SGHU 2552
Introduction to Geographic Information System

Chapter Three

Mohammad Zakri Tarmidi, PhD
Department of Geoinformation
Faculty of Geoinformation and Real Estate

Chapter 3

SPATIAL DATA MODELLING

Content

- Introduction
- Entities definition
- Spatial data models
- Spatial data structures
- Modelling surface
- Modelling networks
- Building computer worlds
- Modelling the third and fourth dimension
- Conclusion

INTRODUCTION

How to model the spatial data?

How to store and what structure computer can understand?

Some questions to ponder;

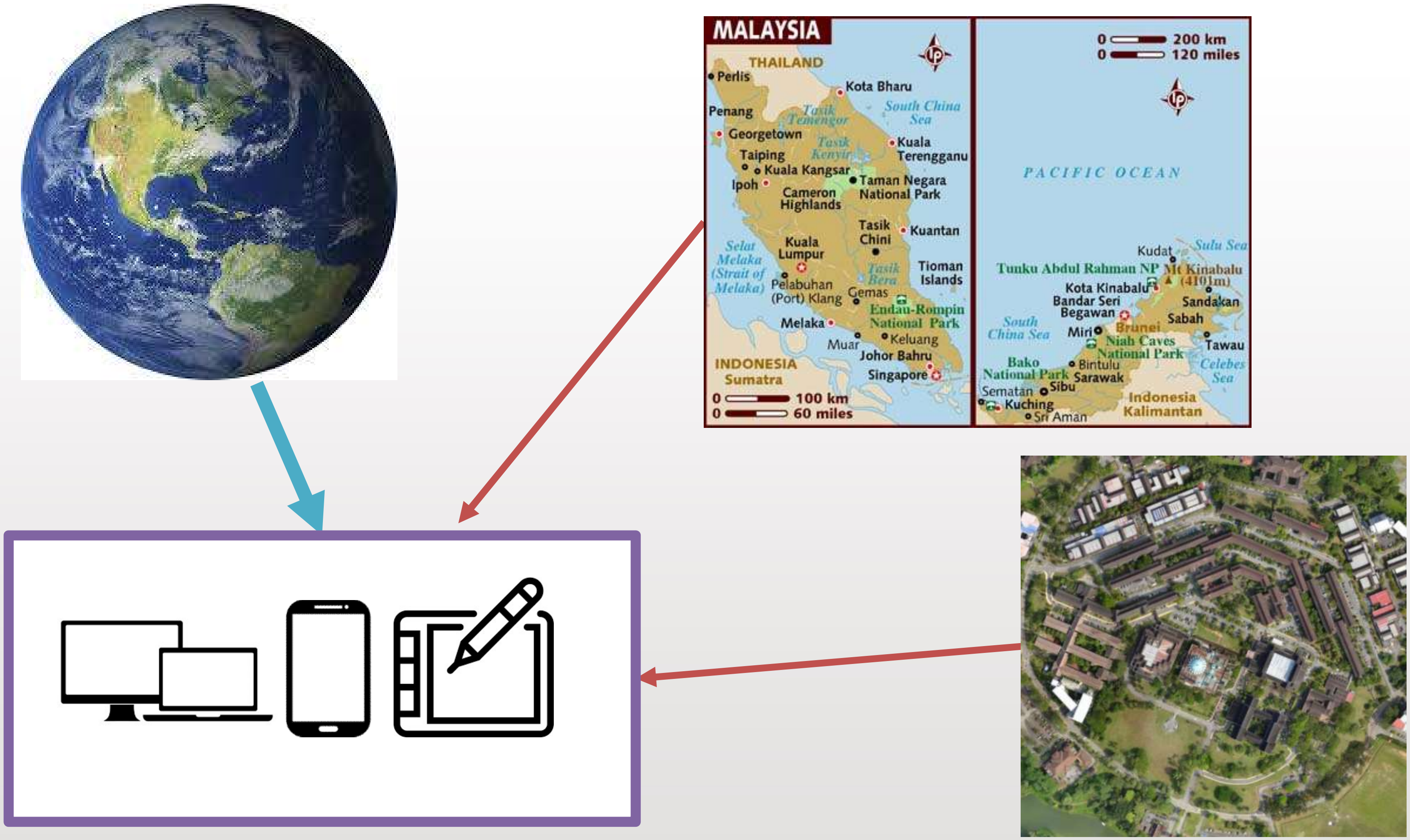
- What is spatial data model?
- How are spatial entities used to create a data model?
- What are raster and vectors data?
- What is a spatial data structure?
- What is topology and how is it stored in the computer?
- What are the advantages and disadvantages of different spatial data models?
- How are time and the third dimension handled in GIS?

Introduction

Spatial data represent;

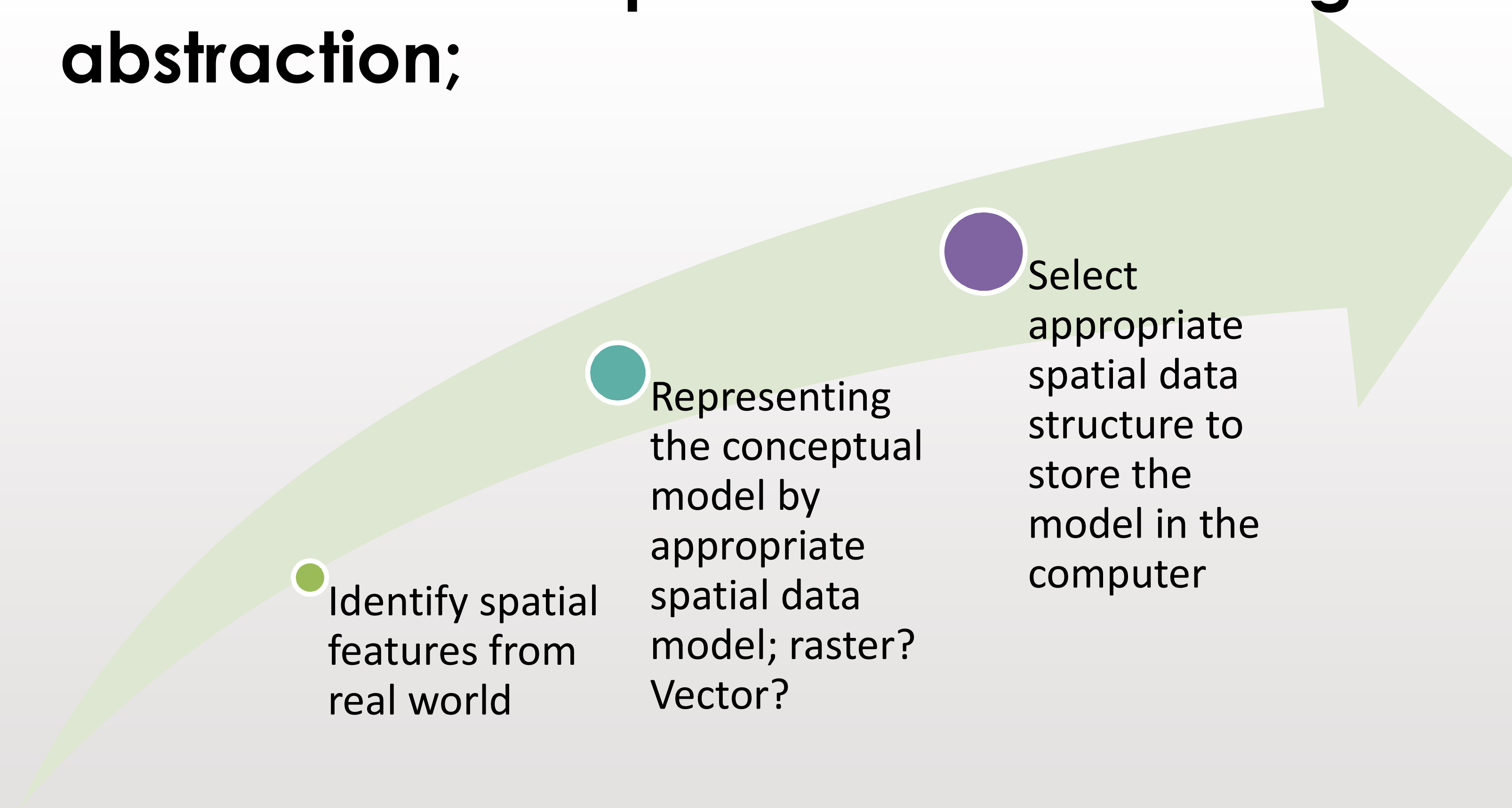
- **Structure** and **distribution** of **features** in geographical sphere
- Must **considered interaction** between features

(cont.) Introduction



(cont.) Introduction

- **Construction of spatial data have stages of abstraction;**



ENTITY DEFINITION

Entity Definition

Everything change

- Tree grow
- River flood
- Cities expand

Two main issues;

- How to select entities type for appropriate representation?
- How to represent changes over time?

(cont.) Entity Definition

Road;

for user, line is sufficient, for road engineer? Road maintainer?

Sea;

level of water? High tide? Low tide? For container ship? Fishermen? Marine force?

(cont.) Entity Definition

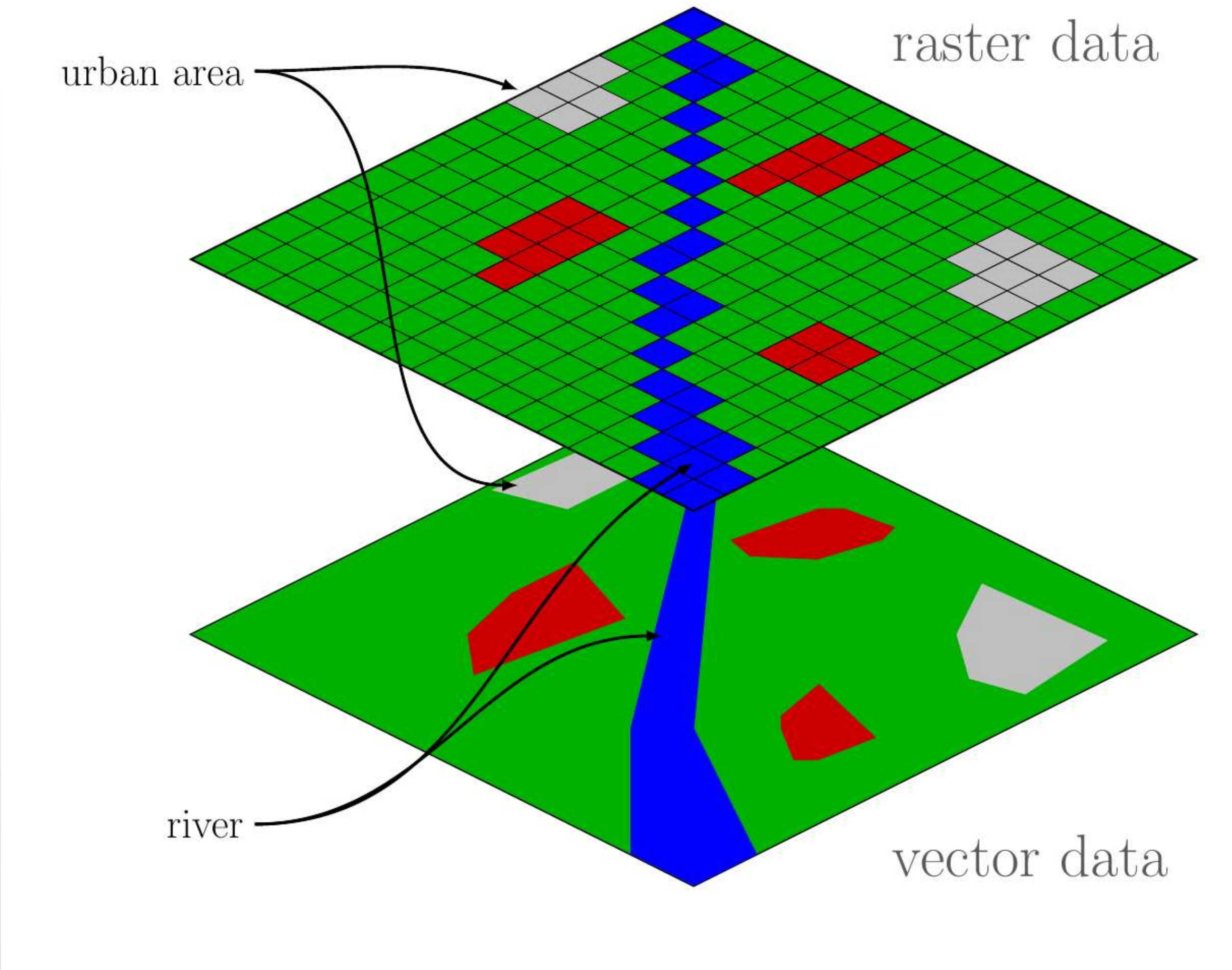
- Entities and feature selection not straight forward, it need experience and know how to produce

SPATIAL DATA MODEL

Spatial Data Models

- **Human** can **understand real world**, can describe, but how about computer?
- Currently, computer recognized; **vector and raster** model.

How entities been show in computer



(cont.) Spatial Data Models

Raster	• Using grid
Example	• Hospital – 1 single cell, discrete cell • Road; linking cell to the lines • Boundaries; group of cells

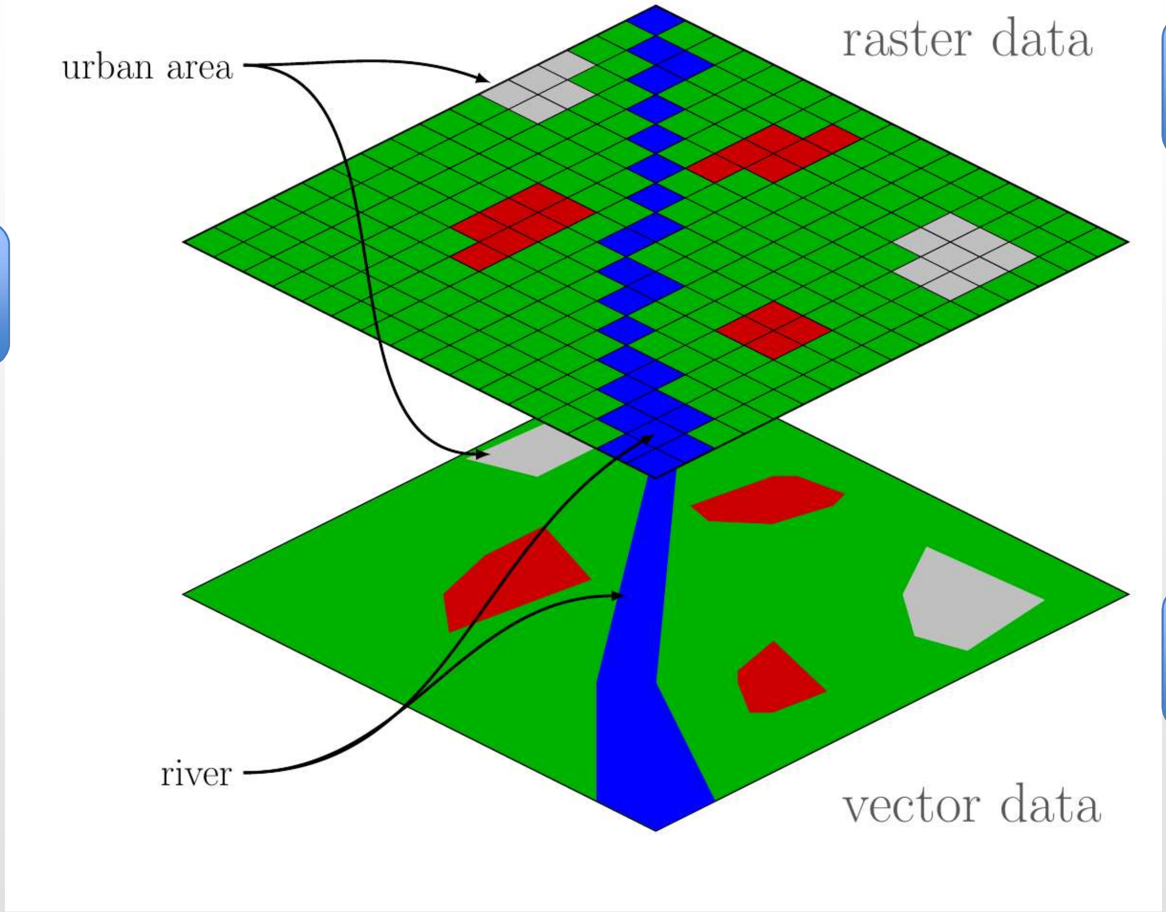
(cont.) Spatial Data Models

- Vector

  - Using ID point (x,y), or coordinate to store
  - Need to select appropriate point to represent
  - Maybe duplicate point?
  - Too few point = shape will be compromise

(cont.) Spatial Data Models

Polygon



Point

Line

Spatial data structure

To store information

Data structure give information in digital form

Two type of spatial data structure;

- Raster
- Vector

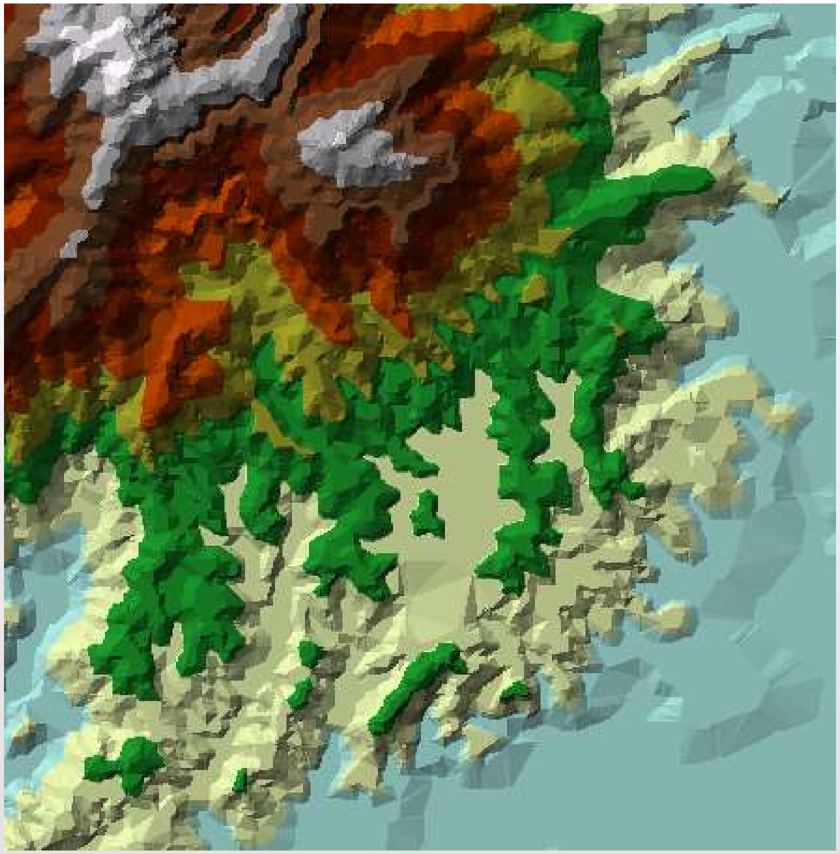
MODELLING SURFACE

Modelling the surfaces

Surface Modelling

Modelling surface of height? Pollution? Rainfall?

Surface using Digital Terrain Model (DTM)



(cont.) Modelling the surfaces

Raster approach;

↓

Grid height;

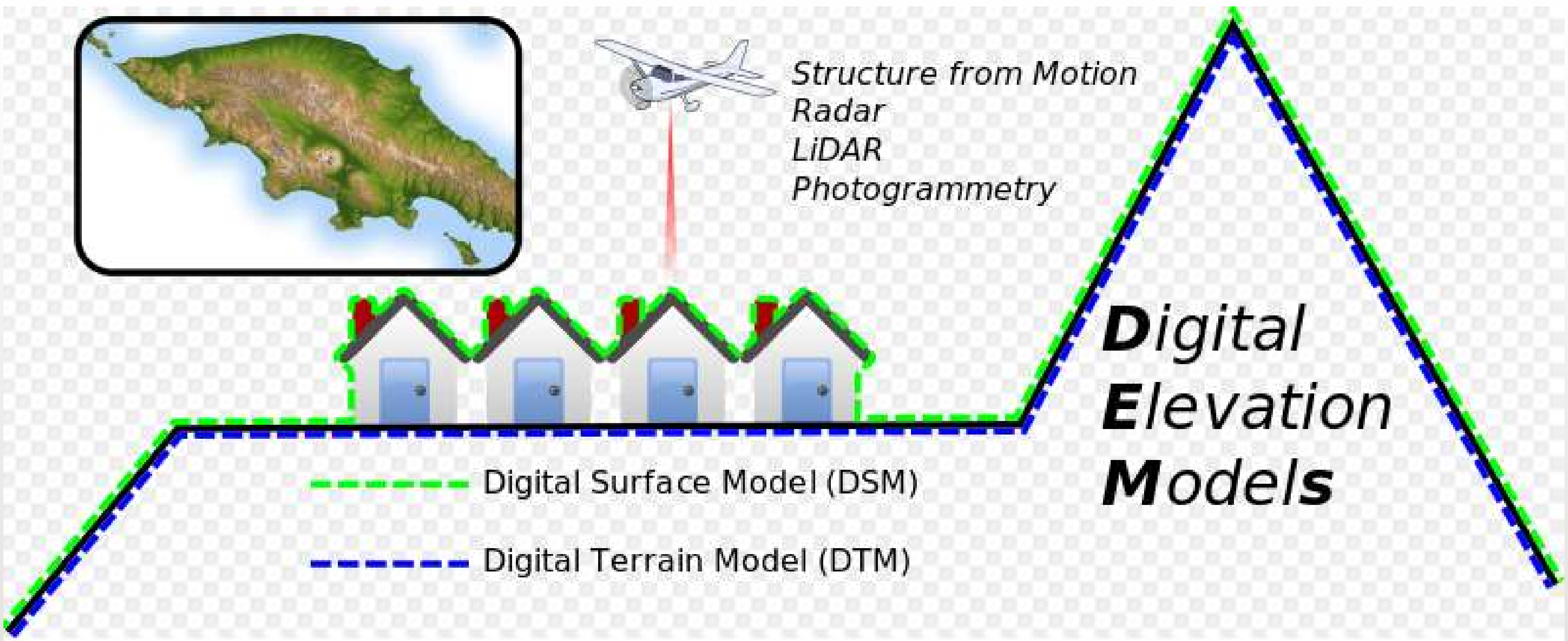
Each cell have height information

↓

Accuracy?

Depend on complexity and resolution

(cont.) Modelling the surfaces



(cont.) Modelling the surfaces

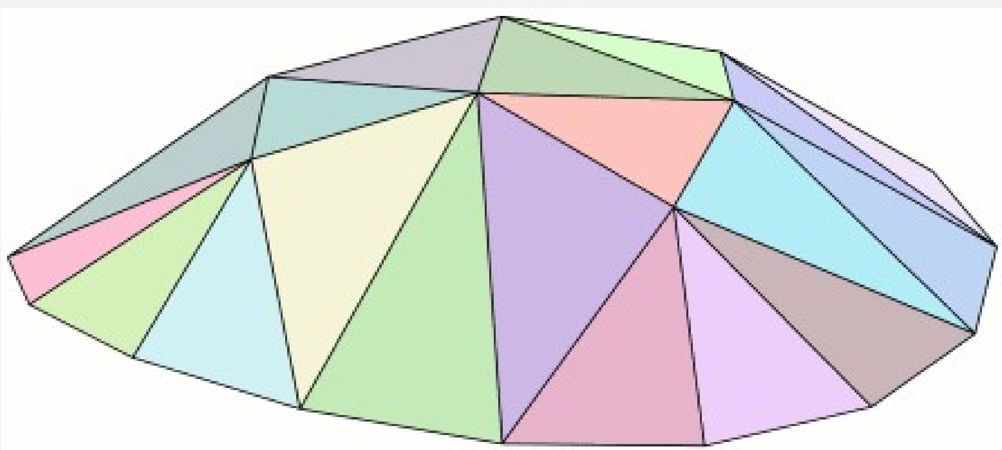
Vector approach;

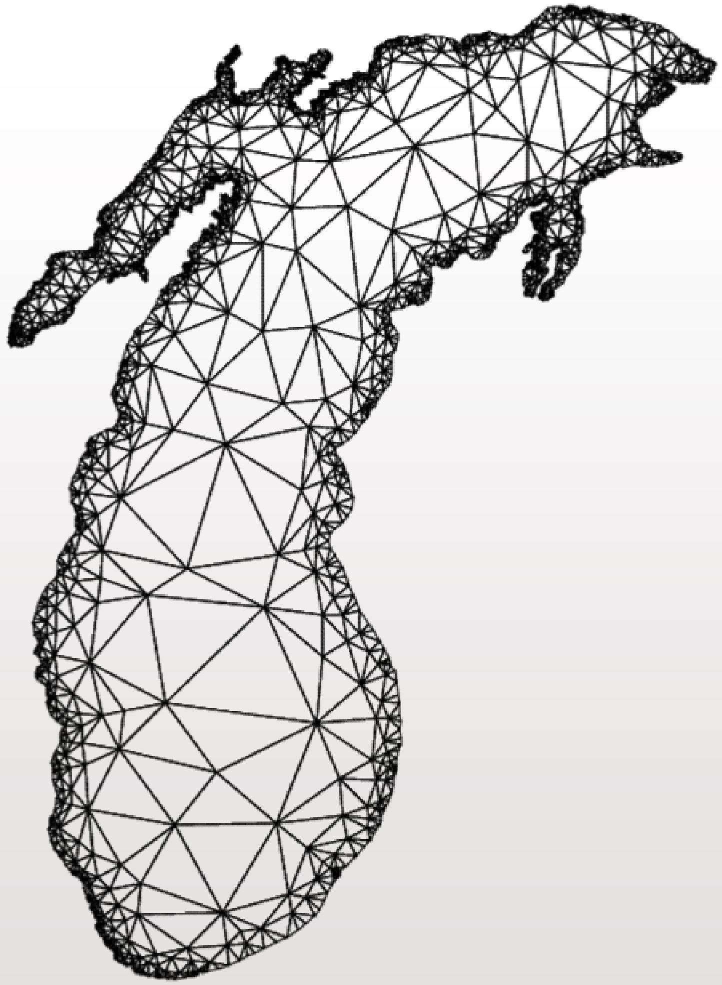
- Spot height for terrain surface
- Using TIN: Triangulated Irregular Network

Mosaic of irregular triangle

(cont.) Modelling the surfaces

Example of TIN





MODELLING NETWORK

Modelling network

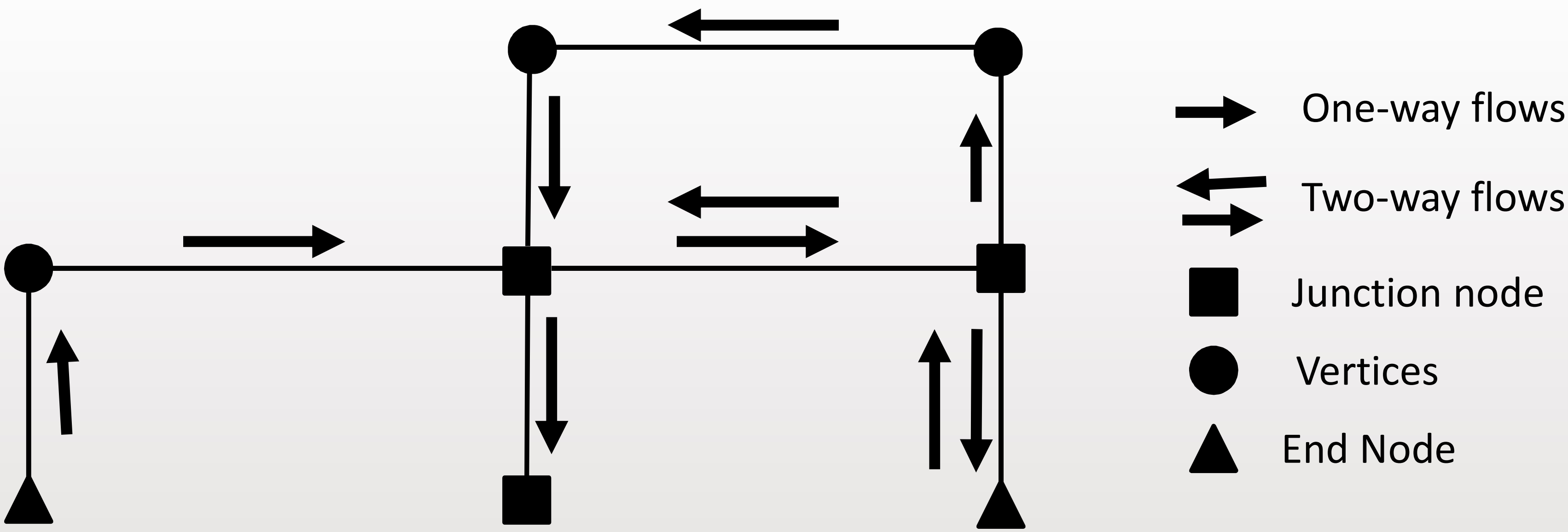
Network;

- Connected linear features (line)

Topology;

- Correct and connectivity are extremely important

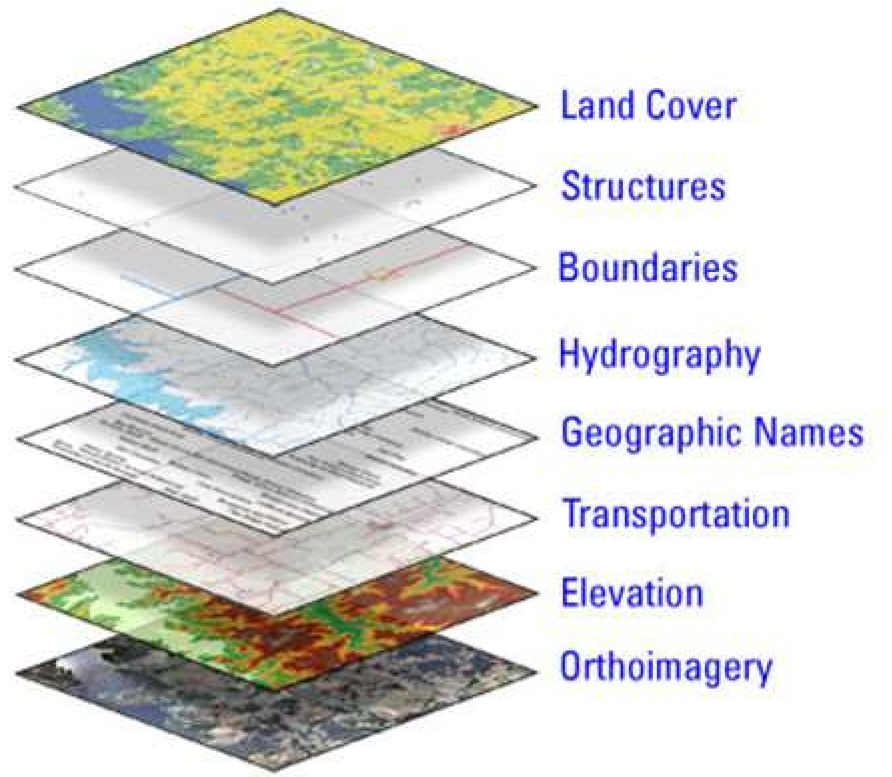
(cont.) Modelling network



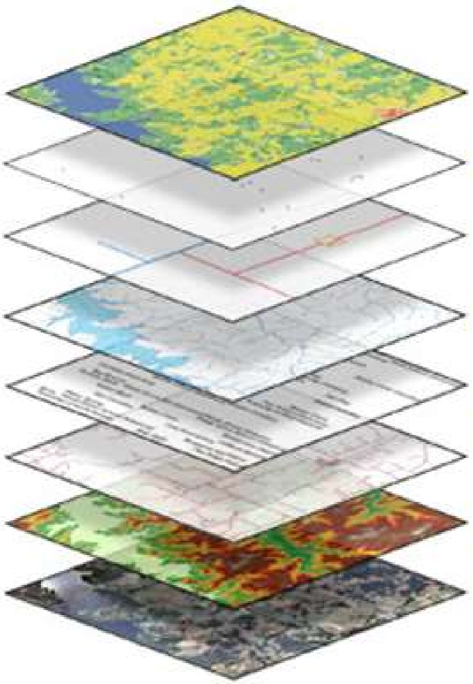
BUILDING COMPUTER WORLDS

Building computer world

- How to construct computer world by grouping spatial entities together?
- Common methods; layered entities



(cont.) Building computer world



Thematic layers

Select Layers

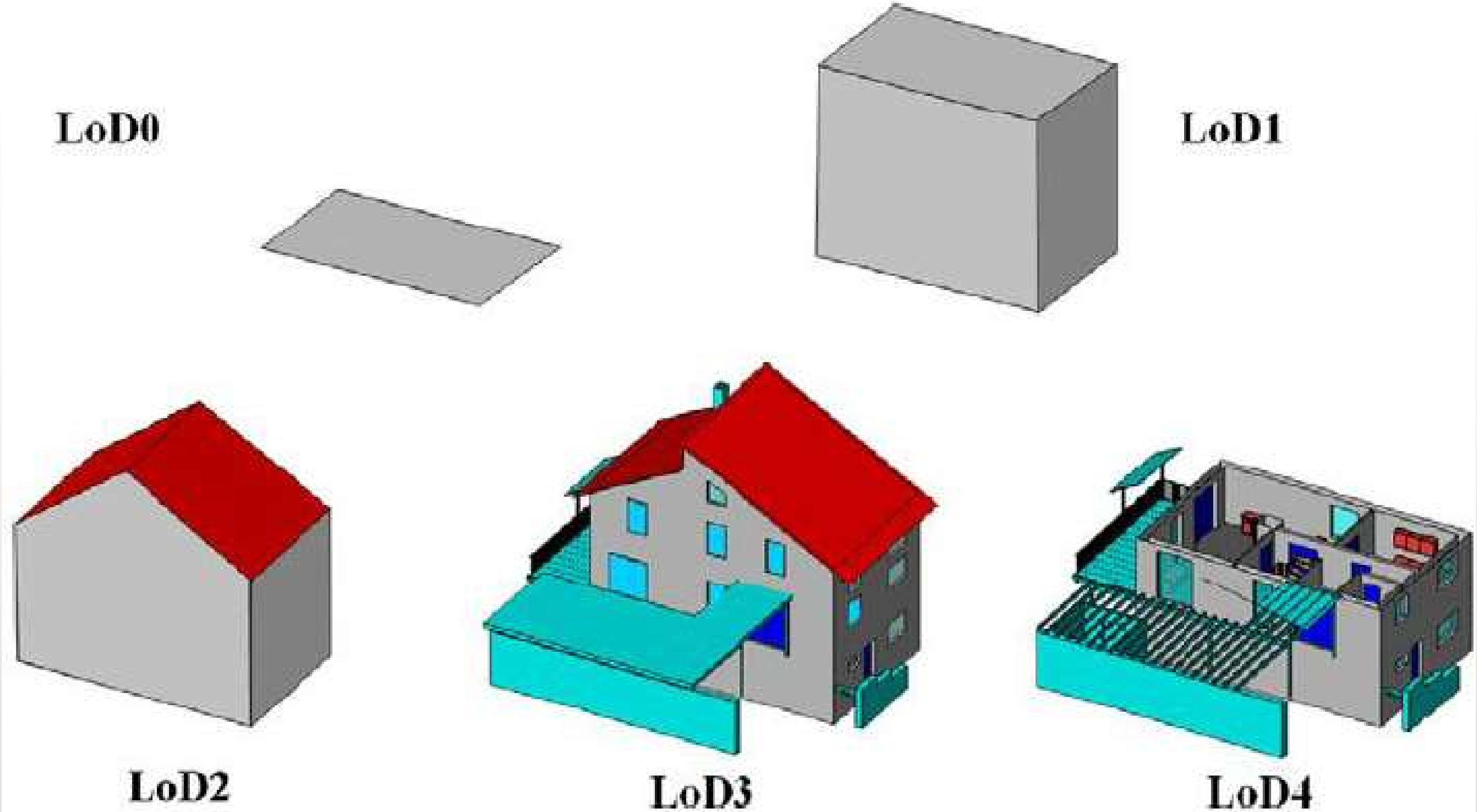
Point of Interest Map Malaysia

MODELLING THIRD AND FOURTH DIMENSION

Modelling third and fourth dimension

3 dimensional data model:	• 3D Data
Surface;	• 2.5 dimension
3D Data;	• It will required 3D topology; which is extremely difficult
3D data model	• Has been developed, but not matured yet

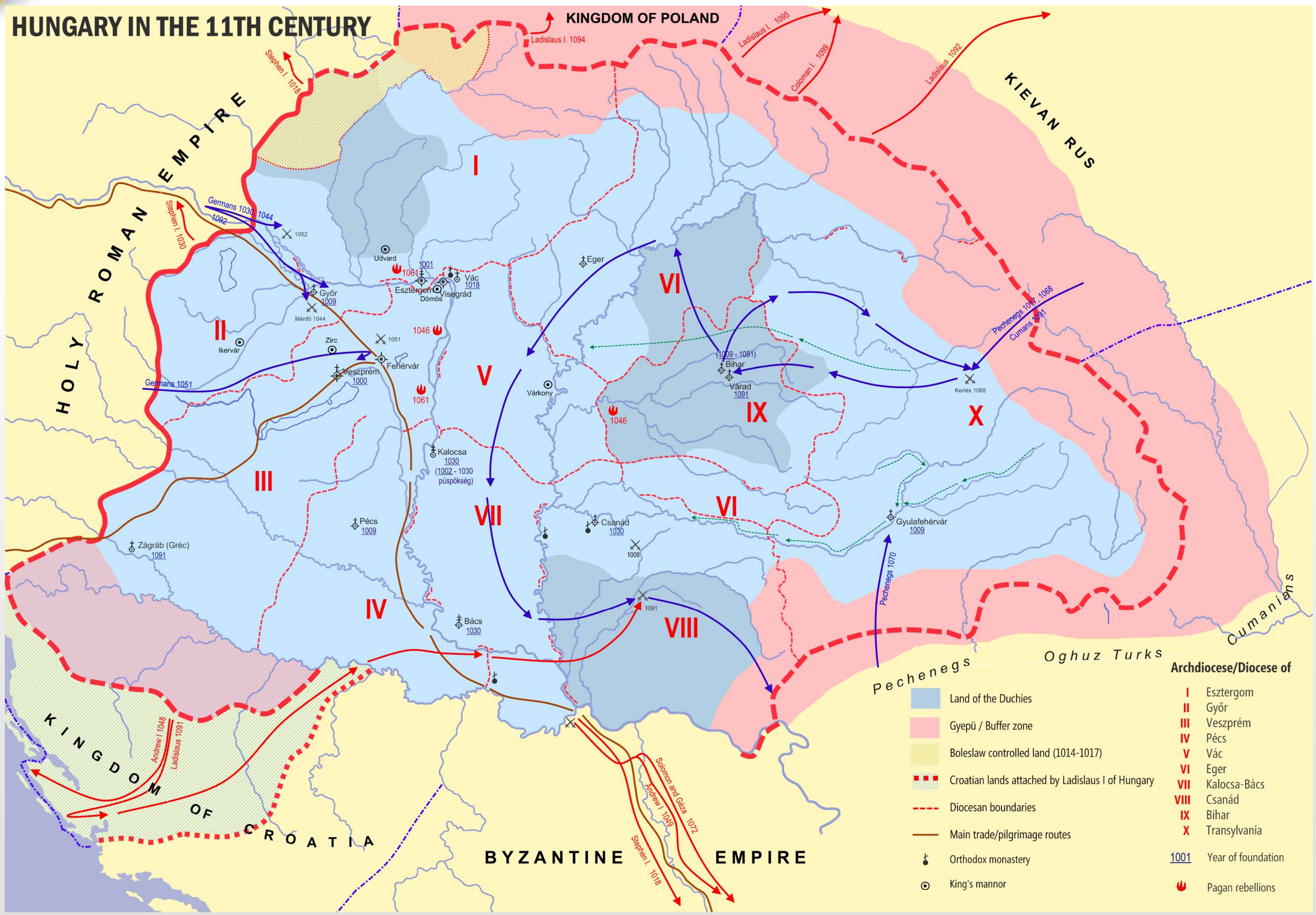
Level of Detail (LoD)

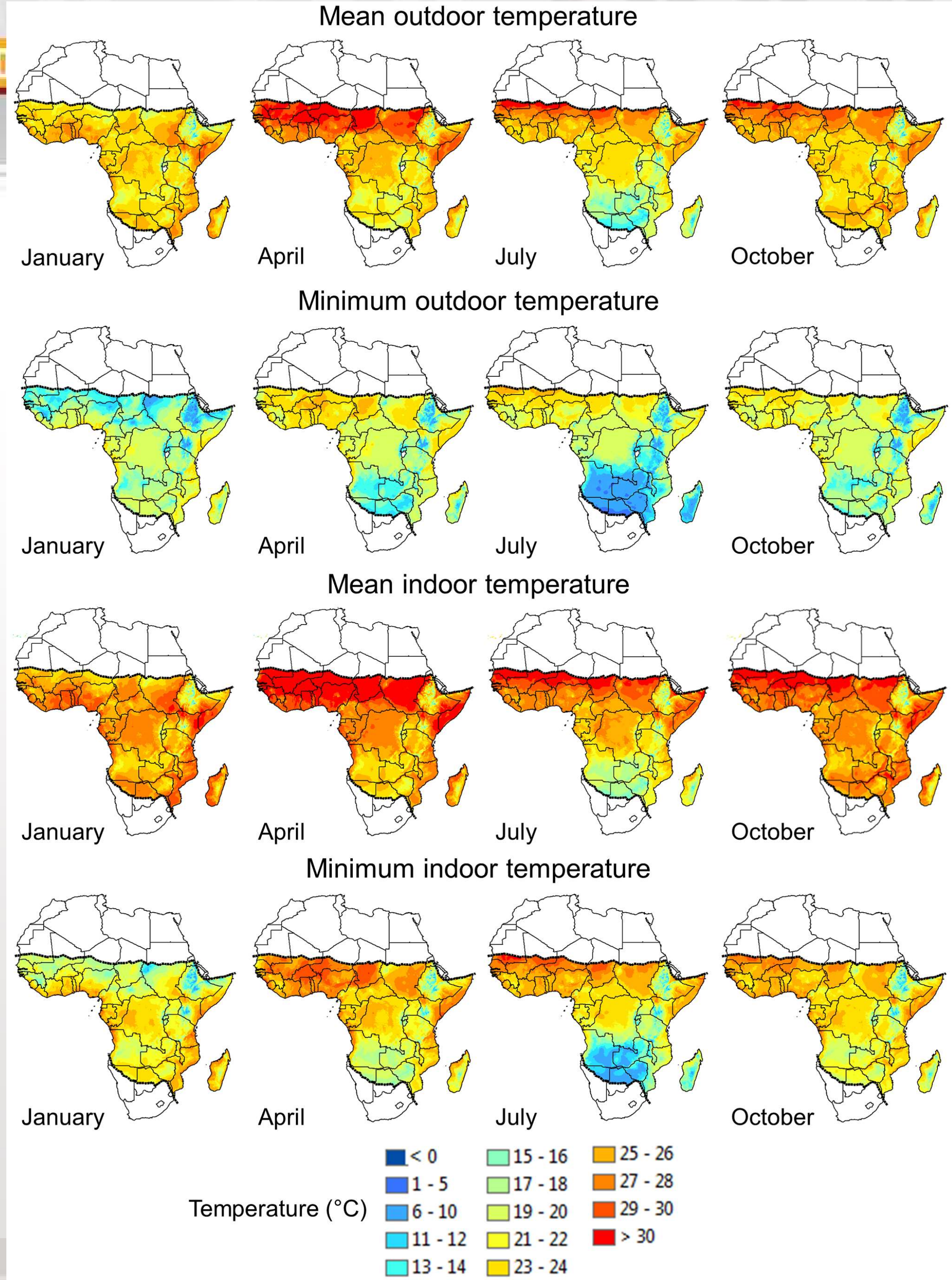


Source: Biljeki et al, 2016

(cont.) Modelling third and fourth dimension

- 4 Dimensional Data Model: **4D Data**
- Data have **different period** of **time**
- Basically: **2D + time** or **3D + time**


HUNGARY IN THE 11TH CENTURY
KINGDOM OF POLAND
HOLY ROMAN EMPIRE
KIEVAN RUS
KINGDOM OF CROATIA
BYZANTINE EMPIRE
Pechenegs
Oghuz Turks
Cumanians
Germans 1030, 1044
Germans 1051
Stephen I. 1018
Stephen I. 1030
Ladislaus I. 1094
Ladislaus I. 1095
Coloman I. 1099
Ladislaus 1092
Pechenegs 1017, 1068
Cumans 1091
Pechenegs 1070
Andrew I 1048
Ladislaus 1091
Solomon and Géza 1072
Andrew I 1049
Stephen I. 1018
Udvard
Győr 1009
Ménfő 1044
Esztergom 1001
Dömös
Visegrád
Vác 1018
Ikervár
Zirc
Veszprém 1000
Fehérvár
Eger
Várkony
Bihar (1009 - 1091)
Várad 1091
Kerlés 1068
Kalocsa 1030 (1002 - 1030 püspökség)
Pécs 1009
Csanád 1030
Gyulafehérvár 1009
Zágráb (Grécs) 1091
Bács 1030
I
II
III
IV
V
VI
VII
VIII
IX
X
Land of the Duchies
Gyepü / Buffer zone
Boleslaw controlled land (1014-1017)
Croatian lands attached by Ladislaus I of Hungary
Diocesan boundaries
Main trade/pilgrimage routes
Orthodox monastery
King's mannor
Archdiocese/Diocese of
I Esztergom
II Győr
III Veszprém
IV Pécs
V Vác
VI Eger
VII Kalocsa-Bács
VIII Csanád
IX Bihar
X Transylvania
1001 Year of foundation
Pagan rebellions


Mean outdoor temperature
January
April
July
October
Minimum outdoor temperature
January
April
July
October
Mean indoor temperature
January
April
July
October
Minimum indoor temperature
January
April
July
October
Temperature (°C)
< 0
1 - 5
6 - 10
11 - 12
13 - 14
15 - 16
17 - 18
19 - 20
21 - 22
23 - 24
25 - 26
27 - 28
29 - 30
> 30

Conclusion

- **This chapter discuss on;**
  - Detailed how to model spatial data
  - Reviewed on basic spatial data entities
  - Raster vs Vector spatial data structure
  - Modelling of 3D and 4D

Terima kasih

References

- Biljecki, Filip, Hugo Ledoux, and Jantien Stoter. "An improved LOD specification for 3D building models." *Computers, Environment and Urban Systems* 59 (2016): 25-37.