DIGITAL MAP MAKING AND GIS HANDBOOK FOR CIVIL SOCIETY ORGANIZATIONS

INTERNEWS MONGOLIA

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INTRODUCTION

Welcome! This handbook provides a collection of resources to get you started finding, collecting, analyzing, and visualizing digital map data. It covers downloadable software like QGIS and Google Earth, as well as online tools like Google Maps Engine and GeoCommons.

Internews – an international nonprofit whose mission is to empower local media – held a series of training workshops in Mongolia throughout 2014. More than 50 people participated, primarily from civil society organizations engaged in monitoring extractive industries. This handbook is adapted from the training material developed and polished during these workshops.

Many thanks to the workshop participants, the Mongolian Environmental Civil Council, Publish What You Pay Coalition, Internews staff, and all others who have contributed to this project!

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PROJECT SCENARIOS

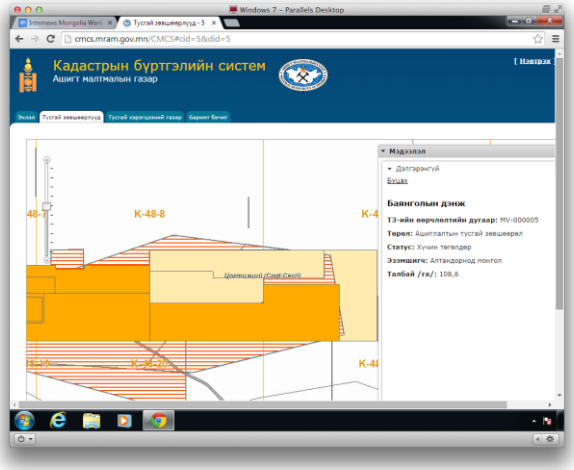
What kind of project are you working on?

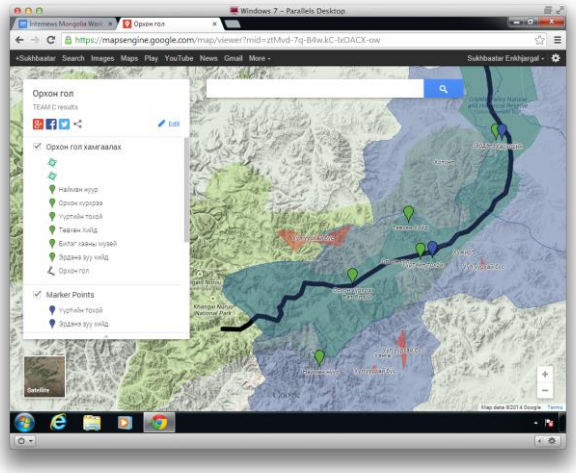
A. I want to find maps and data that others have created

There are many excellent sources online for maps and data about Mongolia. Most are operated by government agencies, universities, or international organizations. There are also some online maps with worldwide coverage, but the information they provide is more general. All these websites are listed in the **Sources for Map Data Sidebar.a**

Another place to check is GeoCommons (*http://geocommons.com*), which is a community website where individuals and organizations can share map data with the public.

What about finding satellite images? The best tool for this is the Google Earth app, which you can download to your computer for free (*http://earth.google.com*). Its historical imagery tool lets you compare satellite images across different points in time. **Exercise 3** will introduce you to the key features of Google Earth.





B. I want to make an interactive map and share it online

This is a great way to get started with digital map-making. One of the best tools is Google Maps Engine (*http://mapsengine.google.com*), which lets you draw point markers, lines, and shapes on top of various base maps. You can choose between the traditional Google Map, a terrain map, or a satellite map. If you share a link to your map, others will be able to see the features you drew, including labels, descriptions, photographs, and so on. **Exercise 2** will get you started with Google Maps Engine.

Another similar tool is Mapbox (*https://www.mapbox.com*), which is based on Open Street Map data rather than Google Maps. To get started, sign up for a free account and look for the button labeled "Create Project." Mapbox offers more styling options than Google Maps Engine, and also lets you import data files directly from your computer onto the web map. However, its base maps provide limited detail for the Mongolian countryside.

C. I want to open up files of map data

The QGIS software program can open all the common formats of map data, but there are many simpler tools as well. (See **Exercise 4** for an introduction to QGIS.)

Several websites can open map data from your computer, as long as the files aren't too large. GeoJSON.io (*http://geojson.io*) can open KML and GeoJSON files, plus CSV spreadsheets that contain latitude-longitude coordinates. Mapbox (*http://mapbox.com*) can do the same. Ogre (*http://ogre.adc4gis.com*) will convert Shapefiles and other proprietary GIS data formats into GeoJSON format, which you can view on a map using one of the other websites. Please refer to the **Data Formats Sidebar** for more about this.

The free Google Earth app (*http://earth.google.com*) is great for opening KML files and GPX files on your computer (GPX is the format generated by GPS receivers). **Exercise 3** will get you started with Google Earth. Finally, if you want to open ArcGIS project files but don't have that software package (it's expensive), you can download a free viewer called ArcGIS Explorer (*http://www.esri.com/software/arcgis/explorer*).

D. I want to learn how to use GIS software

Professionals analysts and cartographers use Geographic Information System (GIS) software to work with geographic data. This software has numerous features that are missing from simpler tools like Google Earth or web-based apps: image processing and statistics, ability to create printed maps, features for working with map projections, and the ability to work with many different file types, to name a few.

Multiple software programs provide these same GIS features. The most common commercial software is ESRI ArcGIS (*http://esri.com*) and the most common open-source software is QGIS (*http://qgis.org*). This brochure focuses on QGIS. See **Exercise 4** for an introduction to it. If you can read some English, there is excellent documentation on the QGIS website: *http://documentation.qgis.org*.

E. I want to see how different maps line up with each other

One of the big challenges of using paper maps is matching locations from different maps. If there's an animal habitat marked on one map and a road marked on another map, how do you figure out whether the road goes near the habitat? Most maps have design elements to help with this: coordinate grids, distance scales, and common features can all be used to estimate where a feature from one map would appear on another.

Digital map software lets us align maps much more precisely, but the process can get complicated. The best is if you can find map data in an easily readable format like KML, GPX, or Shapefile. You can open all of these layers at once using software like Google Earth or QGIS. However, if your maps are image files – like scans or screenshots – you'll have to *georeference* them first so the GIS software knows how they should be aligned with other maps. **Exercise 7** will show you how to do this!

F. I want to create a printed map for a report, brochure, or poster

The QGIS software has nice tools for creating printed maps. **Exercise 6** walks you through this, but you should start with **Exercise 4** if you haven't used QGIS before.

When you're designing a map, it can be helpful to think of the map telling a story. What are you trying to communicate to the viewer? The first step is to choose what information is most important to include on the map. Perhaps it's about weather patterns or industrial sites or soum statistics. Then, add some more features to provide geographic context: maybe roads or aimag boundaries or terrain.

As you start applying graphical styles, make the more important features the boldest and easiest to read. Choose contrasting colors. Sometimes maps have so much background detail that it's hard to make out what's important — so think about whether there's anything you can remove to make the map clearer. At the end, add titles, labels, and explanatory text. Add a map key explaining what the colors and symbols mean. Add a scale bar to show distance, and maybe even coordinate markings.

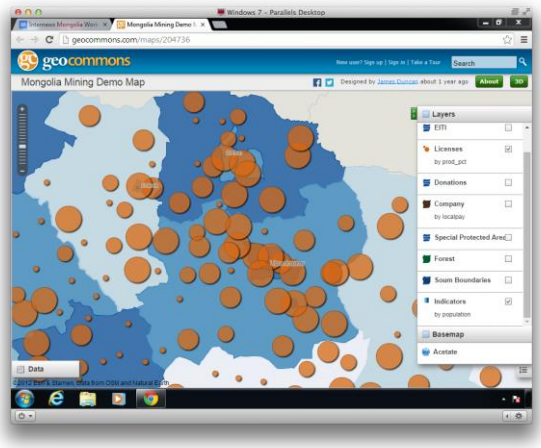
Before printing your final map, test out the process to make sure the map will look sharp! Saving the map into PDF format is better than a picture format like JPG, GIF, PNG, TIF. Once something is in a picture format, it can't be enlarged beyond a certain point without becoming blurry.

G. I want to share data files I have with the public

Of all the web-based map making tools, GeoCommons (*http://geocommons.com*) is the best for sharing you data files with the public. If you post map data there, other users of the site can easily add it to their own GeoCommons maps, or download it to their computer. Here's an example of Mongolian map data on GeoCommons, set up by the

World Bank:
http://geocommons.com/maps/204736

You can also post data files directly to a blog, to Facebook, or to other websites. It's best to ZIP the data into a single file (especially if it's in Shapefile format), and you should tell



people how to open them. Think about providing multiple data formats if it's not too hard: Shapefiles for people using GIS systems, and KML for people using Google Earth or web-based mapping tools.

SIDEBAR: SPECIAL TERMS (GLOSSARY)

ArcGIS – the most common commercial GIS software

Attributes – characteristics of a feature, like the name of a town or the population of an aimag

Cadastre – a registry of land ownership and use rights, such as for mining licenses

Coordinates – a pair of numbers specifying geographic locations relative to a particular reference point

Feature – any item represented on a map, such as a city or a road or an aimag

Georeferencing – specifying the coordinates of key locations on a scanned map so that it can be aligned with other layers of map data

GIS (Geographic Information System) – professional software for working with geographic data and maps

Interactive web map – an online map that lets you pan and zoom, and frequently provides other features like controlling layers and selecting features

Latitude & longitude – the most common system of coordinates, specifying the location of each point on earth relative to the equator and the Greenwich Meridian.

Layer (or map layer) – a group of features that can be manipulated separately from the rest of the map

Legend – panel next to a map specifying what the colors and symbols mean

Map data – the raw information behind what's displayed on a map, often stored as a text-based list of coordinates, names, and other attributes

Markers (or point markers) – a custom point added to a map, often marked with a pin icon

Open-source – software that's free to use and modify, often maintained by volunteers as an alternative to commercial software products

Projection (or map projection) – one of various standardized methods for stretching the round globe to fit onto a flat map

QGIS – the most common open-source GIS software

Raster data – map data made up of grids of pixels, such as satellite imagery

Remote sensing – technologies for measuring the earth's surface from far away, for example using satellites

Satellite imagery – photographs of the earth's surface taken from satellites

Scale (or map scale) – ruler next to a map indicating the real-world distances

Vector data – map data made up of points, lines, and polygon shapes

SIDEBAR: SOURCES FOR MAPS AND DATA ABOUT MONGOLIA

Ministry of Nature and Environment
- Environmental Information Center - *http://eic.mn*
- Information and Computer Center - *http://www.icc.mn*
- GeoNetwork map database - MNE has lots of data offline as well, and this website provides indexes and contact information for staff - *http://geodata.mne-ngic.mn:8080/geonetwork/*

Mineral Resources Authority
- Main website - *http://www.mram.gov.mn*
- Mining cadastre maps - *http://cmcs.mram.gov.mn/CMCS#cid=5*

National University of Mongolia
- Laboratory for Remote Sensing and GIS - *http://spe.num.edu.mn/*

Extractive Industries Transparency Initiative (EITI)
- Data sharing project in partnership with the World Bank - *http://english.eitimongolia.mn/map.shtml*
- Similar data posted to GeoCommons - *http://geocommons.com/maps/204736*

United Nations Humanitarian Response open data project
- Mongolia data for administrative boundaries, settlements, transportation - *https://www.humanitarianresponse.info/node/all/datasets/locations/mongolia*

Open Street Map (a Wikipedia-style world map with excellent coverage of Ulaanbaatar)
- Online map - *http://www.openstreetmap.org*
- Downloadable data extracts - *http://download.geofabrik.de*

Google Maps
- Online map - *http://maps.google.com*

SIDEBAR: DATA FORMATS DEMYSTIFIED

Shapefile (SHP) – This is the format used by GIS software to store complex vector data. One "shapefile" actually consists of several files with different extensions, all of which must be present. The file with the .SHP extension is the core file containing map geometry.

KML – Common format for storing points, lines, and shapes with limited attributes. Easily opened with Google Earth, QGIS, or online tools.

GeoJSON – Newer format developed for online tools. You can open it with QGIS.

GPX – Format generated by GPS receivers. You can open it with Google Earth or QGIS.

GeoTIFF – Common format for raster data like satellite imagery or scanned maps that you've georeferenced. You can open it with QGIS.

CSV, XLS – Common formats for tables of data. If they include columns with geographic coordinates, you can plot the data on a map using QGIS or online tools.

SIDEBAR: FURTHER RESOURCES

MECC online reference material – <link to come?>
Web links from training workshops – *http://samuelmaurer.info/mongolia*
QGIS User Guide – *http://documentation.qgis.org*
EcoLab GeoJournalism Handbook – *http://geojournalism.oeco.org.br*
GeoCommons User Manual – *http://geocommons.com/help/User_Manual*
StackExchange GIS Q&A website – *http://gis.stackexchange.com*

EXERCISES

Exercise 1: Using Interactive Online Maps

Many websites provide interactive maps that users can pan and zoom to focus on a particular location. Often these maps also have other features like turning on and off map layers, selecting map features, and calculating distances. This exercise uses maps from the Ministry of Nature and Environment's Environmental Information Center (EIC) to introduce these features.

Skills you will learn:
- Finding interactive environmental maps on the EIC website
- Panning, zooming, and controlling the map interface
- Measuring distance and finding latitude and longitude coordinates
- Turning on and off layers of data and reading map keys
- Saving pictures of a map

1) Open a web browser and go to http://eic.mn

2) Choose “Гео-мэдээллийн сан / Geodatabase” from near the bottom of the list. Later you can try other maps, but this one includes all the features we will look at.

3) The toolbar icons above the map let you control the map display. Try using the plus and minus tools to zoom in and out. Try using the hand tool to pan the map from side to side.

4) **Distance**. The map scale ruler in the lower left indicates distances. How far is it from Ulaanbaatar to Darkhan?

5) You can also use the ruler tool in the toolbar to measure distance, by clicking from point to point. What is the distance from the eastern tip to the western tip of Mongolia? The L-shaped ruler tool lets you measure area.

6) **Coordinates**. The grid of lines on the map show latitude and longitude coordinates. The text below the map also tells the precise coordinates as you move the mouse around. What are the coordinates of Ulaanbaatar? What is another city that has the same latitude? What is at coordinates (41.7, 104.9)?

7) **Layer controls**. You can show and hide layers of data using the controls to the right of the map. Zoom into an aimag and turn on soum boundaries and soum centers.

8) Turn on the first vegetation layer. Turn on its legend by clicking the “rows of text” icon to the right of the layer name. You can also use the information tool from above the map (letter “i”) to find out the data categories for any point on the map.

9) Try exploring some of the different map layers, or other maps from the Ministry of Environment web site.

10) **Saving**. Some of the maps have a toolbar button that lets you save a picture of the current view. You can also take a screenshot (of anything on the computer) by typing Alt + Print Screen.

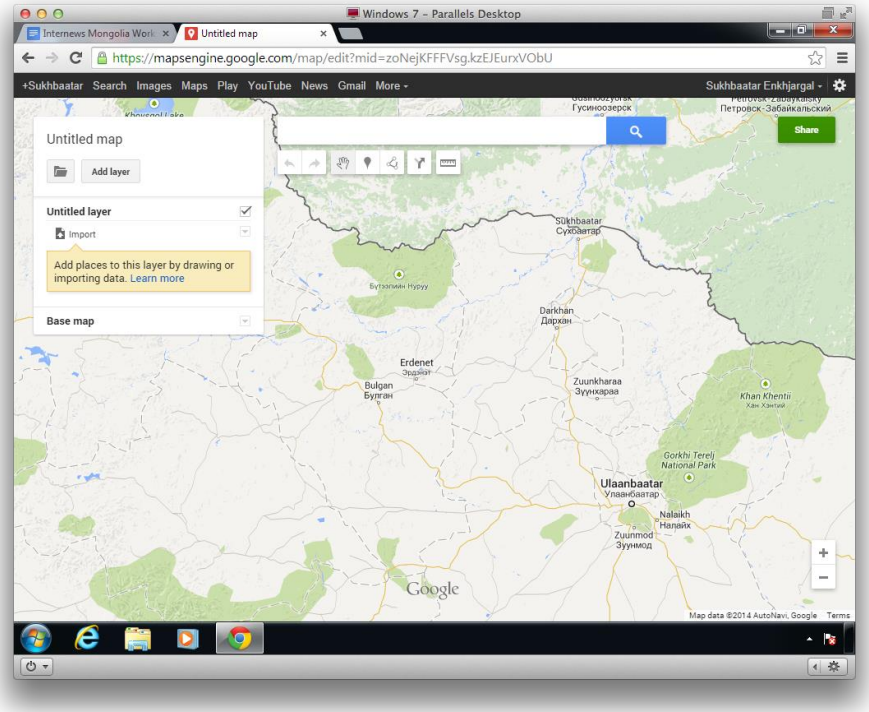
Exercise 2: Creating Interactive Online Maps

This exercise introduces you to Google Maps Engine, which is an online app that lets you draw and label your own custom features on top of a normal Google Map. You can save the map, share it, and edit it collaboratively with colleagues. *http://mapsengine.google.com/map*

Skills you will learn:
- Navigating to Google Maps Engine and creating an account
- Drawing pushpin markers, lines, and labels
- Calculating distances and searching for locations
- Changing the background map to a terrain view or satellite image
- Saving and sharing the map
- Exporting data to a computer file

Sample map of Orkhon River area produced by workshop participants:
https://mapsengine.google.com/map/viewer?mid=ztMvd-7q-B4w.kC-lxOACX-ow

1) Open a web browser and go to **http://mapsengine.google.com/map**



2) Choose "Make New Map" and then sign into your Google account, or create a new account. If you have a login for Gmail, YouTube, or another Google service, you can use the same one here.

3) If Google sends you to a dashboard page instead of to a map, try entering the original address into the menu bar again: http://mapsengine.google.com/map

4) **Drawing features**. Use the pushpin tool (below the search bar) to add a pin to the map. Give it a name and description and click Save. Add some more pins.

5) Each pin appears in a list to the left. If you move the mouse over a name in the list, a "paint can" tool appears and lets you change the color or shape of the pin.

6) You can edit a pin name or location by clicking on it and then choosing the pencil tool in the window that pops up.

7) Try using the line segment tool (below the search bar) to draw paths on the map. To end a path, click on the final point twice. You can also use the ruler tool to measure distances and areas, or the search bar to find locations.

8) **Changing the base map**. Use the Base Map selector (on the left, below the list of pins) to change the background to a satellite image or terrain map.

9) **Sharing online**. Give the map a title by clicking "Untitled Map" on the left and naming it something else. Now click the green "Share" button in the upper right. Next to the words "Private, only you can access," click "Change" and then choose "Public on the web." Click "Save" to return to the sharing window. Now you can copy the map's link and send it to someone, or share it directly on Facebook.

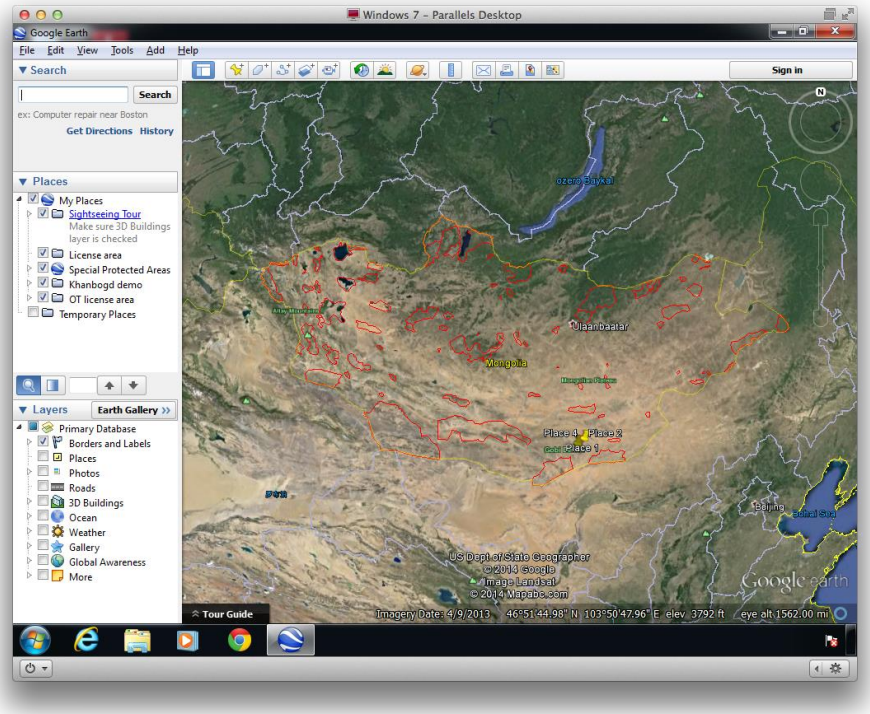
10) **Saving features.** The map is automatically saved to your Google account, and you can keep working on it when you return to Google Maps Engine (on any computer). To save the features as a computer file, click the folder icon under the map title and choose "Export to KML." We will use this file in the next exercise.

Exercise 3: Assembling Map Data with Google Earth

Google Earth is an app that runs on your computer, and if free to download. It's a great tool for working with map data in "KML" or "GPX" format, for example from GPS receivers. Google Earth also provides detailed satellite imagery from multiple time periods. *http://www.google.com/earth/*

Skills you will learn:
- Using the controls to pan, zoom, and rotate the Google Earth satellite map
- Drawing and labeling points, lines, and shapes
- Editing features and measuring distances
- Organizing map features into folders
- Opening, saving, and exporting data
- Searching for latitude-longitude coordinates copied from an EIC map

1) Download and launch the Google Earth application.



2) Try zooming, panning, and rotating the map using the controls in the upper right. You can hide the photos at the bottom to make more room for the map. The "historical imagery" tool is the picture of a clock with a green arrow. Try clicking it and then using the sliding selector to look at older satellite images.

3) **Drawing features**. Use the pushpin tool (along the top) to add a marker to the map. In Google Earth this is called a "Placemark." After clicking the tool, drag the pin to the correct location, give it a name, and click "OK."

4) You can also draw lines and shapes using the tools to the right of the pushpin. To move or edit a marker, right-click on it and select "Properties." You can measure distances using the ruler tool.

5) **Organizing data**. On the left, there is a "Places" panel and a "Layers" panel. "Places" lists the features that you've added to the map, and "Layers" lists features from Google's base map. Try turning off some Google layers to make the map less cluttered.

6) It's best to organize your markers into folders. Right-click on "My Places" and choose "Add -> Folder." Name the folder and click "OK." Drag the markers you created into the folder.

7) **Opening KML data files**. Try opening a KML-format data file. If you completed Exercise 2, you exported one from Google Maps Engine. Go to "File > Open," and find the KML file. In the "Places" panel, move it to a permanent folder.

8) **Copying coordinates**. In a web browser, go to http://mram.gov.mn and click the banner on the right to open the mining license cadastre map. Choose "Licenses." Under "Area Name," search for "Oyu Tolgoi." Click the link in the "Code" column to see the map.

9) Underneath the area description (on the right), click "Coordinates" to see the latitude and longitude boundaries of the permit area. Select the text of one of the coordinate pairs — for example, *106°47'31.48" E 42°58'31.35" N* — and type Ctrl-C to copy it. Go back to Google Earth, paste the coordinates into the search bar by typing Ctrl-V, and click "Search."

10) Google Earth creates a temporary marker for the location you searched for. You can save it by clicking on the folder-with-arrow icon, between the "Search" panel and "Places" panel.

11) Can you find the Oyu Tolgoi mine in the satellite map? (Hint: you will have to zoom out a bit, because it's a large permit area.) Use the ruler tool to measure how far the mine is from the Small Gobi Protected Area.

12) Try copying the coordinates for the other three corners of the permit area into Google Earth as well, and save the markers. Then you can draw a rectangle connecting the markers, indicating where the permit area is. You can delete the corner markers after you draw the rectangle. (Right-click and choose "Delete.")

13) To change the color or opacity of the rectangle, right-click on it, choose "Properties," and go to the "Style, Color" tab.

14) When you click the pushpin tool to create a new marker on the map, you can type latitude and longitude coordinates directly into the box. Try finding some locations from another map, writing down their coordinates, and adding them in Google Earth. (You won't need more than 4 or 5 digits after the decimal points.)

15) **Saving and exporting**. All the features inside "My Places" will be saved in the Google Earth application. If you want to export a KML file with the locations of your markers, right-click on a folder and choose "Save Place As." If instead you want a *picture* of what the map looks like, use the "Save Image" tool (above the map, near the printer icon).

Exercise 4: Introduction to GIS, Part I

GIS stands for "Geographic Information System," and refers to the software systems that professionals use to create and analyze map data and design printed maps. These exercises uses software called QGIS, which is free to download and run on your computer. It's the open-source equivalent of ArcGIS and includes all the same basic features, plus many advanced ones. *http://qgis.org*

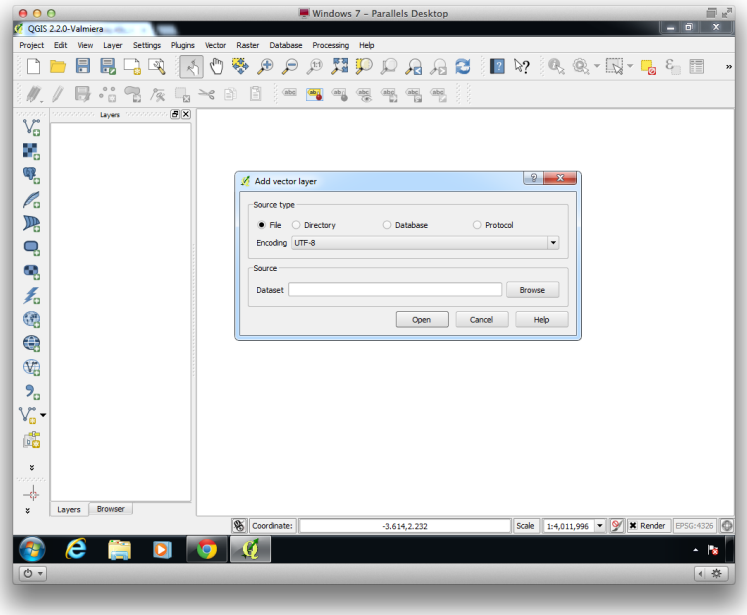
This exercises requires you to download a set of demo data files: <link to come?>

Skills you will learn:
- Loading vector map data like soum boundaries and roads
- Using interface controls to pan and zoom
- Activating, deactivating, and changing the order of layers

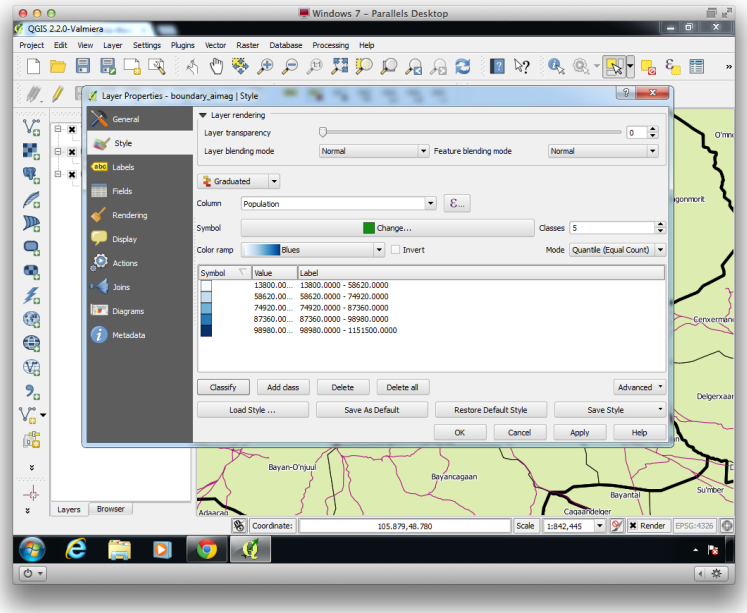
- Adding labels and color styles using the “Properties” controls
- Viewing tabular data using the “Attribute Table” controls

1) Download, install, and launch the “QGIS Desktop” application.

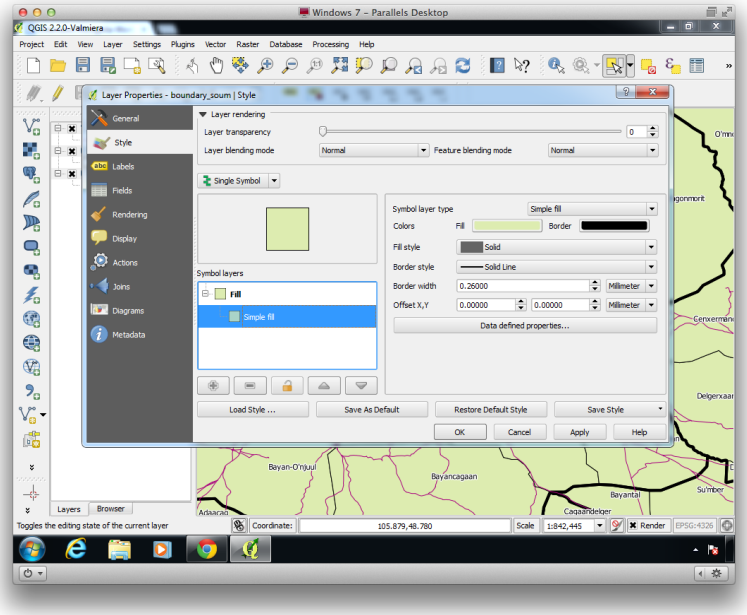
2) **Loading map data**. Click the “Add Vector Layer” button  , then click “Browse,” and go to the



“Map Demo Files” folder on the desktop. Choose the “boundary_aimag” folder and then the file inside with the same name, and click “Open.”



3) Click the “Add Vector Layer” button again, and load the “boundary_soum” layer, then “places,” and then “roads.” If you see a window asking you to choose a coordinate reference system, just click “OK” for now.



4) Try using the hand tool and magnifying glass tools to zoom and pan around the map. If you zoom into Ulaanbaatar, you’ll see that the “roads” layer includes the full city street grid.

5) **Controlling layers**. In the “Layers” panel (on the left), try using the check boxes to turn layers off and on. Try dragging the aimag layer above the soum layer, and then back.

6) **Adding labels**. Double-click on the soum layer name to edit its properties. Choose the “Labels” tab on the far left, and find “Label this layer” at the top of the pane. Click the associated check box, choose the “Name” field, and then click “OK.”

7) **Applying styles**. Double-click again on any of the layer names, and choose the “Style” tab on the far left. Just like there are multiple layers in the map, there are multiple potential styles for each layer, and we have to choose the correct one to edit. Find the box near the middle of the pane that’s labeled “Symbol Layers.” There will be an indented box in it saying either “simple marker” or “simple line” or “simple fill.” Click on this in order to see the correct options for changing the style.

8) Can you figure out how to show thick aimag boundaries and thin soum boundaries, both at the same time? Give their text labels different styles too.

9) **Non-spatial data**. Right-click on the aimag layer and choose “Open Attribute Table.” The layer’s geographic data is shown on the map (aimag shapes), and its non-geographic data (names, populations) is in the attribute table.

10) We can color in the aimags according to their population. First, close the attribute table. Turn off the soum layer, so we can be sure to see the aimag layer. Now, double-click the aimag layer and

choose the “Style” tab. Find the drop-down menu that says “Single Symbol,” and change it to “Graduated.” For “Column,” choose “Population,” and for “Mode” (on the right), choose “Quantile Equal Count.” Click “Classify” (in the lower left) and then “OK.” The aimags with larger populations are colored darker.

11) The “places” layer has a data field for “type” (like city, village, etc). Can you figure out how to use a similar technique to give different colored markers to each type of place?

12) Save the QGIS project file by going to the “Project” menu and choosing “Save.”

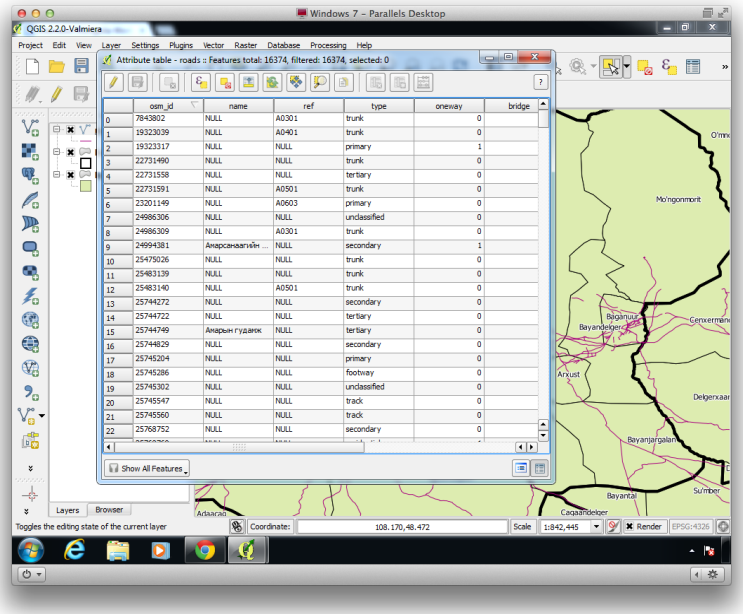
Exercise 5: Introduction to GIS, Part II

This exercise is a continuation of the prior one.

Skills you will learn:
- Selecting data features by hand, by name, and by value
- Identifying data features using selection tools and attribute tables
- Selecting data with spatial queries
- Saving new Shapefiles

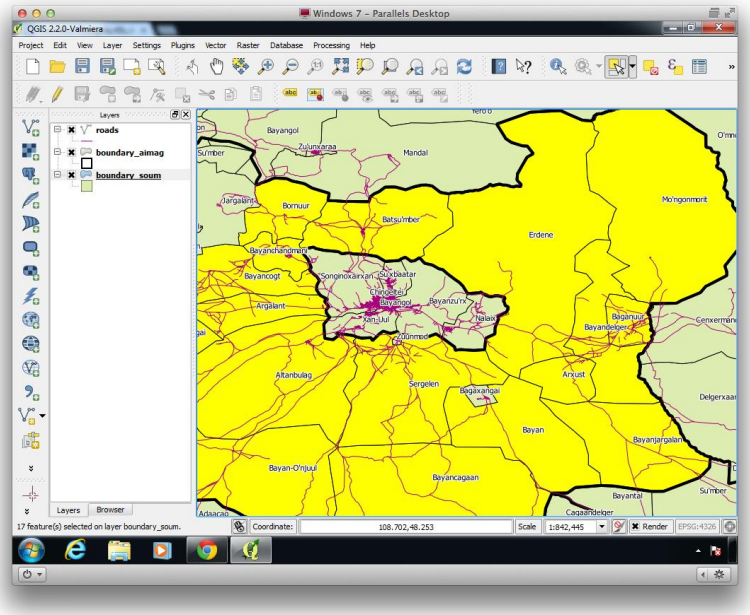
1) Open the “QGIS Desktop” application and load the aimag, soum, and road layers, if they are not already open.

2) **Selecting by hand**. The first way to select features is by clicking them on the map. Choose the “Select Features” tool  . Choose the name of the layer you want to select from, and then try clicking features on the map. When features are selected, they are highlighted in yellow.



Now try choosing a different layer, and selecting its features the same way. You can use the "Deselect Features" tool  to remove the yellow highlighting.

3) **Selecting by data attributes**. The second way to select features is using their data attributes. Right-click the soum layer and choose "Open Attribute Table." Try click on the row numbers on the left, and see how the features you select are highlighted on the map.



4) You can also create a database expression to select all the features that match a certain pattern. Choose the tool with an "E" from the top of the attribute table window. Click the "+" next to "Fields and Values," and double-click on "Aimag_name." Then click the "=" button. You will see the expression being built in the lower part of the window.

5) Click the button labeled "Load Add Unique Values," and then double-click on "Omnogovi." Click "Select" at the bottom, and then "Close." All the soums in Omnogovi should be selected on the map.

6) Right-click the soum layer name and choose "Save Selection As." We will create a new shapefile that contains just the Omnogovi soums. Chose format "ESRI Shapefile" and click "Browse" to choose a location for the file. It's good to save the shapefile into its own folder. Also click the checkbox at the bottom to "Add Saved File to Map."

7) **Selecting by spatial query**. You can also select features based on their spatial relationship with data in other layers. As an example, we will select all the roads that pass through Omnogovi. First, choose the aimag layer, click the feature selection tool, and click on Omnogovi to select it.

8) Go to the "Vector" menu and choose "Spatial Query." (If it is not in the menu, go to the "Plugins" menu, then "Manage and Install Plugins." Choose the "Installed" tab, and turn on the "Spatial Query" plugin.)

9) Build the following query: Select source features from “roads,” where the feature “intersects” reference features of “boundary_aimag,” and use the result to “create new selection.” Now click “Apply” and then “Close.”

10) The roads passing through Omnogovi should have been selected, although it may be hard to tell until you save them as a new layer. Right-click on the roads layer and choose “Save Selection As,” and create a new shapefile with just the Omnogovi roads.

11) Click the button to deselect all features, and try hiding the original soum and road layers, to only show Omnogovi aimag.

Exercise 6: Creating Printed Maps

The QGIS Print Composer provide an easy way to design maps for reports, posters, brochures, and other non-interactive uses.

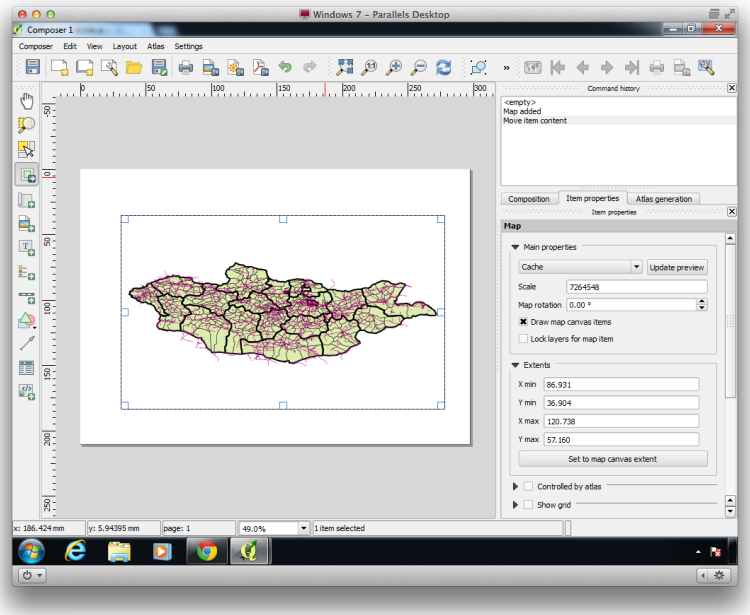
This exercises requires you to download a set of demo data files: <link to come?>

Skills you will learn:
- Creating a new print layout and adding your map
- Adding titles, descriptions, legends, and map scales
- Saving the map as a PDF for optimal printing

1) Arrange the QGIS map window roughly as you would like it to appear on the printed map.

2) From the “Project” menu, choose “Print Composer.”

3) Use the “Add New Map” tool  to draw out a rectangle where the map will appear. You can use the “Move Item Content” tool  to move the map around in the frame.



4) Use the “Add New Label” tool  to add a title, and then go to the “Item Properties” panel on the right to enter text and make it larger.

5) Add a legend  and map scale  to indicate distances and show what the colors and symbols mean.

6) If you would like, add another label explaining the content of the map in more detail.

7) Use “Export as PDF”  to create a file that will print sharply, or “Export as Image” to share the map on the web.

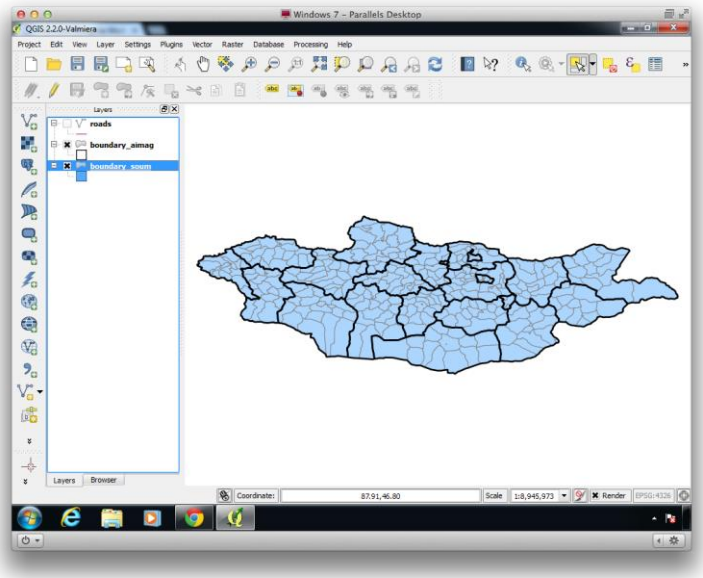
Exercise 7: Map Projections and Georeferencing

A map’s projection refers to the procedure that’s used to stretch the spherical globe out into a flat map. Each projection has its own tradeoffs: some maintain straight lines for north-south and east-west but distort shapes, and it’s common for maps to show distances and shapes accurately in the center but distort features that are closer to the edge. The larger the area covered in a map, the more difficult to find an ideal projection.

This exercises requires you to download a set of demo data files: <link to come?>

Skills you will learn:
- Changing the projection of maps in QGIS
- Comparing common projections like Plate Carree, Mercator, and UTM
- Viewing web maps from Google or OpenStreetMap within QGIS
- Using the Georeferencer tool to align a picture of a map with other data

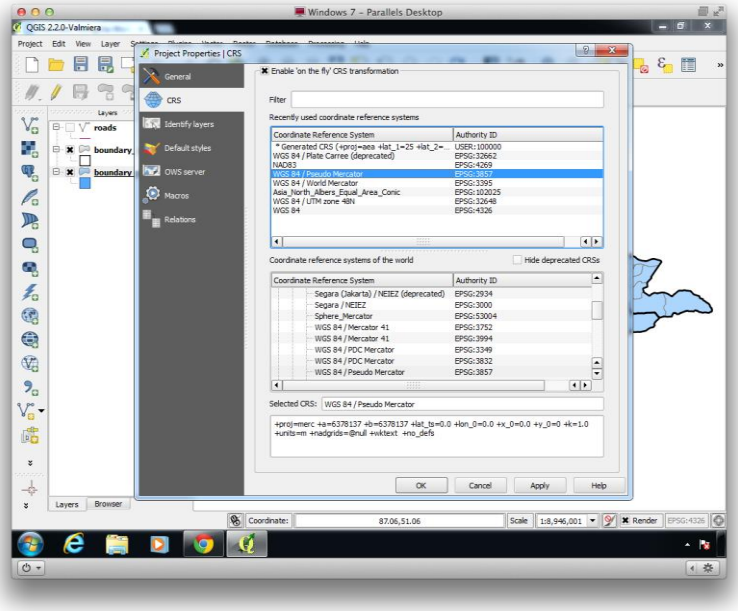
1) Launch QGIS and load some of the demo shapefiles: aimags, soums, roads, etc.



2) Right-click on one of the layers and choose “Zoom to Layer Extent” to see the entire country.

3) **Map projections**. From the “Project” menu, choose “Project Properties.”

4) Make sure you are in the “CRS” tab on the left. Then click the check box at the very top, labeled “Enable On the Fly CRS Transformation.”



5) Search for “48N” (no space), and choose the bottom-most result: “WGS 84 / UTM Zone 48N.” Click “OK,” and watch how the shape of the map changes.

“WGS 84” refers to the current system for assigning latitude/longitude coordinates to points on the globe. “UTM” is a particular map projection, in other words a way of stretching the globe to fit on a flat map. “48N” is the version of it that’s most accurate for Mongolia’s region of the globe.

6) Now we’ll try a different projection. Go back to “Project Properties” and search for the word “pseudo.” Choose the CRS called “WGS 84 / Pseudo Mercator” and click OK. This is the projection used for web maps like Google Maps or Open Street Map.

7) When the data is in this projection, we can load Google Maps as a background layer. From the “Plugins” menu, choose “OpenLayers Plugin” and then “Add Google Streets Layer.” (If the Google map covers all your data layers, drag it to the bottom of the layer list. If “OpenLayers” is not in the menu, go to “Manage and Install Plugins” instead. Search for “OpenLayers” in the “Installed” panel to turn it on, or in the “Get More” panel to download it.)

8) If you try projecting the map back to UTM 48N, the layers will no longer align properly. “Vector” data layers can be drawn in any projection, but “raster” image layers have a particular projection that can’t be easily changed.

9) Remove the Google Maps layer before moving on. (Right-click and choose “Remove.”)

10) **Georeferencing**. Save an image from one of the Ministry of Environment maps that you'd like to bring into GIS. Or, download the demo image from http://samuelmaurer.info/vegetation.png

11) Set the CRS in "Project Properties" to "WGS 84 / UTM Zone 48N." Arrange the GIS window so that you can see the same part of the country that the image you're importing shows. Then, from the "Raster" menu choose "Georeferencer." (If it's not there, go to "Manage and Install Plugins" and search for it in the "Installed" panel to turn it on.

12) Click the "Open Raster" button  and find the map image you want to import. Give it the "WGS 84 / UTM Zone 48N" coordinate reference system.

13) Use the "Add Point" tool  to click on the eastern tip of Mongolia in the image. Then click the "From Map Canvas" button, click on the same point in the GIS window, and choose "OK." Repeat the process for at least three more points.

14) Click the "Transformation Settings" button  to provide some more instructions. Good settings to start with are transformation type "linear," resampling method "cubic," and compression type "LZW." In the "Output Raster" box, choose a location to save the new version of the image. Be sure to click the check-box at the bottom labeled "Load in QGIS When Done."

15) Click the "Start Georeferencing" button  . Choose "WGS 84 / UTM Zone 48N" one more time. Close the Georeferencer window, and the image will be aligned with your other GIS layers.