systems, which do not provide feedback to the user.

The use of basic (low-precision) Galileo services will be free and open to everyone. The high-precision capabilities will be available for paying commercial users and for military use.

The Galileo system will have five main services:

1. Commercial navigation (encrypted) High precision to the centimetre; guaranteed service for which service

providers will charge fees.

2. Open access navigation: This will be available without charge for use by anyone with appropriate mass-market equipment; simple timing, and positioning down to 1 meter.
3. Safety of life navigation Open service; for applications where guaranteed precision is essential. Integrity messages will warn of errors.
4. Public regulated navigation (encrypted) Continuous availability even if other services are disabled in time of crisis; Government agencies will be main users.
5. Search and rescue System will pick up distress beacon locations; feasible to send feedback, e.g. confirming help is on its way.

An exciting new development with Galileo will be that it also has options for indoor navigation, something that is not possible with the traditional GPS.

GLONASS

GLONASS or acronym for Globalnaya navigatsionnaya sputnikovaya sistema (Global Navigation Satellite System in English), is a space-based satellite navigation system operated by the Russian Aerospace Defence Forces. It both complements and provides an alternative to the United States' Global Positioning System (GPS) and is the only alternative navigational system in operation with global coverage and of comparable precision. The development of GLONASS began in the Soviet Union in 1976. Beginning on 12 October 1982, numerous rocket launches added satellites to the system until the constellation was completed in 1995. During the 2000s, the restoration of the system was made a top government priority and funding was substantially increased.

By 2010, GLONASS had achieved 100% coverage of Russia's territory and in October 2011, the full orbital constellation of 24 satellites was restored, enabling full global coverage. The GLONASS satellites' designs have undergone several upgrades, with the latest version being GLONASS-K. There is no clear advantage other than accuracy over GPS. When used alone GLONASS doesn't have that strong coverage as GPS has, but when both used together certainly increases accuracy with coverage. And it is more useful in northern latitudes as Russia started GLONASS originally for Russia. The accuracy is an advantage of GLONASS with up to 2 meter of accuracy. GPS + GLONASS allow your device to be pin pointed by a group of 55 satellites all across the globe. So when you are in a place where GPS signals are stuck like between huge buildings or subways, you will be tracked by GLONASS satellites accurately.

Some modern receivers are able to use both GLONASS and

GPS satellites together, providing greatly improved coverage in urban canyons and giving a very fast time to fix due to over 50 satellites being available. In indoor, urban canyon or mountainous areas, accuracy can be greatly improved over using GPS alone.

Actions were undertaken to expand GLONASS's constellation and to improve the ground segment in order to increase the navigation definition of GLONASS to an accuracy of 2.8 m by 2011. In particular, the latest satellite design, GLONASS-K has the ability to double the system's accuracy once introduced. The system's ground segment is also to undergo improvements.

Beidou

Where the previous systems operate with satellites that are circling the earth and therefore maintain a worldwide coverage, the Chinese Beidou system works differently. It has a limited number of 4 satellites in a stationary orbit (or fixes position). This limits the costs of the GPS system, but also limits the area of coverage (see figure).

Also the calculation of the location is done differently:

A signal is transmitted skyward by a remote terminal and this is received by all satellites. Next each satellite sends the accurate time of when each received the signal to a ground station. The ground station calculates the longitude and latitude of the remote terminal, and determines the altitude from a relief map. The ground station sends the remote terminal's 3D position to the satellites and from the satellites broadcast the calculated position to the remote terminal (your hand held device).

In 2007, the official Xinhua News Agency reported that the resolution of the BeiDou system was as high as 0.5 meters, considerably better than unaided GPS. With the existing user terminals it appears that the calibrated accuracy is 20m (100m, uncalibrated).

Depth Sounders and coastal zone mapping

The Philippines as an archipelagic country relies heavily on its fishery resources and the coast. With more than 60% of the population living near the coastal areas, and half of all municipalities and cities located along the coasts and rivers (NSCB 2012), the nation needs a proper coastal resource management system in place.

Over several decades, coastal and fishery resources have come under increasing threat due to human activities and to changes in climatic conditions which affect the lives of coastal communities. The Local Government Code of 1991 (LGC) provided the means for local government units (LGUs) to develop several management plans. Although coastal resource management plans can be counted as one of them, the overall current scenario still allows for anyone to have unregulated access to the coast and municipal waters and extract resources unchecked. This open-access regime provides limited or no control mechanisms for local governments over the harvest of coastal and fishery resources. Resource use conflicts in the coastal areas such as commercial fishing in municipal waters result in the over exploitation of limited fishery resources and the deprivation of fisherfolk. Population pressure has contributed to overfishing and the use of destructive ¬fishing practices like blast and poison ¬fishing. Valuable coastal habitats like mangrove forests, seagrass beds and coral reefs are losing their ability to provide breeding grounds for marine organisms and other essential ecosystem services such as pollution control. Coastal pollution lowers environmental quality and natural production thereby affecting coastal ecosystems and fisheries.

Many of the coastal resources depend for their existence on specific natural conditions like water depth, type of seafloor substrate etc. In many cases, these are not known, especially in those areas that are always submerged. Using a depth sounder and GIS these features can be mapped and used as input for management and planning purposes.

Echo sounding is a type of SONAR that can be used to determine the depth of water by transmitting sound pulses into water. The time interval between sent and return of a pulse is recorded and is then used to determine the depth of water along with the speed of sound in water at the time. For Coastal Zone Management purposes this is very usefull since it gives us a relatively quick and affordable way of mapping the depth (and in some cases also the type of seafloor) of the coastal zones.

Echo sounding can also refer to hydroacoustic "echo sounders" defined as active sound in water (sonar) used to study fish. In fisheries these are quite often referred to as fish finders.

Although it sometimes may be confusing, the word sounding is used for all types of depth measurements, including those that don't use sound, and is unrelated in origin to the word sound in the sense of noise or tones. Echo sounding is a more rapid method of measuring depth than the previous technique of lowering a sounding line until it touched bottom. The depth of the water is calculated by dividing the time between sent and returned pulse by two and then multiply with the sound of speed in the water (approx 1.5 km/sec). The signal is sent and received by a transponder which should in all cases be fully immersed in water and be placed at the stable location in the boat. Generally a places in the center of

the boat (a stable location) and out of the turbulent water from the boats screw and engine are recommended.

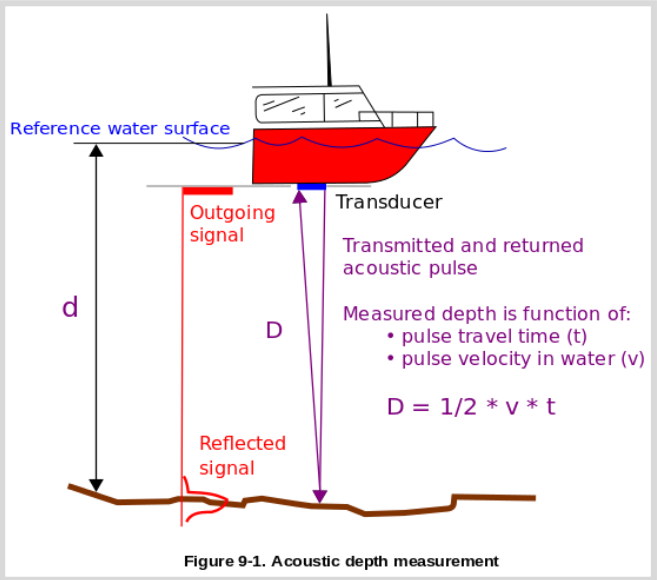


Figure 9-1. Acoustic depth measurement

From Wikipedia, source: EM 1110-2-1003, Manual of Hydrographic Surveying, based upon Principle_of_SBES.jpg by en:User:Mredmayne.; by Brandon T. Fields (cdated) via the US Army Corps of Engineers)

ɔn of this depth is required.
ned with a GPS unit and some
those locations. (note, an additional handheld GPS may be needed to navigate the area in a predefined pattern to make sure the area is well mapped)

Geoplan staff installing the transducer and GPS unit on the outrigger of a banca using an aluminum rod, clamps and tie wires.

The transducer can be either placed on a fixed location in the boat (usually through the hull) so that all the cables can be kept out of the way, or an external fixture has to be made. Having the transducer fixed in the hull has the advantage that once placed, the location is good and the depth sounder is easily made operational. It can however not easily be transferred to another boat. Having an external mount for the transducer (and GPS) makes it possible to work from a broad range of boats and banka's.

As opposed to the one beam from a single beam depth sounder, a multi beam uses more than beam and therefore can map out a bigger area in one sweep. Most modern systems work by transmitting a broad acoustic fan shaped pulse from a specially designed transducer across the full swath across track with a narrow along track then forming multiple receive beams (beamforming) that is much narrower in the acrosstrack (around 1 degree depending on the system). From this narrow beam a two way travel time of the

acoustic pulse is then established utilizing a bottom detection algorithm.

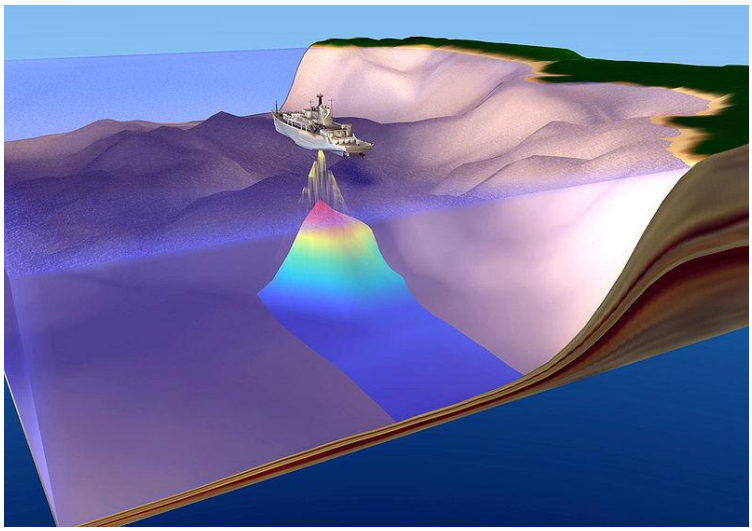


Illustration of echo sounding using a multibeam echosounder.
From Wikipedia, http://www.navy.mil/view_single.asp?id=2767

The side view sonar works different again. Here a big transponder is pulled under water at a specific depth and instead of a top-down view, this creates a more side view image of the underwater world. This tool is more used for deep water and the detailed scanning of wrecks and other underwater structures.

Practical issues:

- In order to have a reliable depth map, you need to correct for the effect of the tide since this effects the depth of the water (the same location with be deeper at high tide then at low tide). Much of the software that comes with the depth sounder is able to this for you. Tide data can be found on the internet or can be obtained from the right authorities (which o which).
- In order to have a good and reliable map, navigate in a regular pattern. Prior to mapping, design transects or a raster in GIS and transfer this to the GPS. This will guide the boatman in navigation (how and where to navigate).
- Make sure you know how deep your transducer is in the water so that you can correct for that (if your transducer is 20 cm below the surface, you have to add 20 cms to the depth of the water. Also if your mapping takes more than one day, make sure that the transducer and GPS are at exactly the same location (and depth) to prevent mistakes.
- Don't go out on rough seas. Apart from the danger to you and the equipment, high waves also strongly affect the depths you perceive (but which may be caused by waves)
- Make sure that all equipment is well secured and (when necessary) water proofed

Tools for participatory data collection

Crowdmap

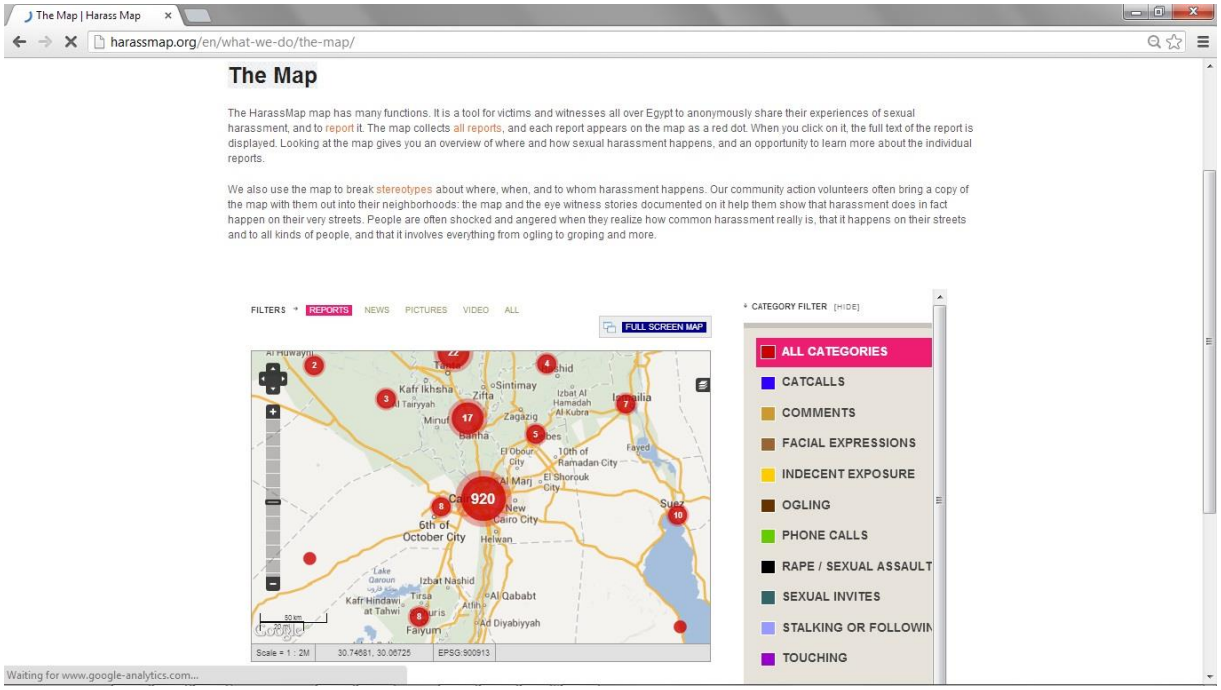
Crowd mapping (a combination of crowd sourcing and mapping) can be described as the aggregation of crowd-generated inputs such as text messages, photos and social media feeds with geographic data to provide real-time, interactive information on events such as wars, humanitarian crises, crime, elections, or natural disasters. When done right, crowd mapping can bring a level of transparency to fast-moving events that are difficult for traditional media to adequately cover in real-time, or to longer-term trends that may be difficult to identify through the reporting of individual events. Because anybody can contribute to a crowd map, there is a whole array of volunteer cartographers, data collectors that can contribute.

Crowdmap can be run from the internet free of costs and there is no installing required. After creating an account, the user has access to the administration side of the application where issues like legend items and colour, extra texts and options; logo's and user settings can be determined. Access to Google Maps, Open Street Map or other background maps can be set as well as the area of interest. For someone with moderate internet skills, a website can be setup in half a day. Once the website is set-up, it is possible to link this with Facebook, Twitter and even text messaging.

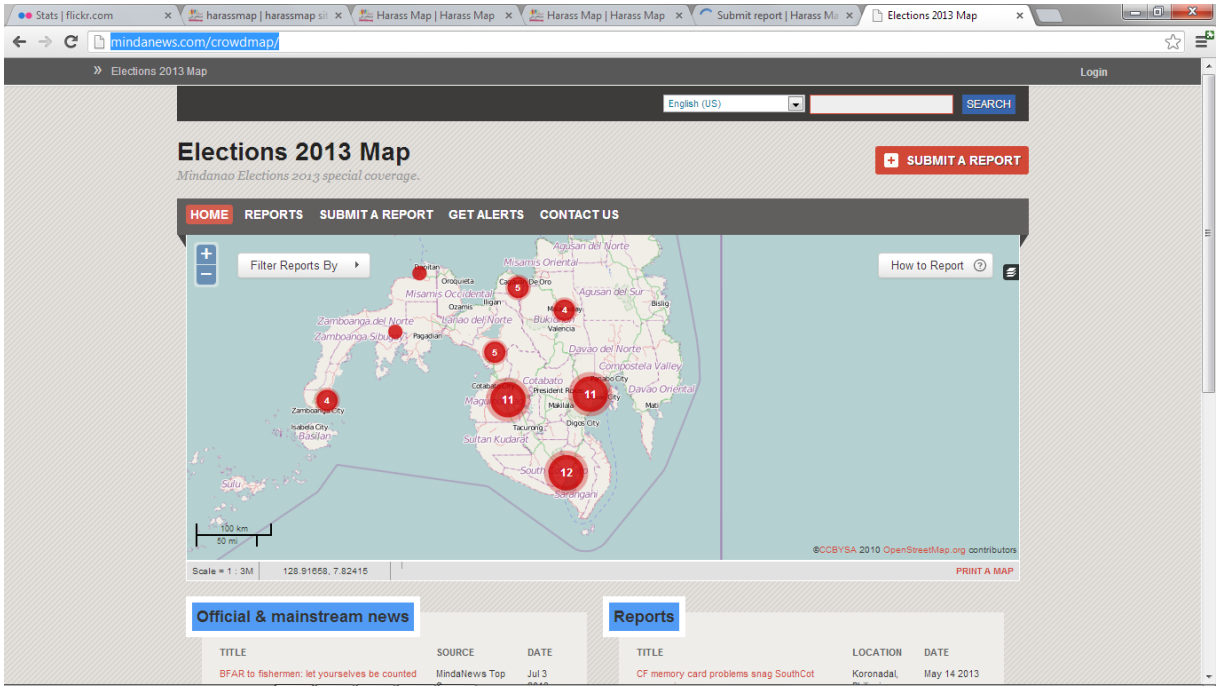
The administrator of the site has the option to provide a quality check on the added data by approving (or nor) or verifying messages from users. Users can add their email information, photo's videos and extra text information to their reports to add information and/or credibility. Since the reports are placed on a map (and therefore have X and Y coordinated, the reports can be exported in KML format and imported again in Manifold GIS for further presentation and/or analysis.

Some famous websites using crowdmapping are:

Harrassmap.org: an award winning site from Ciaro in Egypt where women can report all forms of violence against women.



http://mindanews.com/crowdmap/ a website on irregularities in Mindanao during the 2013 Elections



Open Street Map Philippines

Apart from the efforts from NAMRIA to map the Philippines and the commercial programs from Google, Yahoo and Bing Maps, there is also an open source, community effort to map the Philippines. Open Street Map Philippines is part of the international community effort to make quality spatial data available for all. Mapping of the Philippines started sometime in 2006 when EDSA in Metro Manila was marked via GPS traces. Since then, mapping effort continued to rapidly increase throughout the years. When Yahoo! permitted OSM to use their satellite imagery for tracing in December 2006, mapping of Metro Manila, one of the areas covered exploded and remains to be the most mapped area in the Philippines approaching around 90% of roads mapped.

Other areas with significant mapping activities include Davao City, which is another area covered by Yahoo!'s imagery, areas in greater Metro Manila, Angeles and Clark, Baguio, and Boracay. Government geospatial data has been imported and these include roads for Laguna and the whole of Naga City in Camarines Sur. Major roads of Mindanao have been mapped as well as other national highways around the Philippines.

Since mostly the urban areas in the Philippines are mapped quite well, data from municipalities in the provinces is always welcome and it is a nice way to get added value out of your data by contributing to a national map. OSM has quite strict conventions for adding data, but also a number of tools for uploading your own data.

You can download data from Open Street Map using Geofabrik, which compiles data from OSM and is constantly being updated every 4-5 hours. Geofabrik – German for "geo factory" –, extracts, selects, and processes free geodata for you. They create shape files, maps, map tiles and full-blown web mapping solutions. Their website is at: http://www.geofabrik.de/

Data collection using Android devices

The rapid growth in smart phones and android tablets has given rise to a new generation of tools that can be used for GIS data collection. Since most smart phones and tablets have an integrated GPS and are able to take pictures and movies on spatial data collection becomes much easier.

Geotagging

With the increased use of Internet capable mobile devices such as the Blackberry, iPhone and many android devices, GeoTagging (or plainly geotagging) has seen a surge in popularity as well. With the ability to quickly add GPS information to media, smart phones make geotagging a simple task. Geotagging is the process of adding location to a photo, video or other media file or type. This can not only help people find images and information based on a location, but it can also be used to create location-based news and media feeds by combining an application like Google Maps with geotagged blogs, news articles and Flickr photos. Many GIS software packages and databases also allow the geotagged photos to be stored and displayed on location.

With the geographical information embedded within the image we can show others the exact location of where a picture was taken. Smart phones with built-in cameras and GPS have made geotagging images a breeze. If the GPS of your device is on and the geotagging mode is selected in your camera, the coordinates will be automatically added to your photo or video. If you have access to the EXIF info (the meta information for digital photo's) you can also manually add or change the coordinate information.

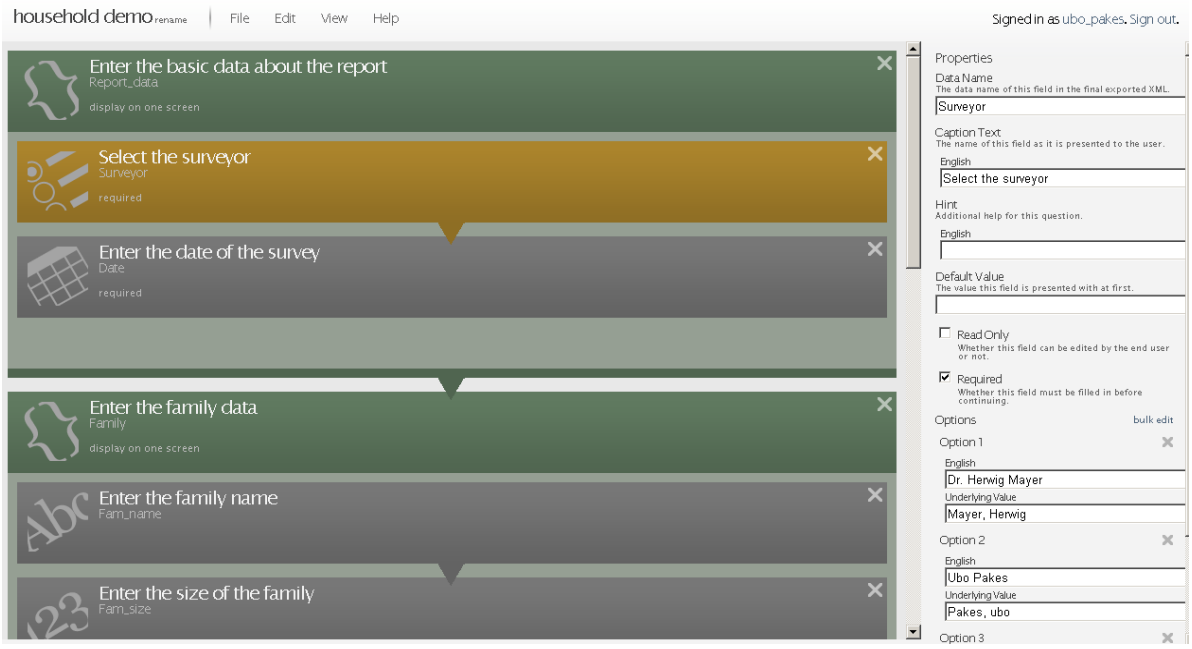
With the decreasing price of smart phones and therefore the increasing availability geotagging (or the later discussed ODK) can be great tools to involve individuals and communities into mapping their environment.

Open Data Kit

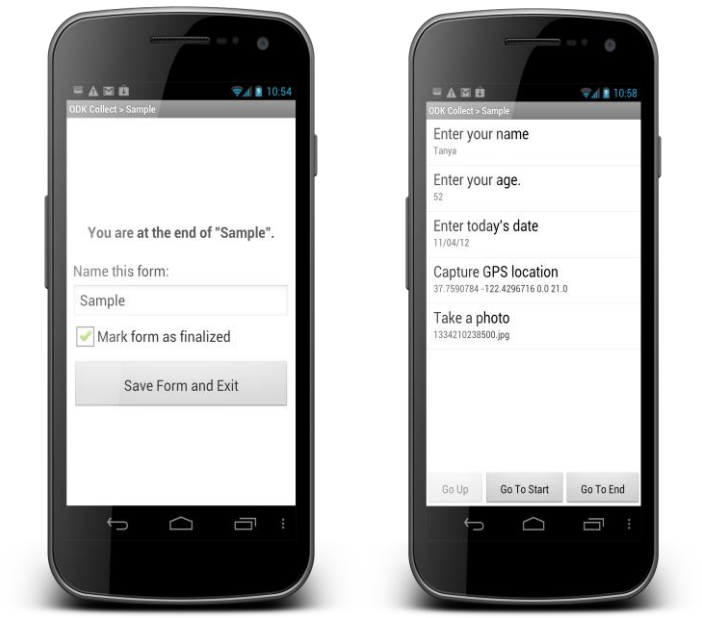
The rise of smart phones and tablets running under the Android Operating System gave rise to a whole new spectrum of mobile tools for collecting data using these mobile devices. Apart from the ever decreasing prices and increasing capacities and availability, these devices have also the advantage that most avail of GPS and a photo camera. This means that both location and a visual image of phenomena can be recorded and used. There are a number of tools who use these tools for a structured data collection and therefore moving from paper based interviews to a more digital environment. There are a number of tools using android cell phones and tablets and a good and easy to use tool is ODK or Open Data Kit (www.opendatakit.org).

Open Data Kit has three modules:

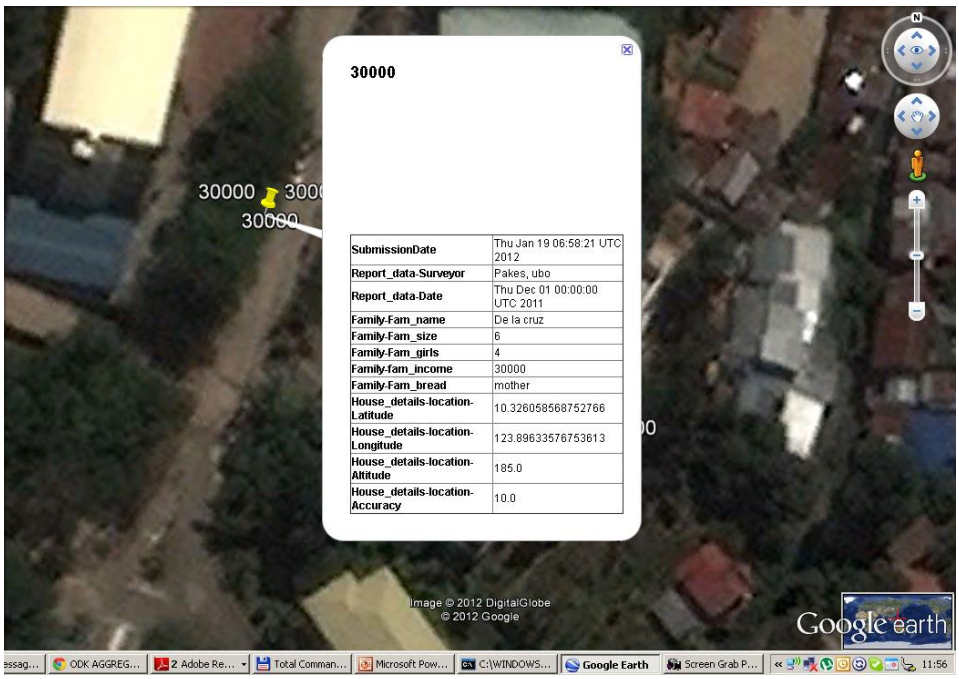
1. **ODK Build:** a web based module for the design of questionnaires. This module needs a username/ password and after a questionnaire is built it can be either uploaded on a server (aggregate) for future download and use on a tablet or it can be directly downloaded to a device. The structure of building forms on the web is structured and quite easy.



2. **ODK Collect:** is the actual tool used for collecting information. It runs on an Android device and for doing the surveys, no internet access is needed. A questionnaire as made in ODK Build can be downloaded on the device and a survey can be done. On one device many different questionnaires and per questionnaire many surveys (or instances) can be made. The questionnaires may contain location (GPS) photo, video and speech. Once back in the office, the finished questionnaires can be uploaded to the next module, ODK Aggregate



3. **ODK Aggregate:** is the module for management of the forms and for combining and aggregating the results. Per questionnaire the data can be combined in easy statistics and graphs, downloaded in KML for further use in GIS or directly visually presented in Google Earth.



Our experiences with Open Data Kit are good. New users are able to conduct structured surveys using tablets with only a minimum of training. Also the training for system administrators for designing questionnaires and managing the web pages takes only a day or so. After a short training, Lapu-lapu City is now using android tablets for: monitoring cases of dengue, monitoring potholes and access times and obstacles to fires (http://news.lapulapucity.gov.ph/fire-reporting-using-android-tablets/) . Ten teams with a tablet are expected to map all business establishments in the city (over 10.000) in under two months' time, putting all locations on a map as part of a GIS supported Business Permit Licensing System.

Quantum GIS for Android

Another relatively development is that Quantum GIS, an open source, mature GIS package, is now also available as GIS package for Android devices. We have been testing the android version of Quantum GIS and even though there are some issues with the screen size and stability of the different versions, the development looks very promising. You may have a complete GIS on your tablet. Unlike the other tools which mainly focus on the collection of data, having a complete GIS means that you can also check in the field if your GIS data are up to date. This could be a great tool for checking real property data.

For practical reasons, it may be good to work on a 10 inch tablet or use one of the android tablets for use so that the screen size is not a limiting factor. The screen size now is no limitation for the display of the maps, but the user interface and the tables are hard to view on a smaller tablet. A device with a stylus has added benefits for editing map layers.

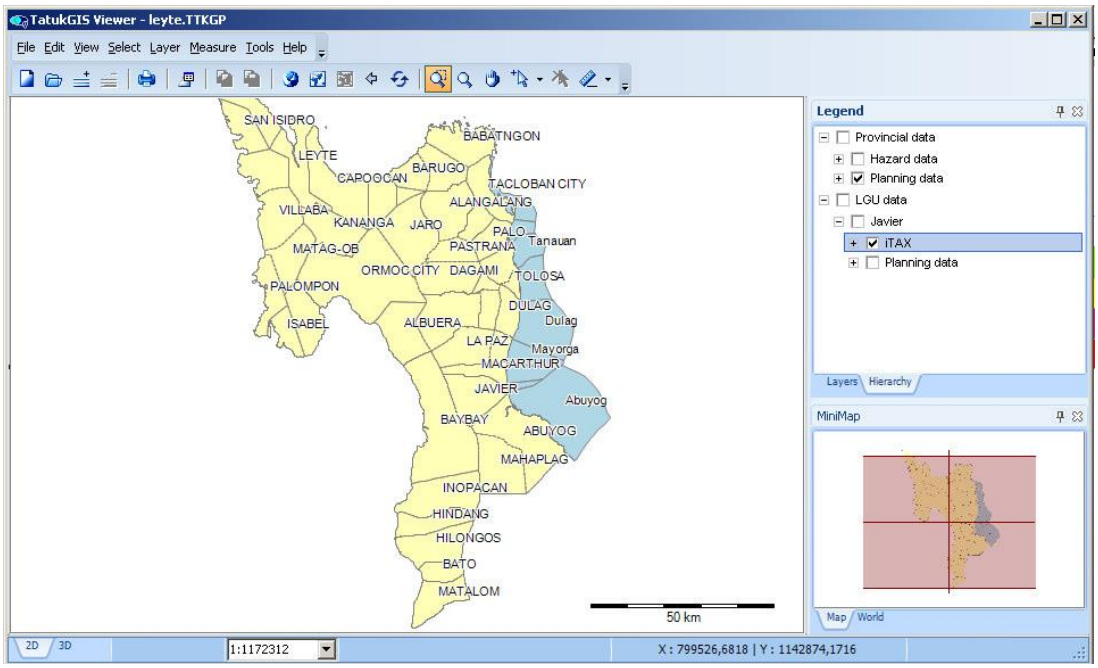
The installer for Quantum GIS for android can be downloaded here: http://hub.qgis.org/projects/android-qgis .

Before you install, it may be wise to check the website to see if your device is supported.

Provincial Map Viewer

The GIZ programs on Decentralization and Environment and Rural Development (resp. GIZ-DP and GIZ-ENRD) have seen the need with many planners to have an easy to use tool for spatial information related to planning. In many municipalities the GIS capacity is low and this means that those who need insight in spatial data cannot always obtain this. It was also observed that collecting the data needed for a Comprehensive Land Use Plan is a both time and money consuming effort where many datasets are obtained from national Government Agencies, but each municipality had to collect these for itself. For this reason a simple map viewer was developed. The Provincial Map Viewer has the following goals:

- It should be easy to use and support local and regional planners with information relevant to the planning process.
- Users should be able to perform basic GIS actions like combining layers, zooming in and out and make basic selections, printing a map etc.. For more complex questions, a GIS should be used
- The viewer can contain data on: provincial level with respect to planning data, regional natural hazard data, and local data on municipal infrastructure and local real property tax information. All map layers can be added with meta information describing the quality and source of the information
- It should run on all windows based PC's and there is no need for Internet Access.



- All map layers have standardized legends which are as much as possible obtained through the respective owners of the data.

The Map Viewer is now in use in Regions 8 and 6 and will be distributed for free to interested parties. The Viewer comes with a training manual and instructions on how to add data from new provinces and municipalities to the viewer. For most users a training of half a day is enough to be effective in using the viewer.

Summary

In this Session you have learned some elements of a balanced layout and how to create a layout in Manifold System. A major element of a good map is a good representation of the map elements that are included in the layout. This was the last technical Session on Manifold System GIS. The next Session, Session 7 will focus on a number of new technologies that can change the way how we collect our data.