Introduction to Georeferencing.

MAR-E1046 Basics of GIS.

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Slides borrowed from Jaakko Madetoja

Georeferencing

Data editing

New layers

Attribute editing

Learning goals

Today you will learn

- To describe the basics of different types of referencing systems
- To explain the differences between geographical and projected coordinate systems
- To calculate and detect values of different projected coordinate systems
- To define and transform coordinate systems in ArcMap

What is georeferencing?

- **Georeferencing = to express a location on Earth**
  Location has to be known in GIS

- **We need a reference system to describe a location**
  Reference system has to be
  Unambiguous (to some extent)
  Known to users
  Constant in time

- **Properties of reference systems:**
  Accuracy of positioning
  Type: Metric (distances), ordinal, or nominal

Different types of reference systems

- Place names
- Street addresses
- Identification system

Discussed only shortly, because they are rarely used in a GIS

- **Coordinate system**

Place names

- **Common in every day positioning**
- **Names often commonly known**
  Some can be only locally known
  Same name for different places; ambiguous
- **System scales really well**
  From continents to small villages
- **Changes (slowly) in time**

Identification systems

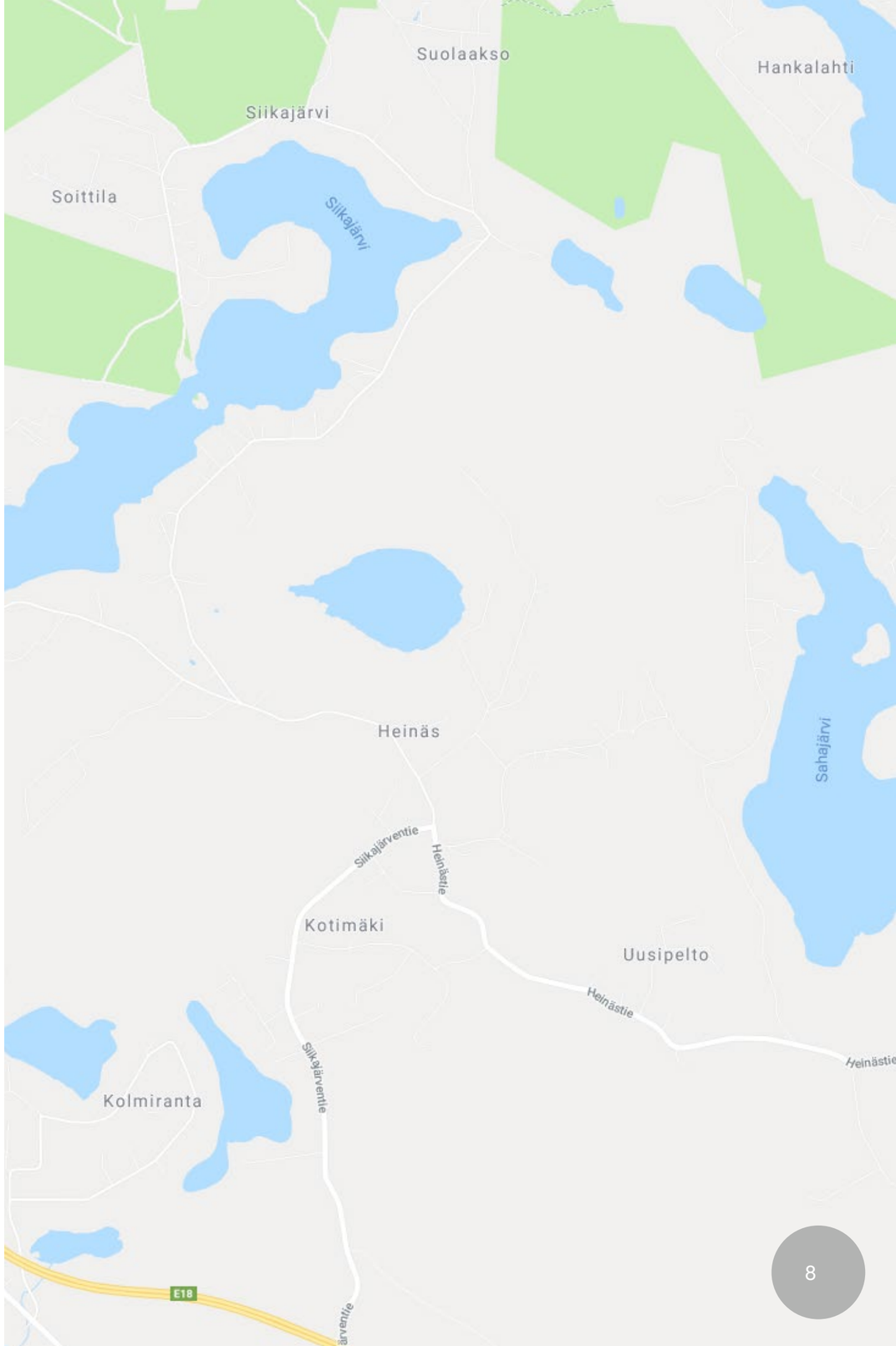
- **Real estate identifier**
  Every real estate and parcel has one
  Hierarchical and unique in Finland

- **Grid identifier**
  E.g. rescue service grid
  Grid size defines the accuracy

- **IP addresses**
  Can be used for geocoding, if the address for the user is known
  Accuracy varies

Coordinate systems

- **Metric: Distances and directions**
- **Standard definitions, unambiguous**
- **Tied to the surface of Earth with benchmarks (kiinto-piste)**
- **Transformations and conversions possible**
- **Stabile: Only small changes in time**
  Tectonic plate movement, upthrust (maannousu), major earthquakes

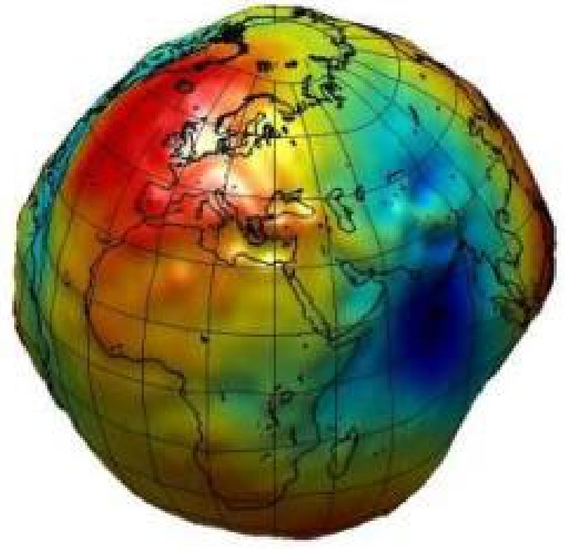


Starting point: Earth

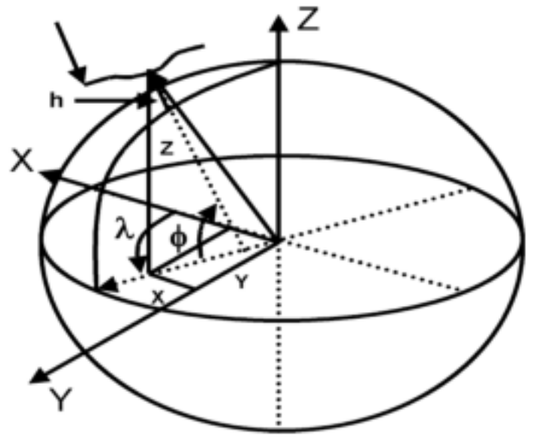
- Geoid (geoidi), i.e. ocean level, is bumpy and slightly flattened ball

- It is replaced by regular shaped ellipsoid in calculations

- Ellipsoid is placed in the center of Earth and tied to rotation creating a reference system



- Location is reported using geographic coordinates latitude, longitude and height (ϕ, λ and h)

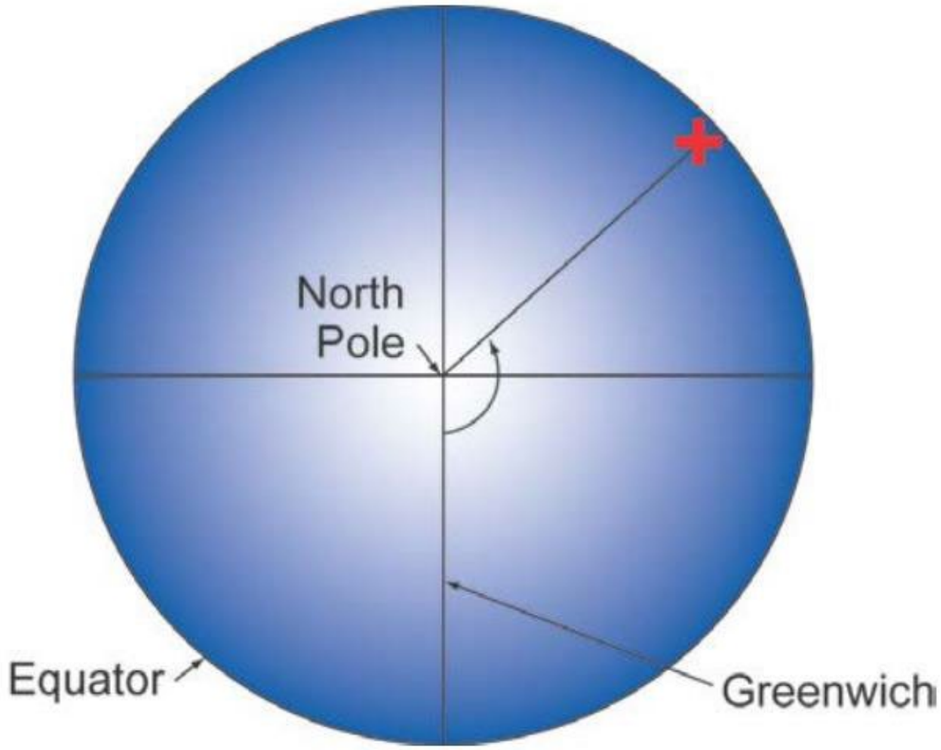


Longitude (pituusaste)

Specifies the east-west position; the angle between a meridian and the Prime Meridian (λ) (East/West [0..180°])

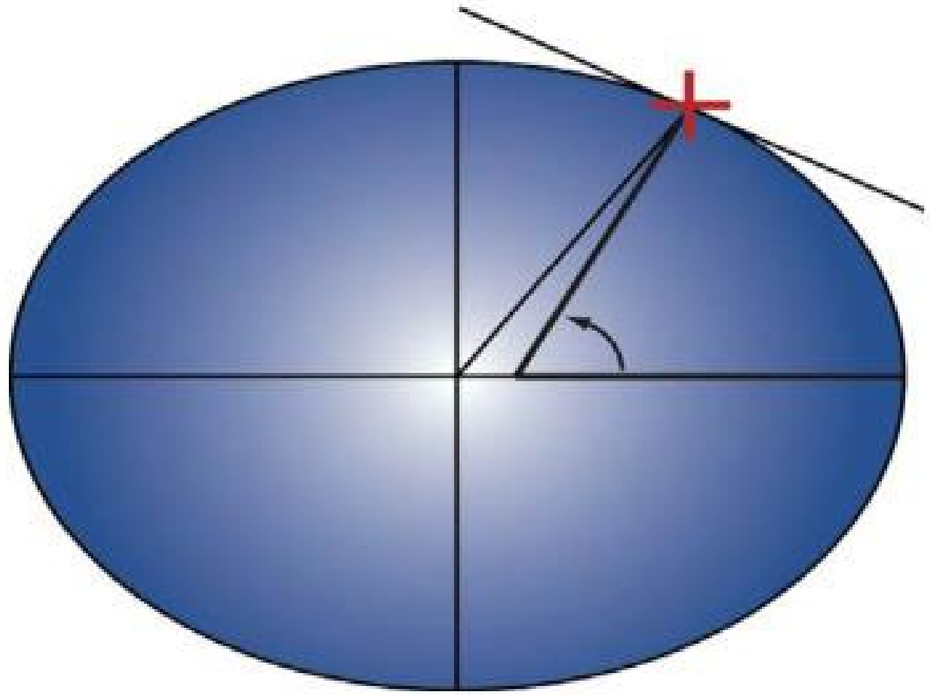
Meridian (pituuspiiri): great circle running through poles

Prime Meridian: meridian running through Greenwich



Latitude (leveysaste)

Specifies the north-south position; the angle between a normal of an ellipsoid and the equator plane (ϕ) (North/East [0..90º])



Geographic coordinate systems

- **Different systems are based on different ellipsoids and center points**
–> Same coordinates point to different places in different systems

- **Transformations between systems possible**

- **This is often automatic in GIS assuming each layer has its real system defined and parameters are correct**
Note: Always set the coordinate system of a layer to the correct one (found from metadata)!

- **Most common geographic coordinate system is WGS84 (used in GPS)**

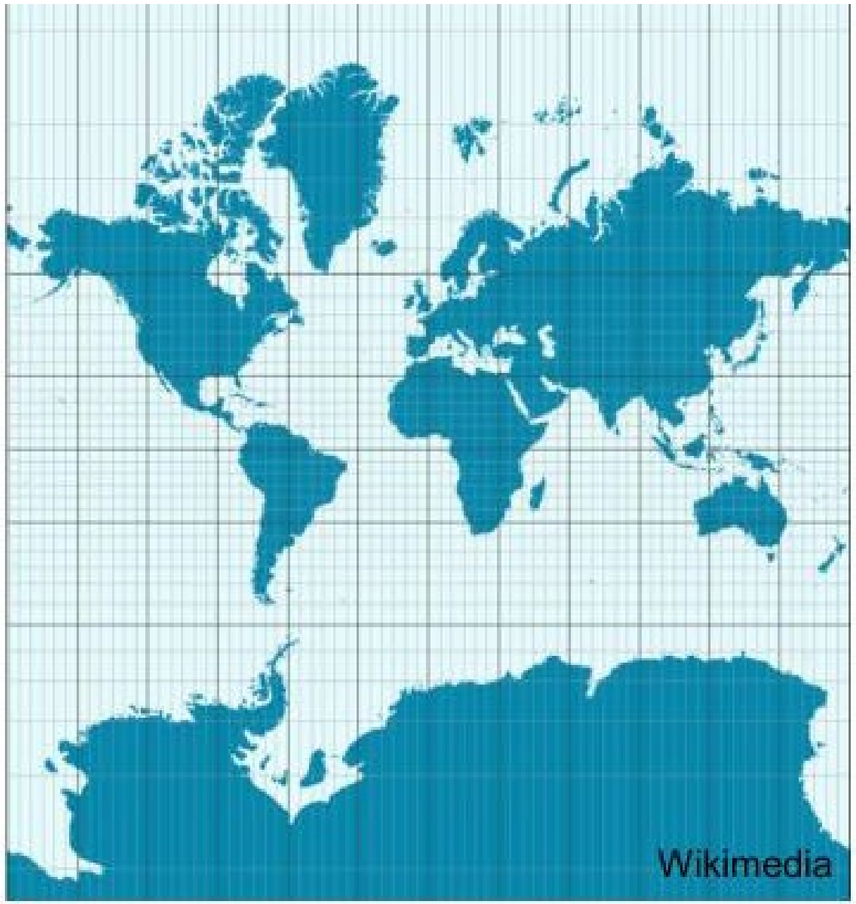
Projection from ellipsoid to a flat plane

- **Multiple reason to use plane coordinates (east, north) instead of angles:**
  - Easier to measure and calculate distances
  - Maps are shown on paper or screen (both planes)
  - Raster is a plane; difficult to create a raster on curved surface
  - Visualizing the Earth all at once can only be done when projected

- **Projecting a curved surface to a plane always causes deformations:**
  - Conformal projections preserve shapes and angles
  - Equivalent projections preserve areas and area ratios
  - Equidistant projections preserve distances between points

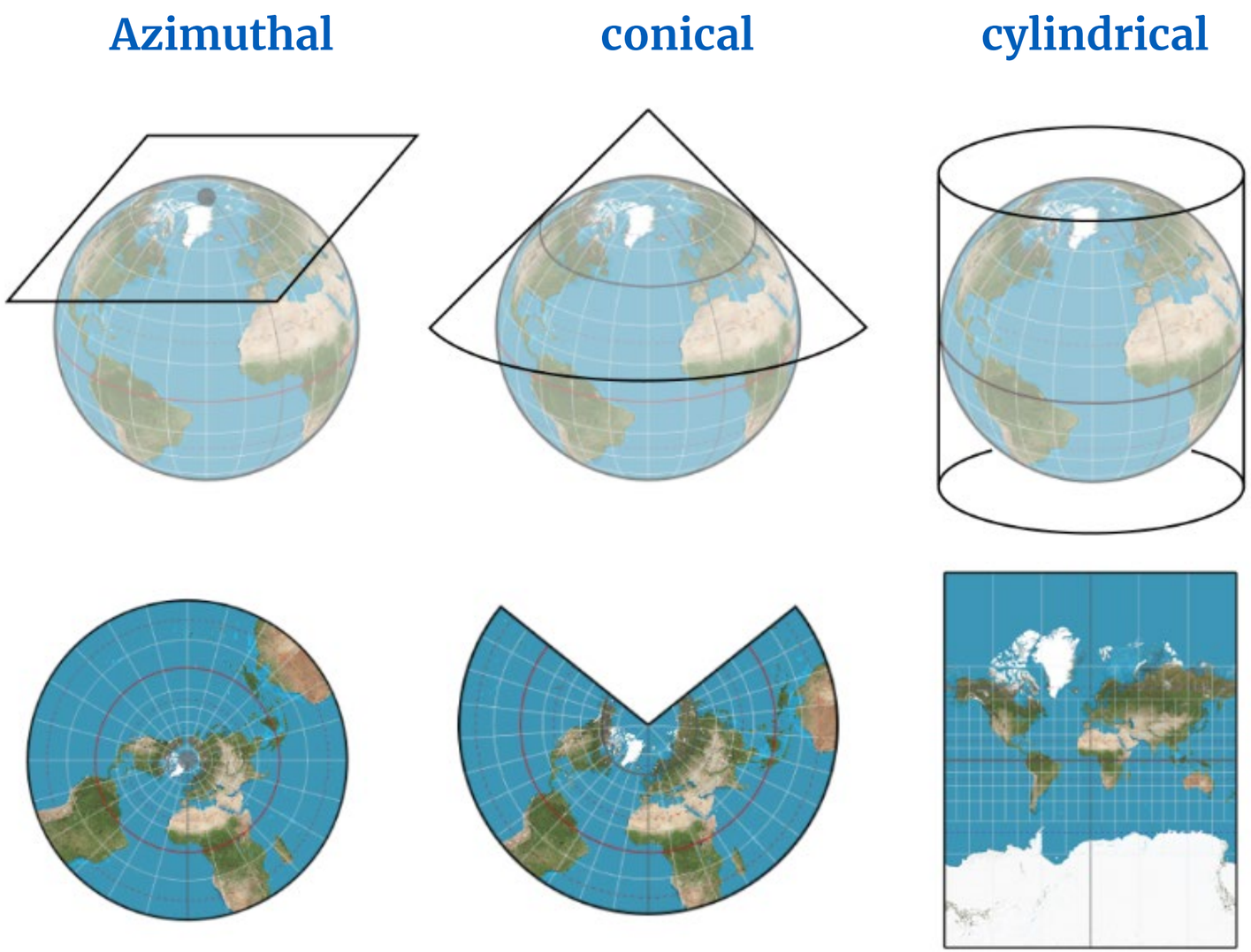
Example: Conformal and equivalent projections

Mercator (conformal)



Peters (equivalent)

Projection



https://gistbok.ucgis.org

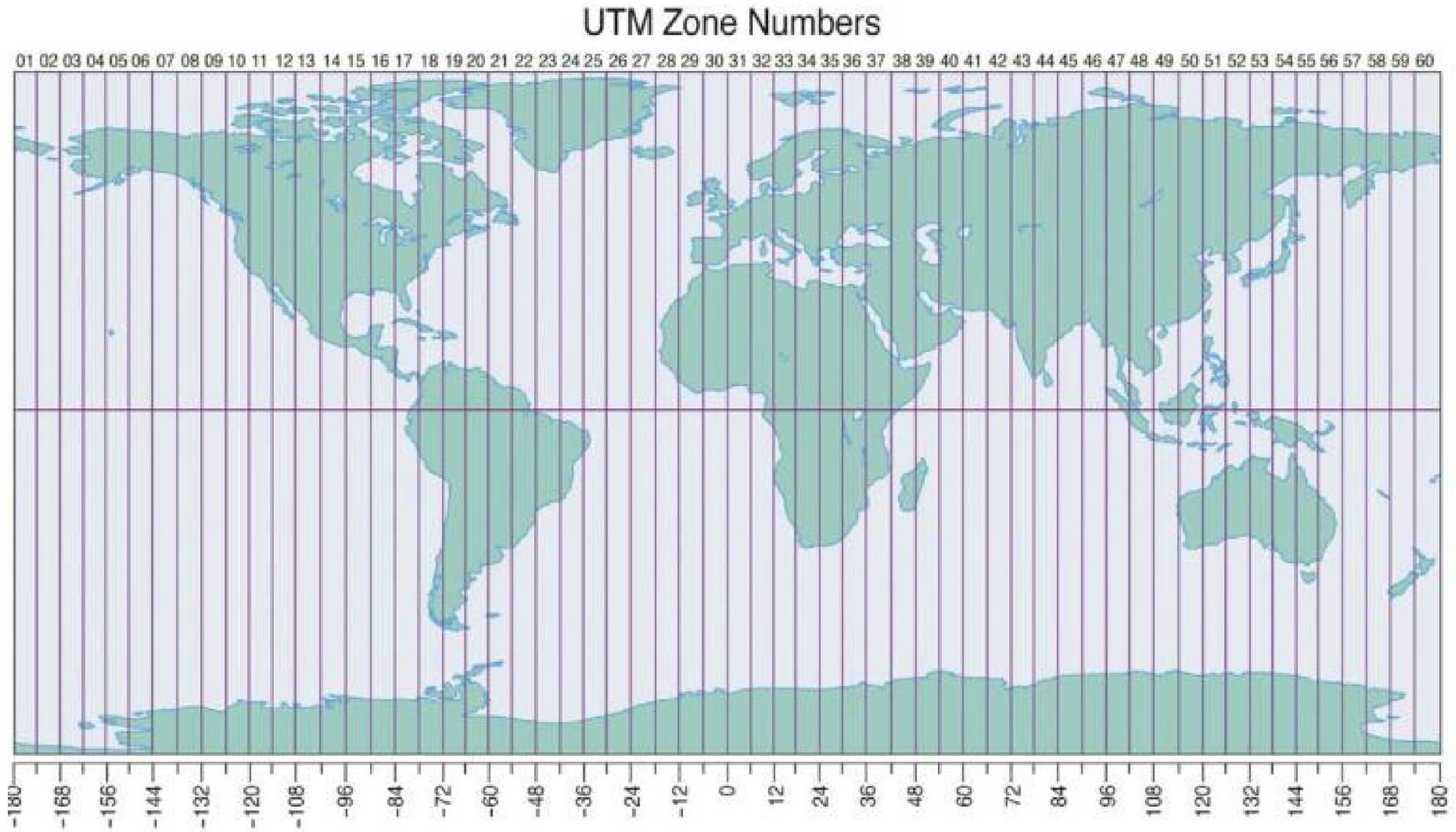
Using zones in projected coordinate systems

- **Motivation: Projected coordinate systems are accurate only along a thin strip**

- **Zonal projections: Divide the whole area (continent, country) in zones (thin strips) and use a separate projection and coordinate system for each**

  Coordinate values are not continuous when moving from one zone to another; need conversions

Zones in Universal Transverse Mercator (UTM) system



Universal Transverse Mercator (UTM) System

Using zones in projected coordinate system

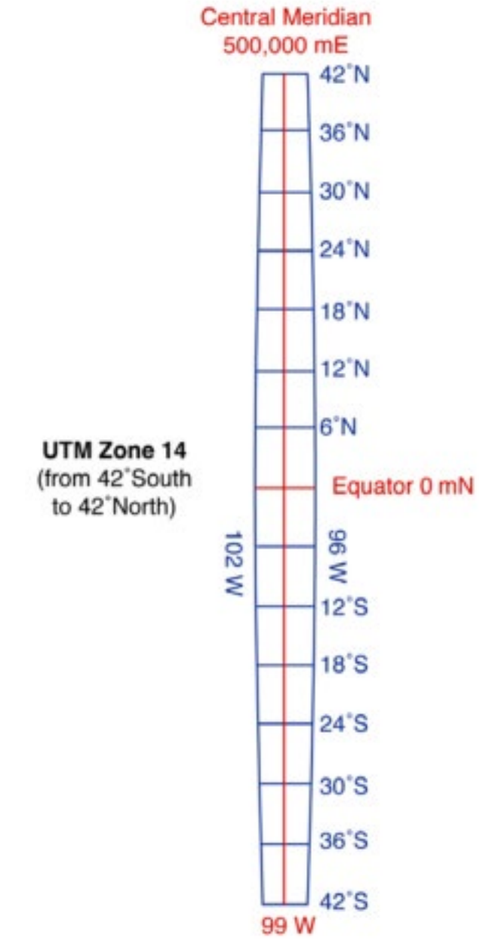
- **North coordinate (N) is measured from the Equator**

- **East coordinate (E) is 500 000 m in the central meridian**
  This is to avoid negative coordinates

- **Finnish version, ETRS-TM35FIN:**
  ETRS refers to ellipsoid ETRS89 (or EUREF-FIN)

  TM35 (Transverse Mercator) zone number 35

  FIN refers to special conditions made: wider zone than normal



Switch to ArcMap

- **Open a new document (File -> New) to ensure the map view has no coordinate system**
- **Add layers buildings.shp and postal_code.shp** (note that they are missing the .prj-file!)
- **Where are the data sets located in the map view?**
  Use Zoom to Layer to find out (right-click the layer).
  What can you say about the coordinate systems based on the values shown in the lower right corner of the map view?

- **Delete both layers from the view and open Catalog from Window -> Catalog. From there you can change/set coordinate systems by right-clicking a layer -> Properties -> XY Coordinate System**
  Set WGS 1984 (Geographic -> World) for the buildings and ETRS 1989 TM35FIN (Projected -> National Grids -> Finland) for the postal code areas

- **Add the layers now to the map view (note how the .prj file has appeared). You might also need to set the projection for the map view by right-clicking the Layers in Table of Contents**

Coordinate transformation in ArcMap

Setting the coordinate system to a different does not transform the coordinate values!

Easiest way to transform coordinates for a layer is setting a desired system to map view (right-click Layers…) and exporting data (right-click the layer, Data -> Export Data) with the option "Use the same coordinate system as: the data frame".

Try transforming the buildings to ETRS 1989 TM35FIN system