UNIVERSITAS GADJAH MADA

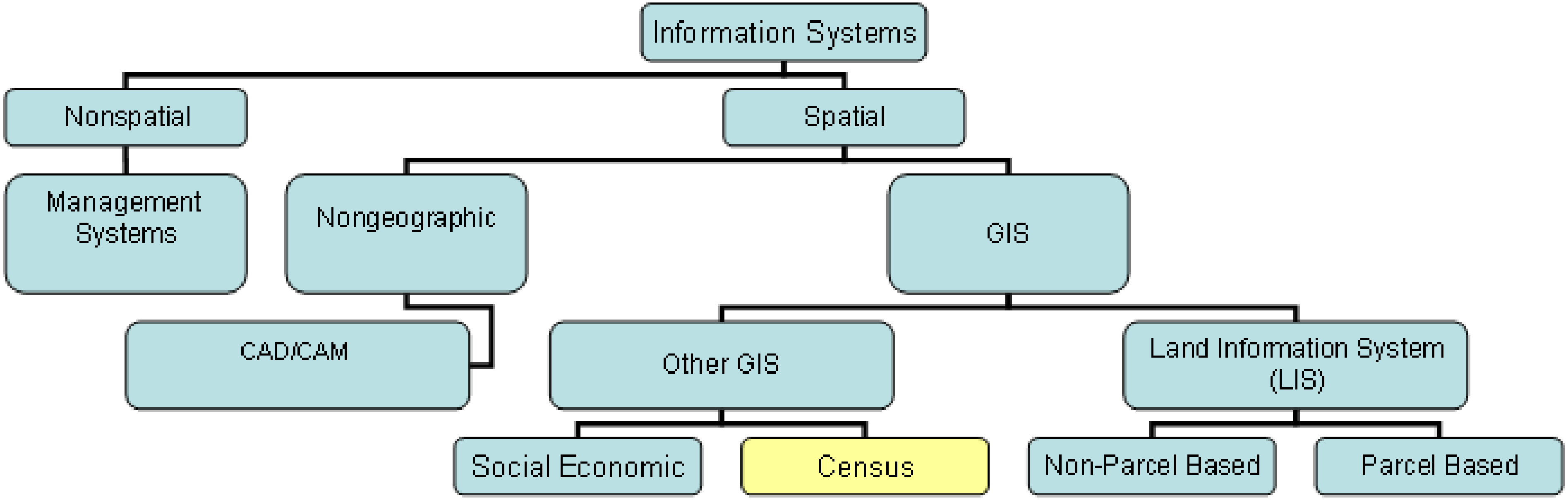
Model dan Struktur Data Spasial

Sistem Informasi Geografis

Ibnu Rosyadi

Spasial vs Geospasial?

Taxonomy of Information Systems (De Mers, 1997)

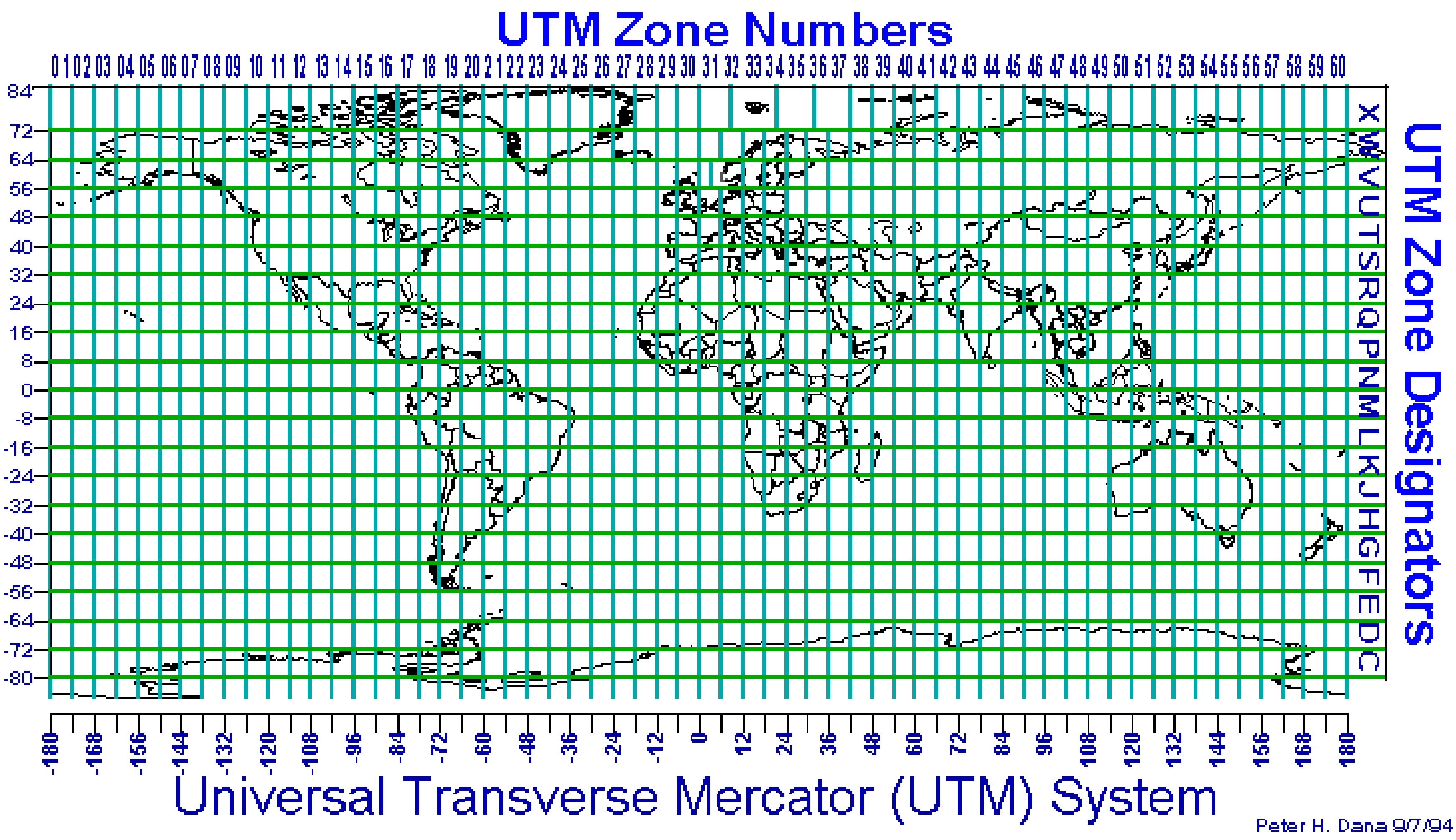


UU Nomor 4 Tahun 2011 Tentang INFORMASI GEOSPASIAL Pasal 1:

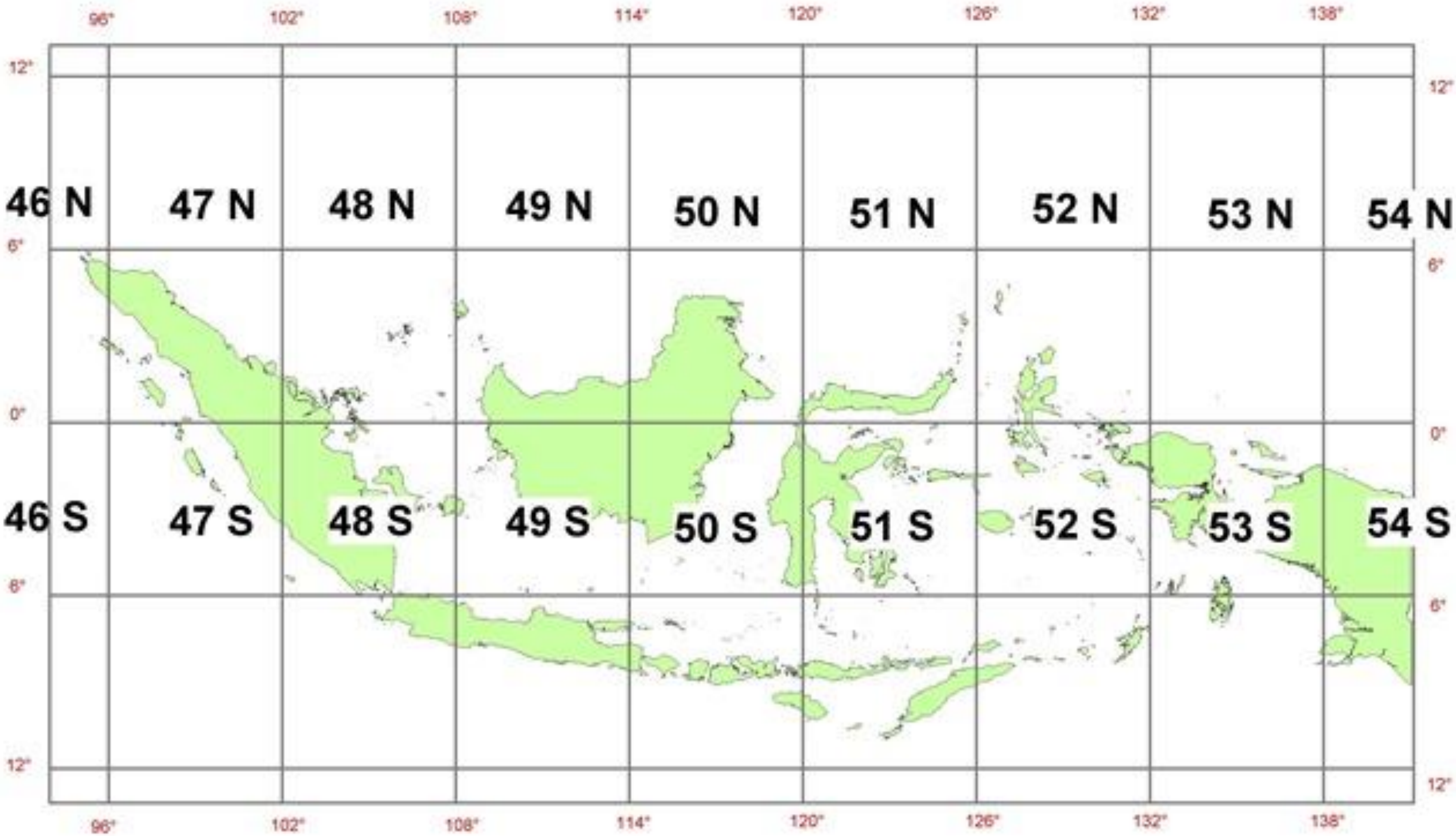
1. Spasial adalah aspek keruangan suatu objek atau kejadian yang mencakup lokasi, letak, dan posisinya.
2. Geospasial atau ruang kebumian adalah aspek keruangan yang menunjukkan lokasi, letak, dan posisi suatu objek atau kejadian yang berada di bawah, pada, atau di atas permukaan bumi yang dinyatakan dalam sistem koordinat tertentu.
3. Data Geospasial yang selanjutnya disingkat DG adalah data tentang lokasi geografis, dimensi atau ukuran, dan/atau karakteristik objek alam dan/atau buatan manusia yang berada di bawah, pada, atau di atas permukaan bumi.
4. Informasi Geospasial yang selanjutnya disingkat IG adalah DG yang sudah diolah sehingga dapat digunakan sebagai alat bantu dalam perumusan kebijakan, pengambilan keputusan, dan/atau pelaksanaan kegiatan yang berhubungan dengan ruang kebumian.

Spatial Database Systems: Design, Implementation and Project Management
(Brent G. Hall & Albert K. W. Yeung, 2007)

- Data spasial adalah data yang dapat ditampilkan, dimanipulasi dan dianalisis dengan sarana atribut spasial yang menunjukkan lokasi pada atau di dekat permukaan bumi
- Data spasial mempunyai dua sifat penting:
  - Bereferensi pada *geographic space,* yang berarti datanya terdaftar pada sistem koordinat bumi, sehingga data dari sumber yang berbeda bisa *cross-referenced* dan *integrated spatially*.
  - Direpresentasikan dalam berbagai skala geografis.

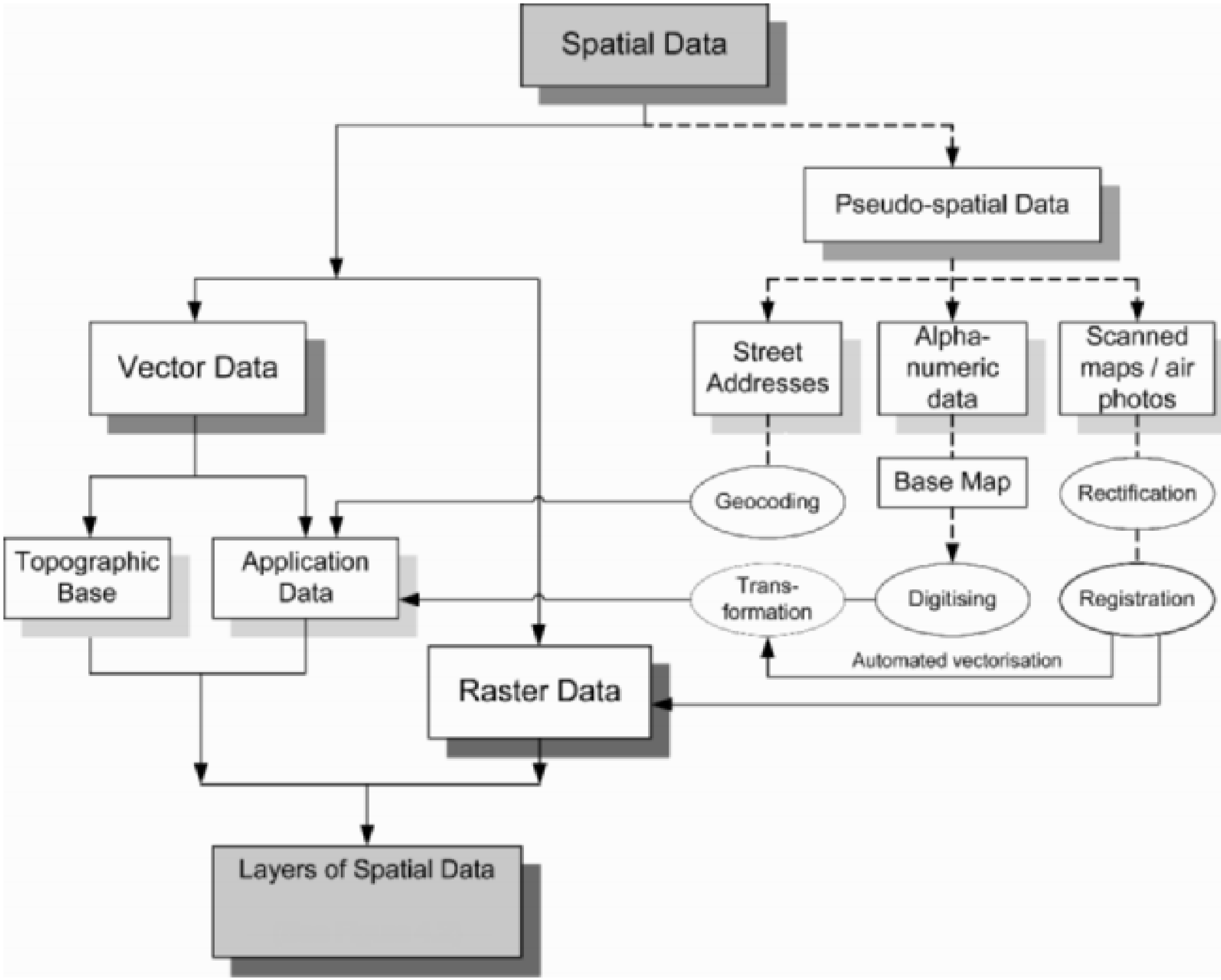


UTM Zone Numbers
01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60
84 72 64 56 48 40 32 24 16 8 0 -8 -16 -24 -32 -40 -48 -56 -64 -72 -80
X W V U T S R Q P N M L K J H G F E D C
UTM Zone Designators
-180 -168 -156 -144 -132 -120 -108 -96 -84 -72 -60 -48 -36 -24 -12 0 12 24 36 48 60 72 84 96 108 120 132 144 156 168 180
Universal Transverse Mercator (UTM) System
Peter H. Dana 9/7/94

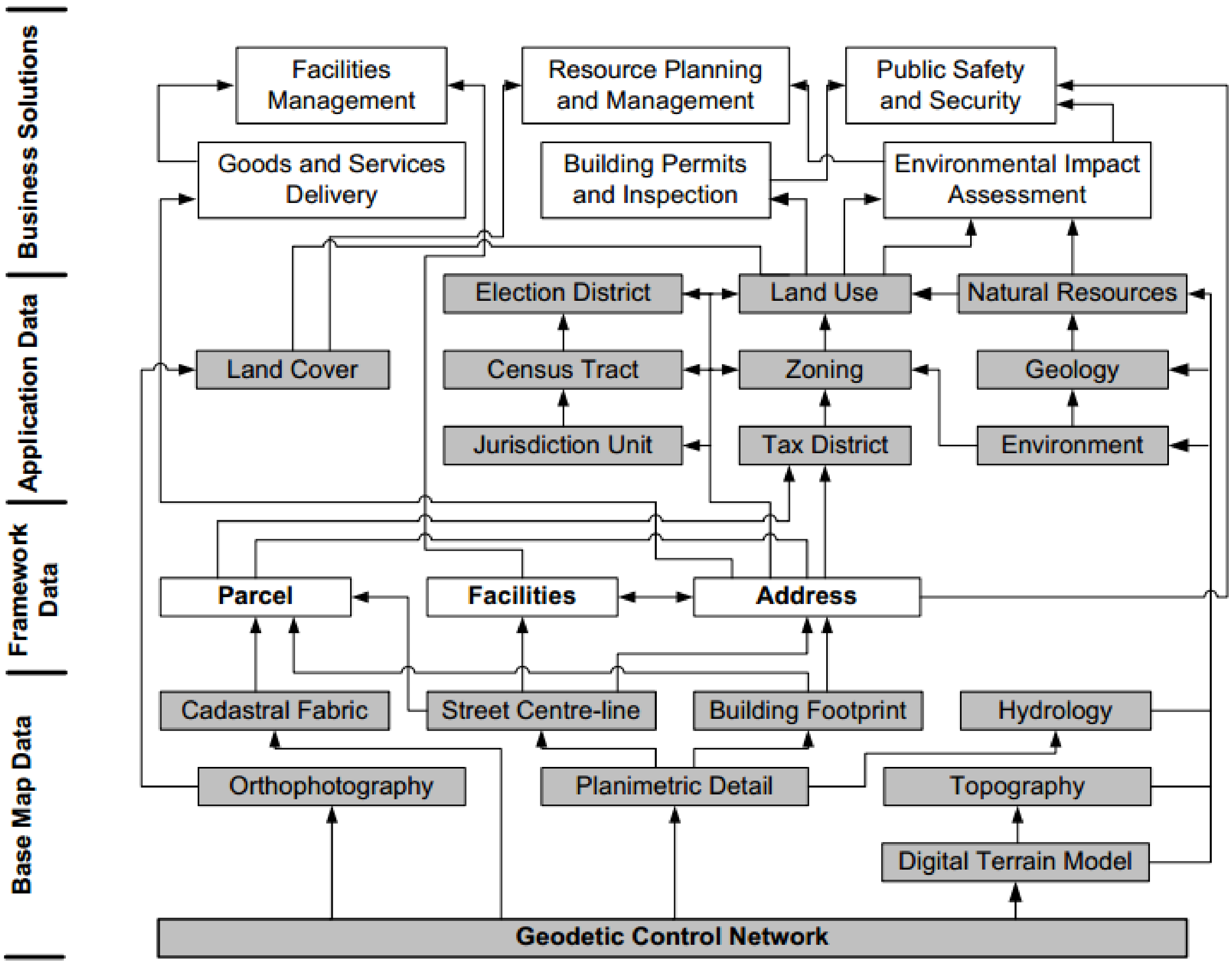


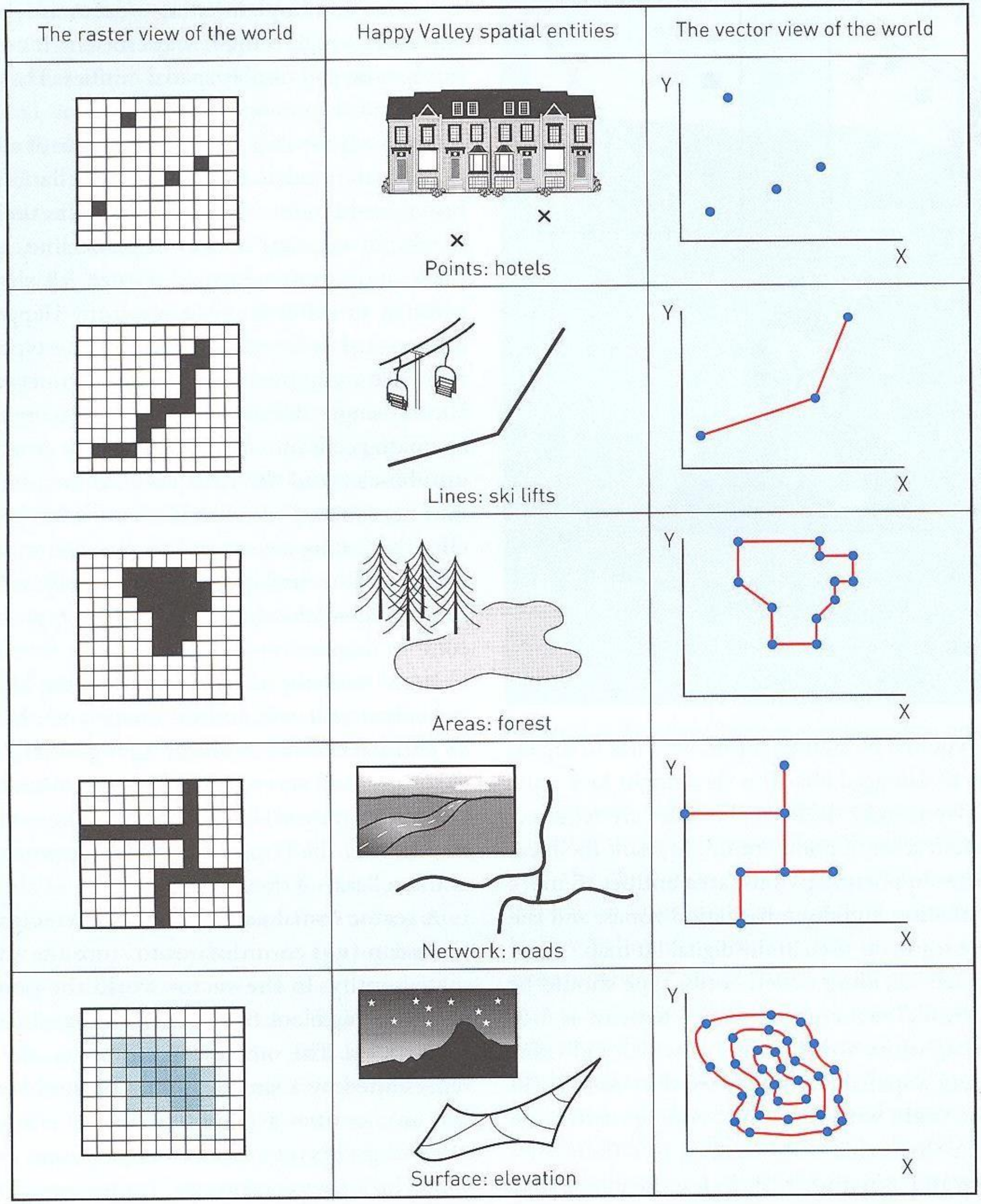
Pembagian Zona UTM Wilayah Indonesia

Types of spatial data



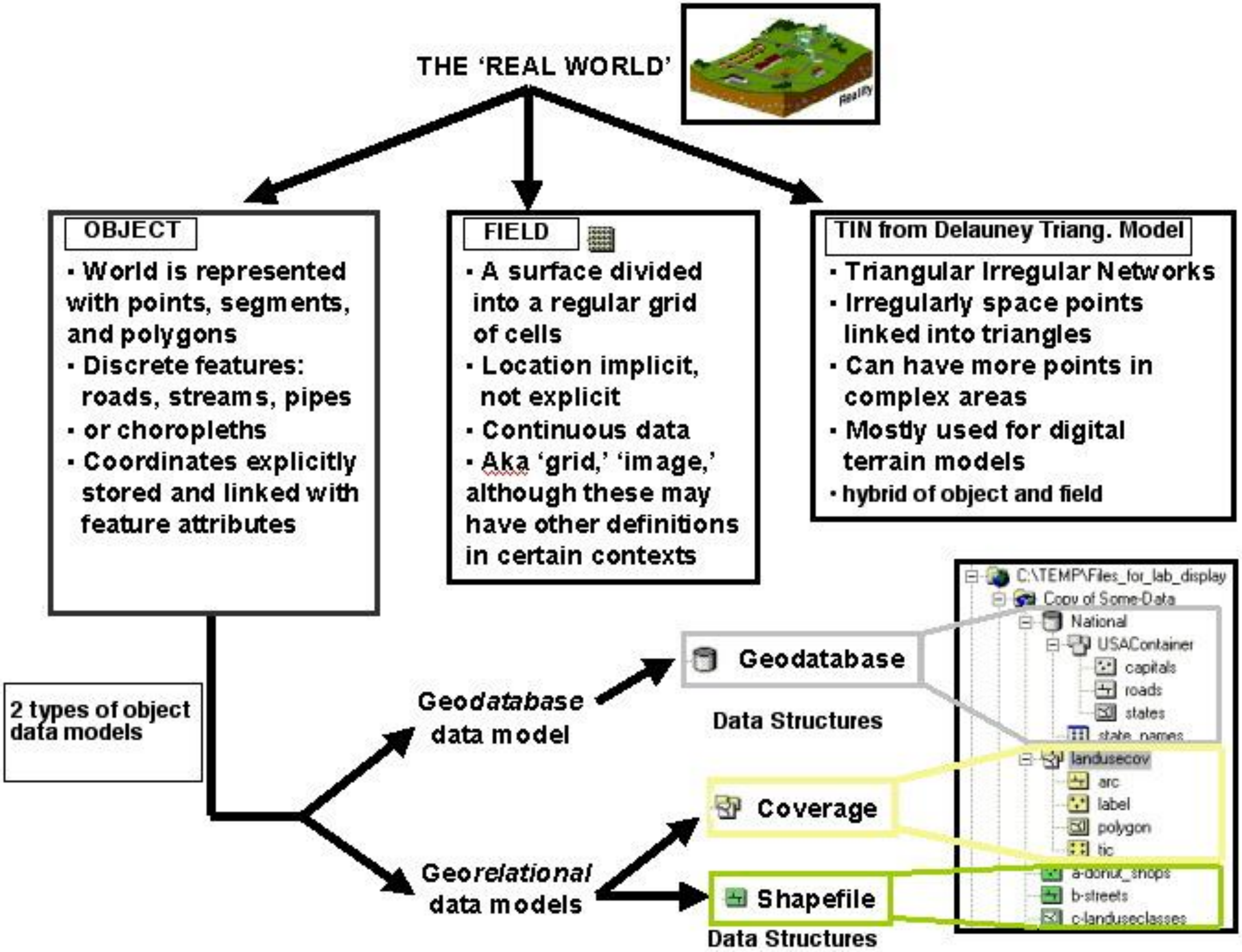
Functional classification of spatial data




The raster view of the world
Happy Valley spatial entities
The vector view of the world
Points: hotels
Lines: ski lifts
Areas: forest
Network: roads
Surface: elevation
Y
X

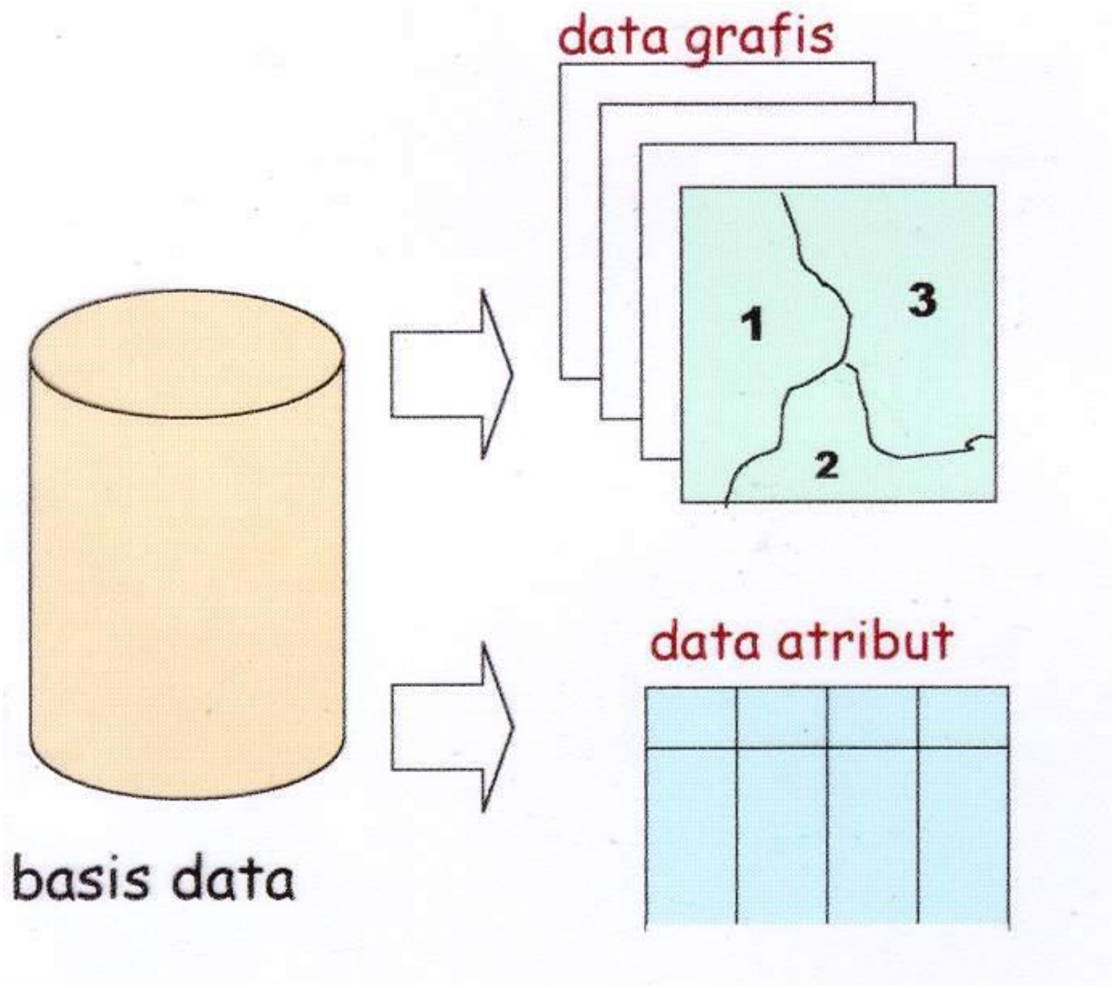
Model Data, Struktur Data dan Struktur File

- **Model data** digunakan untuk mendeskripsikan *conceptual view* tentang bagaimana data yang dimaksudkan untuk *model reality* disusun dalam sistem komputer
- **Struktur data** merupakan *logical view*
- **File structure** merupakan pengaturan data secara *actual physical* dalam system komputer


THE 'REAL WORLD'
Reality
OBJECT
▪ World is represented with points, segments, and polygons
▪ Discrete features: roads, streams, pipes
▪ or choropleths
▪ Coordinates explicitly stored and linked with feature attributes
FIELD
▪ A surface divided into a regular grid of cells
▪ Location implicit, not explicit
▪ Continuous data
▪ Aka 'grid,' 'image,' although these may have other definitions in certain contexts
TIN from Delauney Triang. Model
▪ Triangular Irregular Networks
▪ Irregularly space points linked into triangles
▪ Can have more points in complex areas
▪ Mostly used for digital terrain models
▪ hybrid of object and field
2 types of object data models
Geodatabase data model
Georelational data models
Geodatabase
Data Structures
Coverage
Shapefile
Data Structures
C:\TEMP\Files_for_lab_display
Copy of Some-Data
National
USAContainer
capitals
roads
states
state_names
landusecov
arc
label
polygon
tic
a-donut_shops
b-streets
c-landuseclasses

Data Vektor

BASIS DATA SIG



Data Spasial dan Atribut

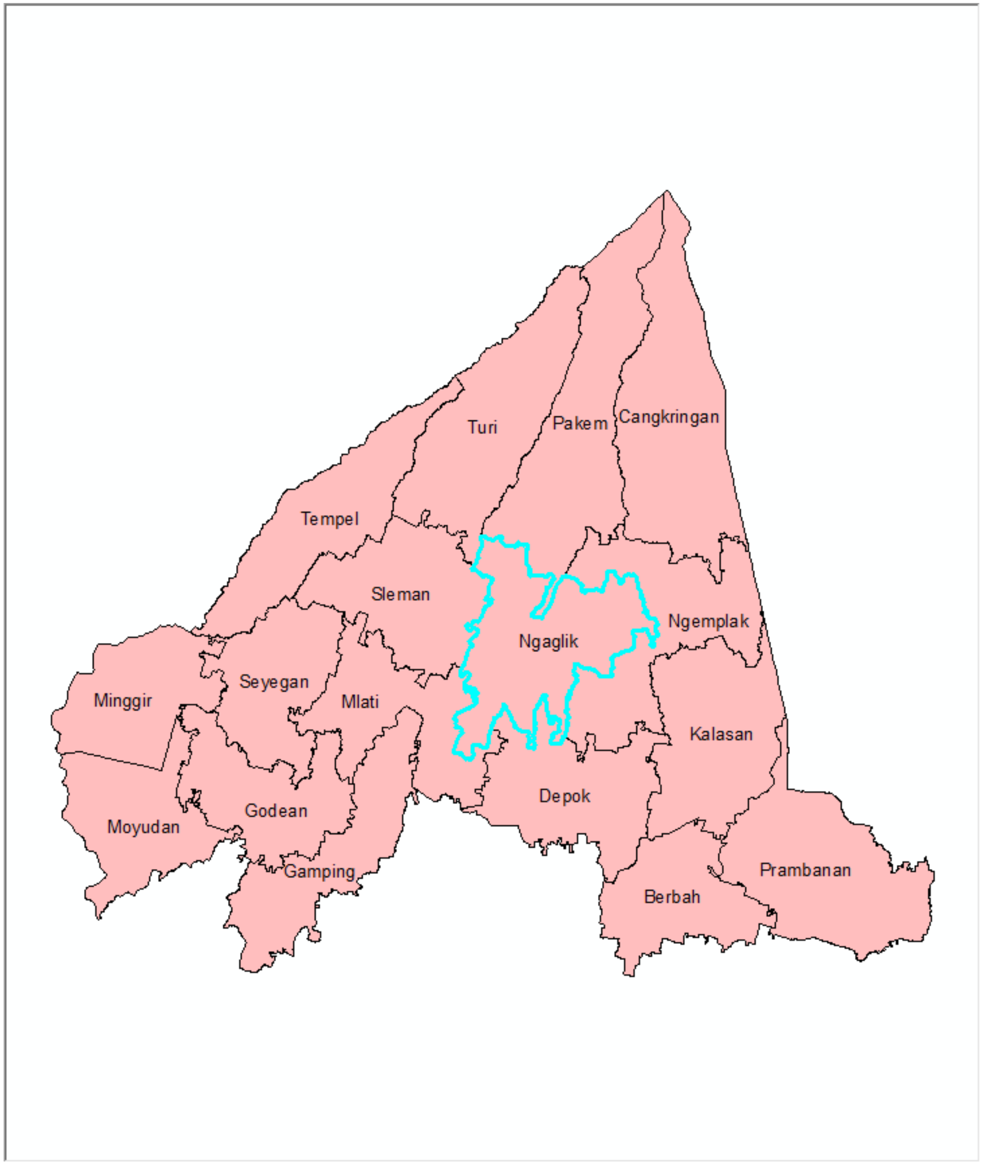
Table

Batas_Administrasi_Kecamatan

FID	Shape *	KECAMATAN	Luas
0	Polygon	Berbah	24.95661
1	Polygon	Cangkringan	48.174305
2	Polygon	Depok	32.136702
3	Polygon	Gamping	29.064794
4	Polygon	Godean	26.751287
5	Polygon	Kalasan	35.75383
6	Polygon	Minggir	26.90699
7	Polygon	Mlati	28.404642
8	Polygon	Moyudan	27.492733
9	Polygon	Ngaglik	38.331046
10	Polygon	Ngemplak	36.530734
11	Polygon	Pakem	45.781439
12	Polygon	Prambanan	41.310651
13	Polygon	Seyegan	26.536978
14	Polygon	Sleman	31.199695
15	Polygon	Tempel	32.367361
16	Polygon	Turi	40.257485

0 (1 out of 17 Selected)

Batas_Administrasi_Kecamatan



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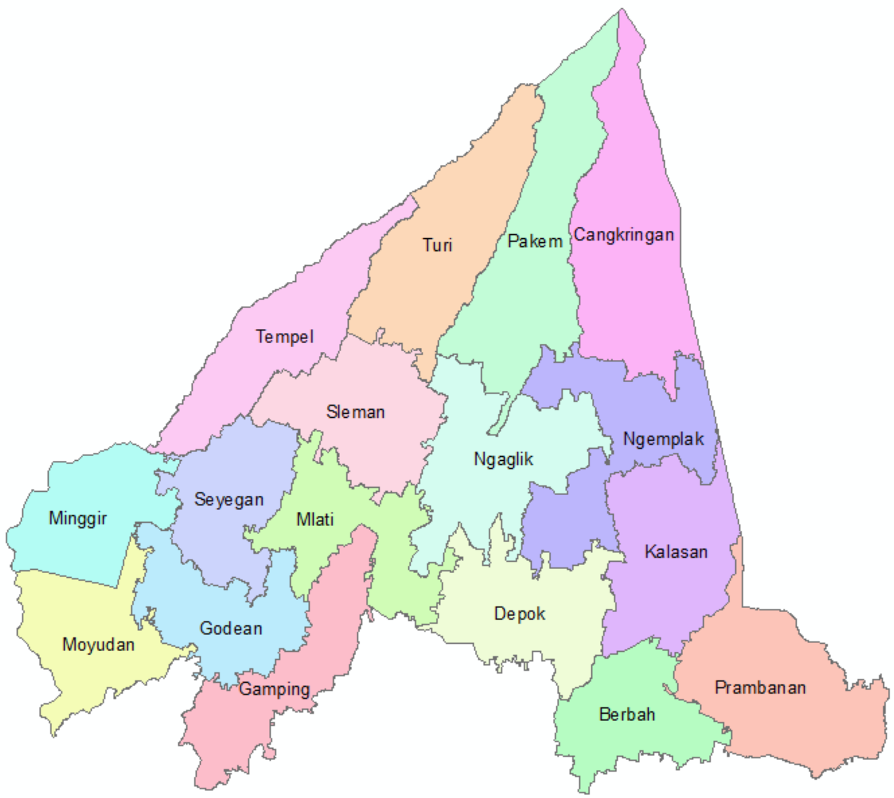
Batas_Administrasi_Kecamatan



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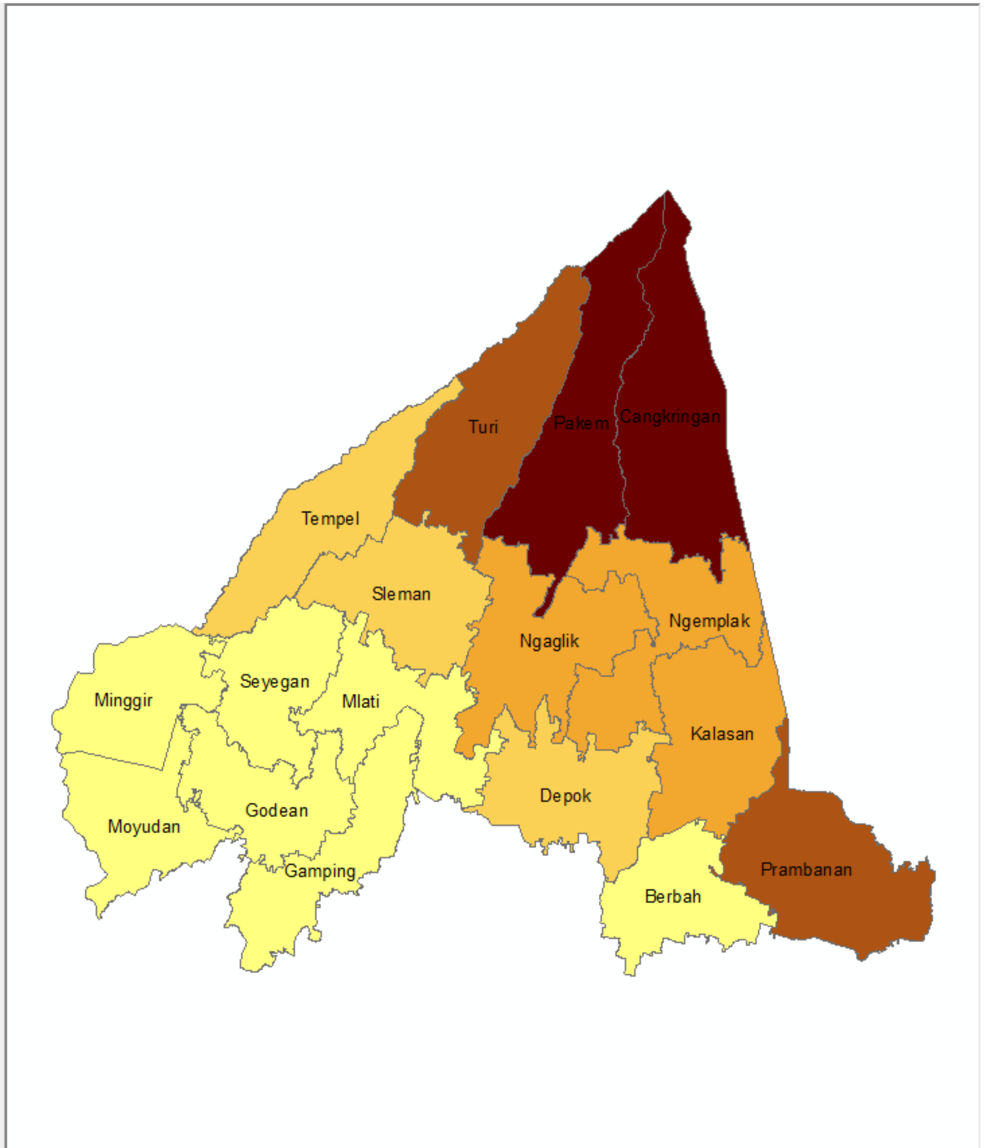
Batas_Administrasi_Kecamatan

Luas

- < 30
- 30 - 35
- 35 - 40
- 40 - 45
- > 45

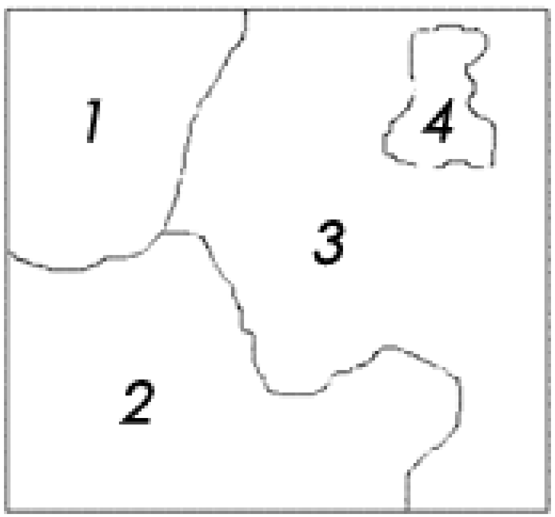
0 (0 out of 17 Selected)

Batas_Administrasi_Kecamatan

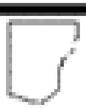
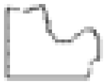
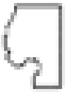
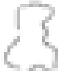


PENYIMPANAN FEATURE CLASS PADA BASIS DATA SIG

Geographic View

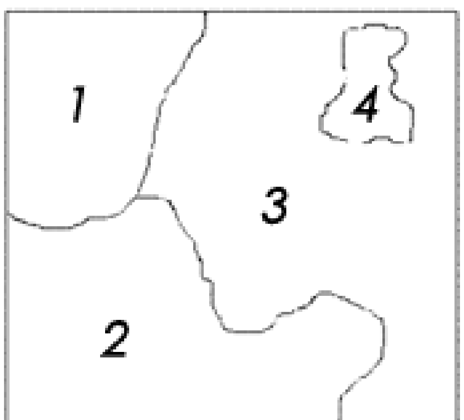


Tables View

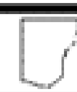
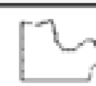
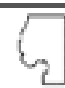
Object ID	Shape	Name	LV Code	Management Agency
1		Shady Pines	20	Private
2		Pinewood Village	30	Pinewood Village Association
3		Sarah Park	80	City Park Board
4		Town Park	99	City Park Poard

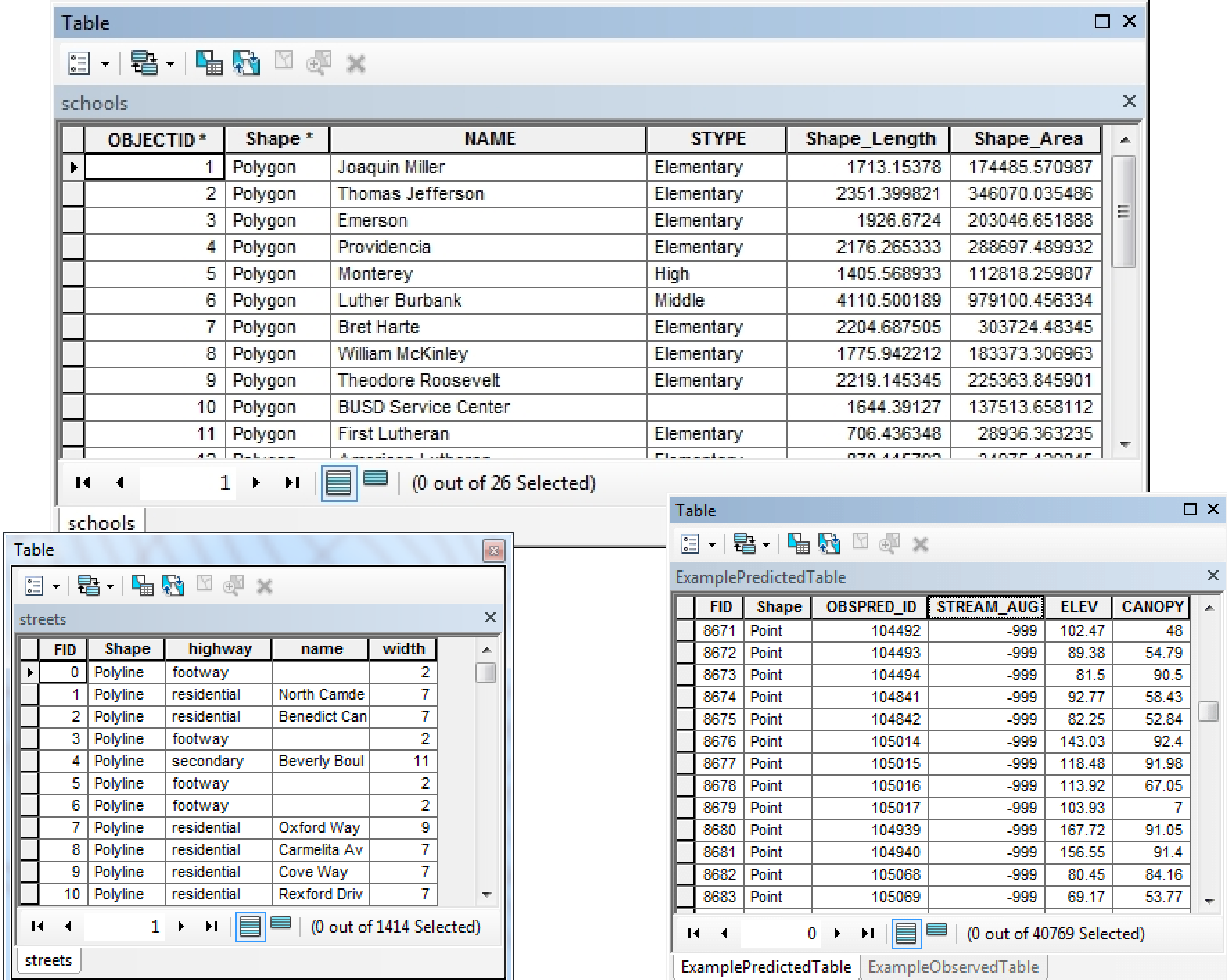
- *OpenGIS Simple Feature Specification for SQL* (OGC, 1999) menyatakan hirarki tipe data spasial, disebut model objek geometri, yang memungkinkan fitur spasial diwakili dalam database.
- Kata "Geometri" digunakan untuk mewakili fitur spasial sebagai "objek" yang memiliki setidaknya satu atribut tipe geometrik dalam database.

Geographic View



Tables View

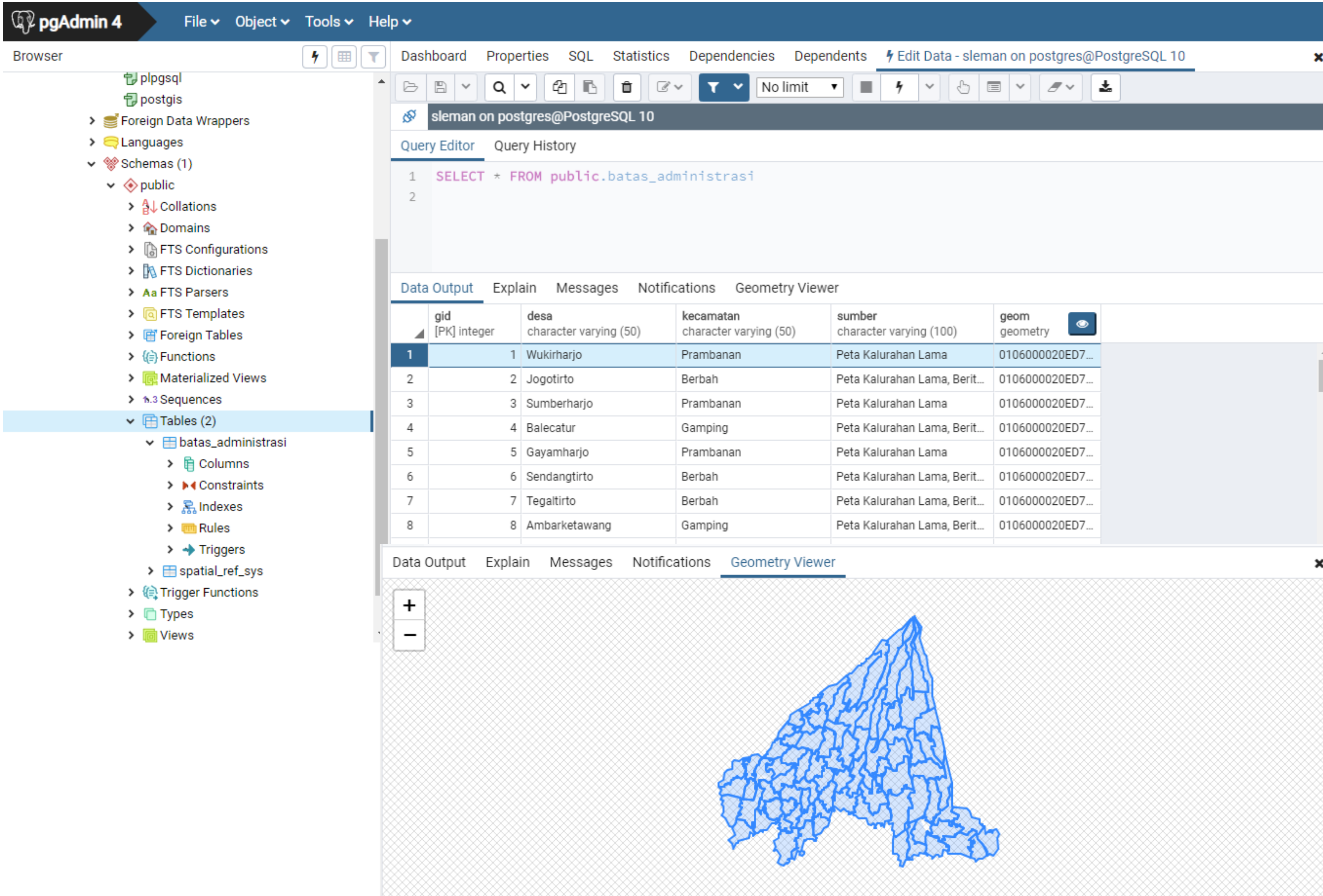
Object ID	Shape	Name	LV Code	Management Agency
1		Shady Pines	20	Private
2		Pinewood Village	30	Pinewood Village Association
3		Sarah Park	80	City Park Board
4		Town Park	99	City Park Poard



OBJECTID *	Shape *	NAME	STYPE	Shape_Length	Shape_Area
1	Polygon	Joaquin Miller	Elementary	1713.15378	174485.570987
2	Polygon	Thomas Jefferson	Elementary	2351.399821	346070.035486
3	Polygon	Emerson	Elementary	1926.6724	203046.651888
4	Polygon	Providencia	Elementary	2176.265333	288697.489932
5	Polygon	Monterey	High	1405.568933	112818.259807
6	Polygon	Luther Burbank	Middle	4110.500189	979100.456334
7	Polygon	Bret Harte	Elementary	2204.687505	303724.48345
8	Polygon	William McKinley	Elementary	1775.942212	183373.306963
9	Polygon	Theodore Roosevelt	Elementary	2219.145345	225363.845901
10	Polygon	BUSD Service Center		1644.39127	137513.658112
11	Polygon	First Lutheran	Elementary	706.436348	28936.363235

FID	Shape	highway	name	width
0	Polyline	footway		2
1	Polyline	residential	North Camde	7
2	Polyline	residential	Benedict Can	7
3	Polyline	footway		2
4	Polyline	secondary	Beverly Boul	11
5	Polyline	footway		2
6	Polyline	footway		2
7	Polyline	residential	Oxford Way	9
8	Polyline	residential	Carmelita Av	7
9	Polyline	residential	Cove Way	7
10	Polyline	residential	Rexford Driv	7

FID	Shape	OBSPRED_ID	STREAM_AUG	ELEV	CANOPY
8671	Point	104492	-999	102.47	48
8672	Point	104493	-999	89.38	54.79
8673	Point	104494	-999	81.5	90.5
8674	Point	104841	-999	92.77	58.43
8675	Point	104842	-999	82.25	52.84
8676	Point	105014	-999	143.03	92.4
8677	Point	105015	-999	118.48	91.98
8678	Point	105016	-999	113.92	67.05
8679	Point	105017	-999	103.93	7
8680	Point	104939	-999	167.72	91.05
8681	Point	104940	-999	156.55	91.4
8682	Point	105068	-999	80.45	84.16
8683	Point	105069	-999	69.17	53.77


pgAdmin 4
File
Object
Tools
Help
Browser
plpgsql
postgis
Foreign Data Wrappers
Languages
Schemas (1)
public
Collations
Domains
FTS Configurations
FTS Dictionaries
FTS Parsers
FTS Templates
Foreign Tables
Functions
Materialized Views
Sequences
Tables (2)
batas_administrasi
Columns
Constraints
Indexes
Rules
Triggers
spatial_ref_sys
Trigger Functions
Types
Views
Dashboard
Properties
SQL
Statistics
Dependencies
Dependents
Edit Data - sleman on postgres@PostgreSQL 10
No limit
sleman on postgres@PostgreSQL 10
Query Editor
Query History
SELECT * FROM public.batas_administrasi
Data Output
Explain
Messages
Notifications
Geometry Viewer
gid [PK] integer
desa character varying (50)
kecamatan character varying (50)
sumber character varying (100)
geom geometry
1 1 Wukirharjo Prambanan Peta Kalurahan Lama 0106000020ED7...
2 2 Jogotirto Berbah Peta Kalurahan Lama, Berit... 0106000020ED7...
3 3 Sumberharjo Prambanan Peta Kalurahan Lama 0106000020ED7...
4 4 Balecatur Gamping Peta Kalurahan Lama, Berit... 0106000020ED7...
5 5 Gayamharjo Prambanan Peta Kalurahan Lama 0106000020ED7...
6 6 Sendangtirto Berbah Peta Kalurahan Lama, Berit... 0106000020ED7...
7 7 Tegaltirto Berbah Peta Kalurahan Lama, Berit... 0106000020ED7...
8 8 Ambarketawang Gamping Peta Kalurahan Lama, Berit... 0106000020ED7...
Data Output
Explain
Messages
Notifications
Geometry Viewer

Vector Data Model

The three main geometric shapes used in the vector data model, to represent real world features are:

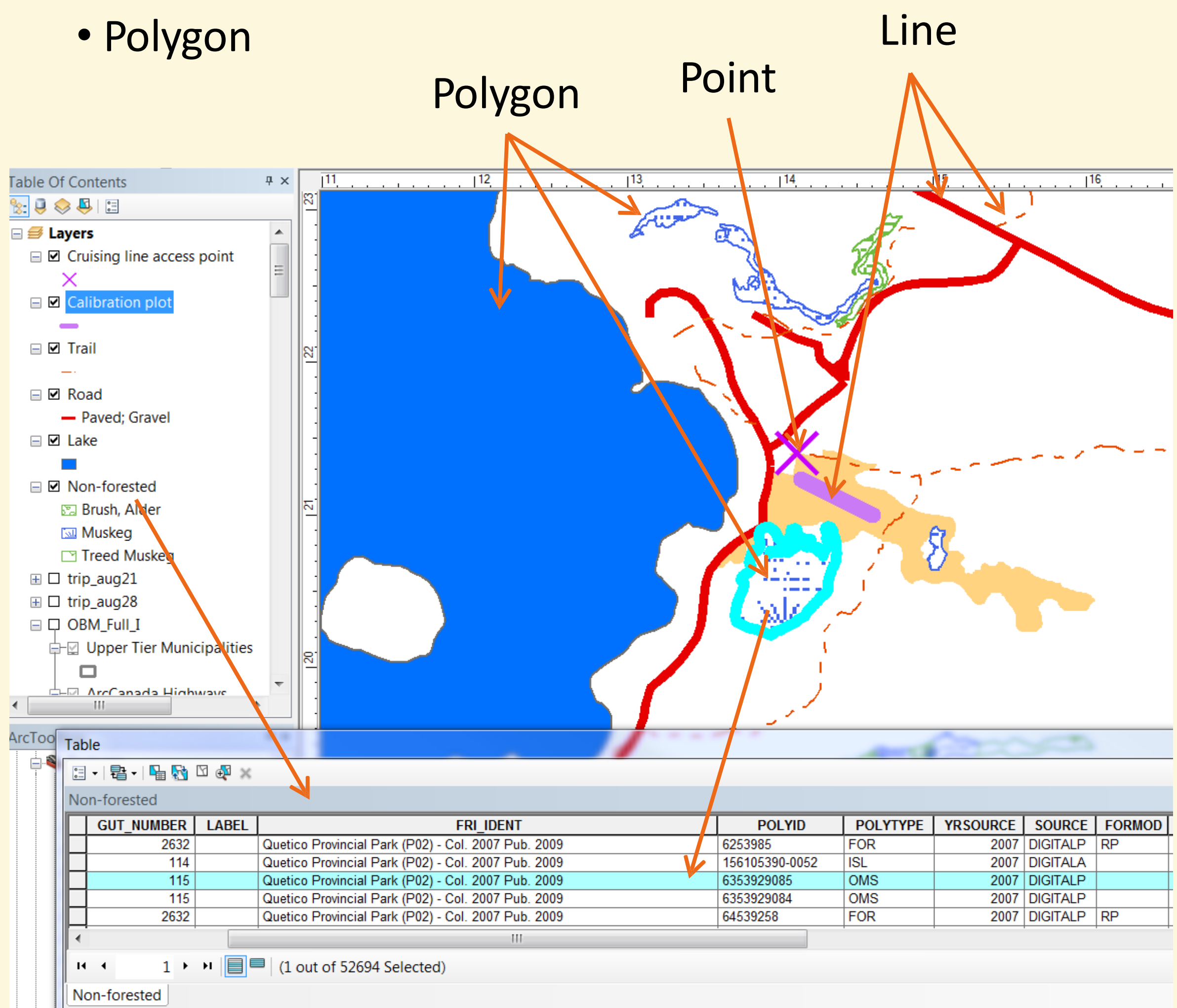
- Point
- Line
- Polygon

•Points, lines and polygons are stored in separate, point, line, and polygon, GIS files.

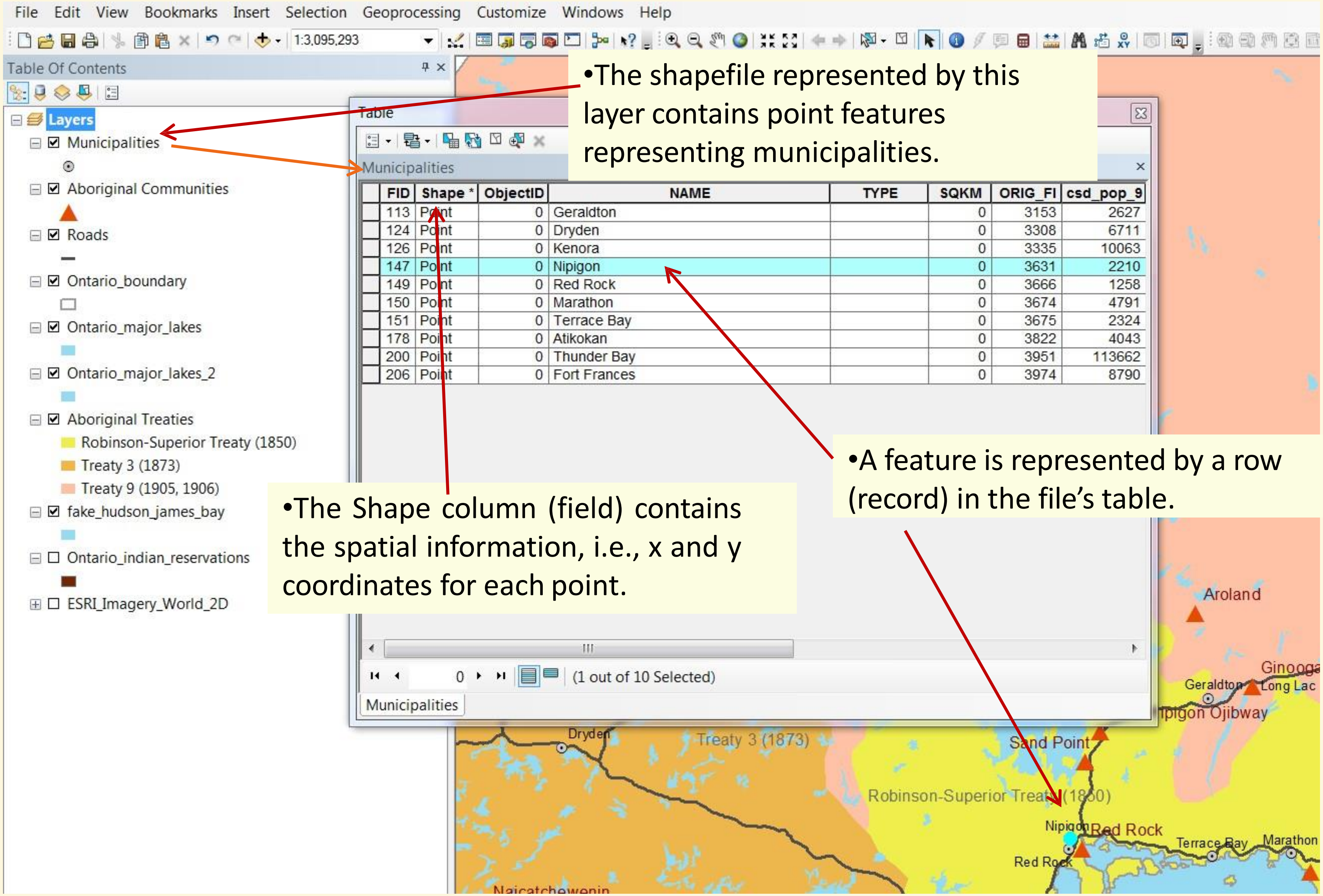
•Each GIS file along with spatial features also contains a table in which each row (record) represents one of the spatial features.

•(An exception to the above are so called *multipart features*, where one row represents multiple features.)

•Columns (fields) in the table are used to store data (attributes) describing each feature.



Point GIS File



•The shapefile represented by this layer contains point features representing municipalities.

•The Shape column (field) contains the spatial information, i.e., x and y coordinates for each point.

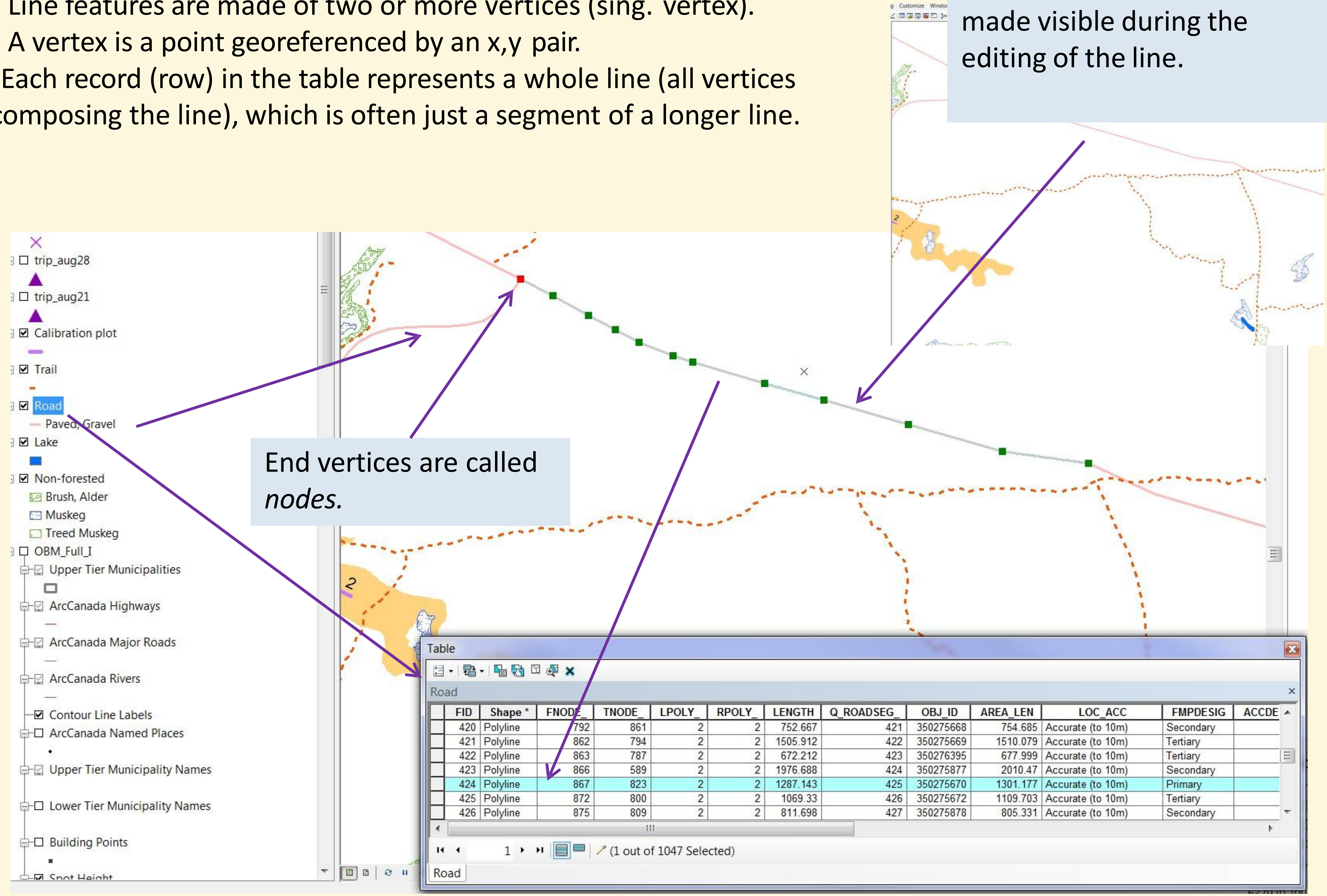
•A feature is represented by a row (record) in the file's table.

Line GIS File

- Line features are made of two or more vertices (sing. vertex).
- A vertex is a point georeferenced by an x,y pair.
- Each record (row) in the table represents a whole line (all vertices composing the line), which is often just a segment of a longer line.

In ArcGIS, vertices are not usually visible but can be made visible during the editing of the line.

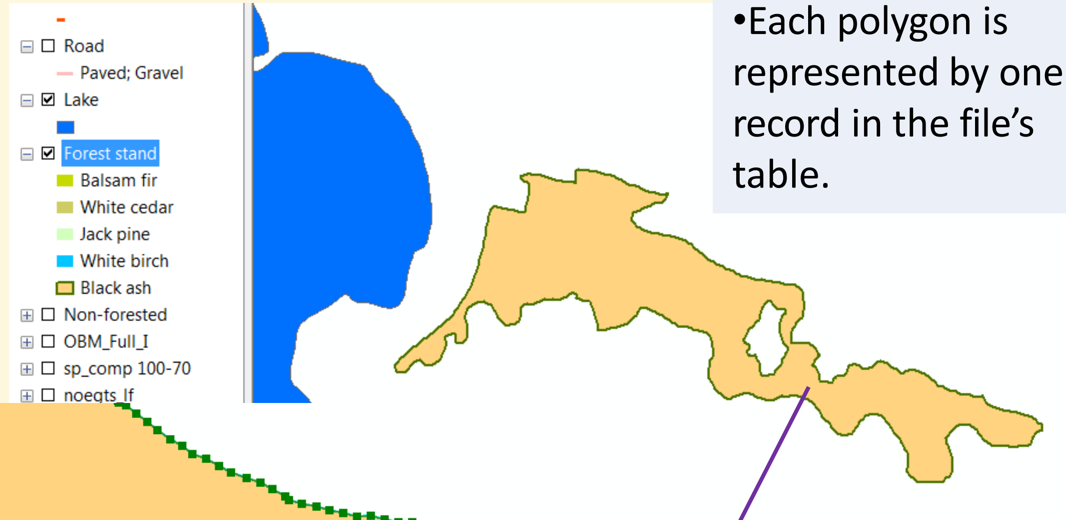
End vertices are called *nodes.*

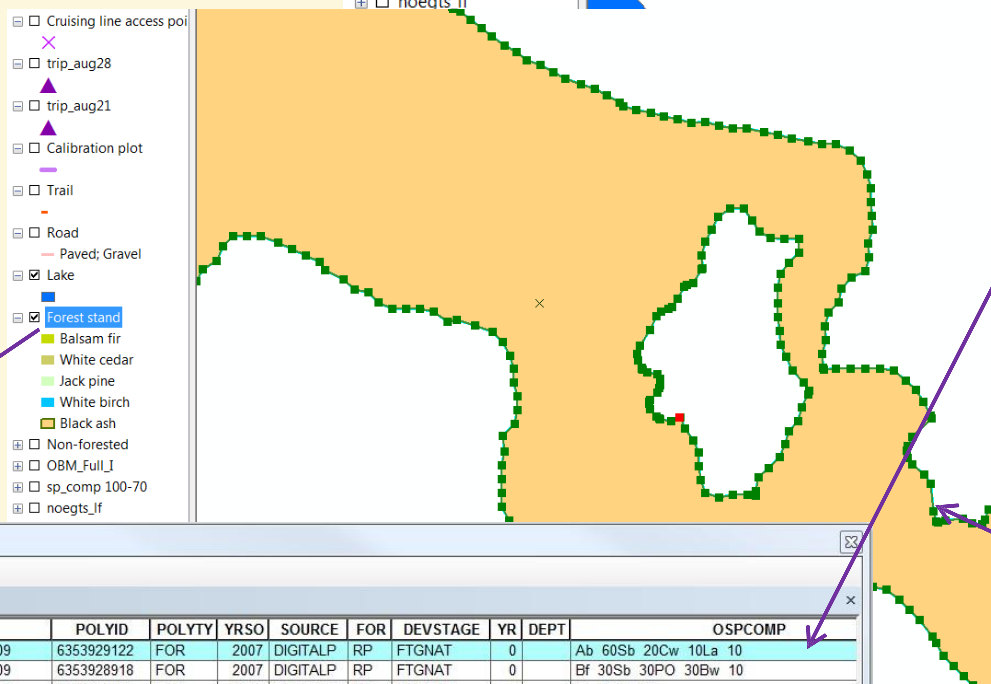


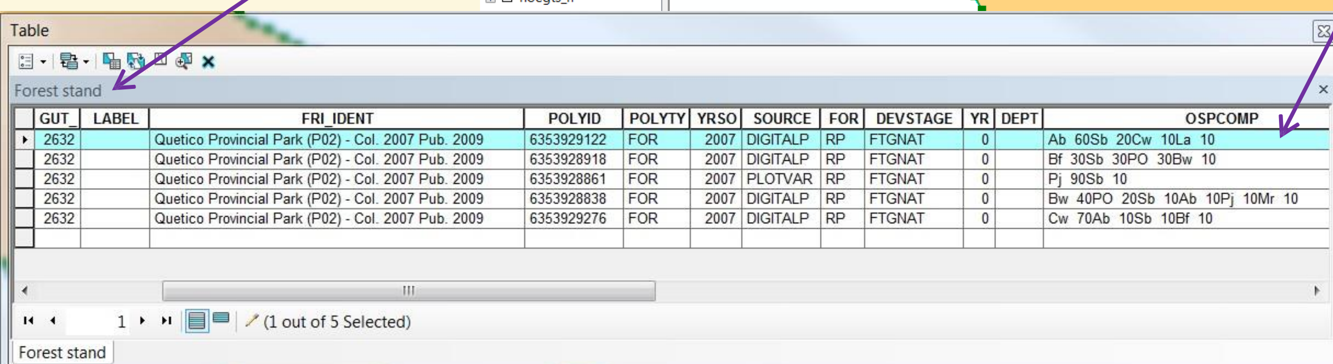
Polygon GIS File

•Polygon features are made of one or more lines that enclose(s) an area.

•Each polygon is represented by one record in the file's table.







Table

Forest stand

GUT_	LABEL	FRI_IDENT	POLYID	POLYTY	YRSO	SOURCE	FOR	DEVSTAGE	YR	DEPT	OSPCOMP
2632		Quetico Provincial Park (P02) - Col. 2007 Pub. 2009	6353929122	FOR	2007	DIGITALP	RP	FTGNAT	0		Ab 60Sb 20Cw 10La 10
2632		Quetico Provincial Park (P02) - Col. 2007 Pub. 2009	6353928918	FOR	2007	DIGITALP	RP	FTGNAT	0		Bf 30Sb 30PO 30Bw 10
2632		Quetico Provincial Park (P02) - Col. 2007 Pub. 2009	6353928861	FOR	2007	PLOTVAR	RP	FTGNAT	0		Pj 90Sb 10
2632		Quetico Provincial Park (P02) - Col. 2007 Pub. 2009	6353928838	FOR	2007	DIGITALP	RP	FTGNAT	0		Bw 40PO 20Sb 10Ab 10Pj 10Mr 10
2632		Quetico Provincial Park (P02) - Col. 2007 Pub. 2009	6353929276	FOR	2007	DIGITALP	RP	FTGNAT	0		Cw 70Ab 10Sb 10Bf 10

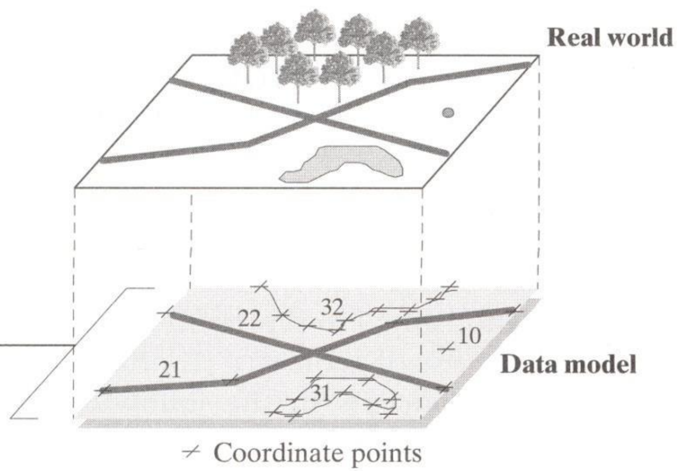
1 (1 out of 5 Selected)

Forest stand

•Since lines are made up of vertices that means that polygons are, in the end, made up of vertices (points), i.e. they are represented by a group of x.y coordinates.

x,y Pairs as Spatial Representation

- Ultimately, GIS vector files, point, line or polygon files, have their spatial representation stored in the computer memory through x,y coordinate pairs.
- There are no ‘lines’ stored – the GIS software recognizes the type of the file (a point, line, or a polygon GIS file) and displays the features as points only or connects the points (vertices) with lines and displays them as lines or fills the line-enclosed areas with a colour and displays the features as polygons.



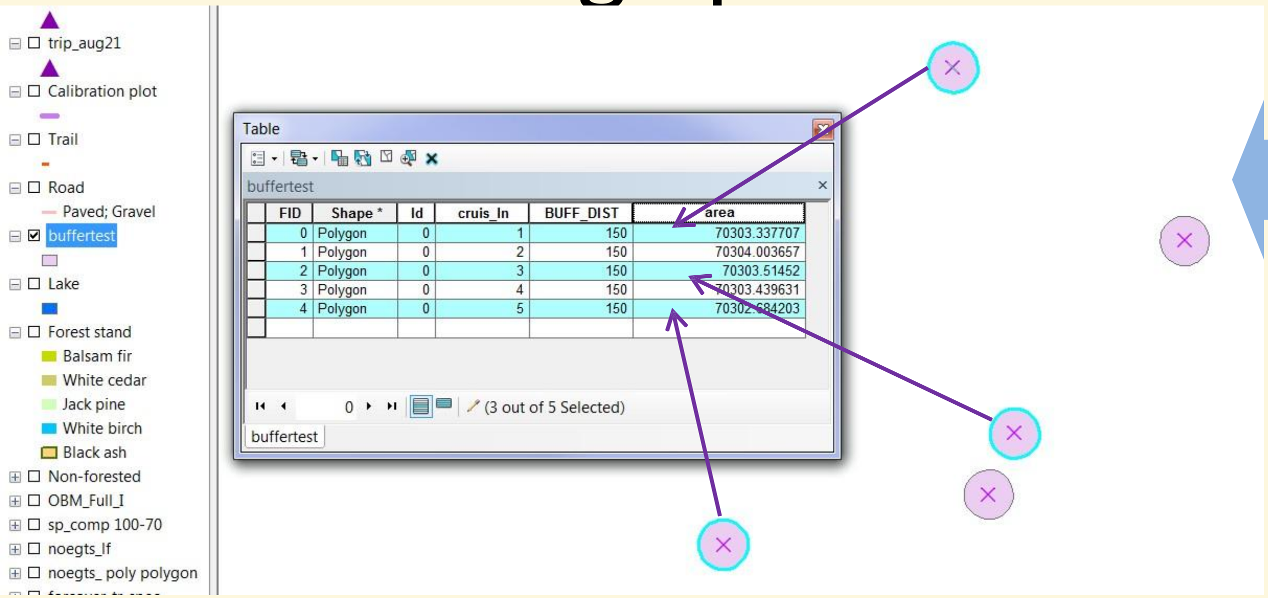
Stored data

Feature ID	Feature type	Location
10	Point	xy
21	Line	$x_1y_1, x_2y_2, x_3y_3 \ldots x_ny_n$ (string)
22	Line	$x_1y_1, x_2y_2, x_3y_3 \ldots x_ny_n$ (string)
31	Polygon	$x_1y_1, x_2y_2, x_3y_3 \ldots x_1y_1$ (closed loop)
32	Polygon	$x_1y_1, x_2y_2, x_3y_3 \ldots x_1y_1$ (closed loop)

Separate GIS files.

Source: Lo et al. (2007)

Singleparts vs.Multiparts



Singlepart

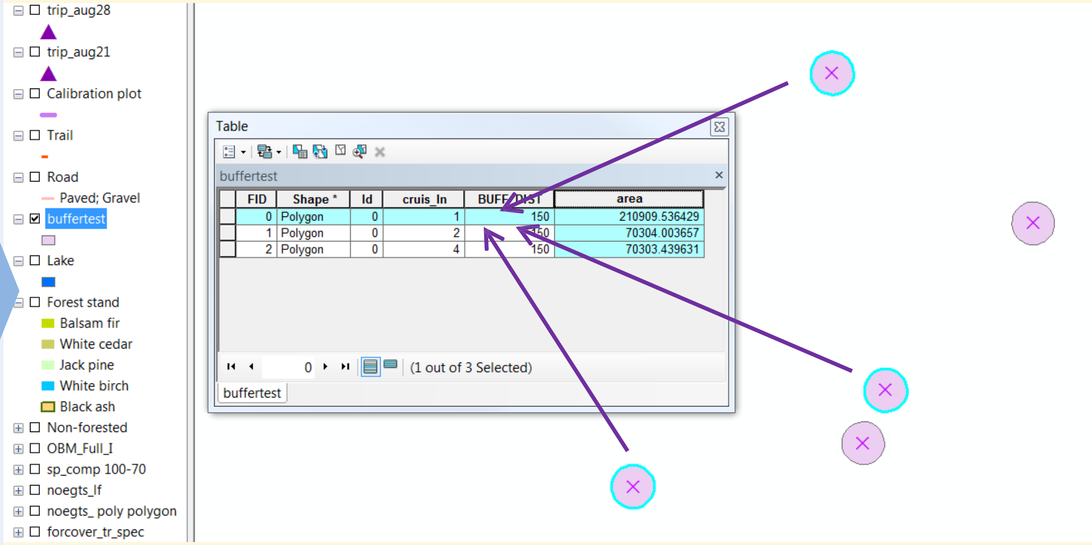
•One feature is represented by one record.

Multipart

•Multiple features are represented by one record.

•Applications for multipart features are for example, multiple polygons representing protective buffers around the same type of features (e.g. eagle nests).

•A downside of a multipart: only one attribute is assigned to all multipart parts, which, e.g. for areas, can be deceiving when looking at individual parts.

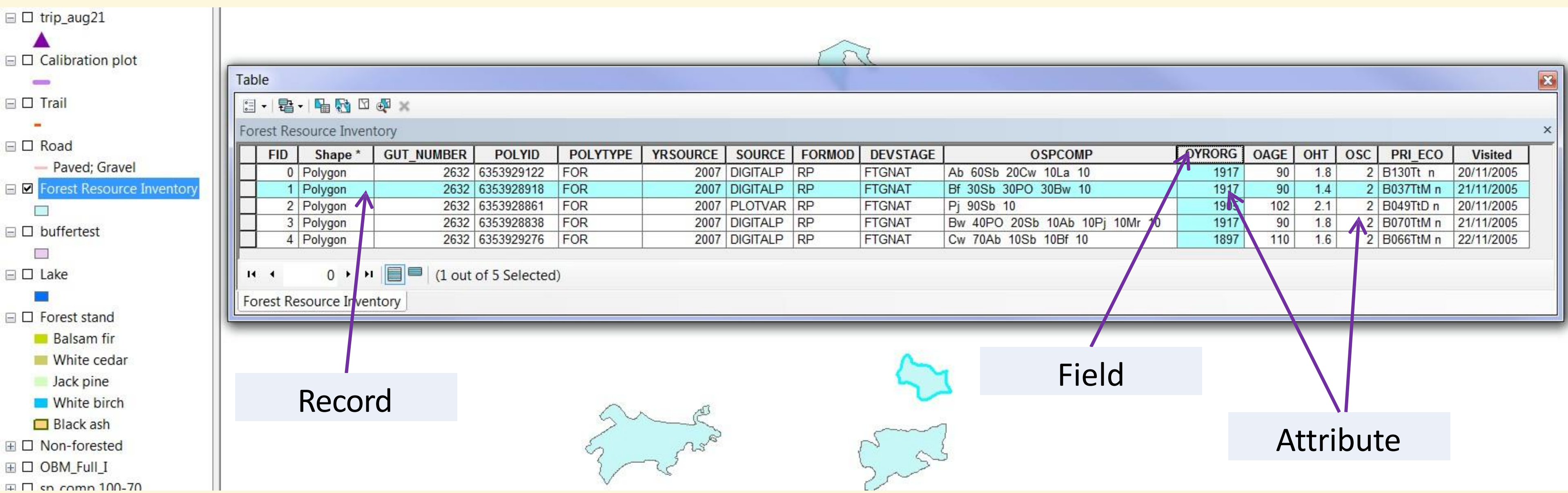


Vector Data Model Attributes

•In GIS vector files attributes are, in a simple form, stored in tables (databases).

•A table consists of records (rows) representing individual features, fields (columns) representing a particular theme describing the feature, and attributes – an intersection between a record and a field.

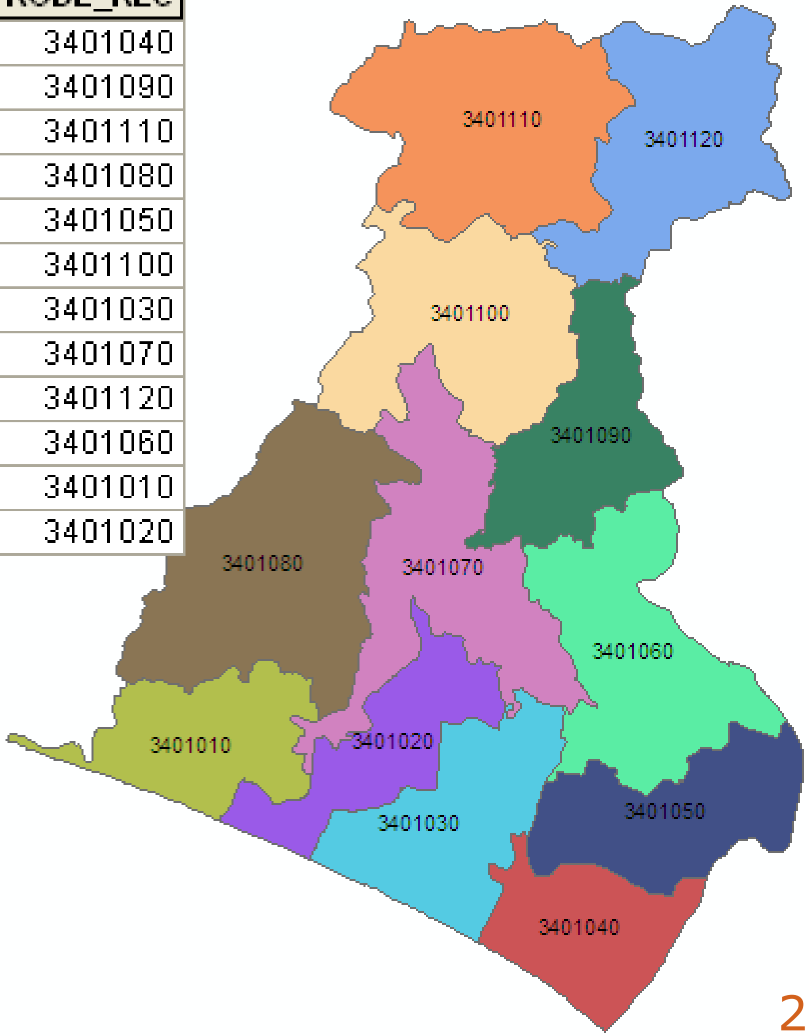
•In ArcGIS, FID and Shape fields, although shown in the Table of Attributes, are not actually part of the attributes, but rather represent the spatial and index information (e.g. the .shp and .shx content in shapefiles). Because of it FID and Shape fields cannot be deleted from the table, unlike any other pure attribute field.



FID	Shape *	GUT_NUMBER	POLYID	POLYTYPE	YRSOURCE	SOURCE	FORMOD	DEVSTAGE	OSPCOMP	OYRORG	OAGE	OHT	OSC	PRI_ECO	Visited
0	Polygon	2632	6353929122	FOR	2007	DIGITALP	RP	FTGNAT	Ab 60Sb 20Cw 10La 10	1917	90	1.8	2	B130Tt n	20/11/2005
1	Polygon	2632	6353928918	FOR	2007	DIGITALP	RP	FTGNAT	Bf 30Sb 30PO 30Bw 10	1917	90	1.4	2	B037TtM n	21/11/2005
2	Polygon	2632	6353928861	FOR	2007	PLOTVAR	RP	FTGNAT	Pj 90Sb 10	1905	102	2.1	2	B049TtD n	20/11/2005
3	Polygon	2632	6353928838	FOR	2007	DIGITALP	RP	FTGNAT	Bw 40PO 20Sb 10Ab 10Pj 10Mr 10	1917	90	1.8	2	B070TtM n	21/11/2005
4	Polygon	2632	6353929276	FOR	2007	DIGITALP	RP	FTGNAT	Cw 70Ab 10Sb 10Bf 10	1897	110	1.6	2	B066TtM n	22/11/2005

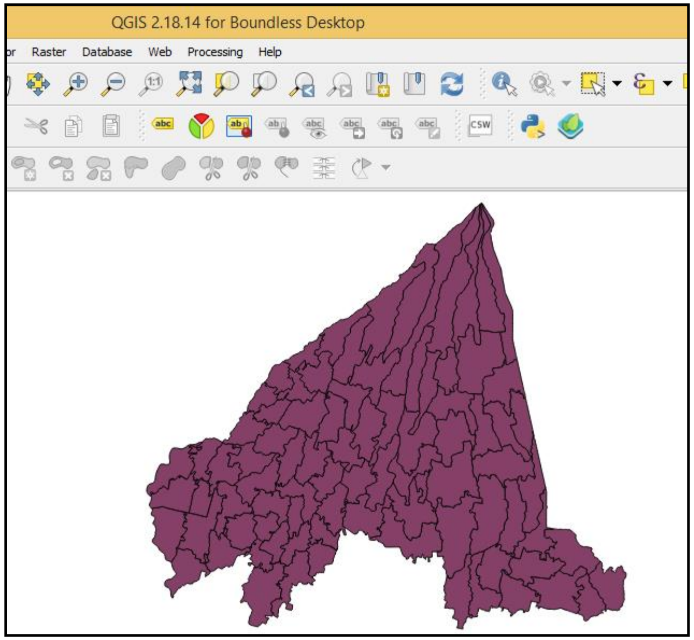
Data Spasial dan Atribut

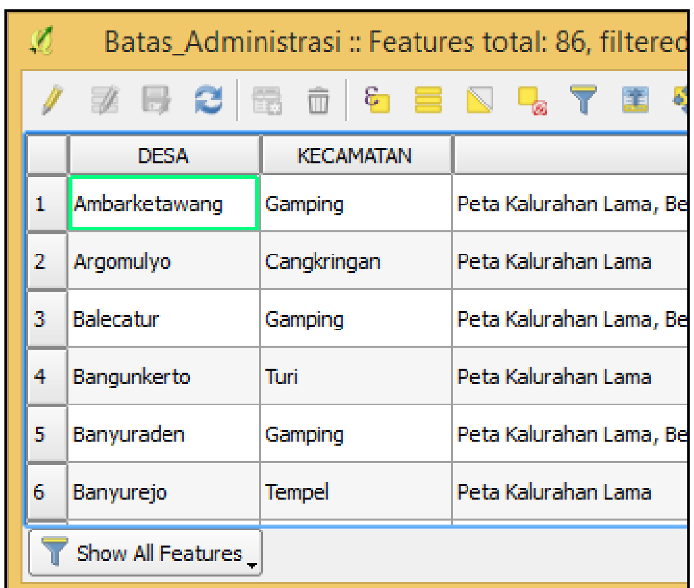
OBJECTID *	Shape *	KODE_KEC
175	Polygon	3401040
17	Polygon	3401090
11	Polygon	3401110
31	Polygon	3401080
62	Polygon	3401050
18	Polygon	3401100
58	Polygon	3401030
23	Polygon	3401070
8	Polygon	3401120
43	Polygon	3401060
56	Polygon	3401010
53	Polygon	3401020



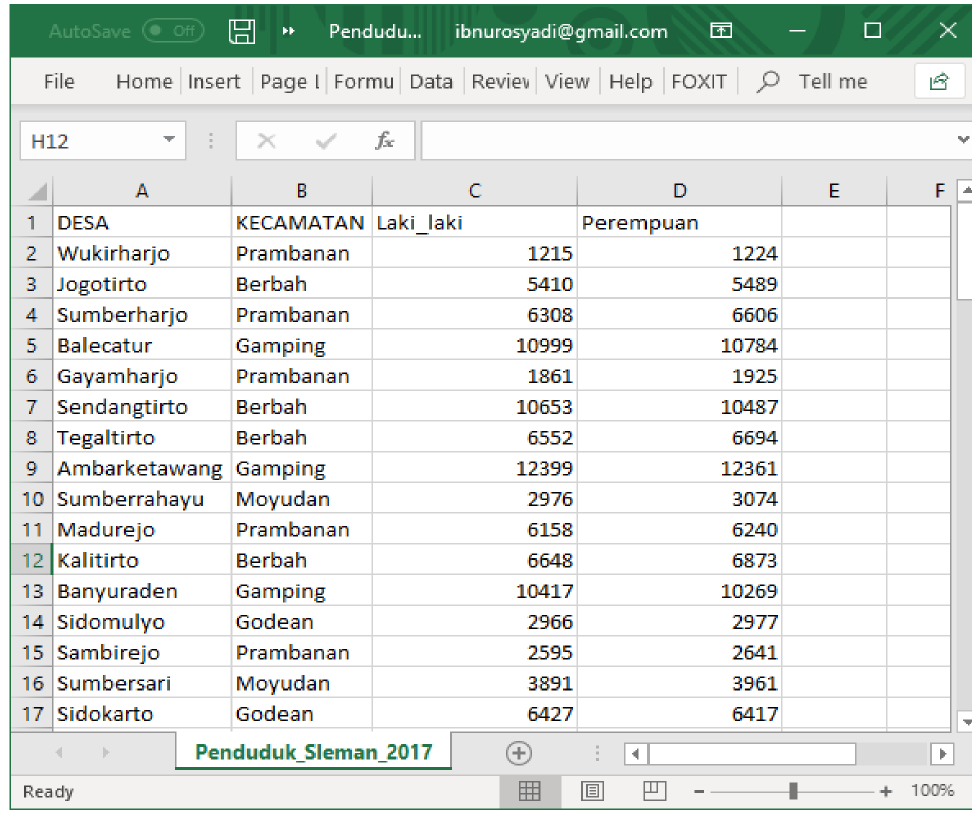
Join Data Spasial dan Non-Spasial

Kode	Kecamatan	Roboh	Rusak_berat	Rusak Ringan	Total	Rencana
3401040	Galur	1,468	2,011	3,064	3,479	20
3401090	Girimulyo	18	37	179	55	12
3401110	Kalibawang	267	473	1,188	740	13
3401080	Kokap	1	0	1	1	0
3401050	Lendah	1,938	1,927	2,220	3,865	1,056
3401100	Nanggulan	13	0	0	13	7
3401030	Panjatan	151	158	655	309	12
3401070	Pengasih	6	6	232	12	1
3401120	Samigaluh	17	0	32	17	3
3401060	Sentolo	593	430	803	1,023	120
3401010	Temon	17	1	28	18	0
3401020	Wates	38	135	99	173	30





	DESA	KECAMATAN	
1	Ambarketawang	Gamping	Peta Kalurahan Lama, Be
2	Argomulyo	Cangkringan	Peta Kalurahan Lama
3	Balecatur	Gamping	Peta Kalurahan Lama, Be
4	Bangunkerto	Turi	Peta Kalurahan Lama
5	Banyuraden	Gamping	Peta Kalurahan Lama, Be
6	Banyurejo	Tempel	Peta Kalurahan Lama



	A	B	C	D
1	DESA	KECAMATAN	Laki_laki	Perempuan
2	Wukirharjo	Prambanan	1215	1224
3	Jogotirto	Berbah	5410	5489
4	Sumberharjo	Prambanan	6308	6606
5	Balecatur	Gamping	10999	10784
6	Gayamharjo	Prambanan	1861	1925
7	Sendangtirto	Berbah	10653	10487
8	Tegaltirto	Berbah	6552	6694
9	Ambarketawang	Gamping	12399	12361
10	Sumberrahayu	Moyudan	2976	3074
11	Madurejo	Prambanan	6158	6240
12	Kalitirto	Berbah	6648	6873
13	Banyuraden	Gamping	10417	10269
14	Sidomulyo	Godean	2966	2977
15	Sambirejo	Prambanan	2595	2641
16	Sumbersari	Moyudan	3891	3961
17	Sidokarto	Godean	6427	6417

Join Data Spasial dan Non-Spasial

OBJECTID *	Shape *	KODE_KEC
175	Polygon	3401040
17	Polygon	3401090
11	Polygon	3401110
31	Polygon	3401080
62	Polygon	3401050
18	Polygon	3401100
58	Polygon	3401030
23	Polygon	3401070
8	Polygon	3401120
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3401080	Kokap	1	0	1	1	0
3401050	Lendah	1,938	1,927	2,220	3,865	1,056
3401100	Nanggulan	13	0	0	13	7
3401030	Panjatan	151	158	655	309	12
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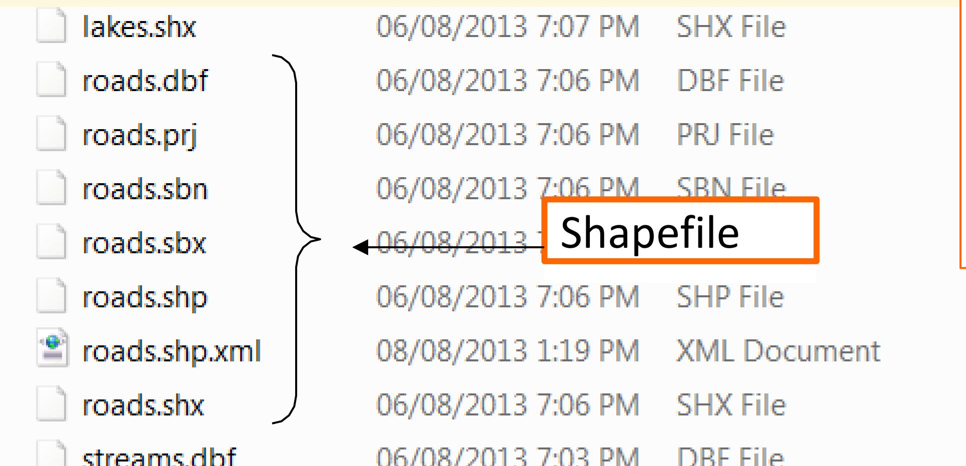
3401120	Samigaluh	17	0	32	17	3
3401060	Sentolo	593	430	803	1,023	120
3401010	Temon	17	1	28	18	0
3401020	Wates	38	135	99	173	30

Shapefile Vector File Format

• Shapefiles are vector composite files, made up of 3-13 separate files.

• In Windows Explorer all shapefile components are shown, in ArcCatalog entire shapefile is shown as one item.



* Basic shapefile elements (a shapefile is defunct without any of them).

Possible composite file extensions:

***.dbf** – dBase table (database) file, containing attributes.

***.shp** – the file that stores the feature geometry, i.e., x,y coordinates.

***.shx** – the file that stores the index connecting .dbf and .shp files.

.prj – projection file.

.shp.xml – metadata file.

.sbn, .sbx – spatial index files – sometimes present.

.ain and **.aih –** attribute index file.

.atx – new, ArcGIS,atribute index file.

.lxs, .mxs – geocoding index files.

.cpg – specifies character set code page.

•All components of a shapefile need to be present together (important when transferring files!), otherwise the shapefile can be defunct or incomplete.

•The projection file is a beneficial addition to a shapefile, although not a necessary one—shapefiles can be used without a projection file but this is to be avoided.

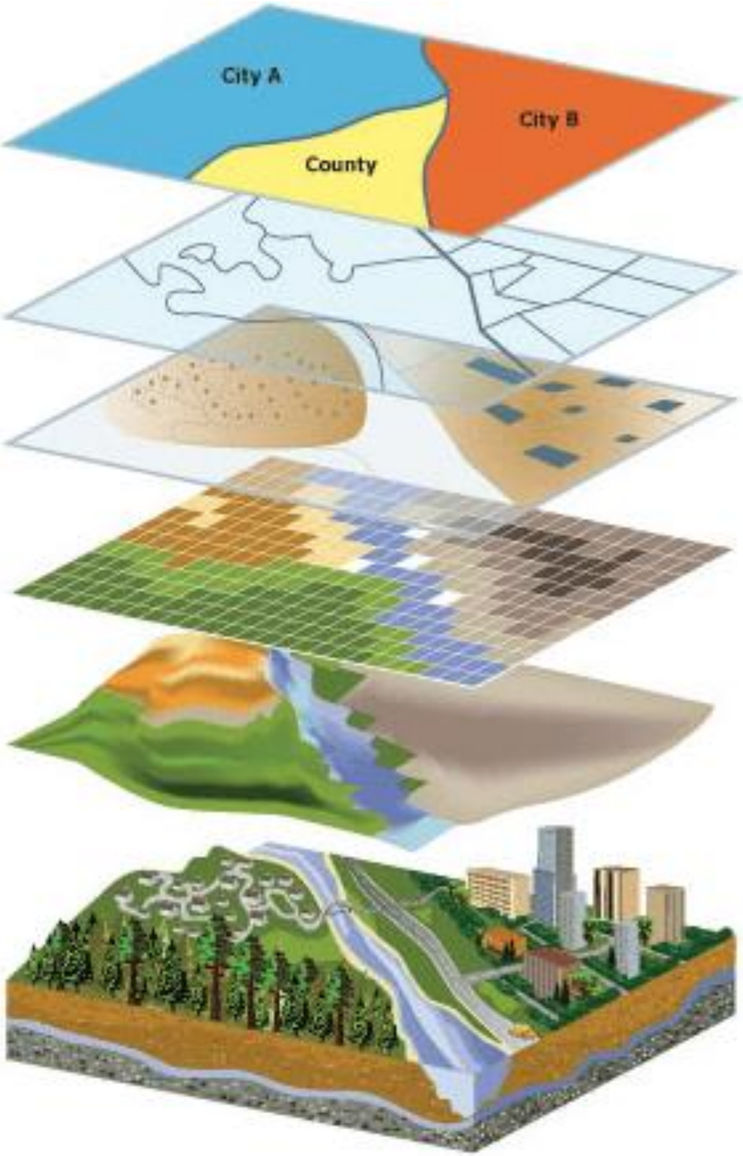
• All elements have the same filename (e.g., roads).

•Shapefiles can be either a point or a line (arc) or a polygon file -- <u>they cannot contain more than one shape type</u>!

Layer dibedakan

- bentuk grafis primitif
  - Point
  - Line
  - Polygon

- tipe fitur atau entity



Model Data TIN

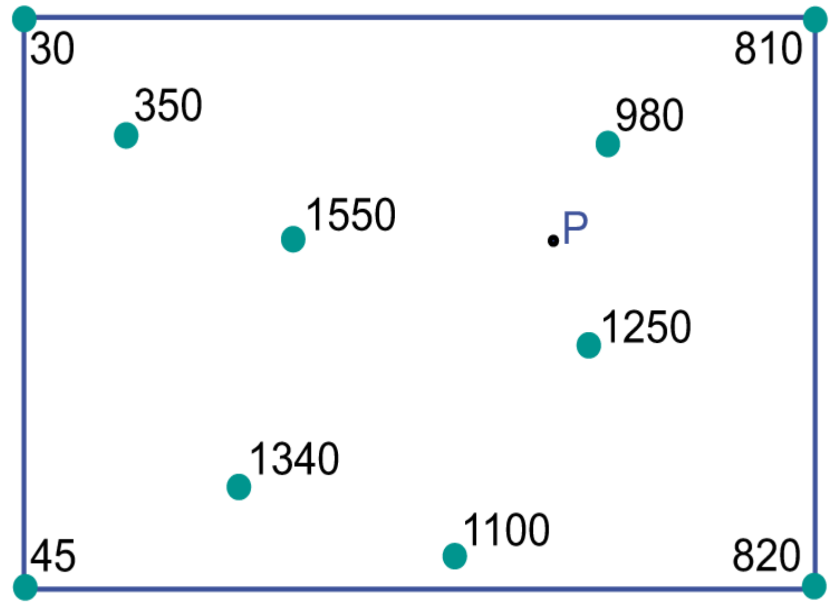
- **Model Data TIN** (*Triangulated Irregular Network*)
- Merupakan salah satu bentuk model data berbasis vektor dan digunakan untuk representasi permukaan tanah.
- Struktur data TIN mempunyai kelebihan untuk menyimpan data terrain suatu wilayah dikarenakan data masukan dapat berupa data acak, yang berarti merupakan data asli.

Model Data TIN (cont)

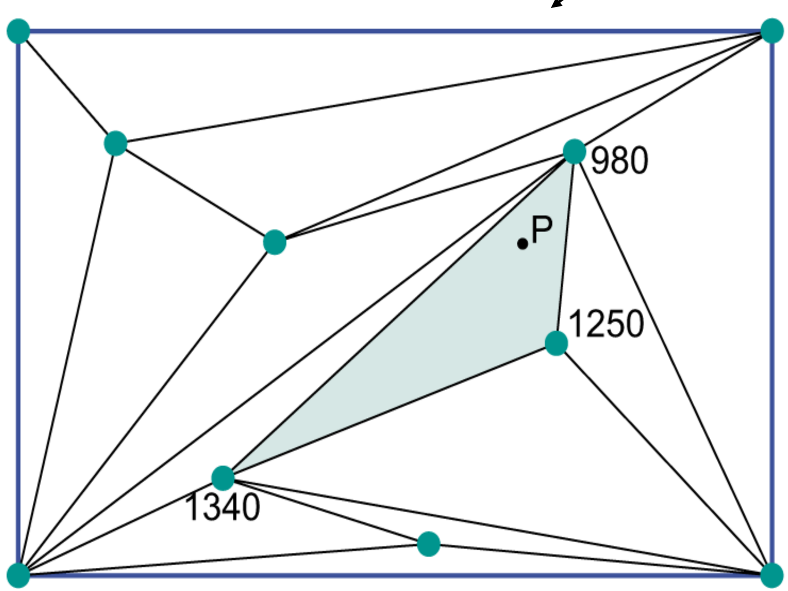
- Triangulated Irregular Networks
- Menggambarkan permukaan tanah
- Gabungan grid dan vektor
- Biasanya digunakan untuk topografi

Model Data TIN (cont)

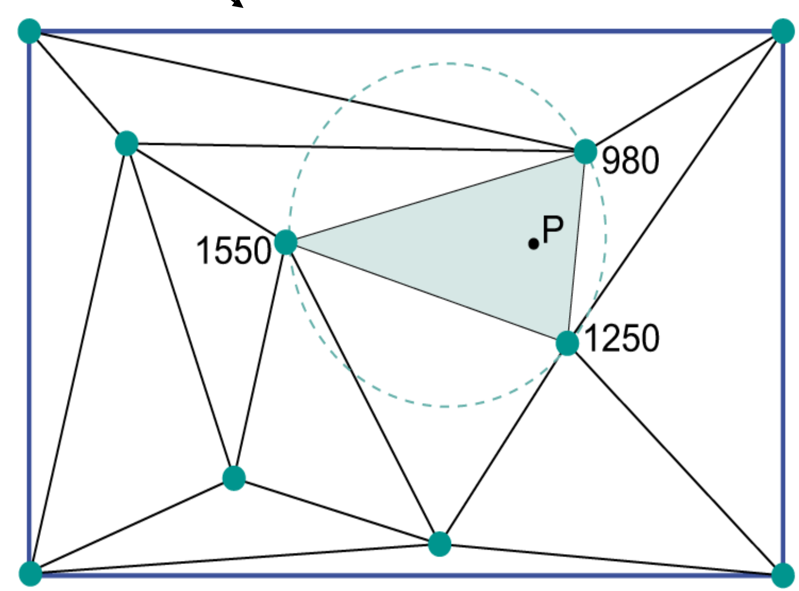
- TIN: 3 titik unik yang tidak terletak dalam 1 garis
- Sejak 3 buah titik diketahui posisi dan ketinggiannya, setiap posisi dalam segitiga tersebut diketahui



Tesseletion triangulasi



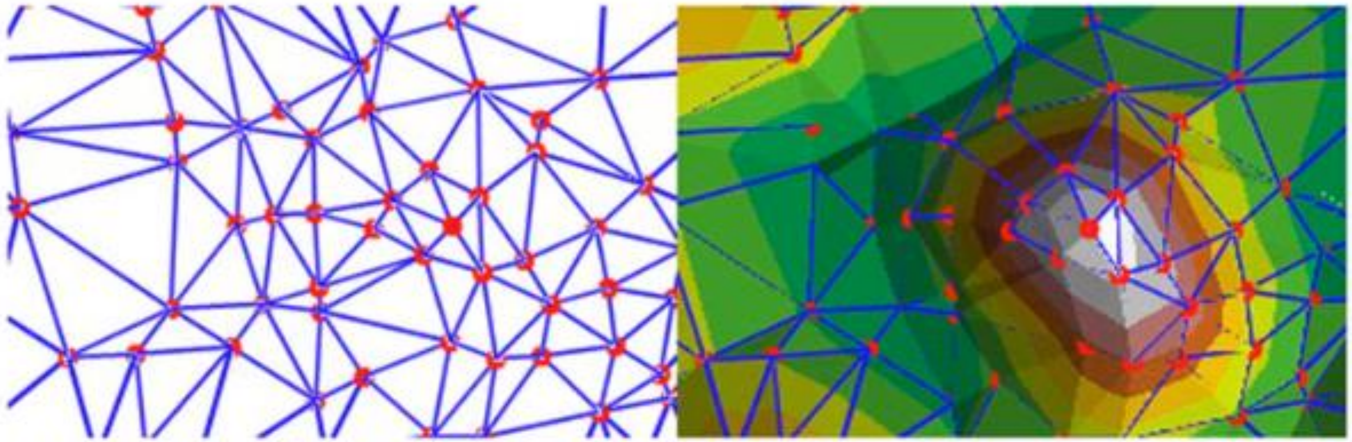
Delaunay triangulasi



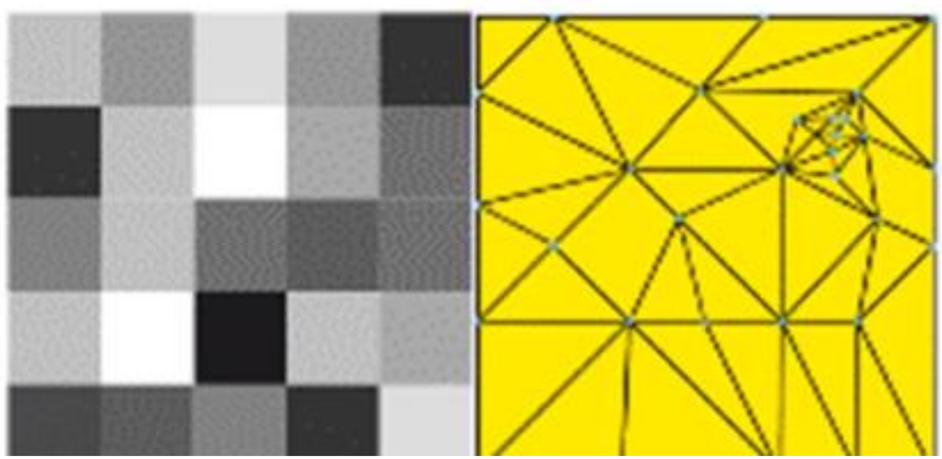
TIN

ArcGIS generates a TIN (Triangular Irregular Network) to interpolate elevation data and create a vector 3D model.

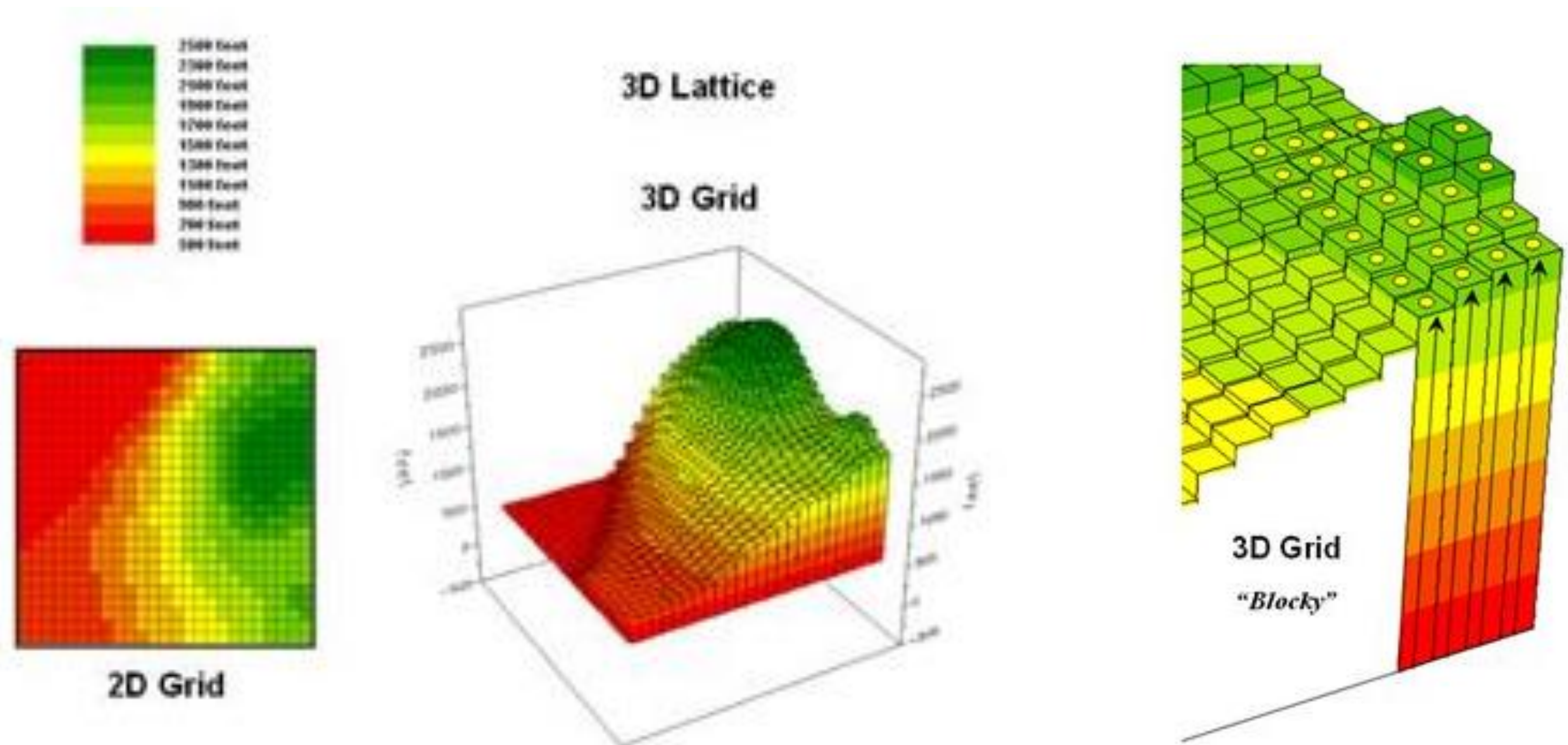
Connecting adjacent elevation points or nodes, triangles oriented in the 3D space are created, thus allowing to have a z for every possible x,y



Other GIS packages interpolate between vector data creating a raster map of elevation (one elevation for each pixel)



3D Raster



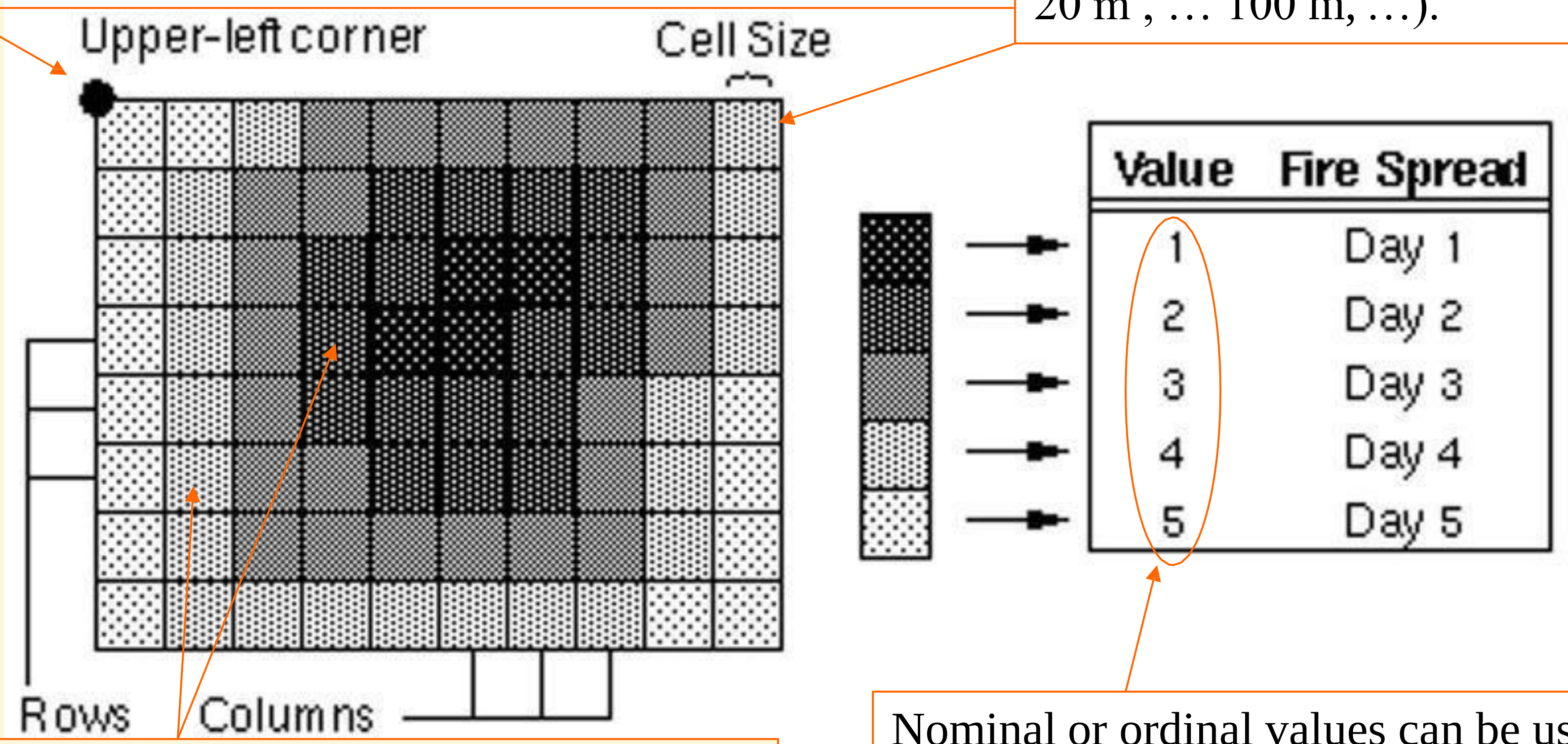
Data Raster

Raster Data Model

•Raster data model is represented by square cells of same size organized in horizontal rows and vertical columns (rows and columns are never slanted).

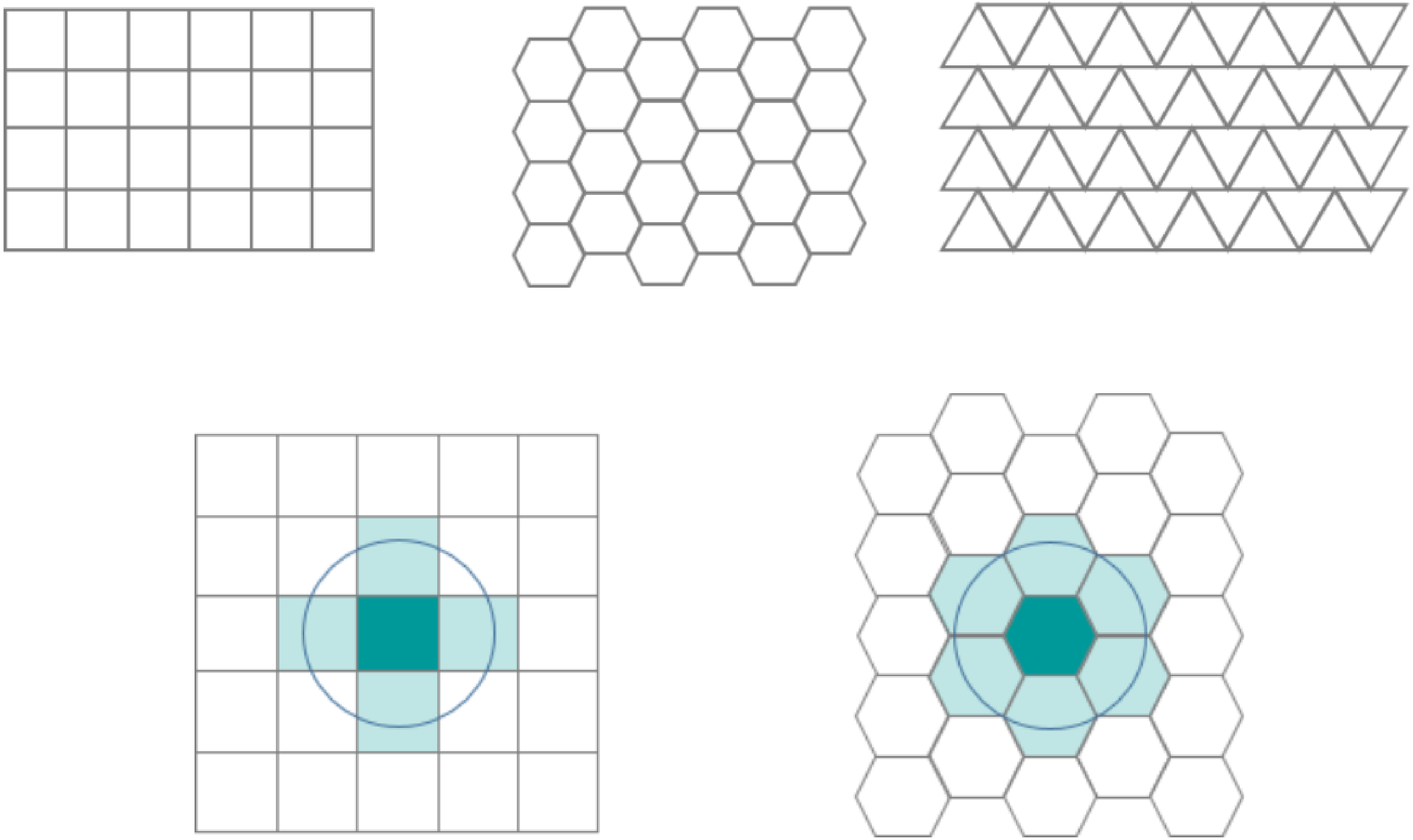
A raster's position (geographic location) is defined by assigning x,y coordinates to one or two corners -- positions of the cells themselves flow from this reference point and the overall Cartesian coordinate system structure.

Spatial resolution of a raster is defined by the cell size (1 m , … 20 m , … 100 m, …).



Each cell contains a value. Values are always numeric and can be either integer or decimal numbers (or nodata in grids).

Nominal or ordinal values can be used in the raster when something is not measured but classified into categories (themes).

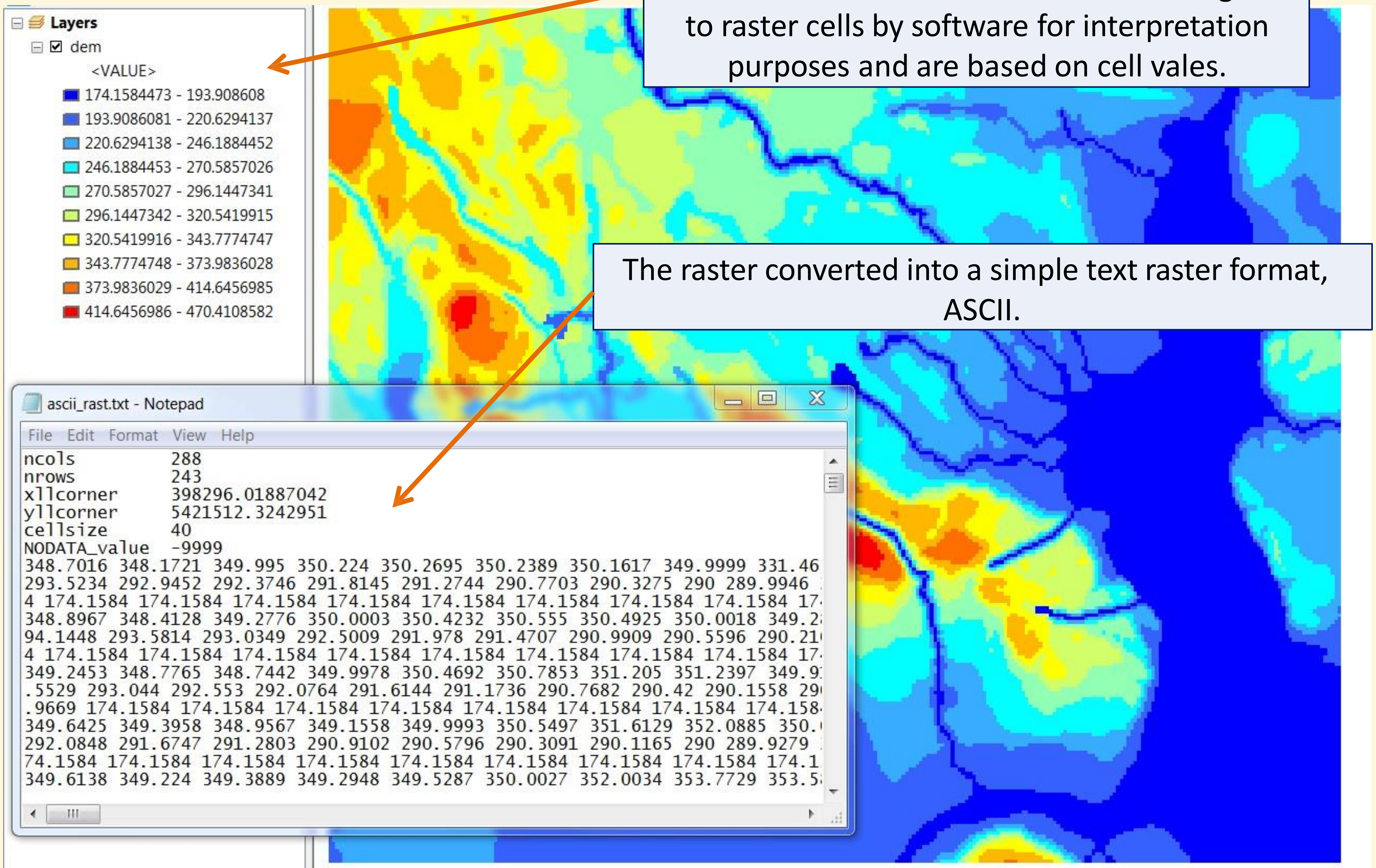


https://strimas.com/post/hexagonal-grids/

- A raster dataset representing terrain.

An ArcMap layer representing a raster that contains elevation values. The raster itself doesn't contain colours – colours are assigned to raster cells by software for interpretation purposes and are based on cell vales.

The raster converted into a simple text raster format, ASCII.



Raster Dataset Properties

- Format: the type of file used to store the raster (for example, .jpg, .tiff).

- Number of Bands: the number of layers in the raster file, representing the same area but through different values.

- Data Type: the type of data assigned to raster cells; integer (whole number), float (decimal number), etc. The data type is assigned to the entire raster, all cells have the same data type – there can't be one cell having an integer value and the next cell a float number value.

- Data Depth: also known as pixel or bit depth – the per-cell binary range assigned to the raster; e.g., an 8-bit integer raster can have integers (whole numbers) from 0 – 255 (8 bits = 255) assigned to a cell, only.

- Statistics: include minimum and maximum value, mean, and standard deviation of all values assigned to raster cells.

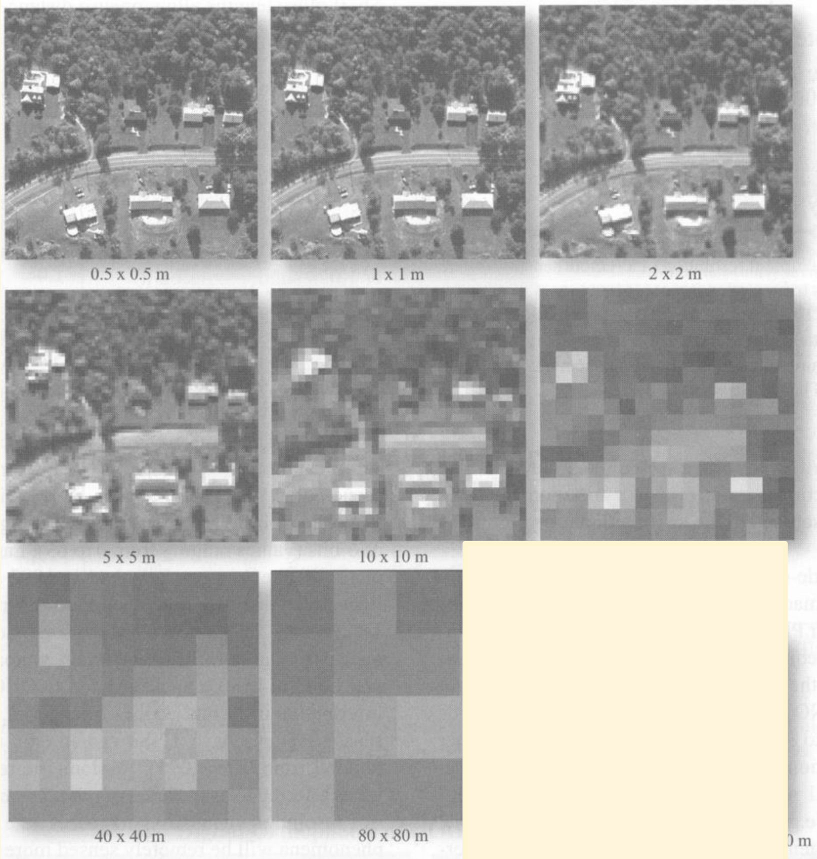
- Extents: left, right, top and bottom coordinates of the raster dataset.

- Projection: raster's coordinate system (map projection).

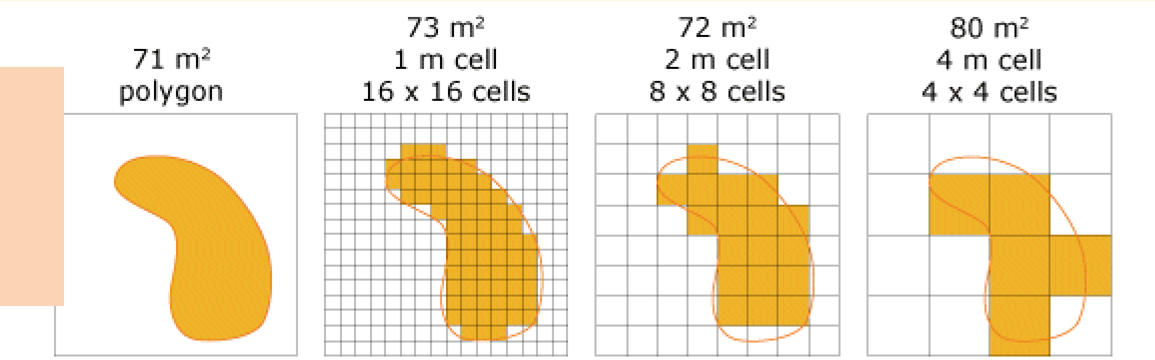
- Size of the Raster: the number of rows and columns in the raster.

Raster's Spatial Resolution

- Expresses the size of the earth surface represented by one (square) cell.
- A 10 m raster is a raster whose each cell represents 10 x 10 meters of the earth surface.
- Because of the nature of rasters and their easy computational resampling, raster spatial resolution does not necessarily represent the spatial variability on the ground.
- The measure of represented spatial variability is expressed with Ground Sampling Distance.
- For example, the 80 m raster in the example on the right can be taken and resampled into a 40 m raster, but in that case all four new 40 m cells within each original 80 m cell area would have the same cell value – the spatial resolution would become 40 m, but the Ground Sampling Distance would stay 80 m.



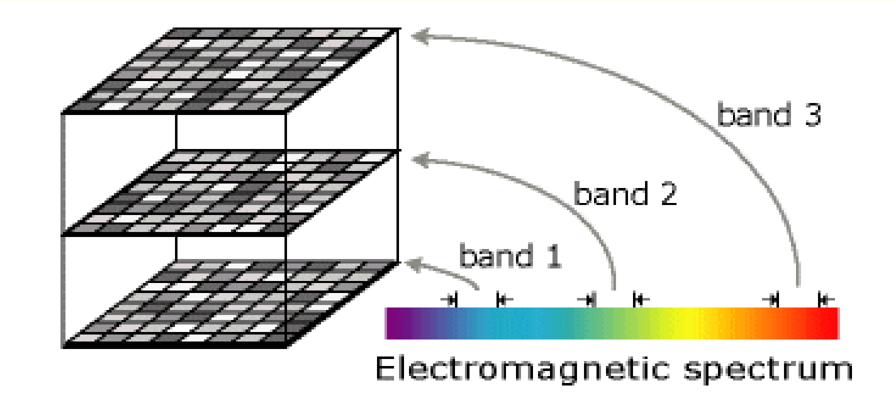
•Chosen coarseness of raster resolution has implications on the feature representation.



Raster Types Based on Cell Values

- In terms of the cell values, generally, rasters can be divided into image, interpolated, and thematic rasters.
- **Image rasters** have values that represent measurements of energy (reflections) captured by a sensor (camera).
- Image raster cell values are usually whole numbers (integers).

• Image raster files are often multiband

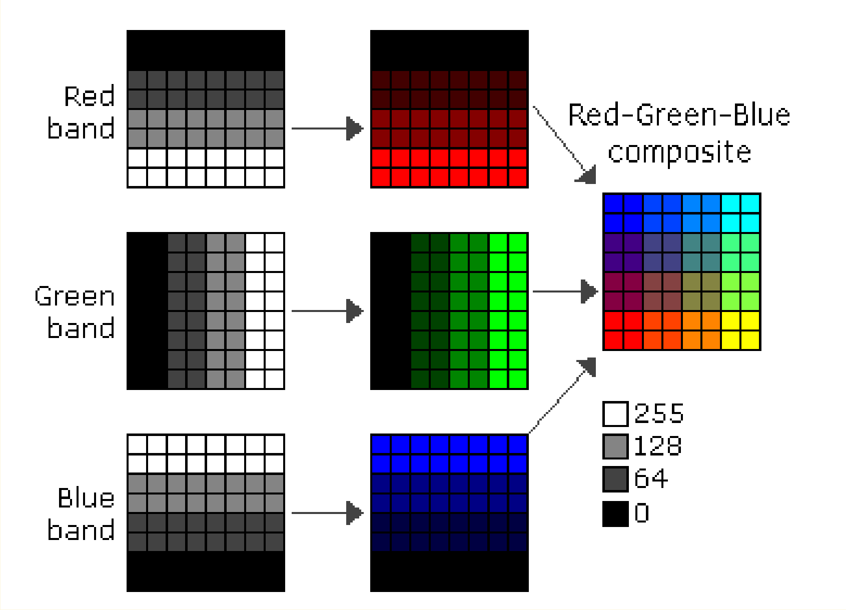


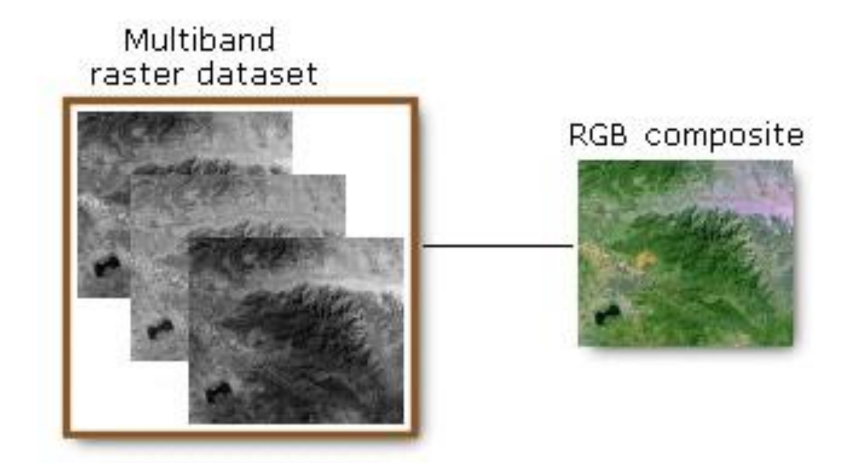
~ 610 – 660 nm

~ 530 – 590 nm

~ 430 – 490 nm

•Values representing different electromagnetic spectrum segments (i.e., primary colours, NIR, etc.), are stored in separate bands (channels) – spectral resolution!

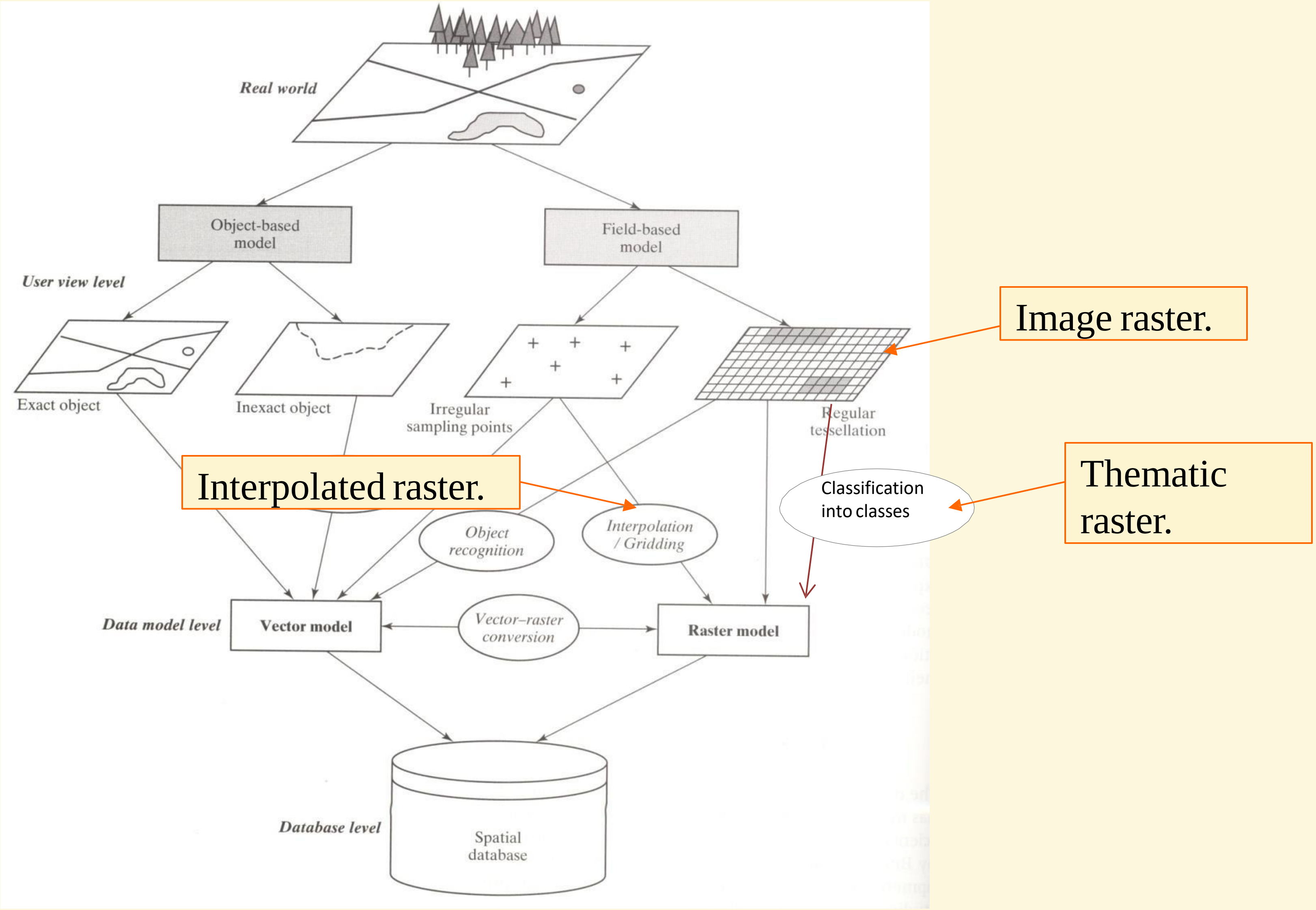




Source: ESRI, ArcGIS Help File, 2011.

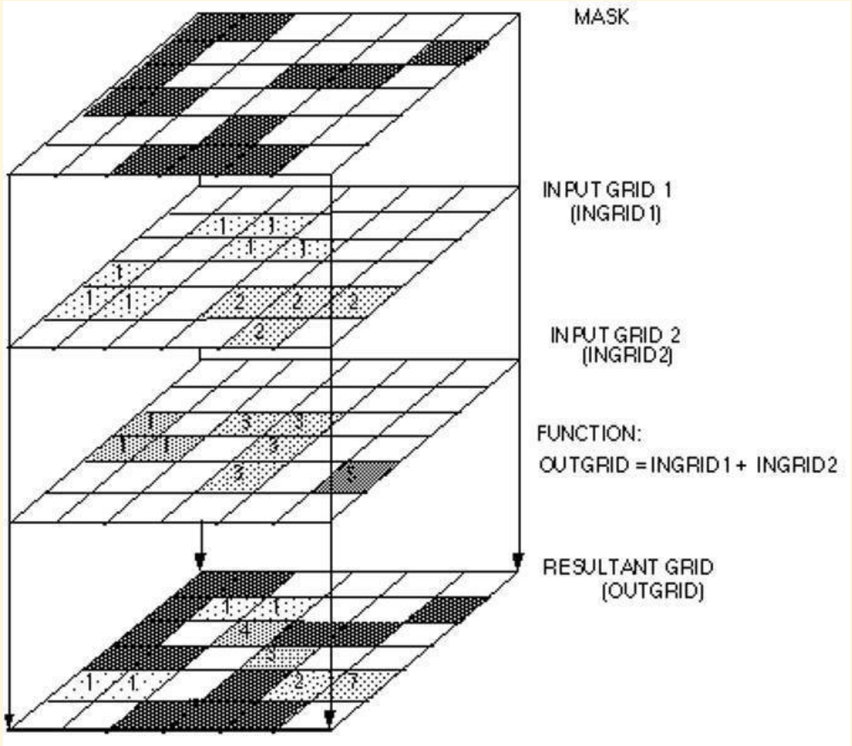
One byte (0-255) per pixel, per channel , if an 8 bit image;
three bytes per pixel (0-16,777,215) per channel , if a 24 bit image, etc.

Raster Types Based on Cell Values

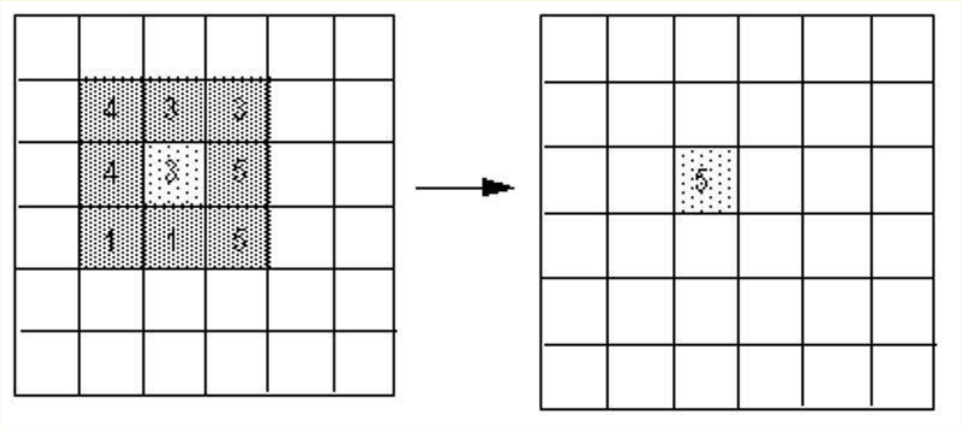


Regular pattern of sizes and distances in the raster data model means that topology is inherent to it, allowing for a range of spatial, topological analyses.

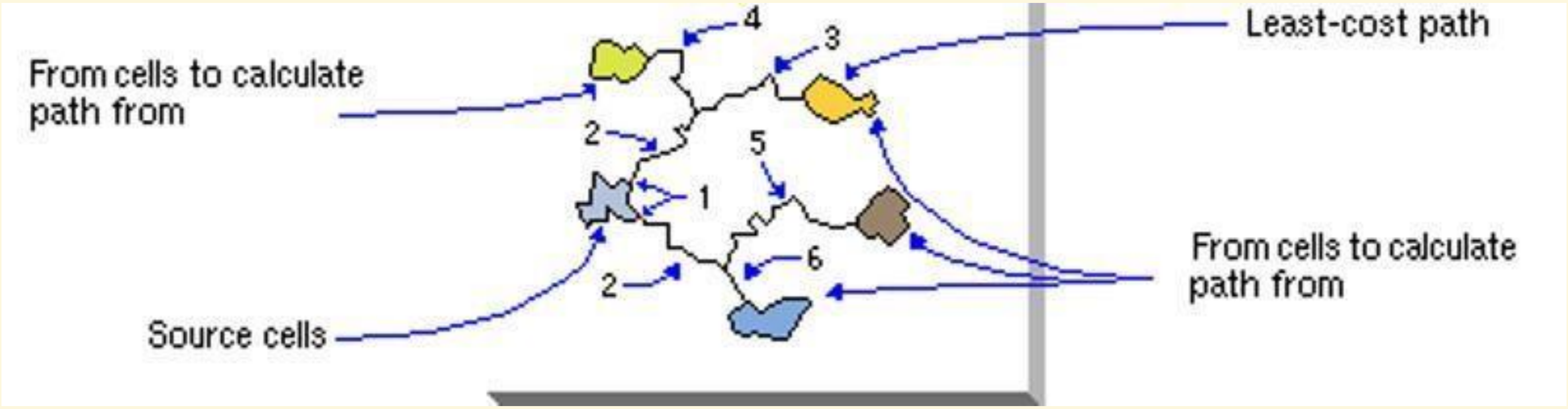
Relation Analyses Through Overlapping



Neighbourhood Analyses



Cost-Path Analyses



Raster Data Model

•In the raster data model, attributes are limited to the numeric values of the cells themselves, and while it is possible to link additional attributes to the groups of cells having same values, this is rarely done in practice for the reasons of low utilization value and cumbersome data management.

•Raster data models often take more memory space than the spatial component of the vector data models (attributes attached to the vector data models can tip the balance the other way).

• Rasters can also have NoData values, which indicates absence of data (not the same as zero!).

Typical Raster Data Formats in ArcGIS

GRID – a raster data format used by ESRI platforms; can contain both integers and floats; usually one-band but can be stacked into so called grid stacks.

.img – a raster file format created for ERDAS, a remote sensing software.; can contain both integers (up to 32 bit) and floats; can be both one-band or multiband (including > 3 bands).

.tiff - can contain both integers (up to 32 bit) and floats; can be both one-band or multiband (including > 3 bands).

.jpg - cannot contain > 8-bit (unsigned) values and cannot have > 3 bands.

ASCII – uncompressed, simple raster data format, used to transfer information.

Vector and Raster Data Models and Their Advantages

Vector Data Model

Suitable for:

•Recording discrete features with definable boundaries.

•Attaching both textual and numerical attributes to spatial features, and managing and analyzing these attributes and through them the features themselves.

•Editing, update, and management of the spatial features.

•Representing natural shapes.

Raster Data Model

Suitable for:

•Representing continuous spatial features.

• Containing images (aerial, satellite) .

•Analyzing relations between continuous phenomena taking place on the same geography.

•Analyzing spatial relations between features (cost-path, density, interspersion, edge contact, etc.).

• Neighbourhood analyses.

In many respects, vector and raster data models complement each other and get switched between along the processes of data collection, observation, analyses, and presentation.