Introduction to GIS (Geographic Information System) And Its Application to Agriculture

By

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What is the GIS?

It is a tool that utilize the computer ability to manage spatial database aiming at summary several kind of spatial data into spatial information.

At any particular point, several kinds of data are processed for its information.

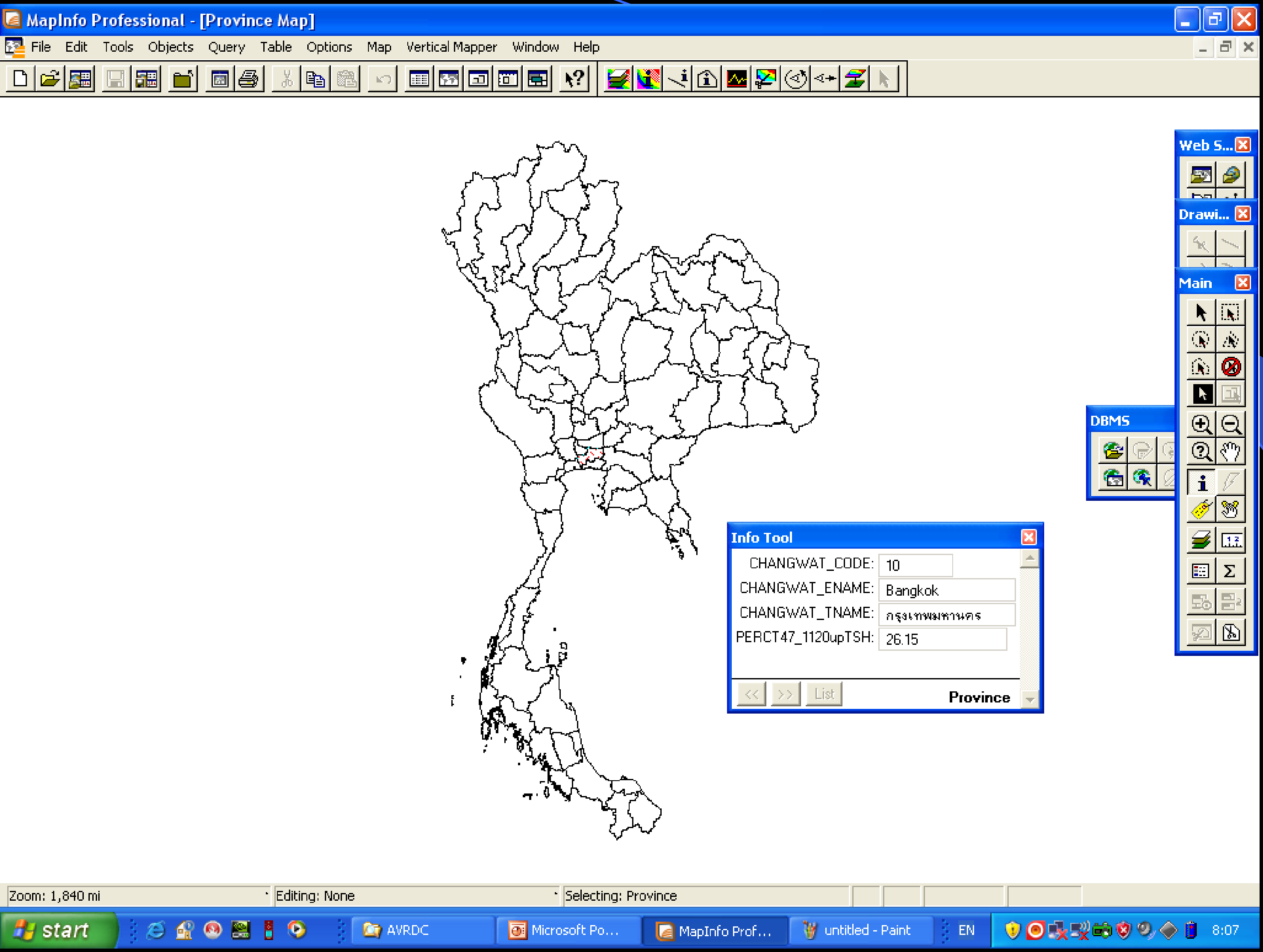
One Database: comprises of

1. one/many Tables
2. Software to maintenance data
3. Algorithms to maintenance data
4. Tables' location

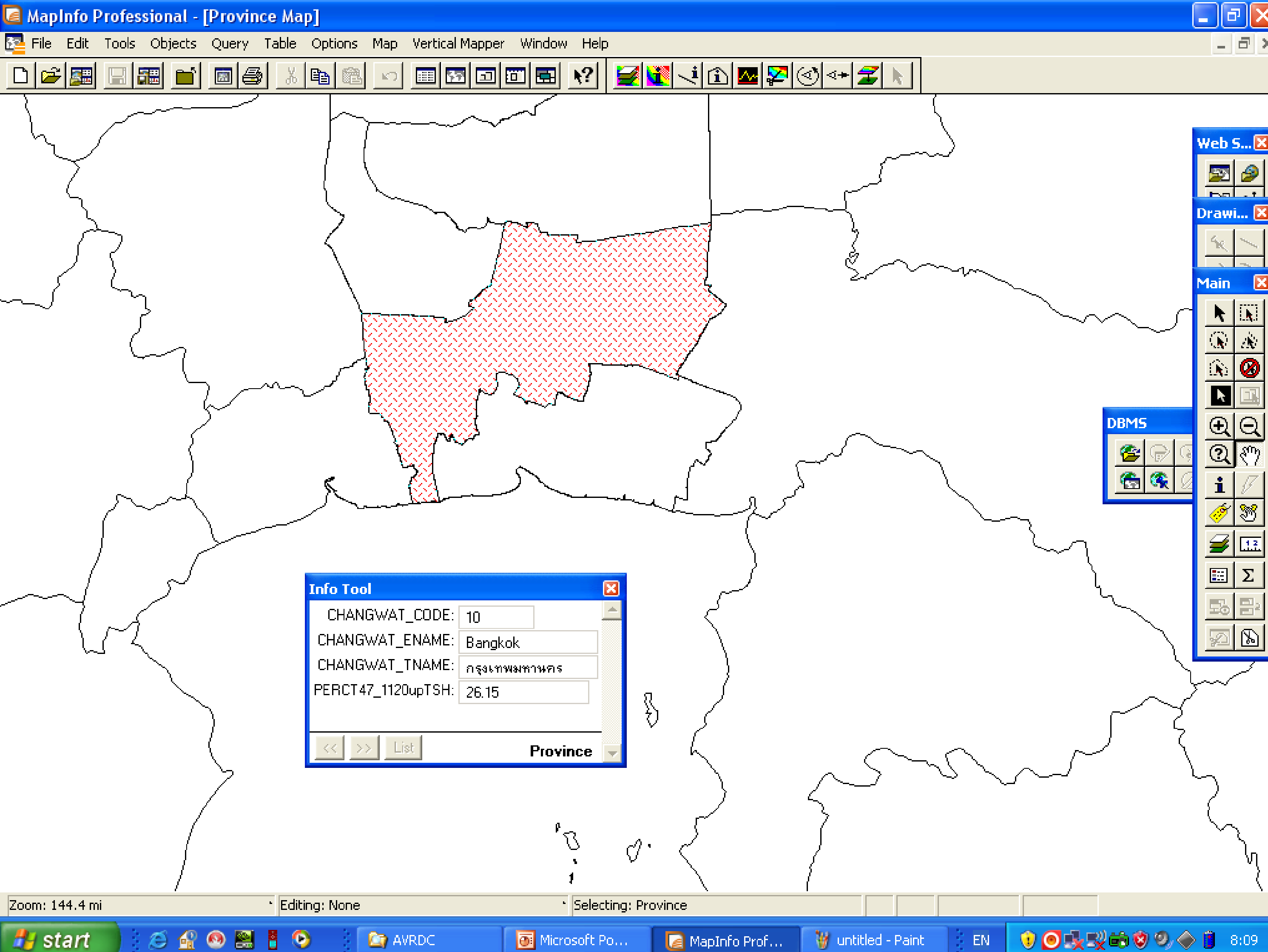
One spatial database

1. GIS system --- 2 & 3
2. Many 1 & 4
3. Many spatial locations

Example of one Table

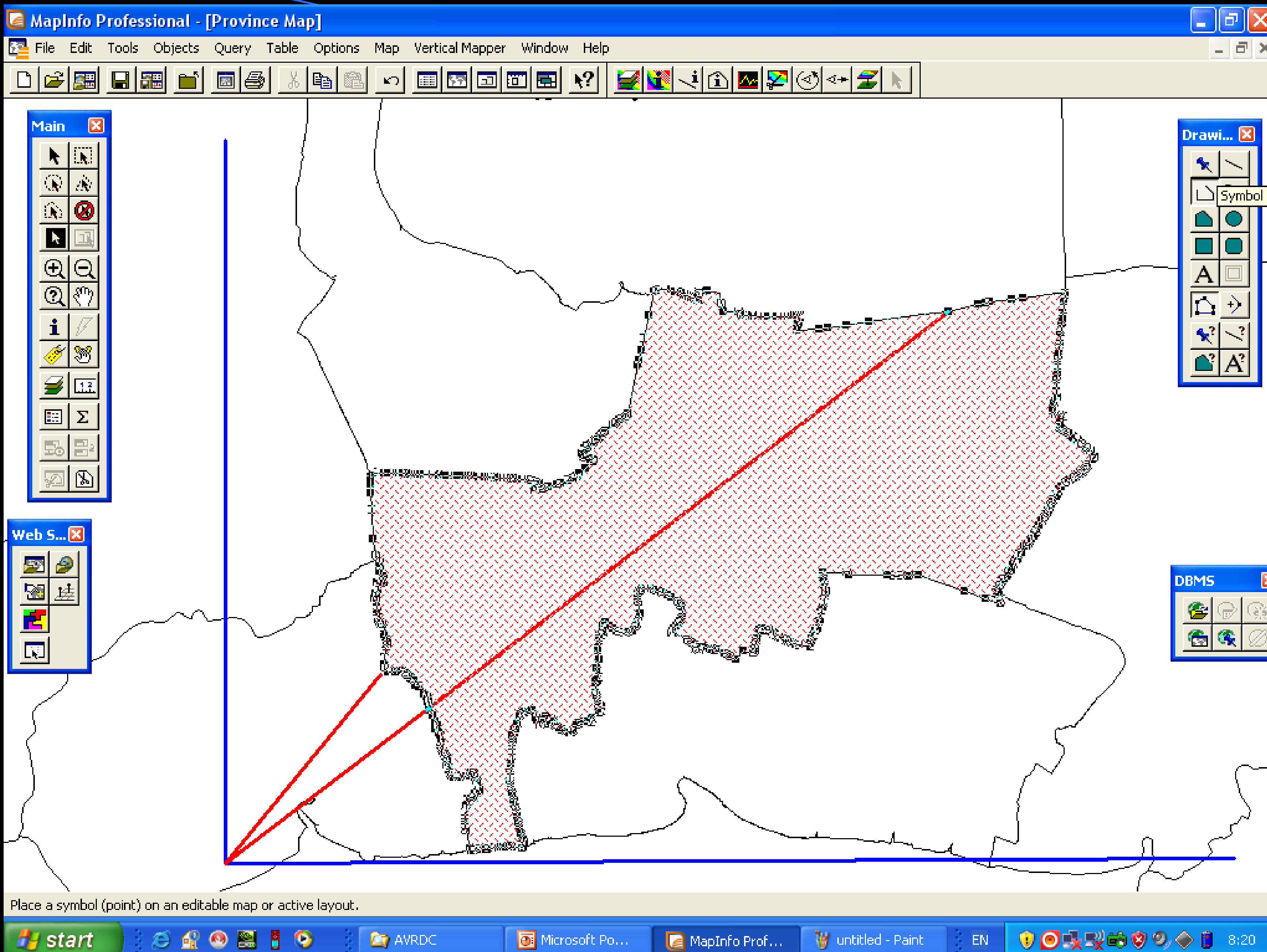


Thai's provincial boundary.—called a layer



Selected object:-- an object location and attributes of that selected object

Attributes of an object:
Mostly be stored as
relational database
Location of an object:
Mostly GIS software dependent
either vector type or raster type
vector either topology or
sphagetti form
GIS software can process either
vector or raster or vector/raster
Simultaneously.
This type of DB called OBJECT-RDB


MapInfo Professional - [Province Map]
File Edit Tools Objects Query Table Options Map Vertical Mapper Window Help
Main
Drawi...
Symbol
Web S...
DBMS
Place a symbol (point) on an editable map or active layout.
start
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Microsoft Po...
MapInfo Prof...
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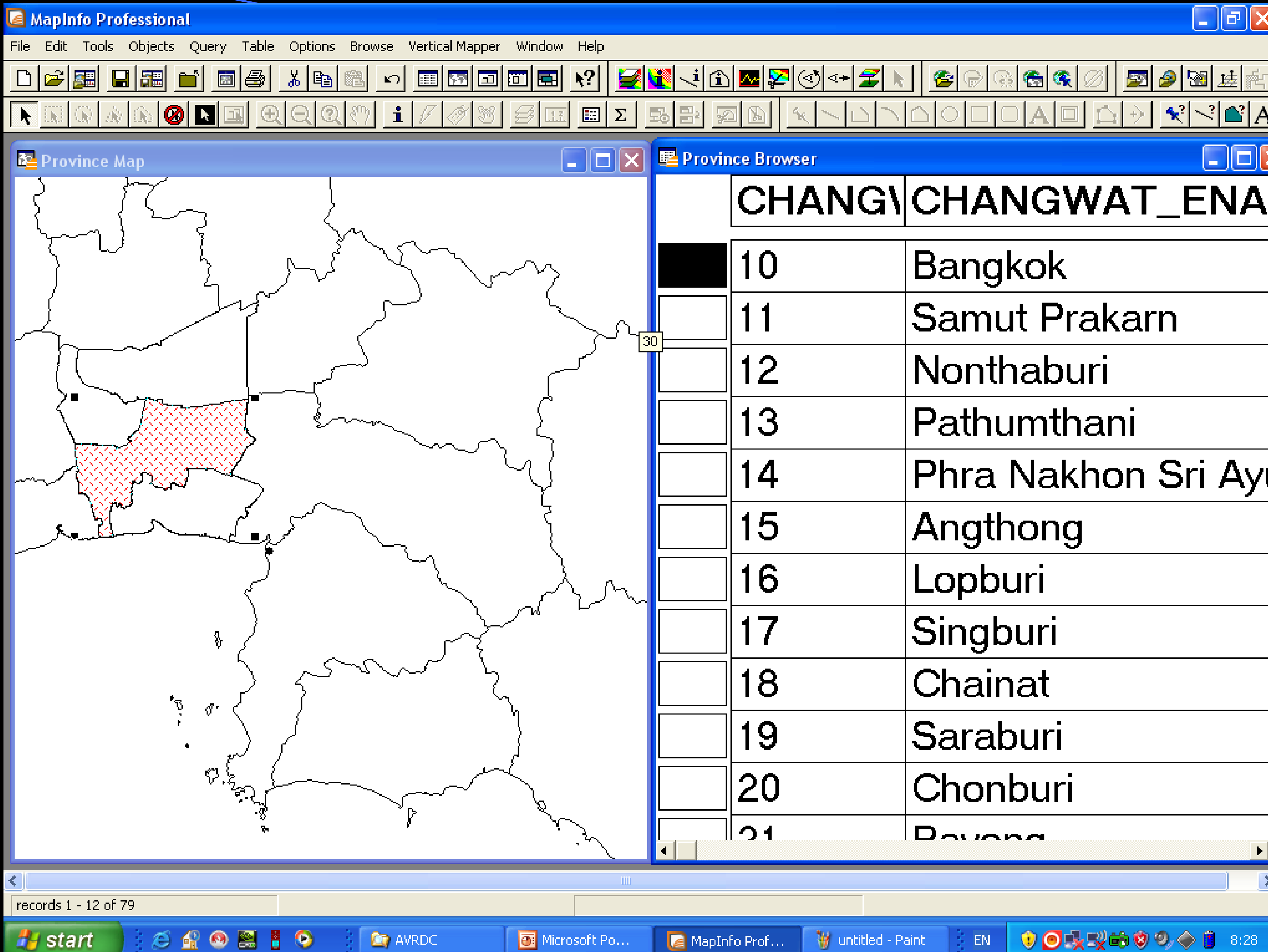
EN
8:20


MapInfo Professional
File Edit Tools Objects Query Table Options Browse Vertical Mapper Window Help
Province Map
30
Province Browser
CHANGW CHANGWAT_ENA
10 Bangkok
11 Samut Prakarn
12 Nonthaburi
13 Pathumthani
14 Phra Nakhon Sri Ay
15 Angthong
16 Lopburi
17 Singburi
18 Chainat
19 Saraburi
20 Chonburi
records 1 - 12 of 79
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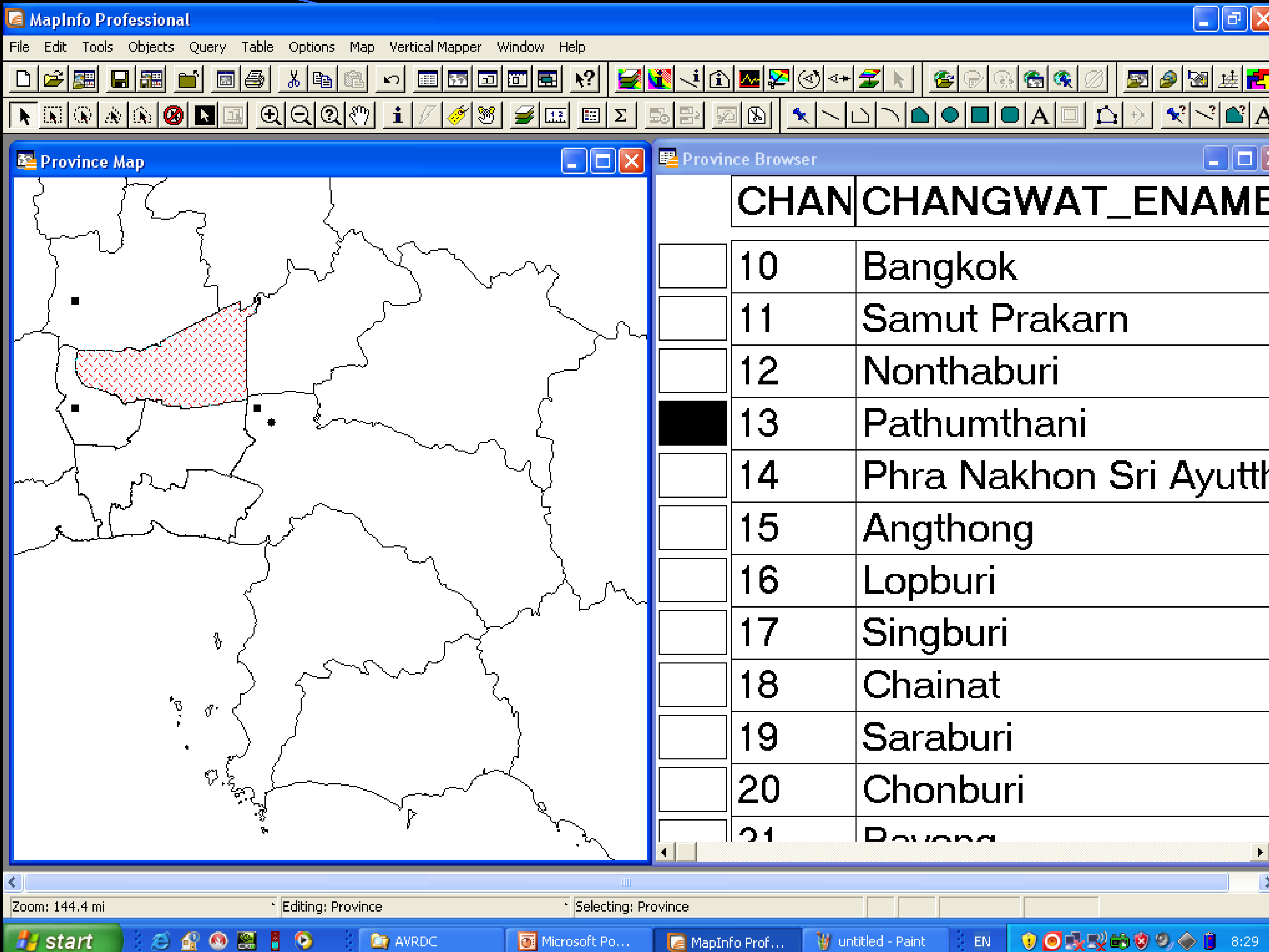
8:28


MapInfo Professional
File Edit Tools Objects Query Table Options Map Vertical Mapper Window Help
Province Map
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CHAN CHANGWAT_ENAME
10 Bangkok
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12 Nonthaburi
13 Pathumthani
14 Phra Nakhon Sri Ayutt
15 Angthong
16 Lopburi
17 Singburi
18 Chainat
19 Saraburi
20 Chonburi
Zoom: 144.4 mi
Editing: Province
Selecting: Province
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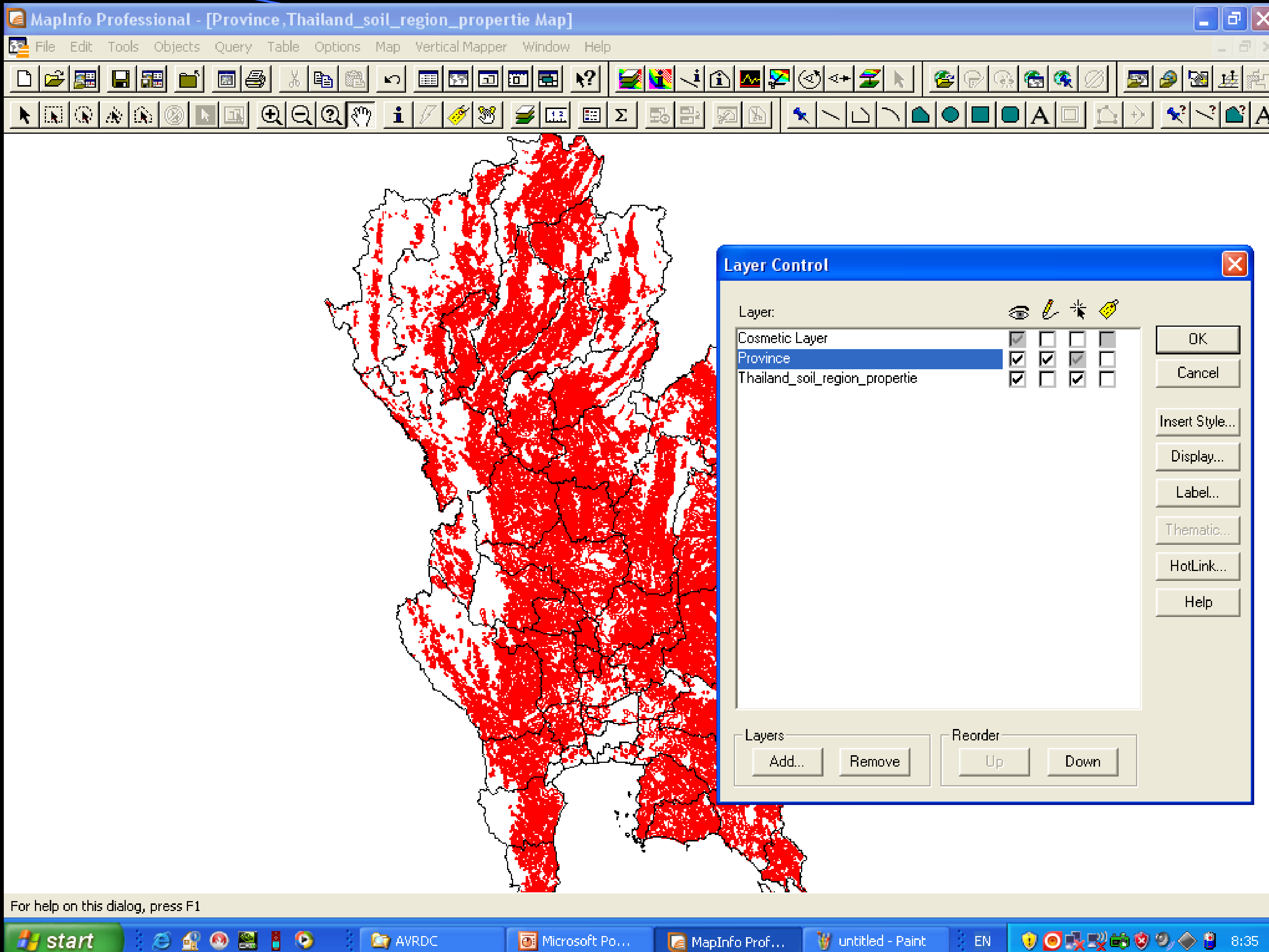
MapInfo Professional - [Province Browser]

File Edit Tools Objects Query Table Options Browse Vertical Mapper Window Help

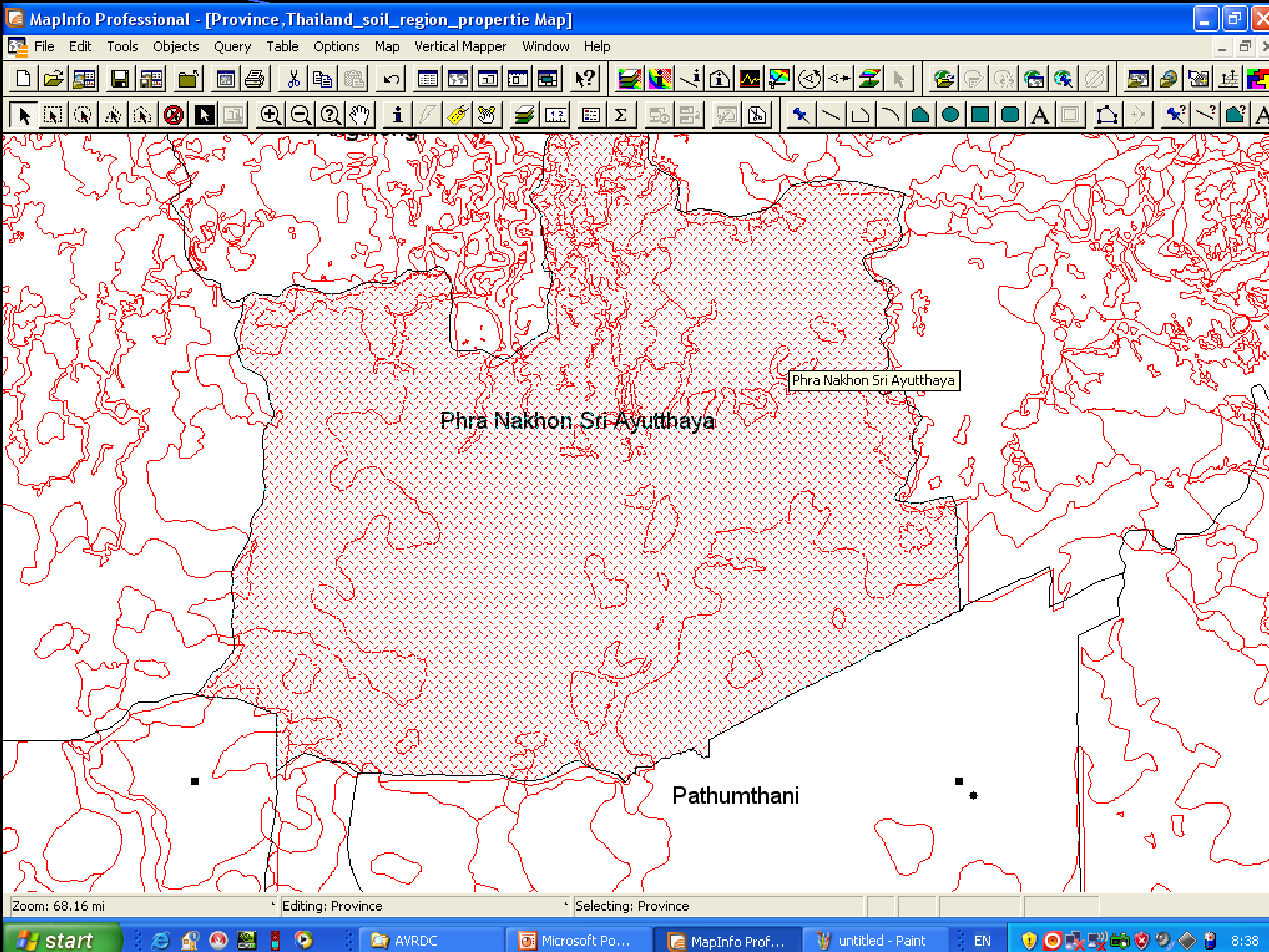
CHAN	CHANGWAT_ENAME	CHANGWAT_TNAME	PERCT47_1120upT
10	Bangkok	กรุงเทพมหานคร	26.1
11	Samut Prakarn	สมุทรปราการ	19.0
12	Nonthaburi	นนทบุรี	16.6
13	Pathumthani	ปทุมธานี	14.0
14	Phra Nakhon Sri Ayutthaya	พระนครศรีอยุธยา	18.0
15	Angthong	อ่างทอง	8.4
16	Lopburi	ลพบุรี	18.7
17	Singburi	สิงห์บุรี	6.2
18	Chainat	ชัยนาท	6.8
19	Saraburi	สระบุรี	13.8
20	Chonburi	ชลบุรี	15.5
21	Rayong	ระยอง	14.9
22	Chanthaburi	จันทบุรี	16.2
23	Trat	ตราด	7.7
24	Chachoengsao	ฉะเชิงเทรา	21.2
25	Prachinburi	ปราจีนบุรี	16.3

records 1 - 17 of 79

start AVRDC Microsoft Po... MapInfo Prof... untitled - Paint EN 8:30



Adding a soil table (red) to the map


MapInfo Professional - [Province,Thailand_soil_region_propertie Map]
File Edit Tools Objects Query Table Options Map Vertical Mapper Window Help
Phra Nakhon Sri Ayutthaya
Phra Nakhon Sri Ayutthaya
Pathumthani
Zoom: 68.16 mi
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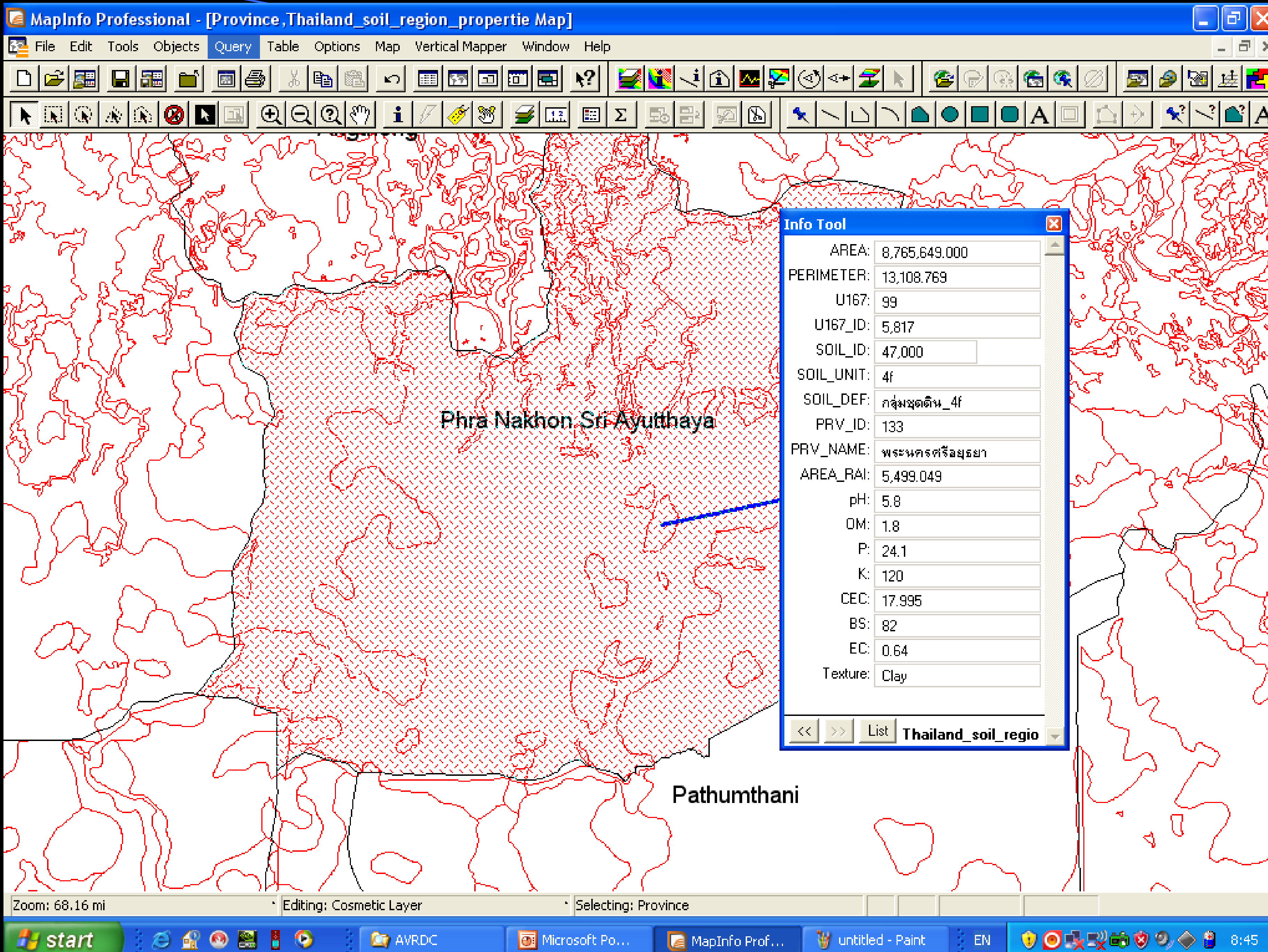
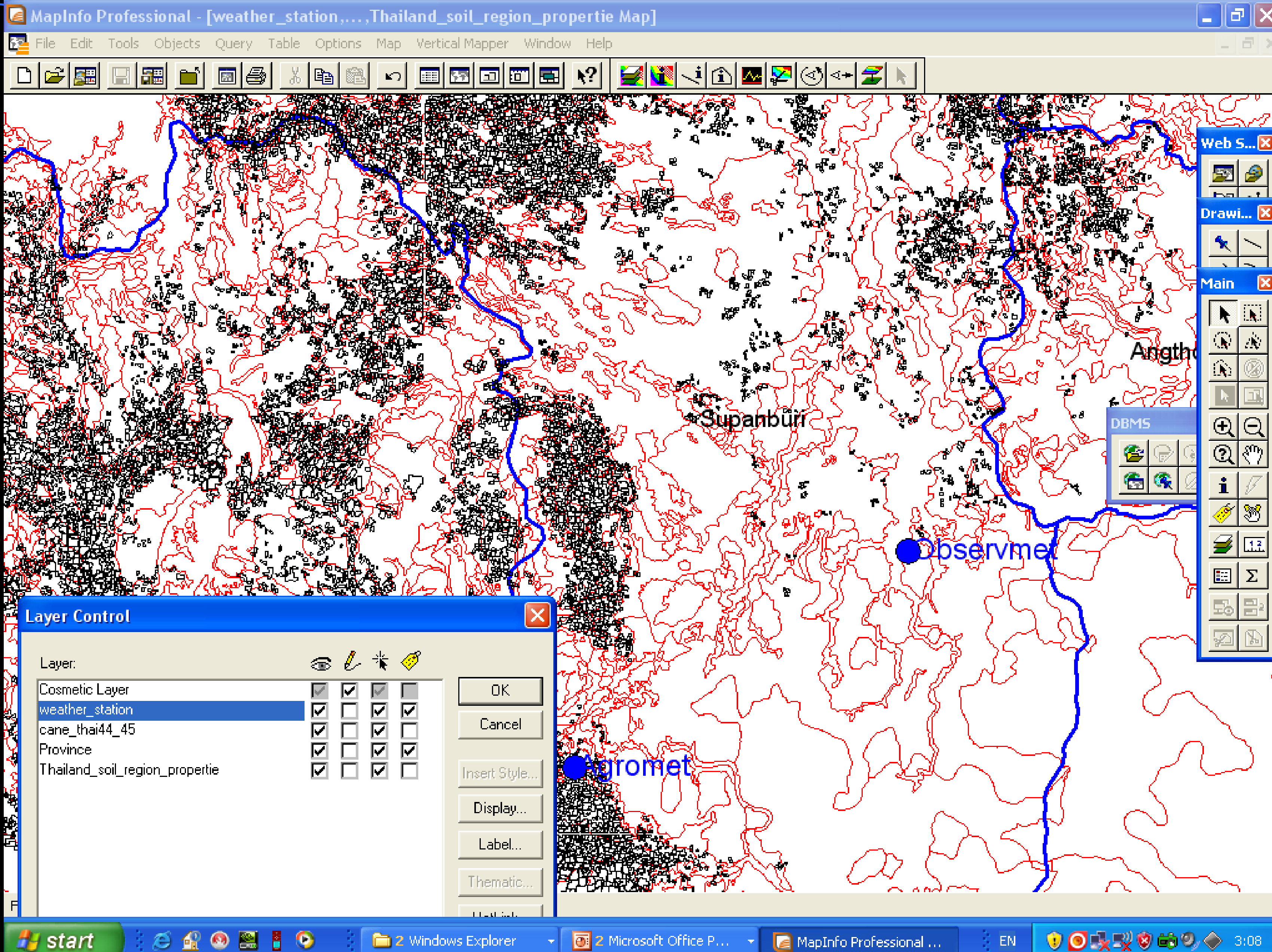

MapInfo Professional - [Province,Thailand_soil_region_propertie Map]
File Edit Tools Objects Query Table Options Map Vertical Mapper Window Help
Phra Nakhon Sri Ayutthaya
Pathumthani
Info Tool
AREA: 8,765,649.000
PERIMETER: 13,108.769
U167: 99
U167_ID: 5,817
SOIL_ID: 47.000
SOIL_UNIT: 4f
SOIL_DEF: กลุ่มชุดดิน_4f
PRV_ID: 133
PRV_NAME: พระนครศรีอยุธยา
AREA_RAI: 5,499.049
pH: 5.8
OM: 1.8
P: 24.1
K: 120
CEC: 17.995
BS: 82
EC: 0.64
Texture: Clay
List
Thailand_soil_regio
Zoom: 68.16 mi
Editing: Cosmetic Layer
Selecting: Province
start
AVRDC
Microsoft Po...
MapInfo Prof...
untitled - Paint
EN
8:45

How does GIS process data to get information?

It processes data through

- **collecting data from many map layers and summarize … or overlaying**
- **GIS preparing spatial data which collected from many map layers and use models to process and summarize data**
- **GIS preparing spatial data and use network analysis**

- GIS provide spatial data of many map layers within any radius sizes of interest ---- buffering


MapInfo Professional - [weather_station,...,Thailand_soil_region_propertie Map]
File Edit Tools Objects Query Table Options Map Vertical Mapper Window Help
Supanburi
Observmet
Agromet
Angtho
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Main
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Layer Control
Layer:
Cosmetic Layer
weather_station
cane_thai44_45
Province
Thailand_soil_region_propertie
OK
Cancel
Insert Style...
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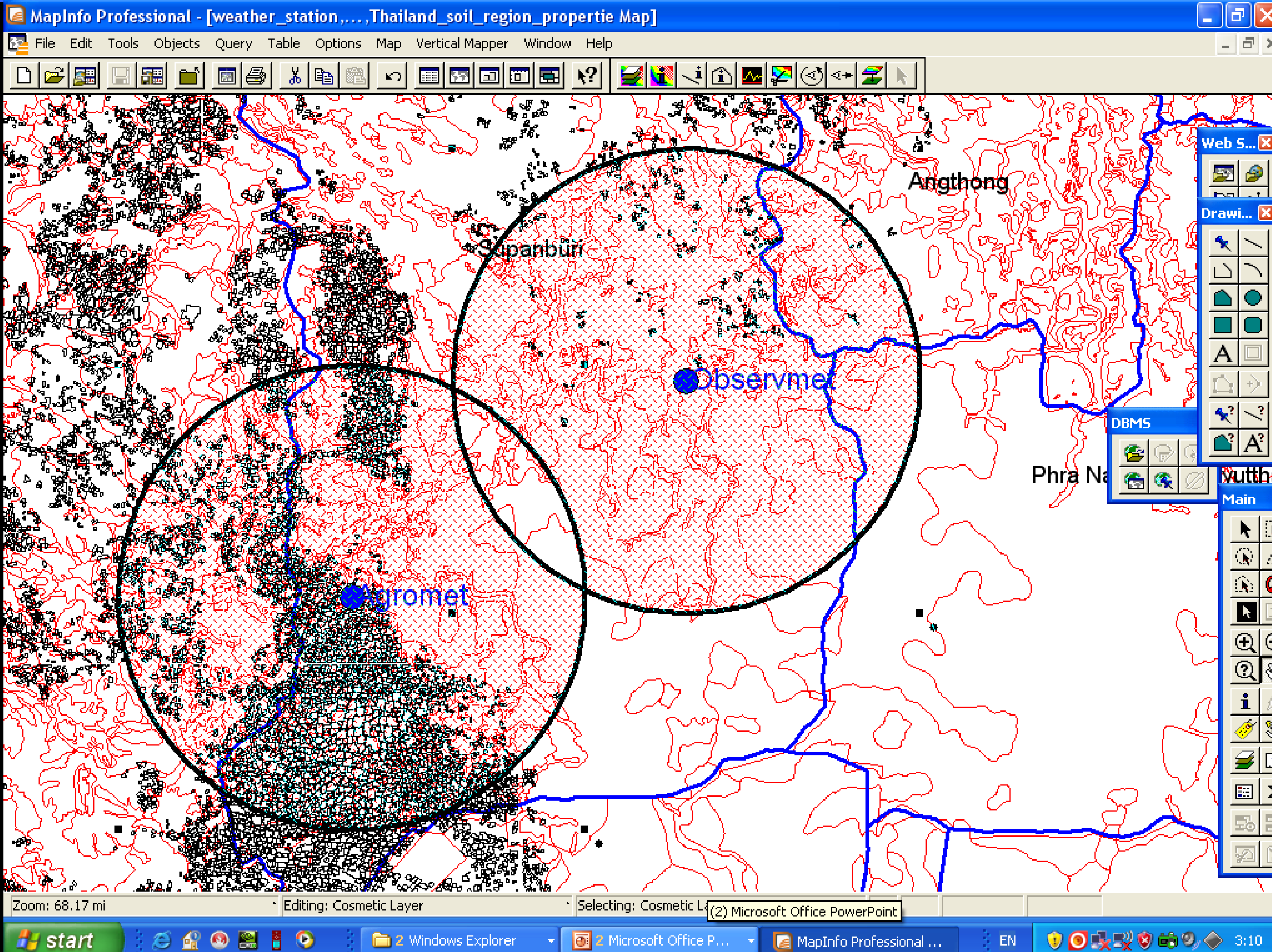
Thematic...
start
2 Windows Explorer
2 Microsoft Office P...
MapInfo Professional ...
EN
3:08

Overlaying


MapInfo Professional - [weather_station,...,Thailand_soil_region_propertie Map]
File Edit Tools Objects Query Table Options Map Vertical Mapper Window Help
Angthong
Supanburi
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Agromet
Phra Na
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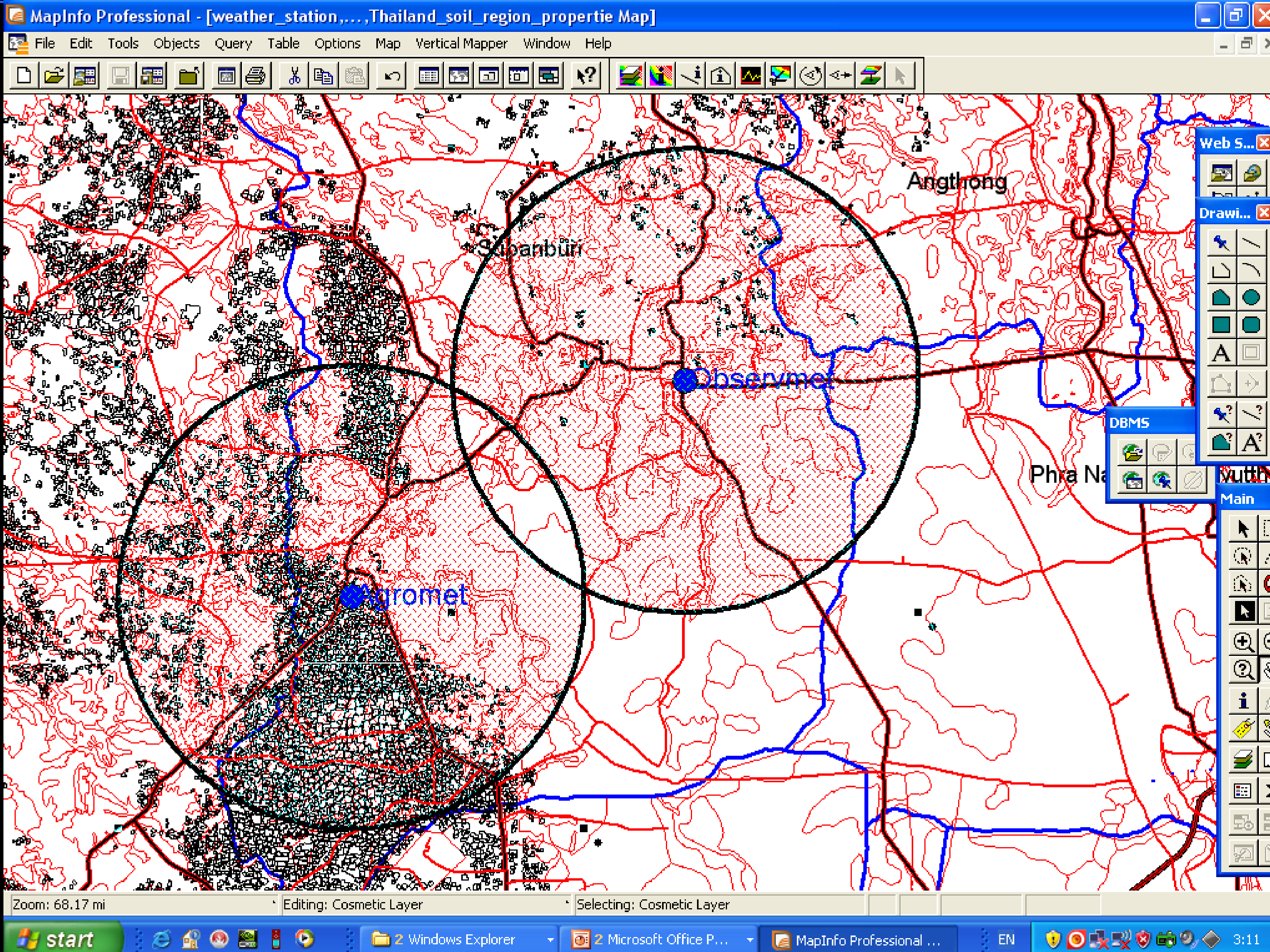
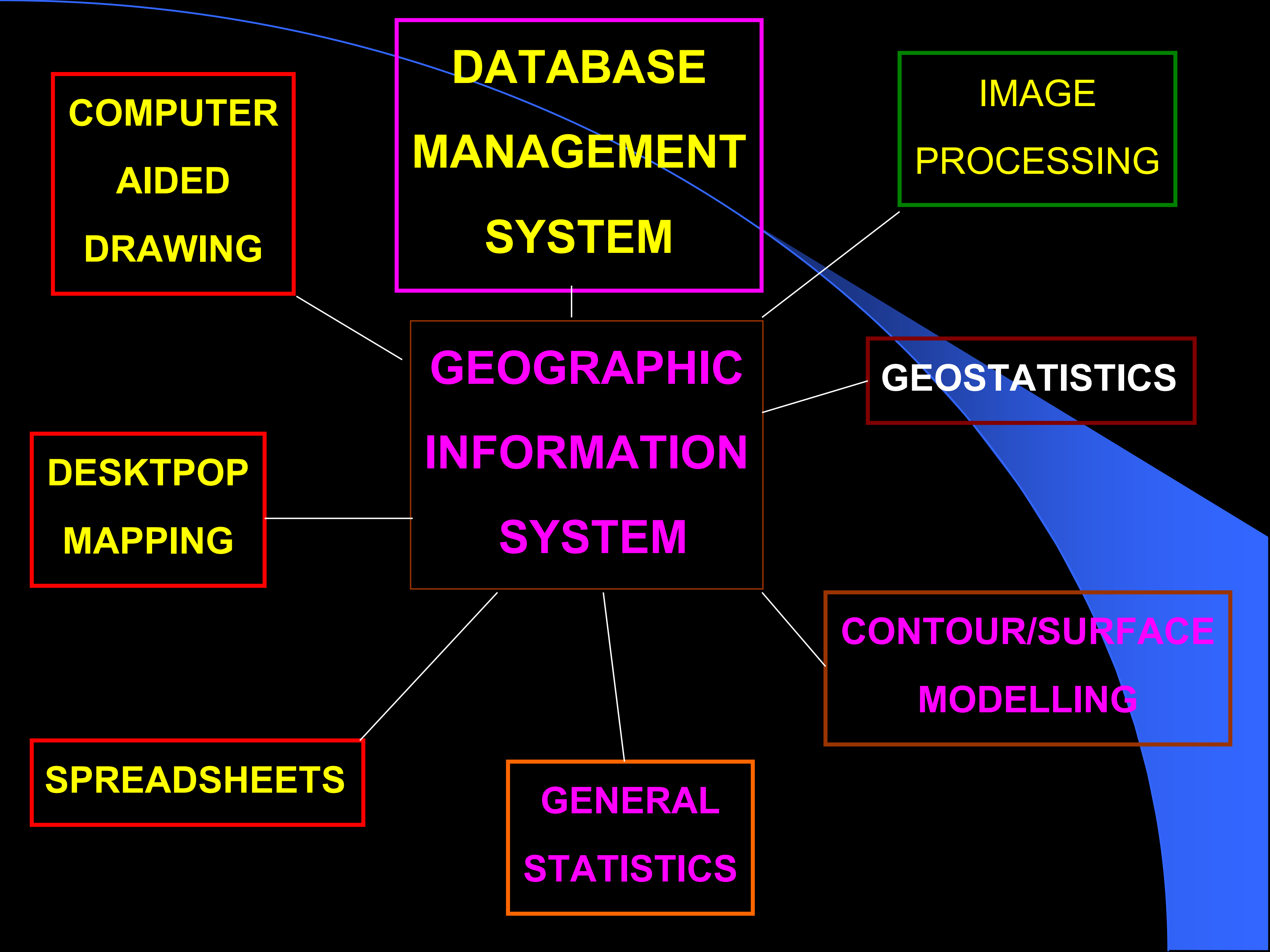
DBMS
Main
Zoom: 68.17 mi
Editing: Cosmetic Layer
Selecting: Cosmetic La
(2) Microsoft Office PowerPoint
start
2 Windows Explorer
2 Microsoft Office P...
MapInfo Professional ...
EN
3:10

Buffering



Networking analysis

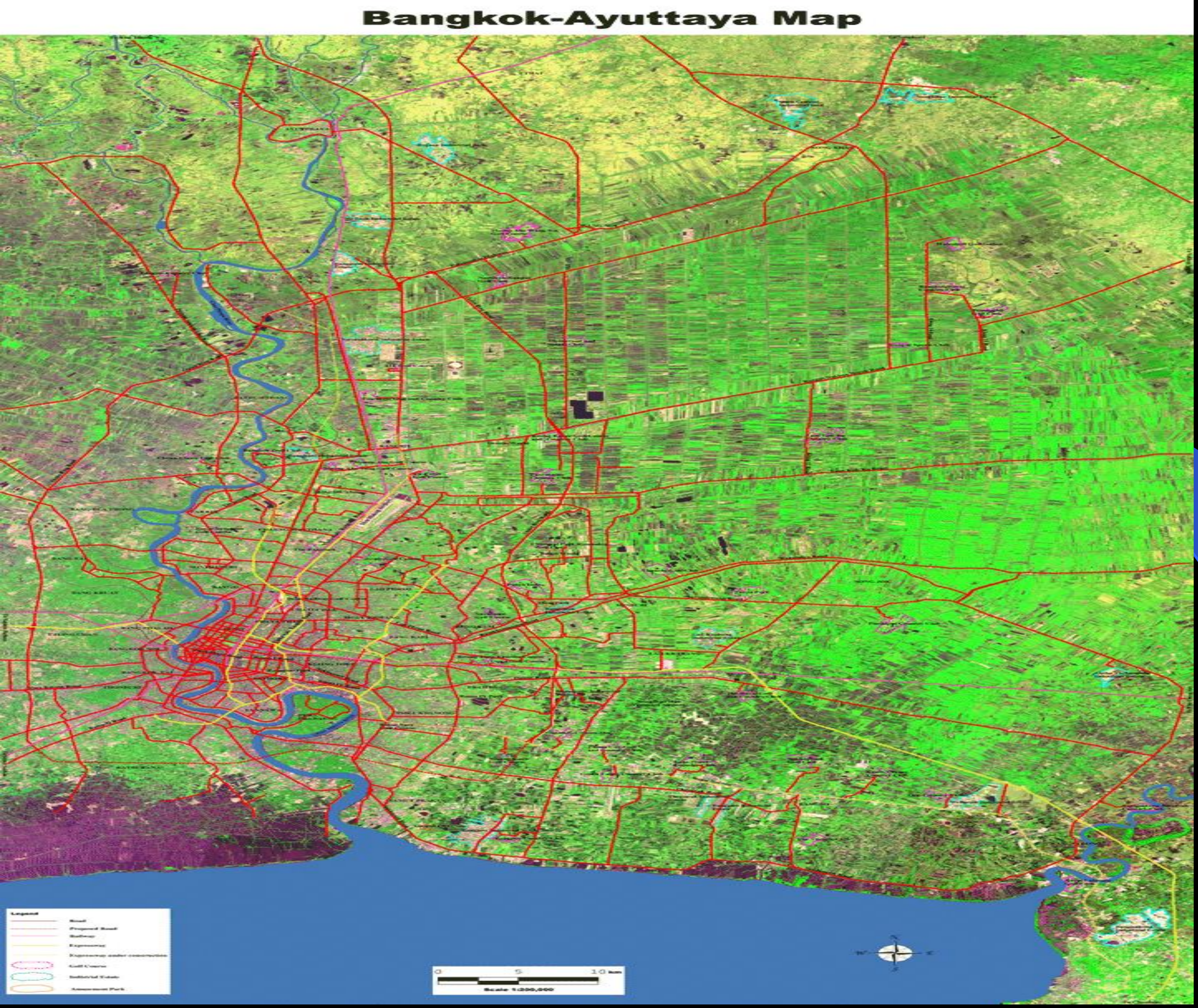

COMPUTER AIDED DRAWING
DATABASE MANAGEMENT SYSTEM
IMAGE PROCESSING
GEOGRAPHIC INFORMATION SYSTEM
GEOSTATISTICS
DESKTPOP MAPPING
CONTOUR/SURFACE MODELLING
SPREADSHEETS
GENERAL STATISTICS

How can users input data into GIS? Sources of data

- Satellite images (LO)
- Satellite data of many sensors (LA)
- Aerial photos (LO)
- Topographic Map (LA)
- GPS data and signals (LO)
- Attributes might be separately collected

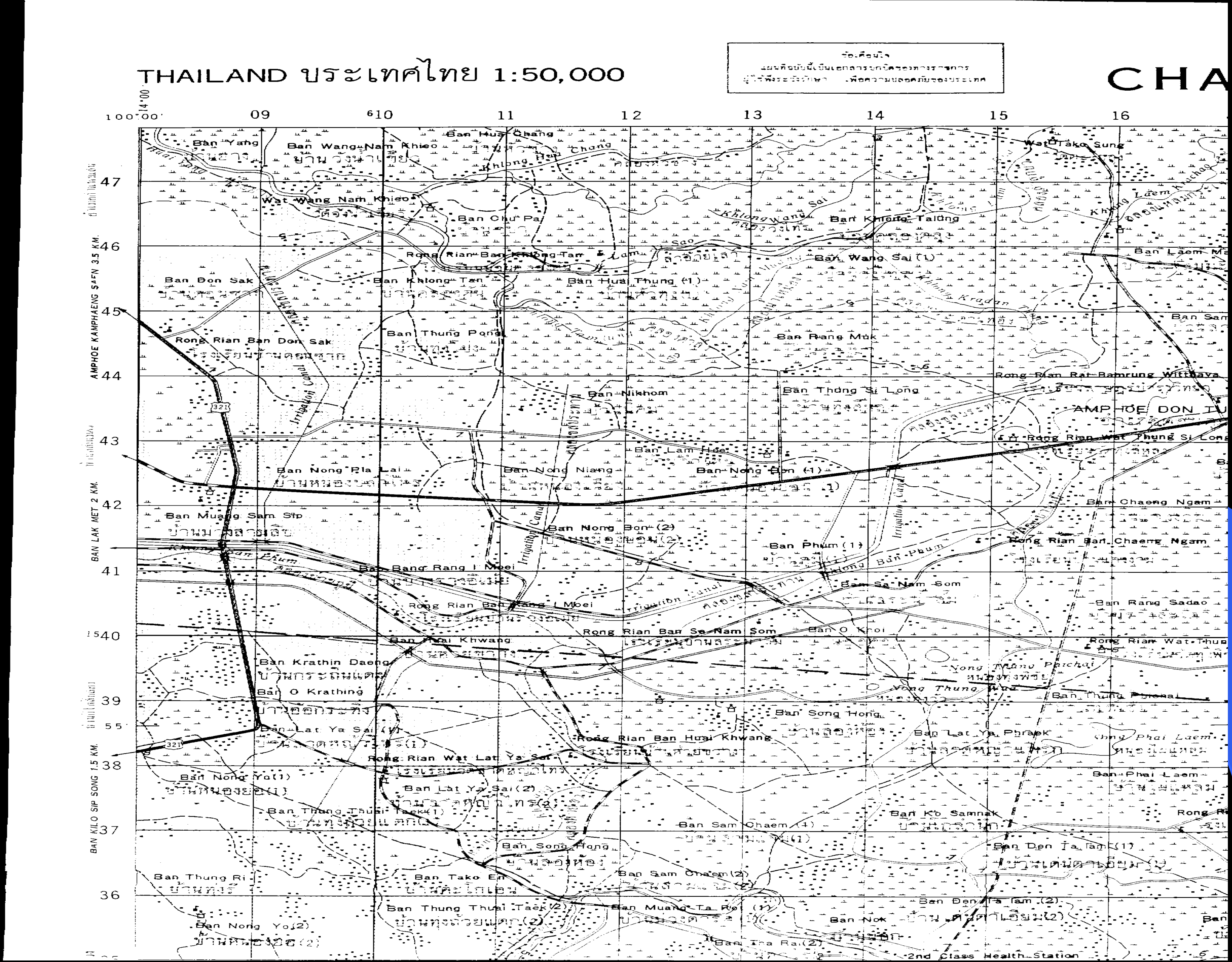
LO=location only

LA=location and attributes



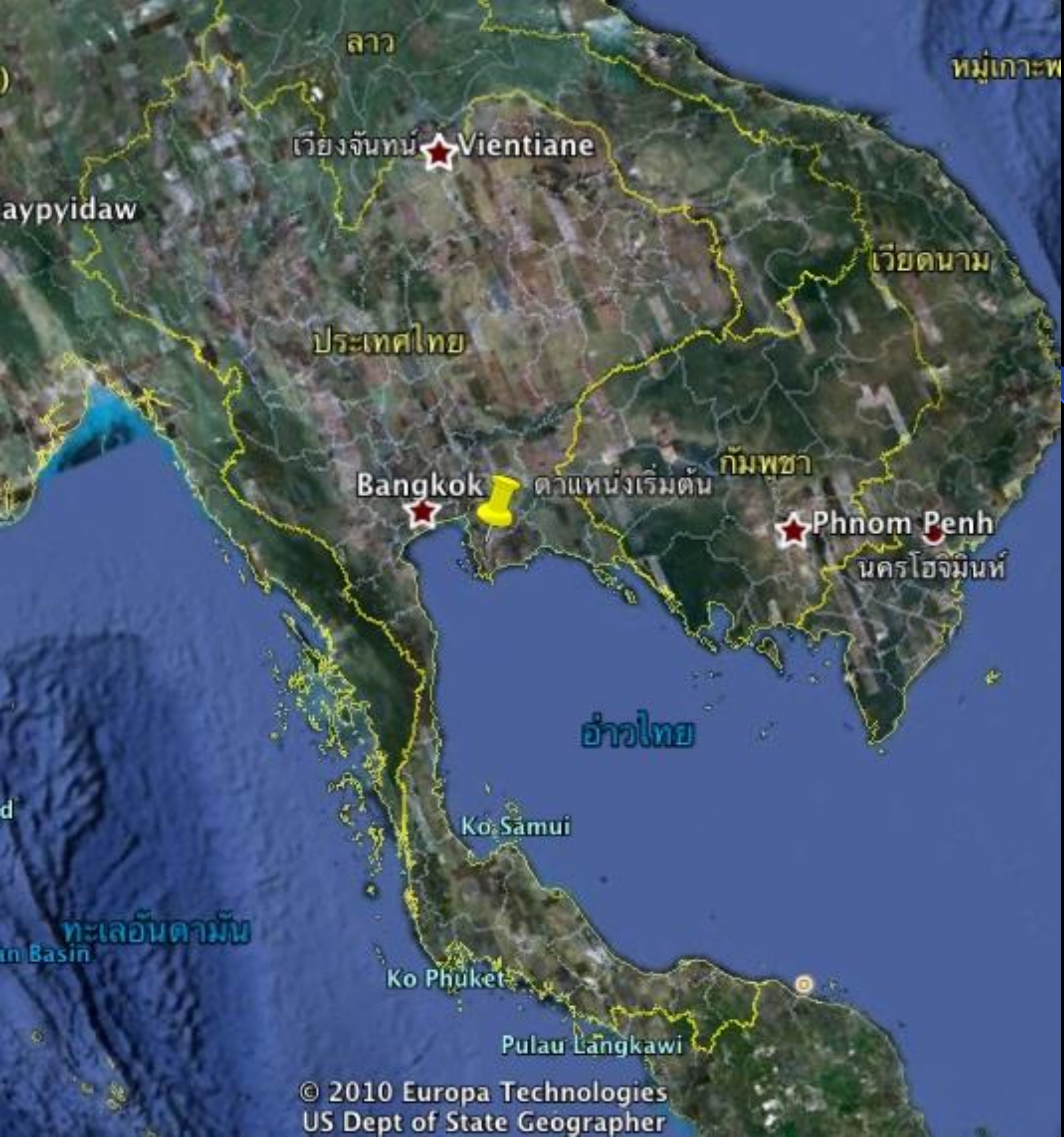
Satellite image and signals

Aerial photo

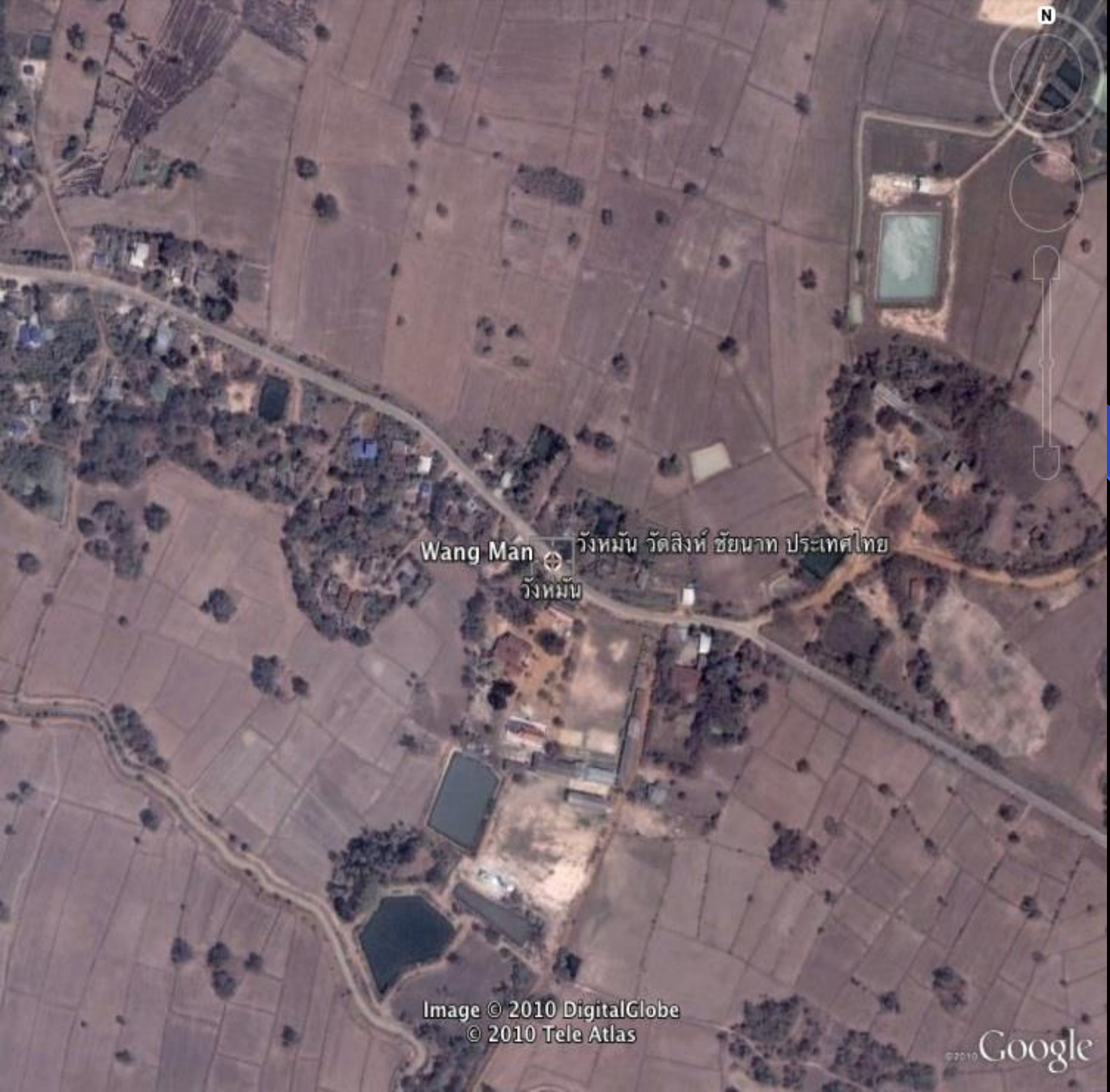


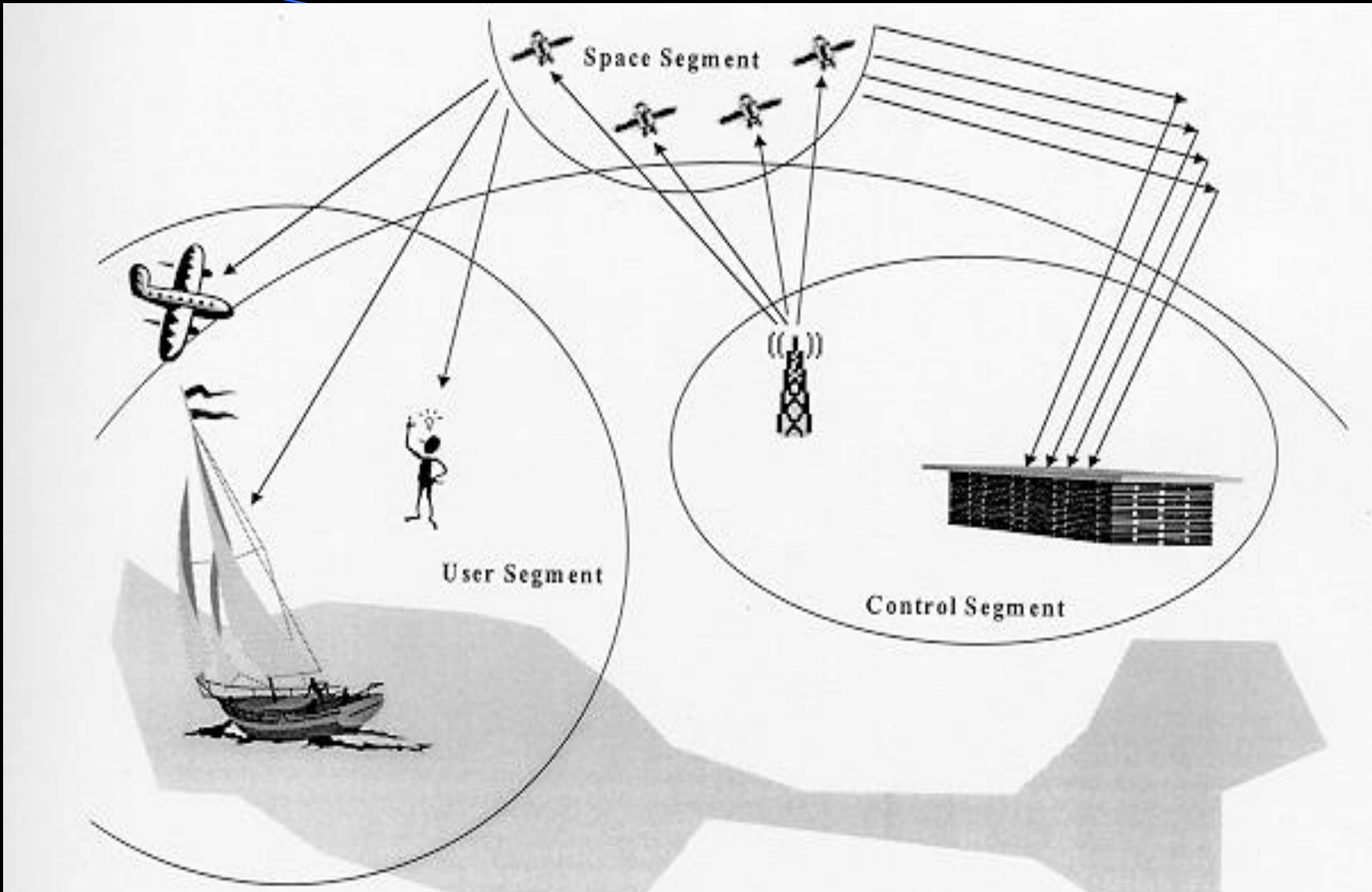
Portion of topographic map

Google Satellite images



Google Satellite image

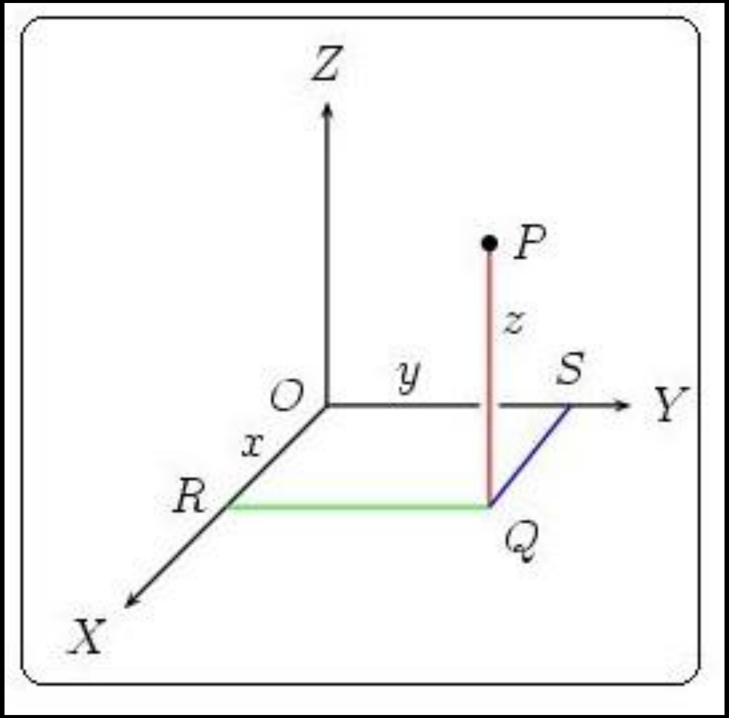




GPS system

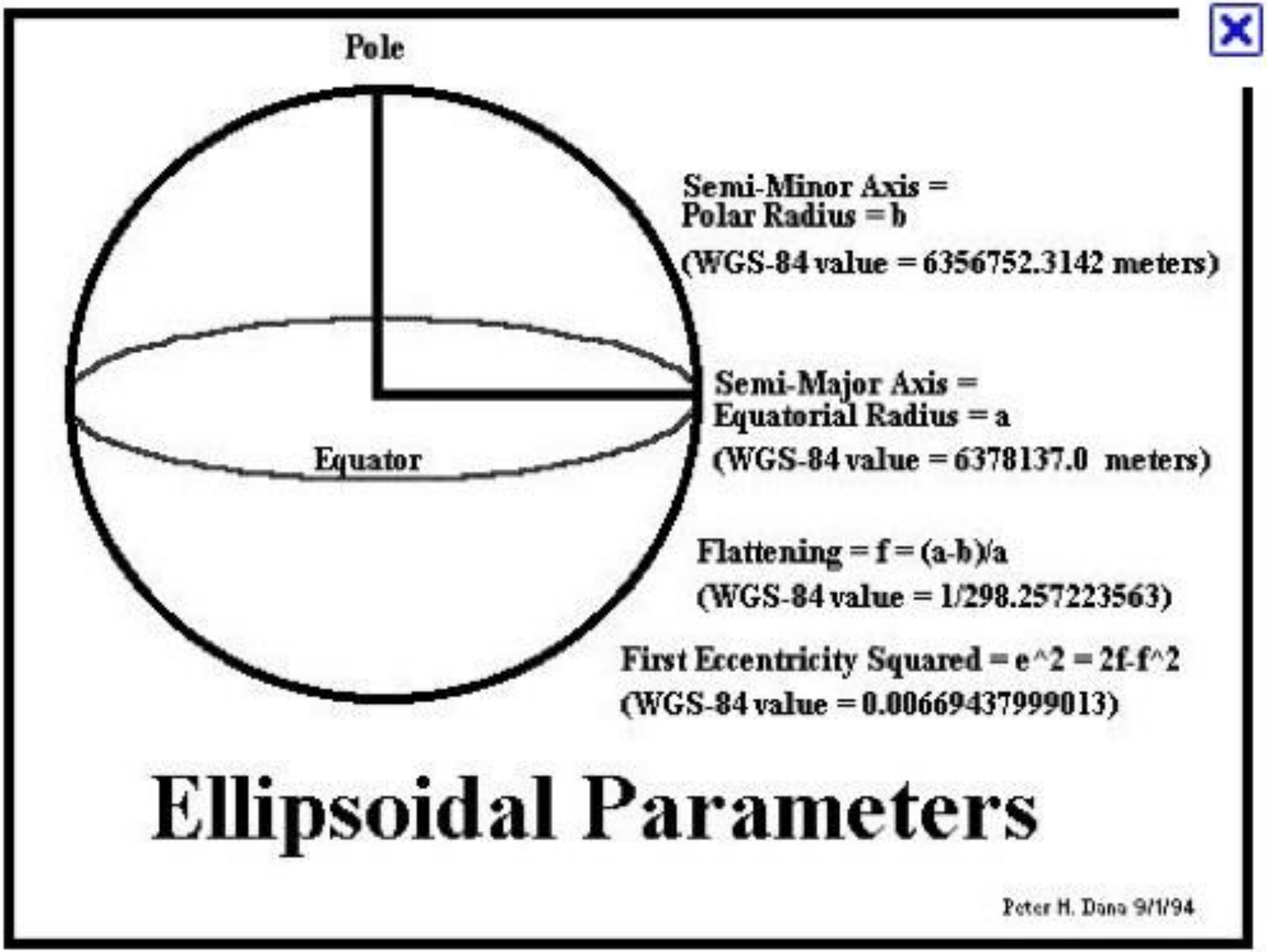

Southeast to I-95 S & 346a
STADIUM
Arrival
10:57
Menu
Turn in
4.0
GARMIN

All spatial data sources (positions) are created under the common co-ordinate system…
(or global coordinating system)



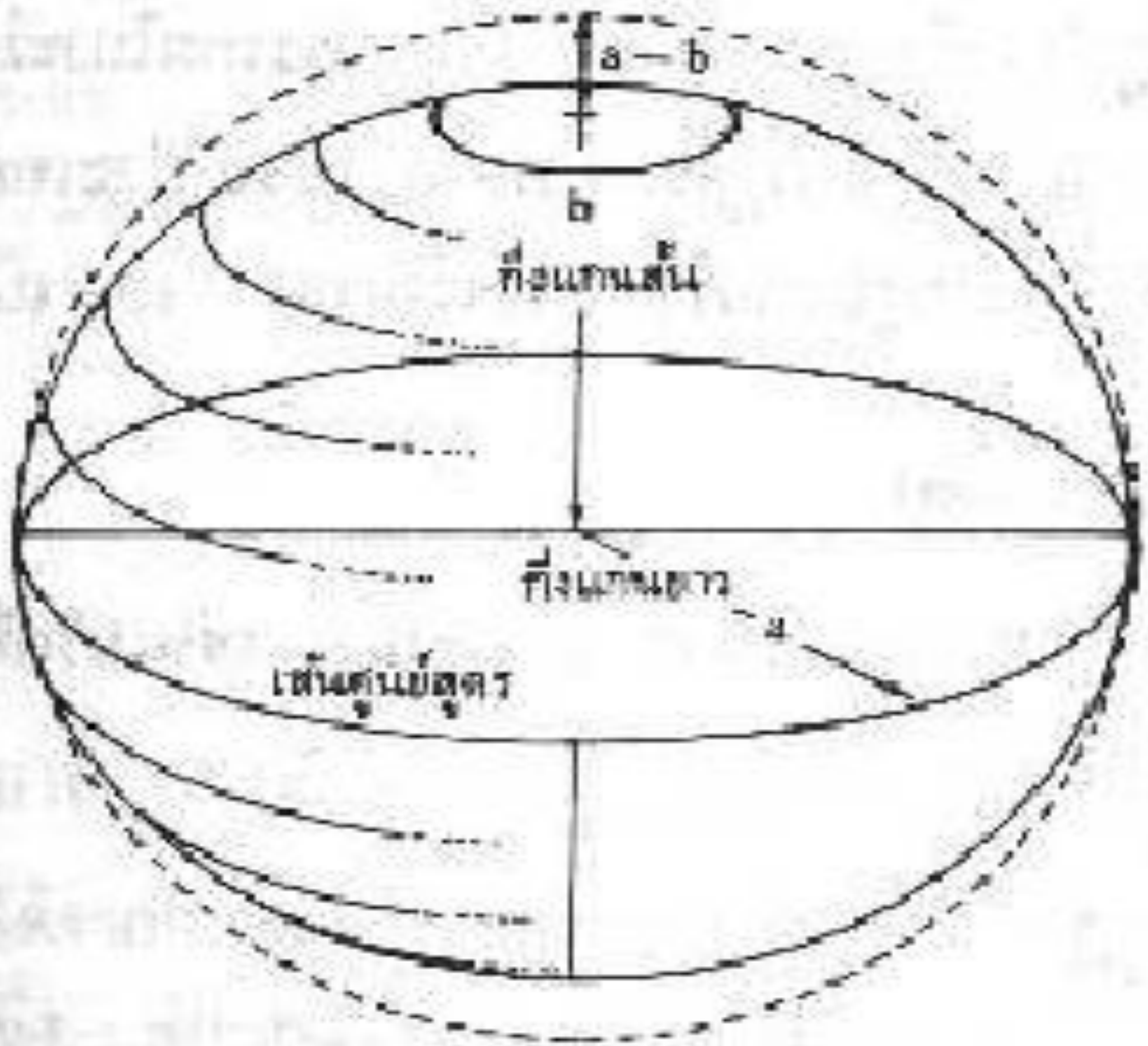
Global origin:
the same (0,0,0) of all spatial data, object P is relative to this (0,0,0)

The circumference of the earth is about 1/300th smaller around the poles, an oblate ellipsoid or spheroid, and is the three-dimensional shape obtained by rotating an ellipse about its shorter axis. An estimate of the earth's surface based on an ellipsoid provides a determination of the elevation of every point on the earth's surface, including sea level, and is often called a datum.


Pole
Semi-Minor Axis =
Polar Radius = b
(WGS-84 value = 6356752.3142 meters)
Semi-Major Axis =
Equatorial Radius = a
(WGS-84 value = 6378137.0 meters)
Equator
Flattening = f = (a-b)/a
(WGS-84 value = 1/298.257223563)
First Eccentricity Squared = e^2 = 2f-f^2
(WGS-84 value = 0.00669437999013)
Ellipsoidal Parameters
Peter H. Dana 9/1/94

Over time, and in different countries, many datums have been developed and used. recent datums are referenced from the center of the earth rather than a theoretical surface.

The resulting North American Datum of 1983 (NAD83)and the slightly refined World Geodetic System (WGS84), from the U.S. Military in 1984, are internationally accepted.



a=semi-major axis; b=semi-minor axis

Geo-referencing system comprises of

-**Datum**
-**Projection**
-**Coordinating system**

Datum

origin of the system and earth shape defined by a and $f=(a-b)/a$

Projection

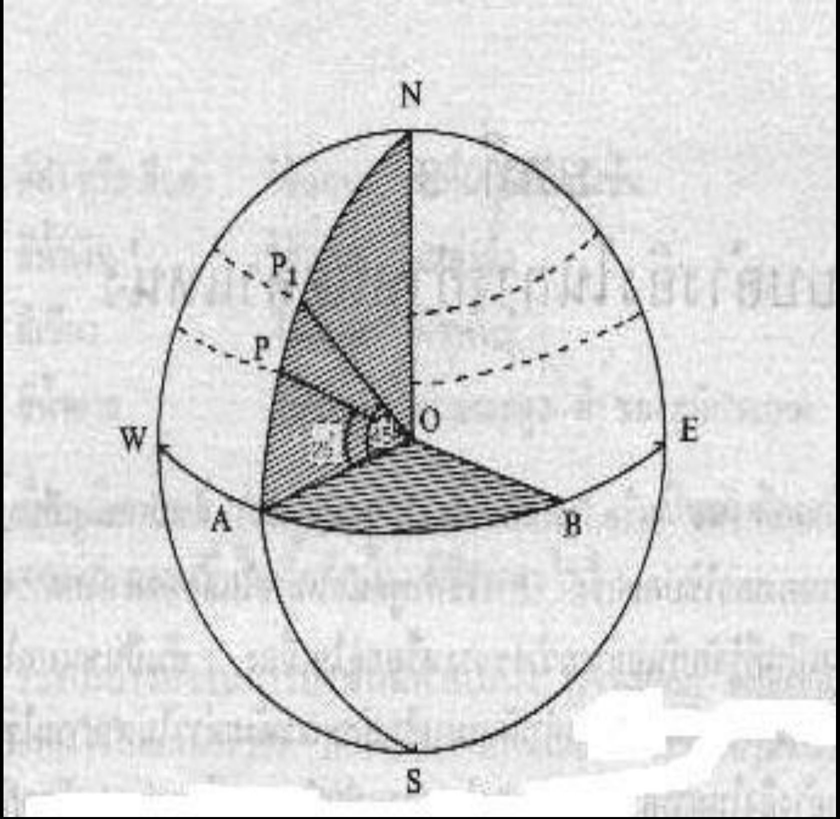
project latitude/longitude from a curve surface to a flat surface.

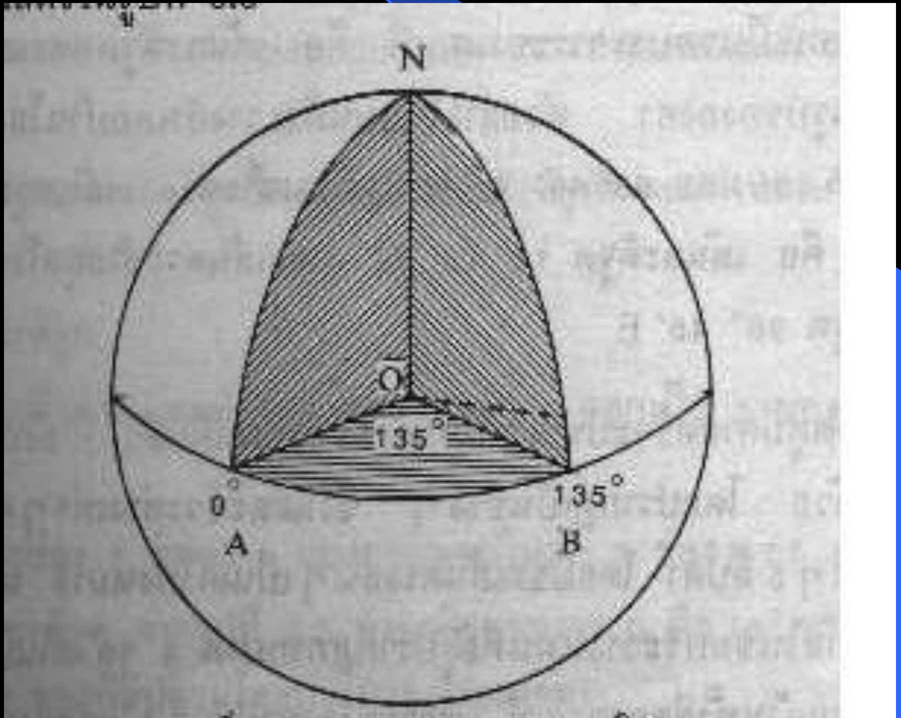
Coordinate system

specify coordinate system

Geographic Coordinates

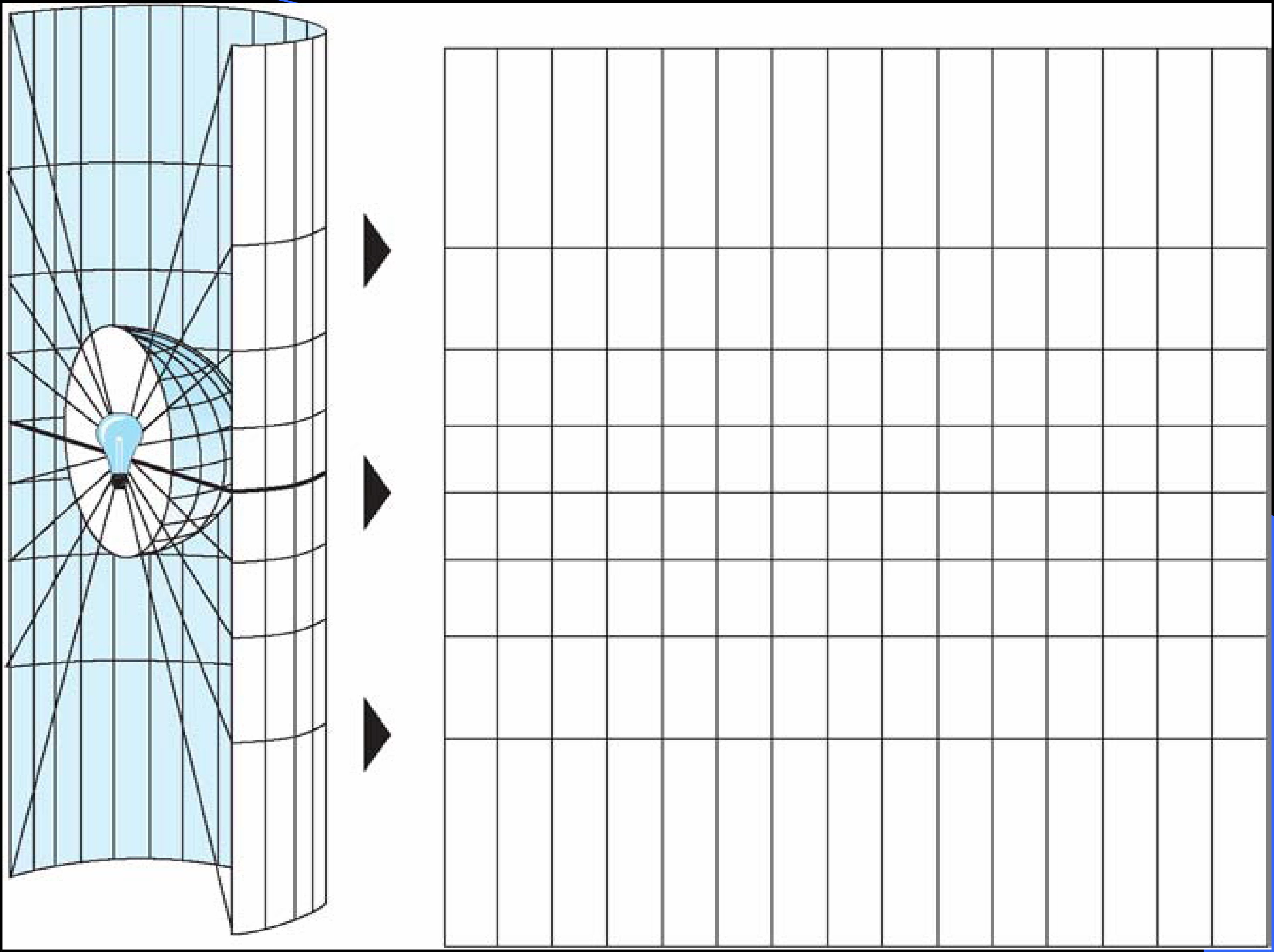
simply refers to the system of latitude and longitude.





รูปที่ 3.3 ความหมายของลองจิจูด

This coordinate system is formed by Creating a grid using the equator as 0 degrees and forming parallels of latitude to the north and south (90 degrees N is the North Pole, 90 degrees S is the South Pole), and meridians of longitude east and west (which meet at 180 degrees, commonly called the International Date Line) of the "Prime Meridian" which passes through Greenwich, England.

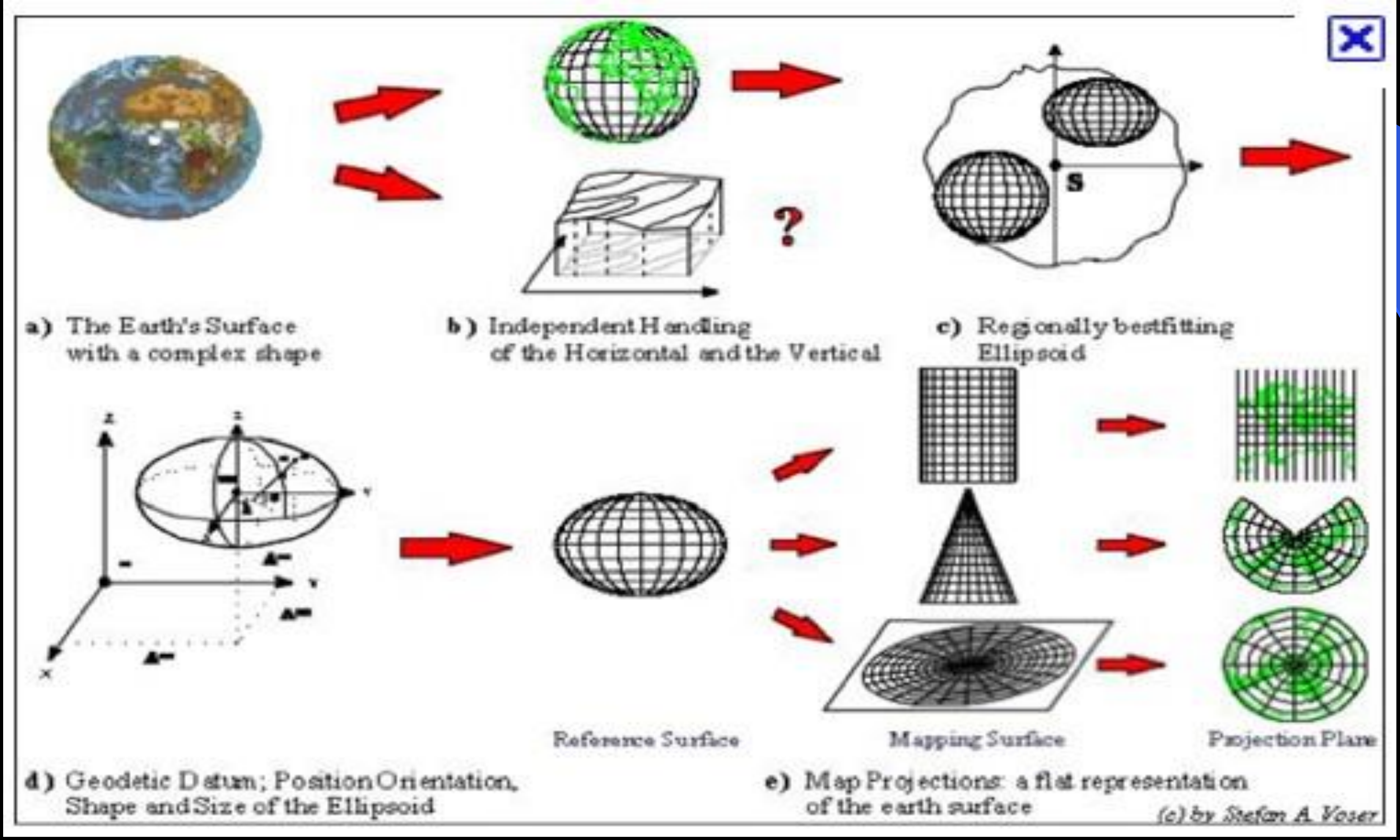


Map projections are used to transfer or “project” geographical coordinates onto a flat surface. Convert the geographic coordinates into an X and Y coordinate system is easiest, where x is longitude and y is latitude.

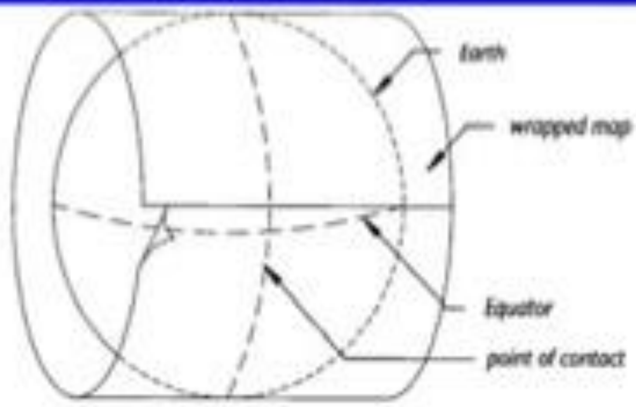
This is an example of “projecting” onto a plane.

Coordinates

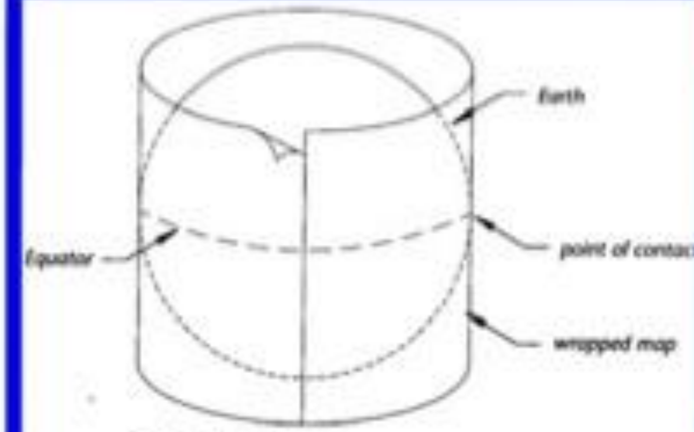
can also be "projected" onto two other flat surfaces, a cylinder or cone, and then unfolded into a map.



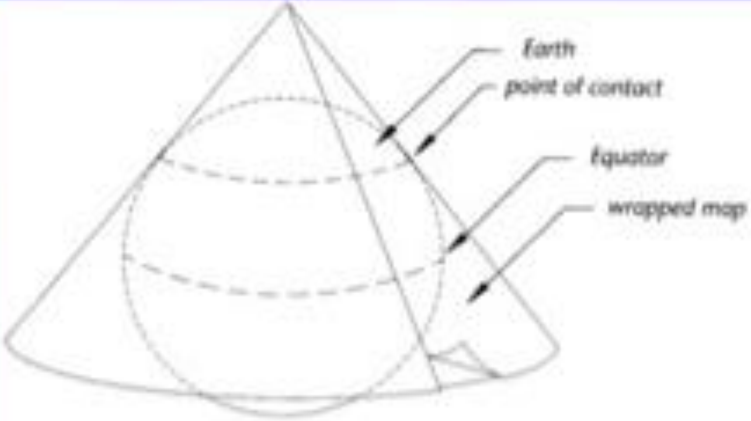
Map Projections



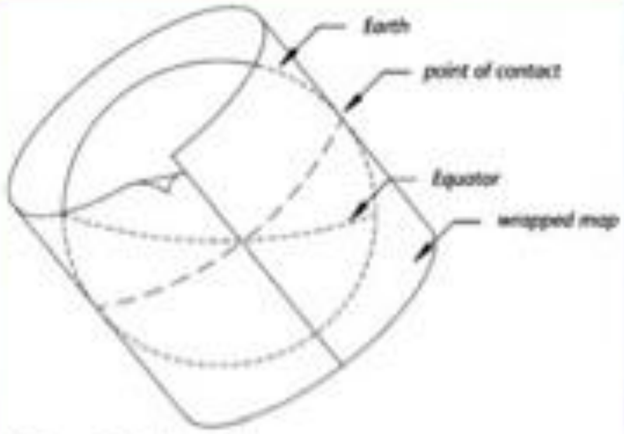
Transverse cylindrical projection



Cylindrical projection



Conic projection



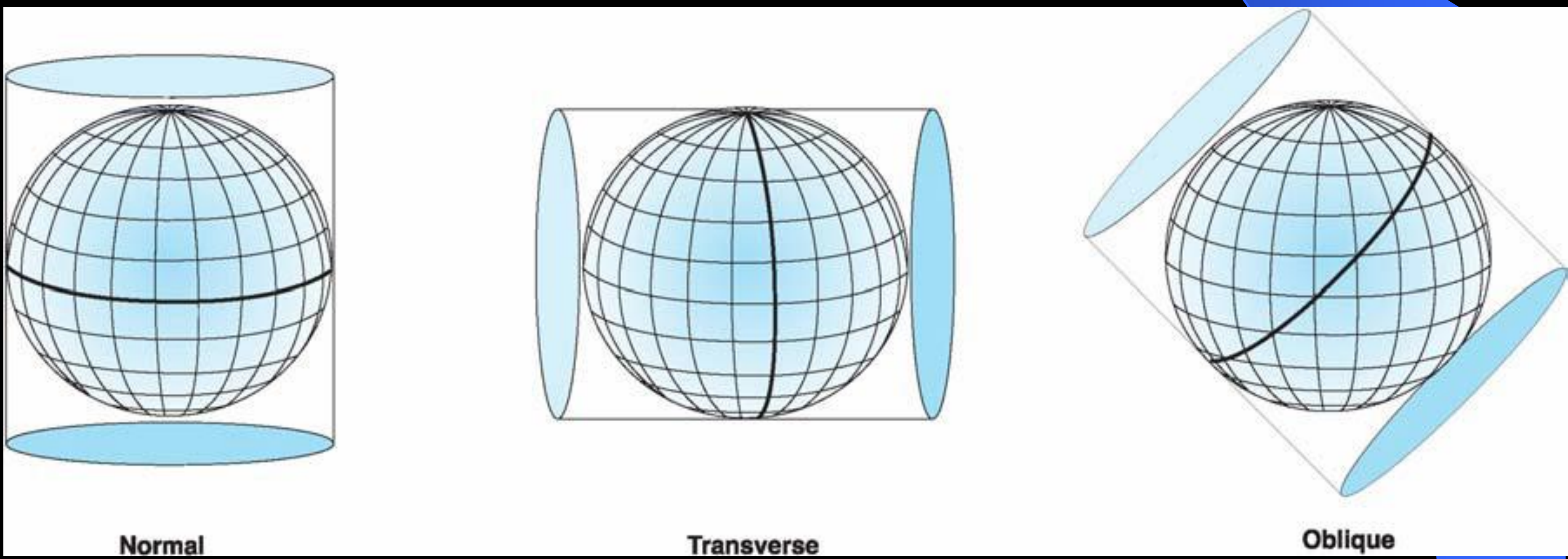
Oblique cylindrical projection

There are thousands of different map projections all depending on how they intersect earth's surface and how they are oriented. For example, the line of latitude or longitude where a projection intersects or "cuts" the earth's surface is called the point of contact, or standard line, where distortion is minimized. Orientations of the three shapes can also vary between equatorial (standard lines of latitude), transverse (standard lines of longitude), and oblique (standard line other than latitude or longitude). Each projection effects the distance, area, and angle relationships of the earth surface as portrayed on the map.

Called Map distortion.

An azimuthal or planar projection is usually tangent to a specific point on earth's surface, but may also be secant. This point, or focus, may be a pole, the equator, or other oblique point. Normally though, the azimuthal projection is used for polar charts due to distortion at other latitudes.

A cylindrical projection usually places the earth inside a cylinder with the equator tangent or secant to the inside of the cylinder. If the cylinder is placed perpendicular to the axis of the earth, the resulting projection is called a transverse projection.


Normal
Transverse
Oblique

In a conic projection, a cone is placed over the earth, normally tangent to one or more lines of latitude.
This tangent line is called a standard parallel and, in general, distortion increases the further away you get from this line. A conic projection works best over mid latitudes for this reason.

Mathematical map projections are not based on developable surface, but often specify a direct mathematical Projection from a spheroid onto a flat surface. These types of map projections can change for different parts or regions of the world in order to reduce certain distortions. They can also be formed by merging other projections in order to get the “best” of each.

Distance, area, and shape:

Equal area projections preserve the property of area. On an equivalent projection all parts of the earth's surface are shown with the correct area. However, latitudinal distances are never accurate.

Conformal projections

preserve right angles between lines of latitude and longitude and are primarily used because they preserve direction. Area is always distorted on conformal maps. Because of GIS's emphasis on cartographic shapes, GIS systems often use conformal projections.

Some projections

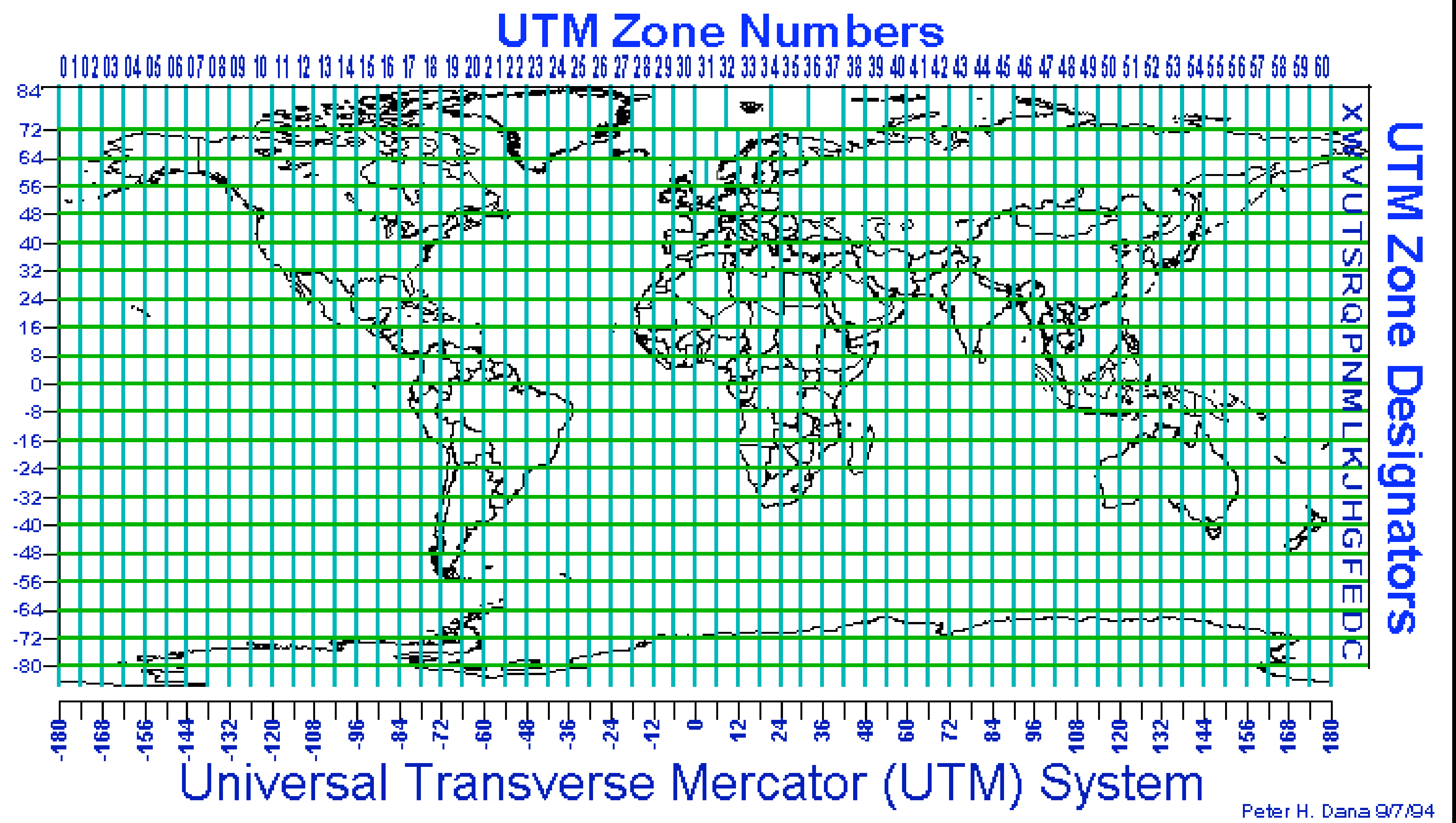
only preserve correct distance relationships along a few lines on the map. For example, an Equidistant azimuthal projection has the distance to the outside of the map portrayed correctly. These are seldom used in GIS.

A final category is compromise maps. They may be the average of two or more projections or interrupted or broken in order to minimize certain distortions.

Coordinate Systems

traditional coordinate systems are based on a flat coordinate system. They are almost always a positive quadrant coordinate system, and are easier to develop and use over a small area. Recently, with improvements in computer processing capabilities, GIS and GPS systems are migrating toward using the spherical coordinate system of longitude and latitude.

- Universal Transverse Mercator (UTM)
  - The UTM coordinate system is commonly used in GIS for larger scale areas within a certain UTM zone.
- UTM divides the earth into pole-to-pole zones 6 degrees of longitude wide.
  - The first zone starts at the International Date Line (180 degrees east) and the last zone, 60, starts at 174 degrees east.



UTM Zone Numbers
UTM Zone Designators
X W V U T S R Q P N M L K J H G F E D C
Universal Transverse Mercator (UTM) System
Peter H. Dana 9/7/94

Each zone have two origins applied to either the North or South side of equator. Every zones apply the same values of origin.

North side of equator:

Northing = 0 m

Easting = 500,000 m

South side of equator

Northing = 10,000,000 m

Easting = 500,000 m

Caution: If your country has such
a large area covering more
than one zone.
You have to decide which zone is
To be used.

Thailand area covers Zone N47 & N48
Normally, we use N47 Zone as default.

All GIS systems must be capable of converting projections and converting coordinates. This involves a lot of Computer programming and computational power. At a minimum, a GIS must be able to convert digitized coordinates to latitude and longitude and re-project them on to a flat surface.

Selecting the proper projection

In order to select the correct projection to use, we must analyze the object of the project.

A projection should be selected which has a standard line which is centered on the area of focus.

You must also determine if correct depiction of area, angle relationships, or distance accuracy is important. Distance may be especially difficult if correct depiction is required over a large area.

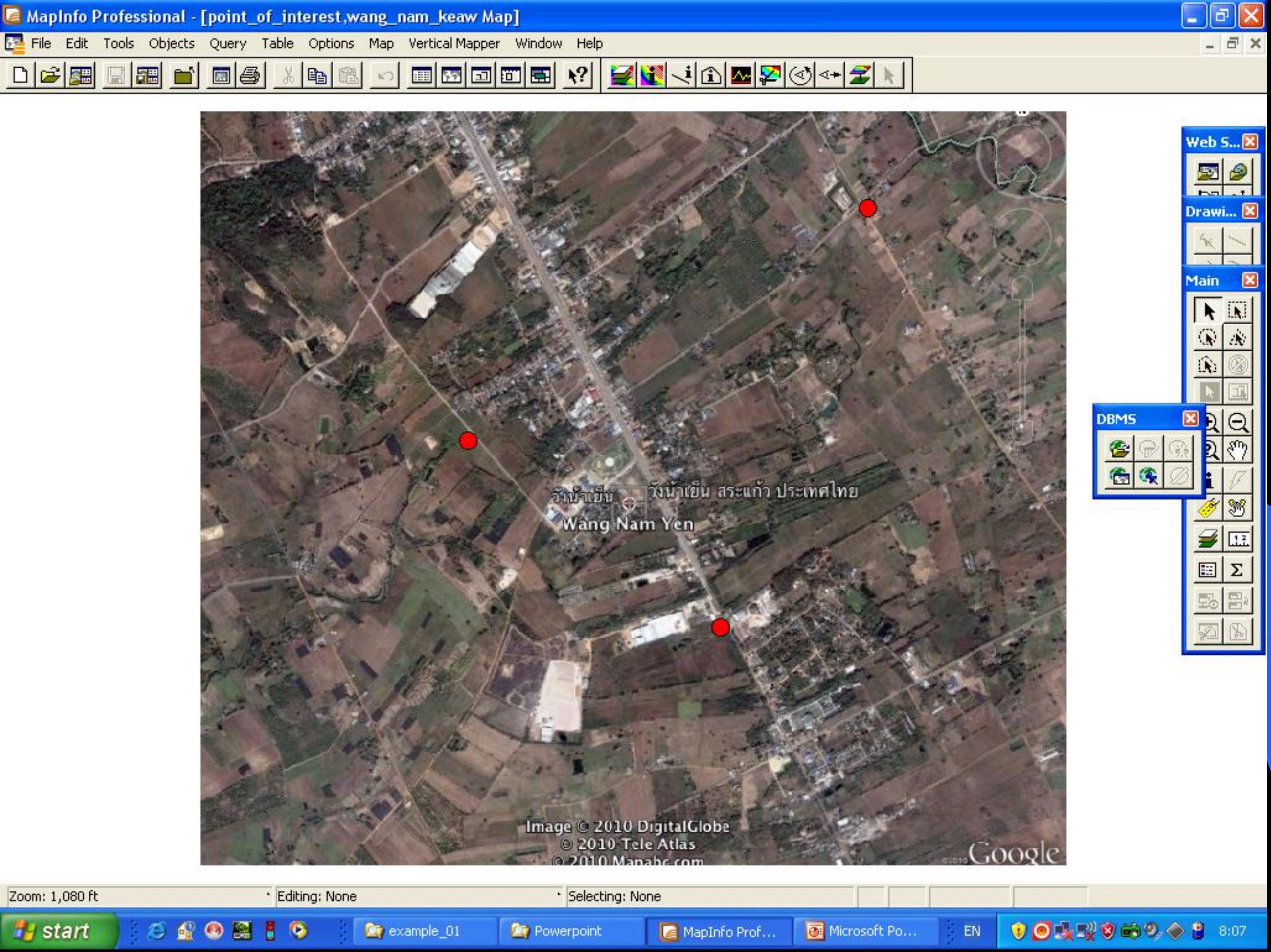
Global use of Geo-referencing system

Datum --- geo-centroid
Projection --- WGS 84
Coordinate system
--- UTM, lat/long

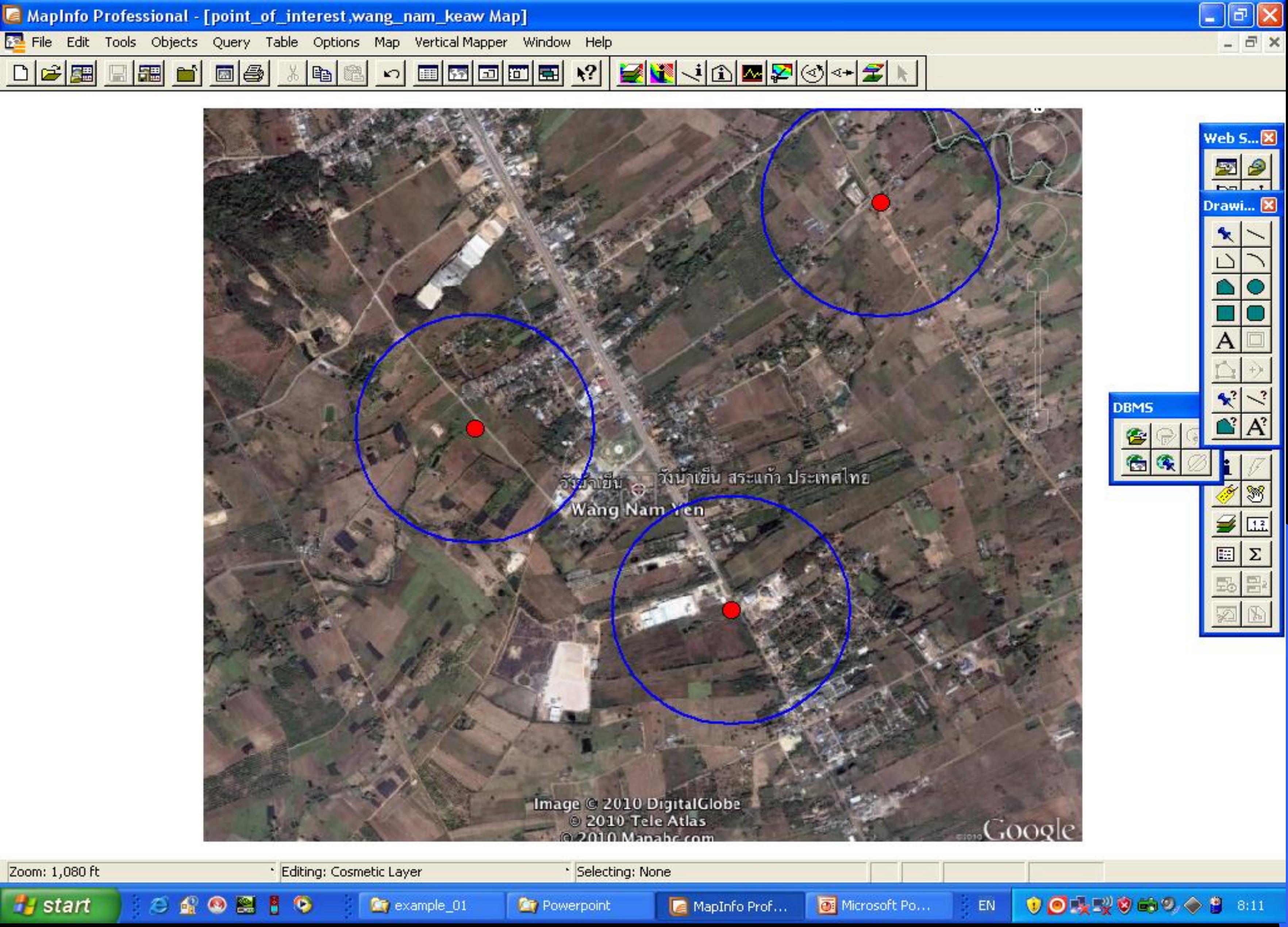
Caution: known datum, projection
uses of digital maps.

What can GIS do?

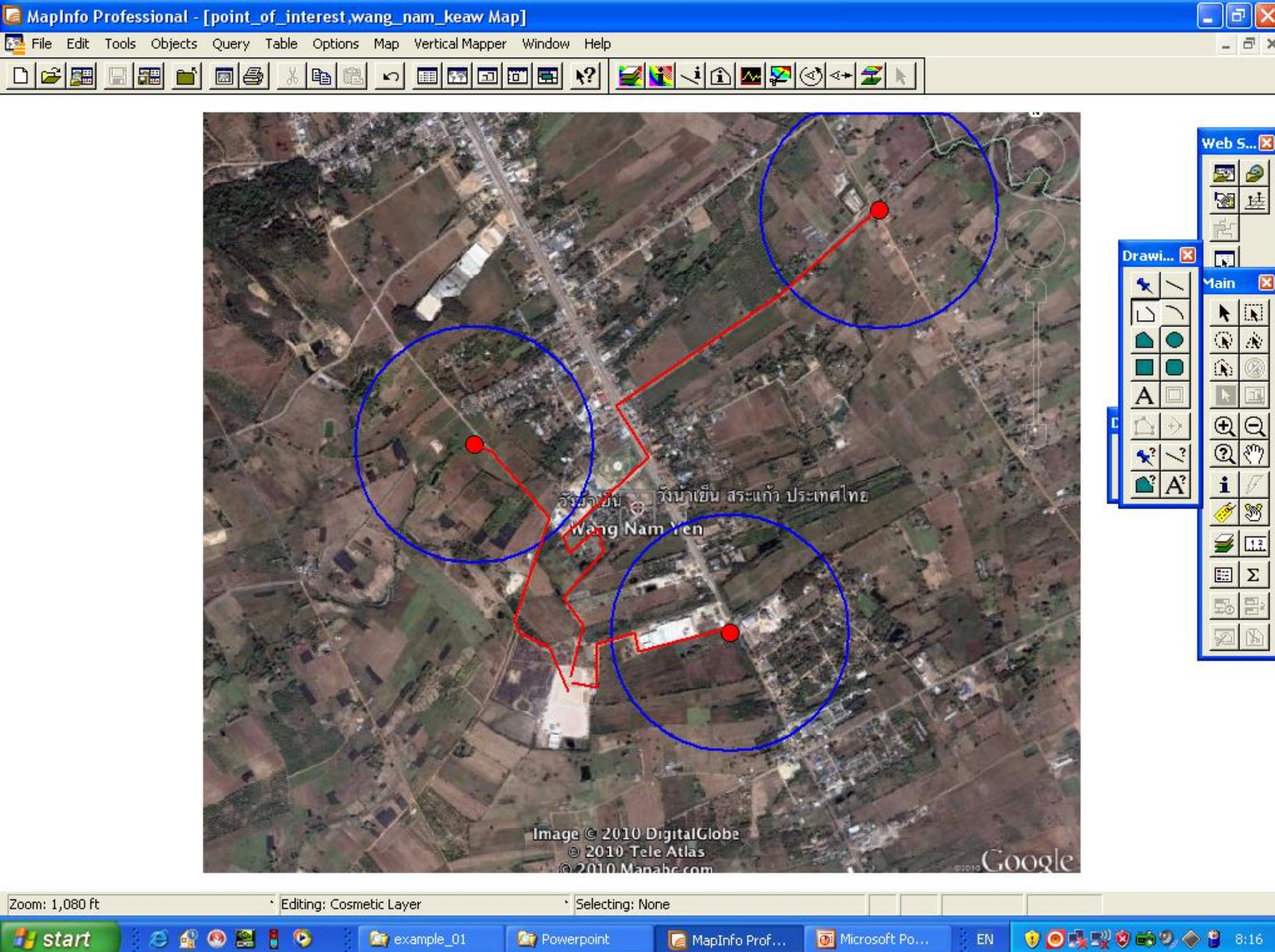
- Depict object spatially as map-like
- Tools to process data-- simple,
  complex
- Statistically summary of data
- it is decision support tools
- assist the planning process



Which point is suitable for point of vegetable purchasing?



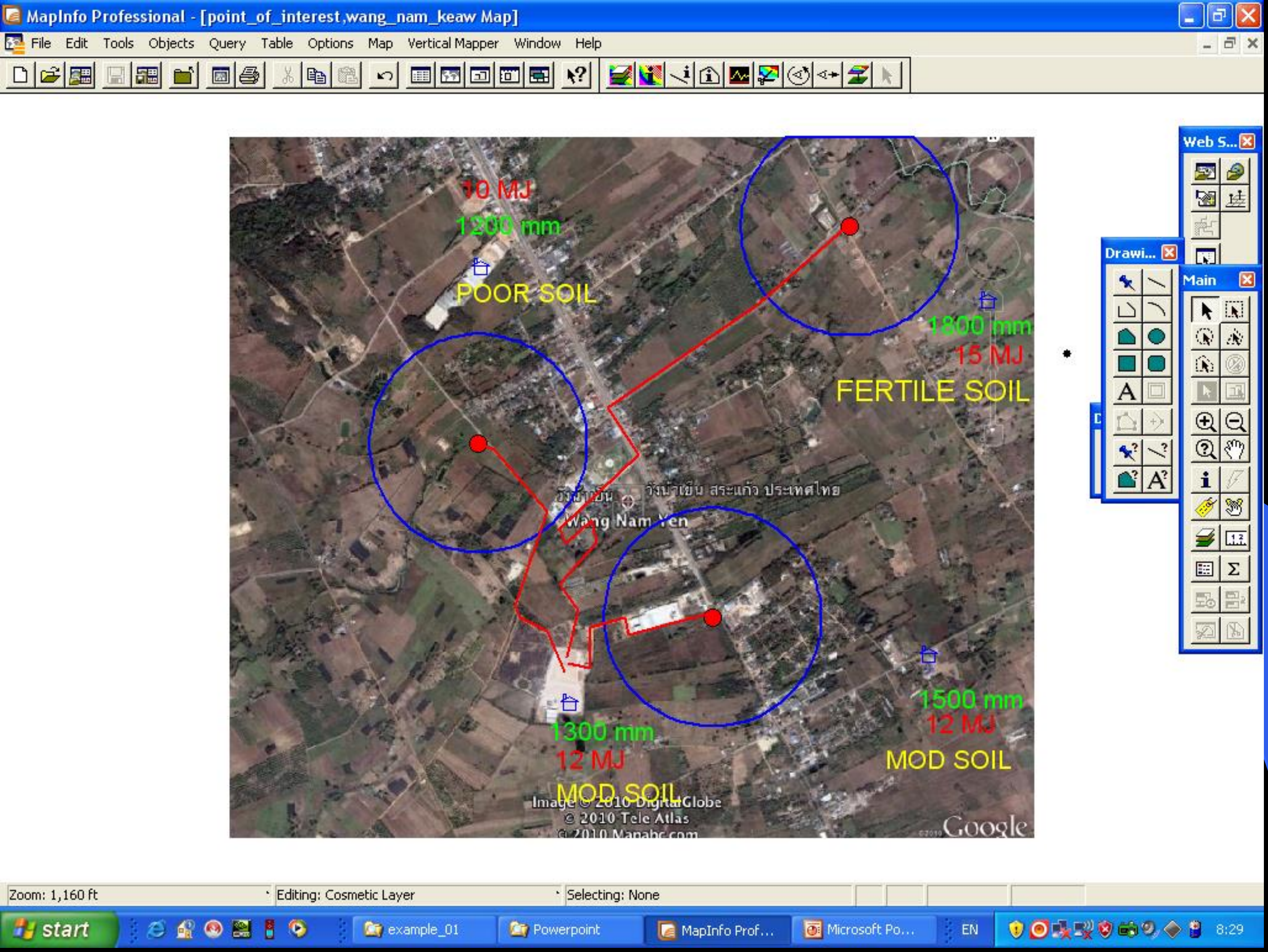
Use buffers to bound around points of interest. Then compute vegetable areas. Draw a continuous line from point to the factory.



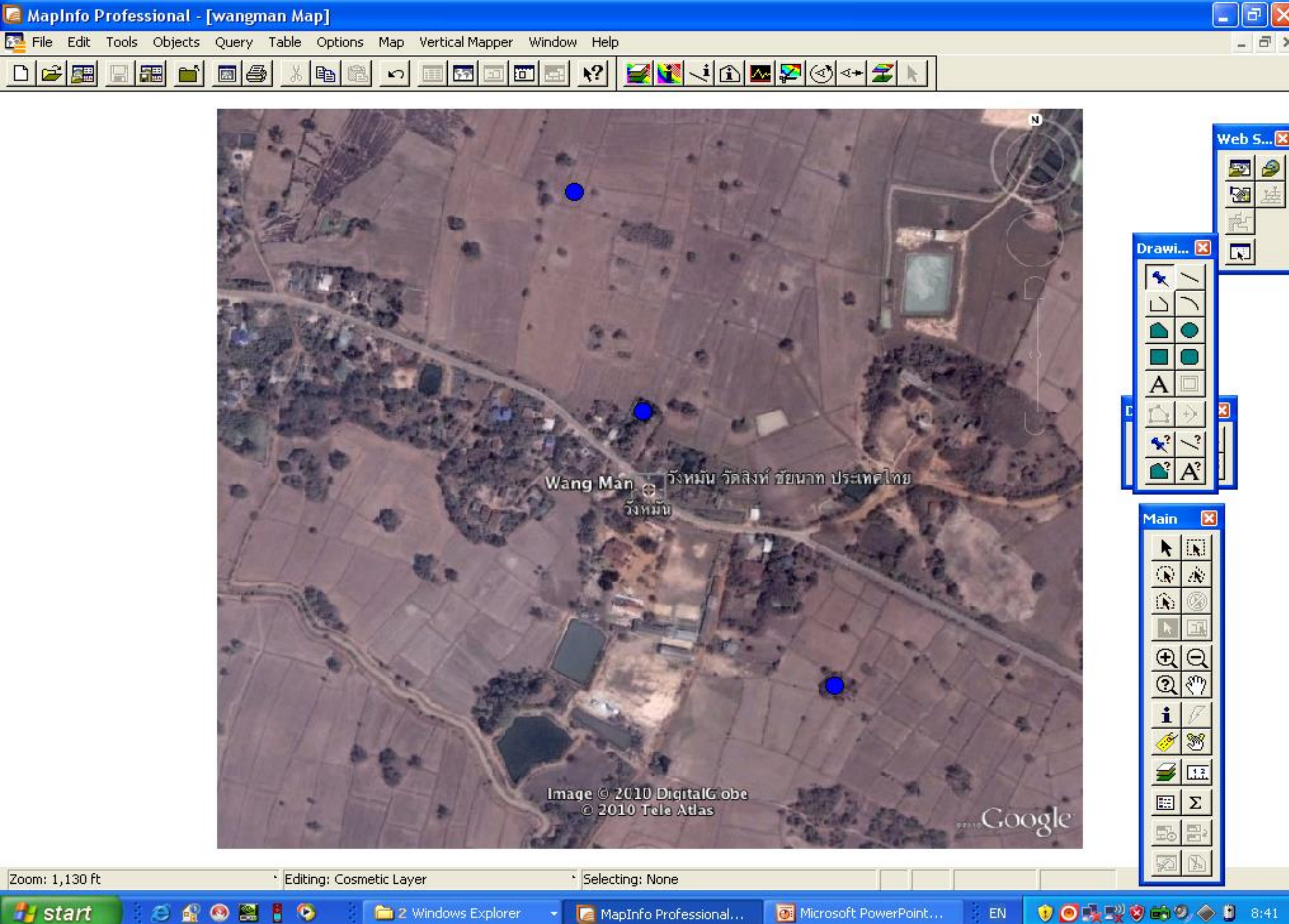
Sum distances along street network. Choose a point.

Large vegetable areas might not be suitable, since vegetable yield is preferred.

Vegetable yield Model is applied.
The model require
- soil
- water availability
- light quantum



Interpolate required data use existing data



Blue points represent 3 original bean-production plots. after their harvesting, collector will tag bean package with location of original (lat/long). Bar-Code application.