swarm

ARISTOTLE UNIVERSITY OF THESSALONIKI

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GIS and Water resources management and GIS (part 2)

Spatial analyst techniques for the management of hydro-meteorological data. Application of GIS in the EU's Water Framework Directive.

By

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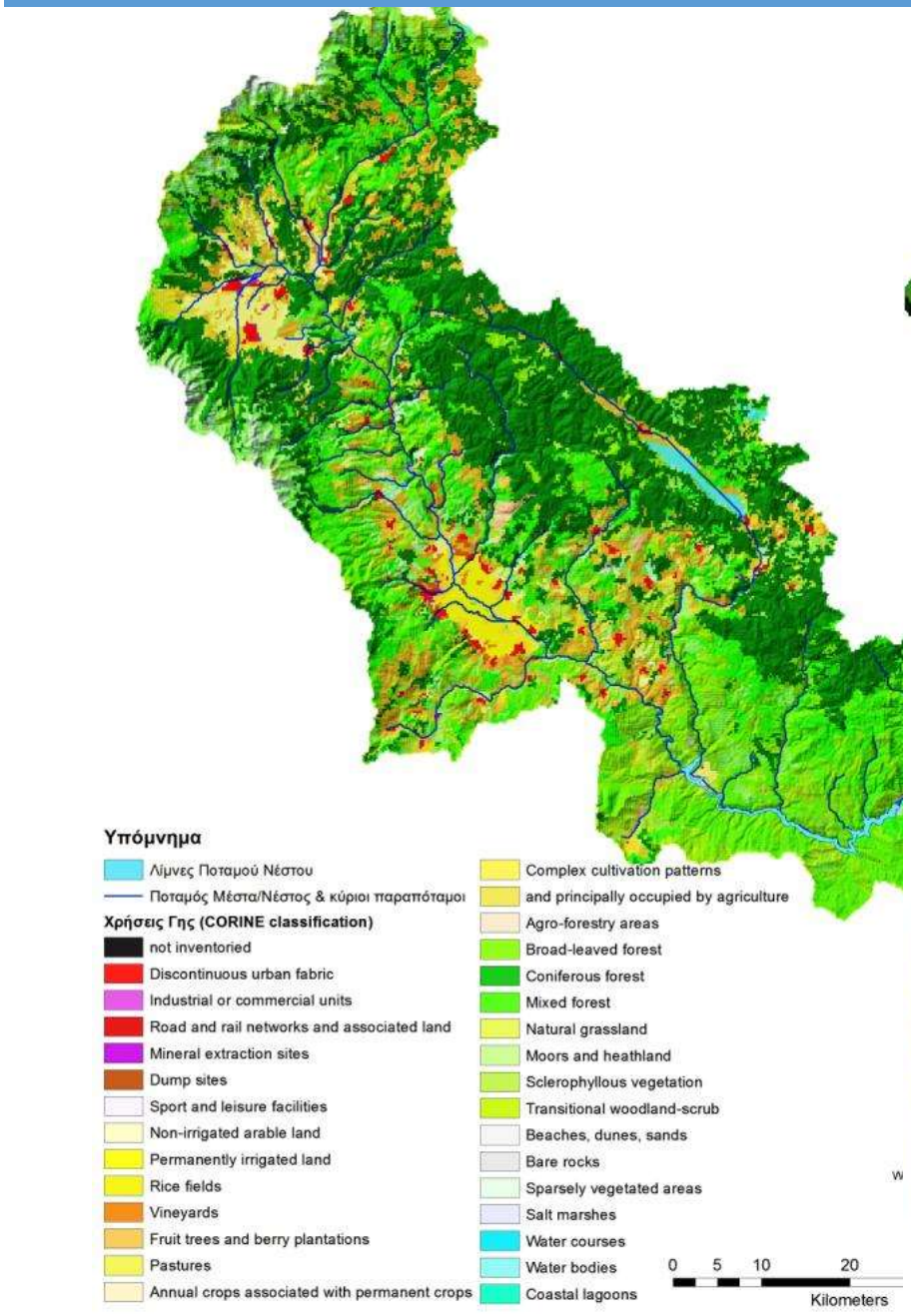
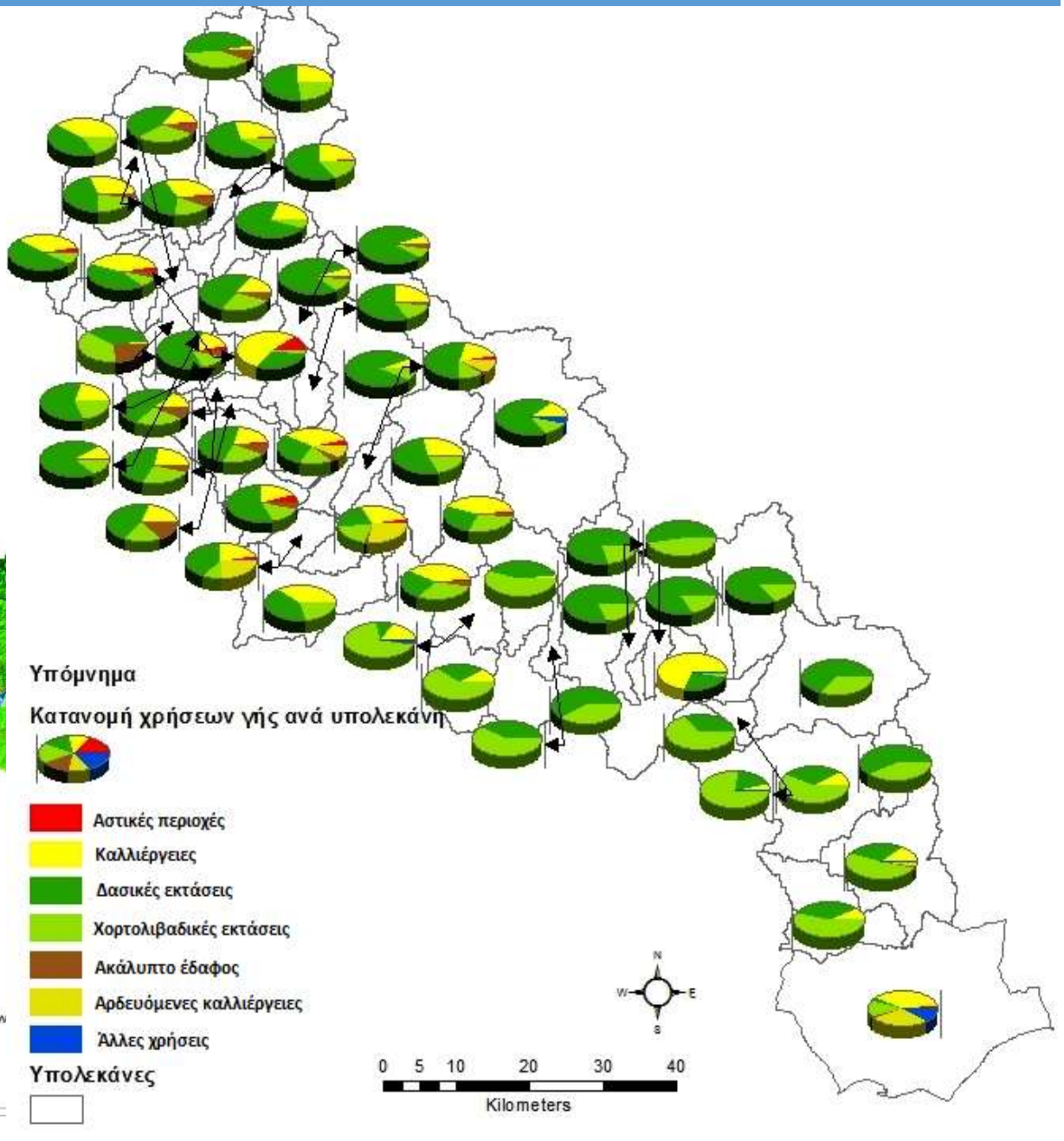
ArcGIS: Statistics (Analysis)

The Statistics toolset contains tools that perform standard statistical analysis (such as mean, minimum, maximum, and standard deviation) on attribute data as well as tools that calculate area, length, and count statistics for overlapping and neighboring features.

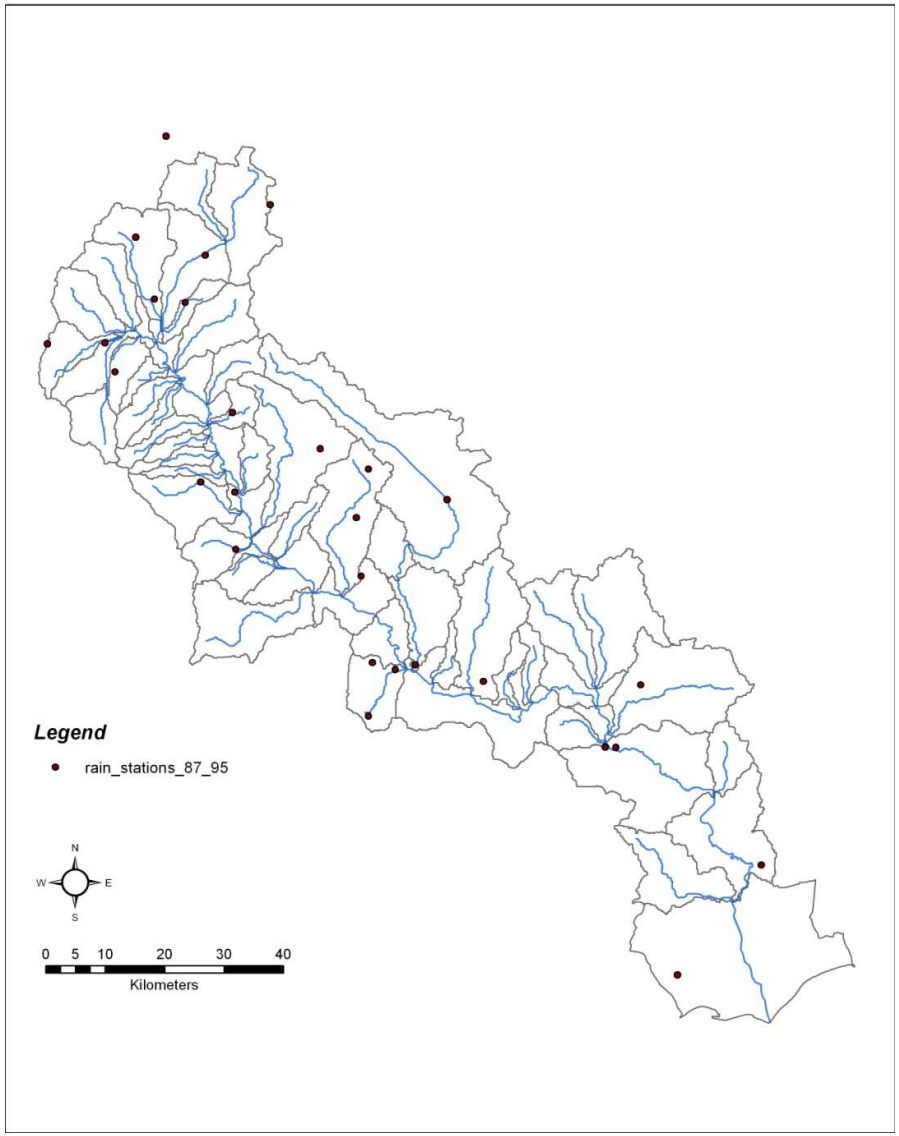
Tool	Description
Frequency	Reads a table and a set of fields and creates a new table containing unique field values and the number of occurrences of each unique field value.
Polygon Neighbors	Creates a table with statistics based on polygon contiguity (overlaps, coincident edges, or nodes).
Summary Statistics	Calculates summary statistics for field(s) in a table.
Tabulate Intersection	Computes the intersection between two feature classes and cross-tabulates the area, length, or count of the intersecting features.

ArcGIS: Statistics (Analysis)





ArcGIS: Distributing point information to space

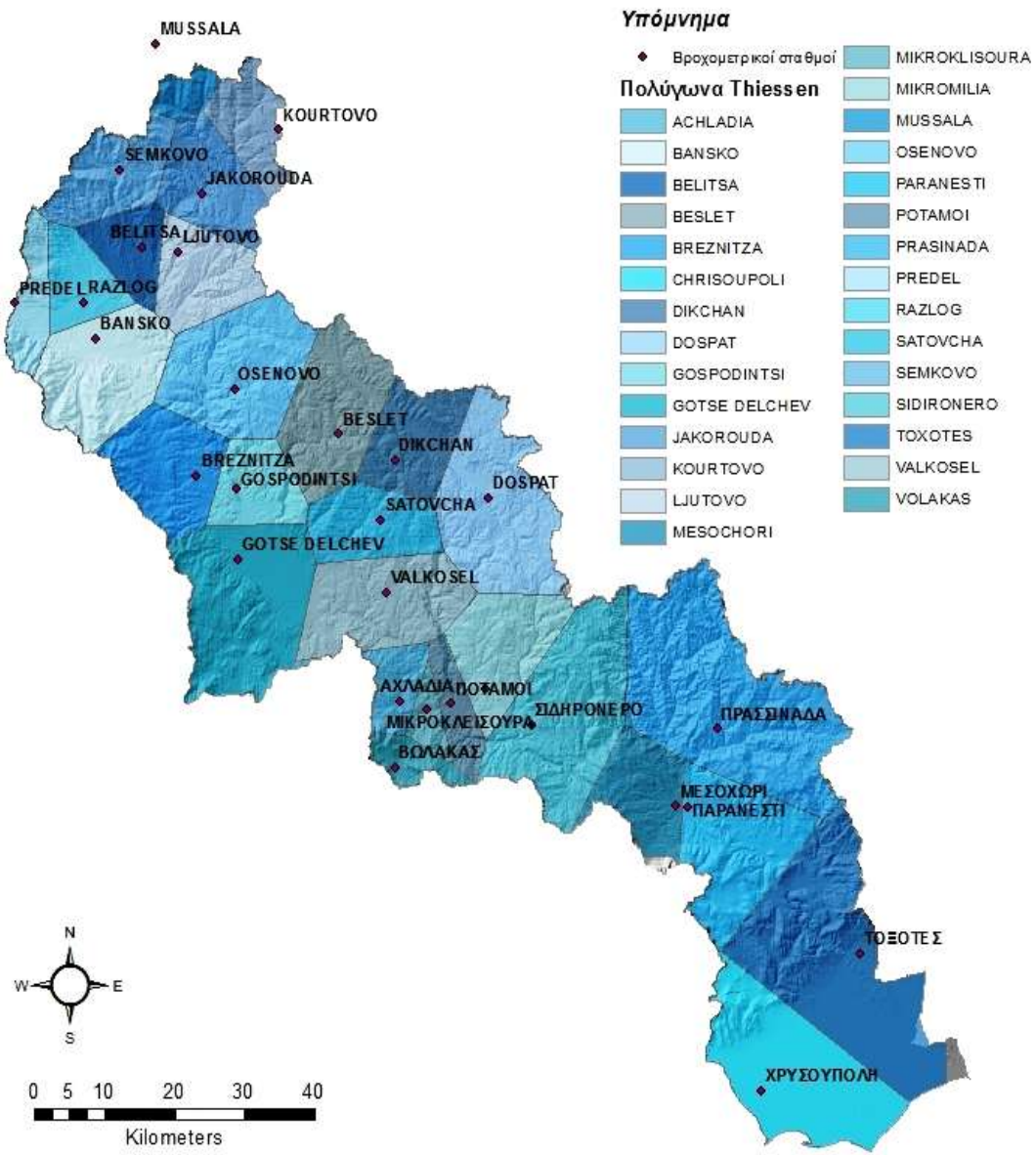


Thiessen polygons

Thiessen polygons can be used to apportion a point coverage into polygons known as Thiessen or Voronoi polygons.

- **Each polygon contains only one Input Features point.**
- **Each polygon has the unique property that any location within the polygon is closer to the polygon's point than to the point of any other polygon**

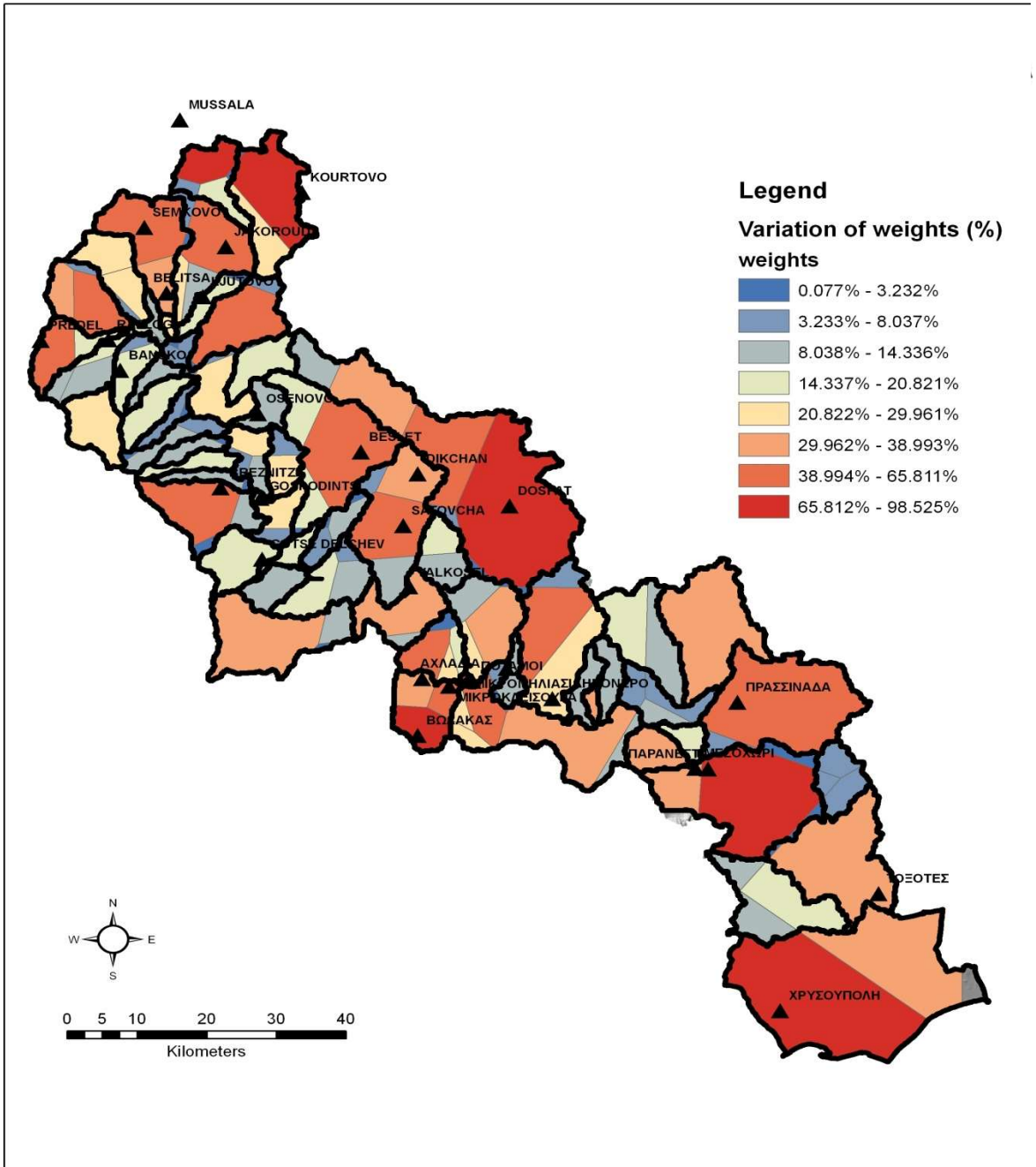
ArcGIS : Distributing point information to space



Thiessen polygons

In effect, the precipitation surface is assumed to be constant and equal to the gage value throughout the region.

ArcGIS : Computation of equivalent rainfall



Computation of equivalent rainfall per subbasin:

$$h_s = \sum_{i=1}^{k} w_i h_i$$

Where

K: the number of stations

h_i: point rainfall (mm)

w_i: the weight factor

ArcGIS : Spatial analyst, Interpolation

• In the mathematical field of numerical analysis, **interpolation** is a method of constructing new data points within the range of a discrete set of known data points.

• In GIS, interpolation is used to predict values for cells in a raster from a limited number of sample data points. It can be used to predict unknown values for any geographic point data, such as elevation, rainfall, chemical concentrations, noise levels, and so on.

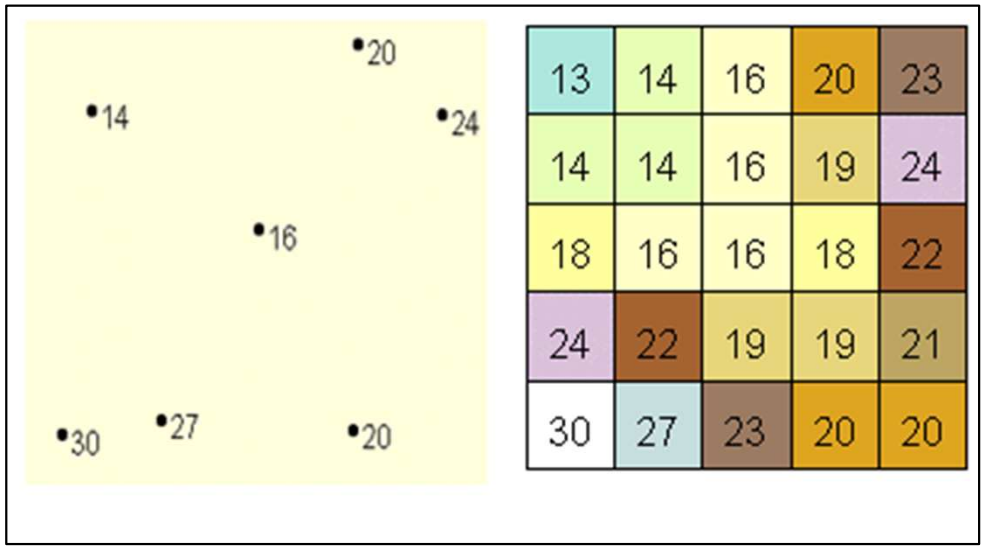


Fig. 1 : Rainfall

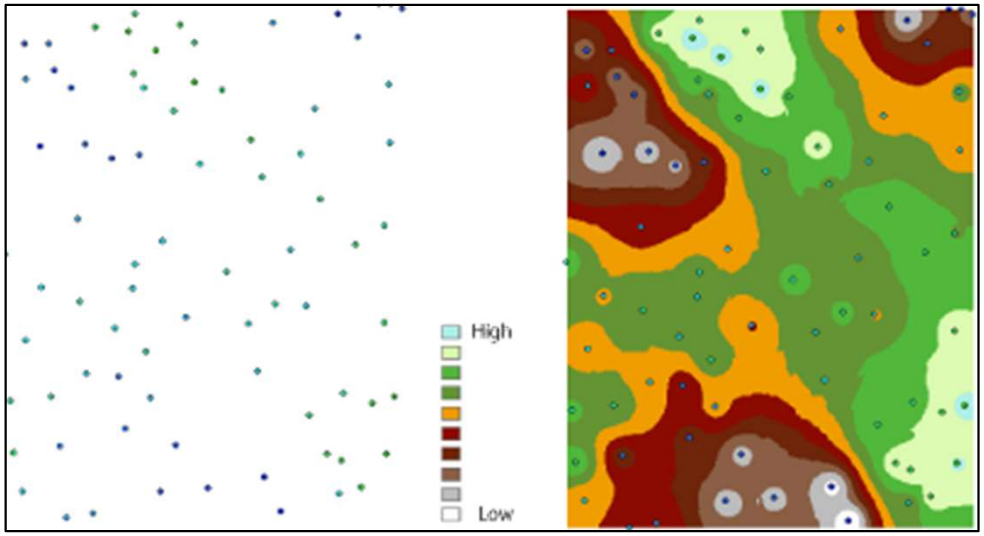


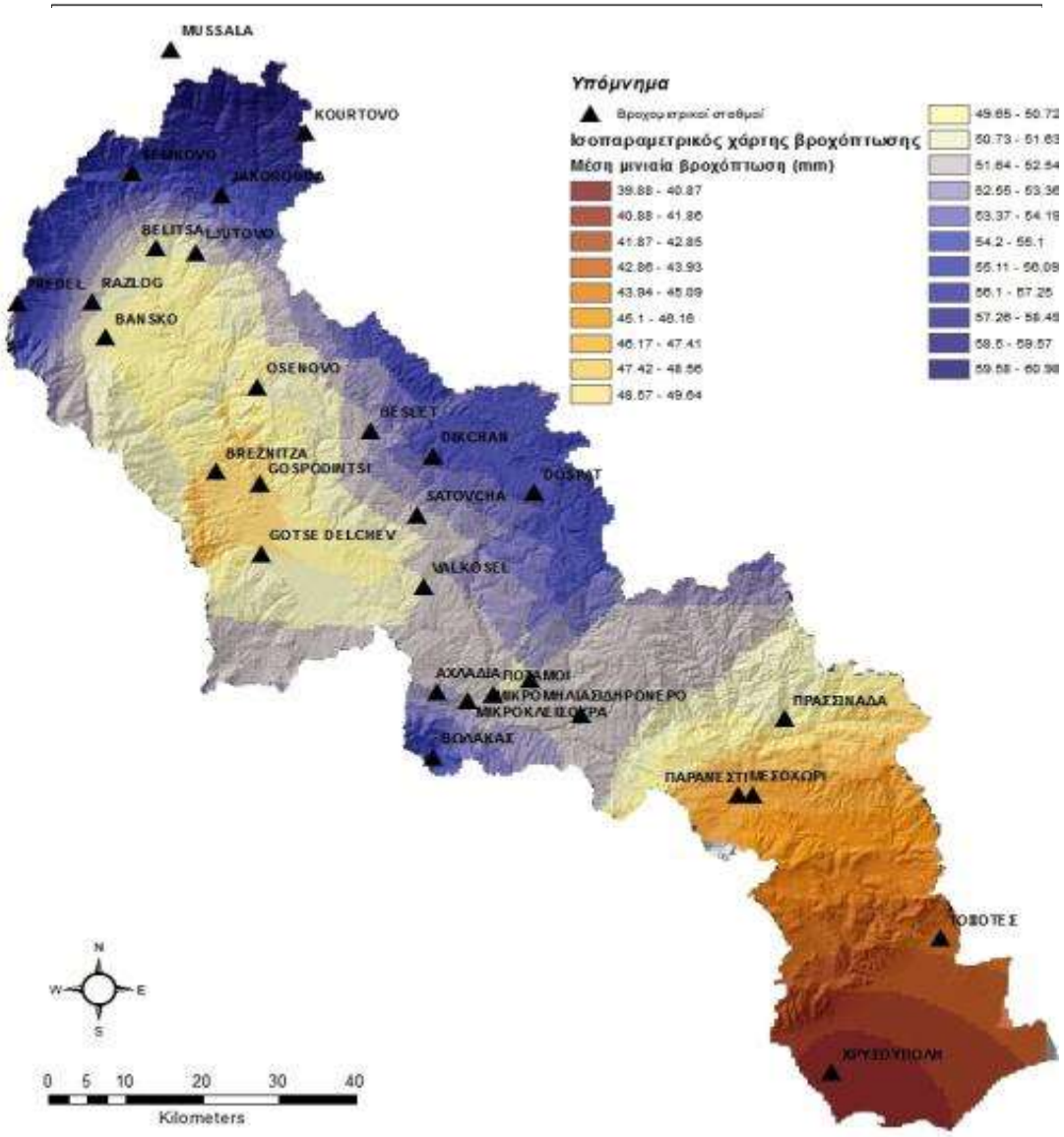
Fig. 2 : Elevation

ArcGIS : Spatial analyst, Interpolation

The assumption that makes interpolation a viable option is that spatially distributed objects are spatially correlated; in other words, things that are close together tend to have similar characteristics.

Tool	Description
IDW	Performs an inverse distance weighted interpolation on a point dataset.
Krige	Interpolates a raster from a set of points using kriging.
Kriging	Interpolates a grid from a set of points using kriging.
Natural Neighbor	Interpolates a surface from points using a natural neighbor technique.
PointInterp	Interpolates a raster from a set of points using a specified neighborhood.
Spline	Performs a two-dimensional minimum curvature spline interpolation on a point dataset resulting in a smooth surface that passes exactly through the input points.

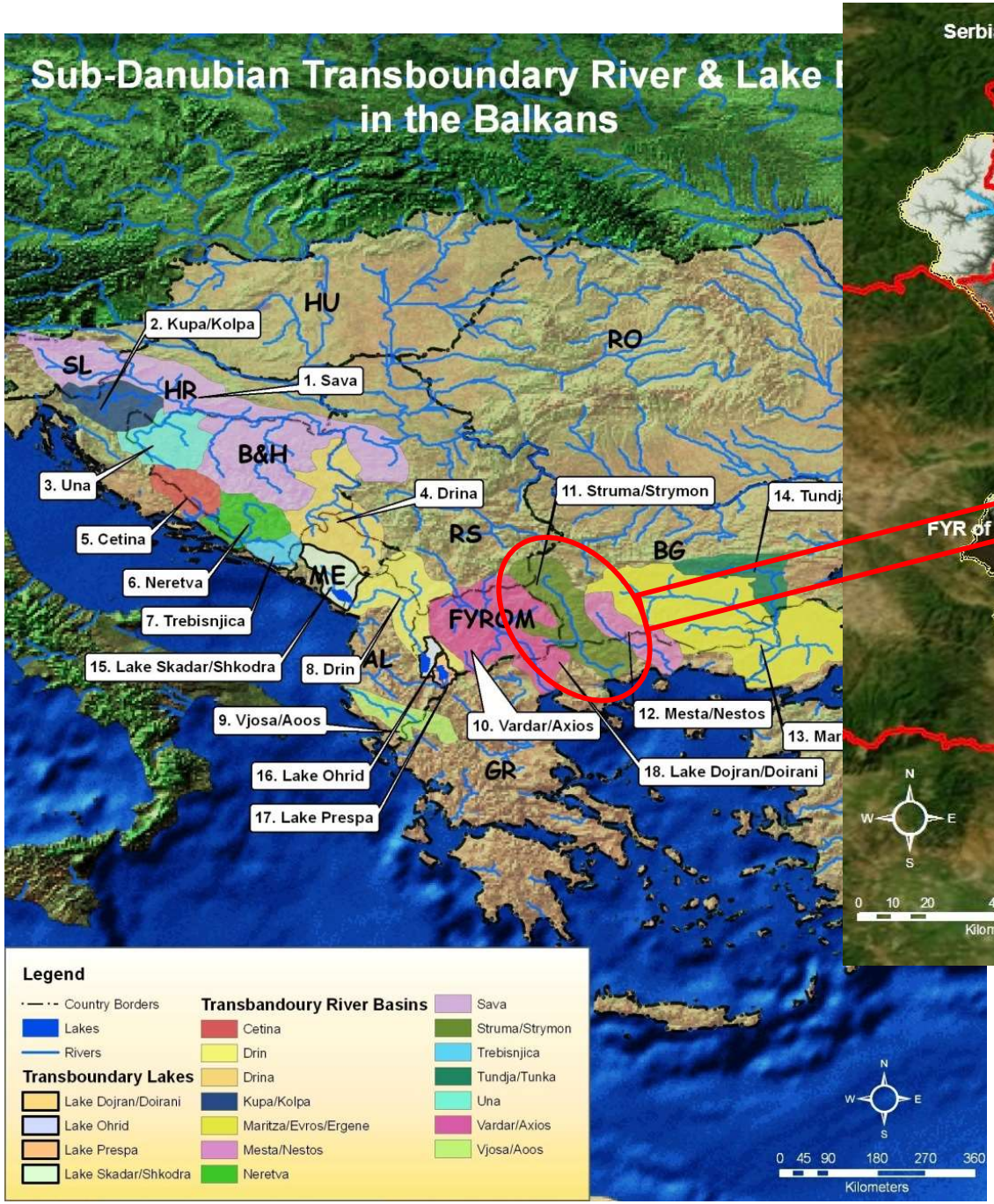
ArcGIS : Example with Kriging

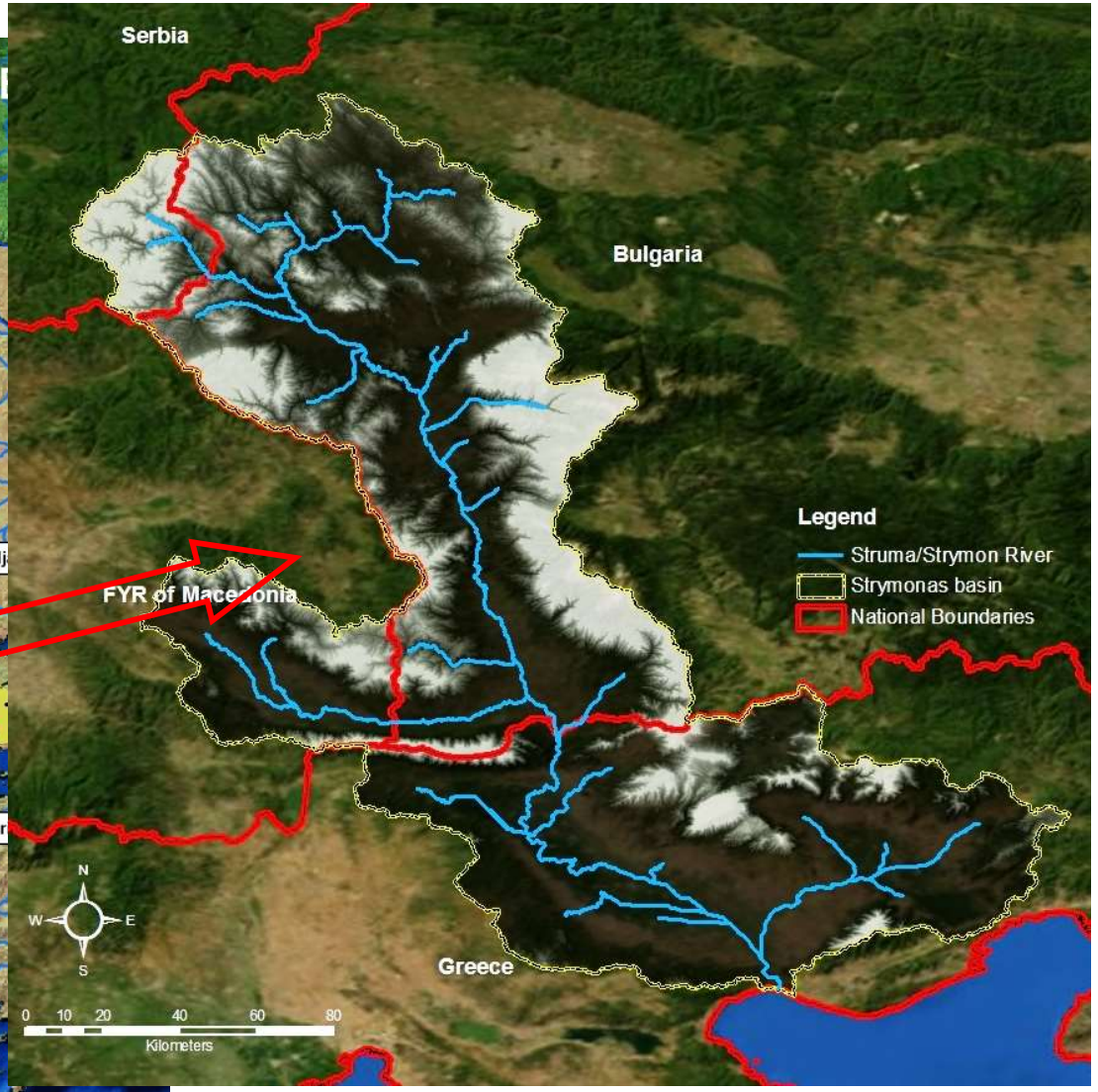


- The Inverse Distance Weighted (IDW) and Spline methods are referred to as deterministic interpolation methods because they are directly based on the surrounding measured values.

- Kriging is based on statistical models that include autocorrelation—that is, the statistical relationships among the measured points

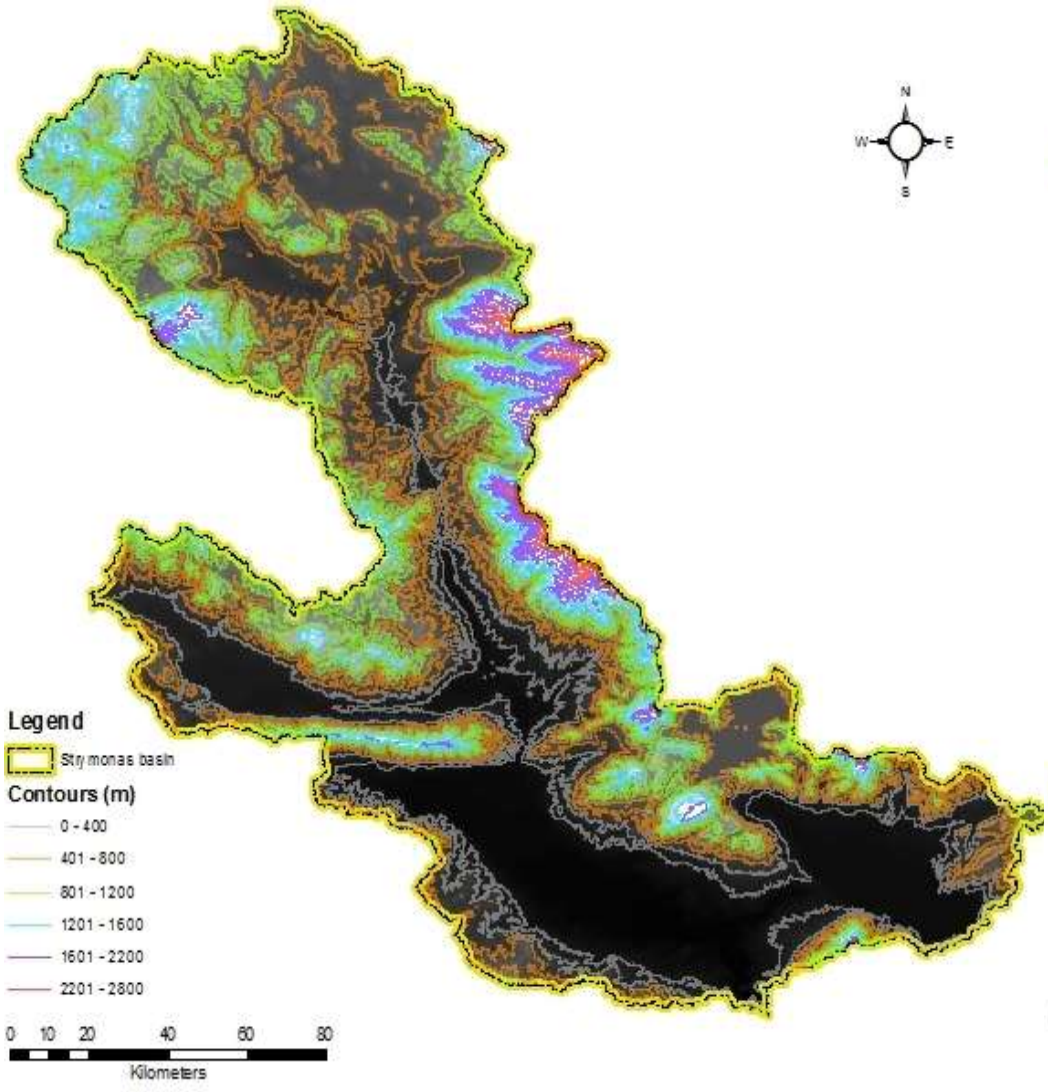
Case study: The Strymon River basin



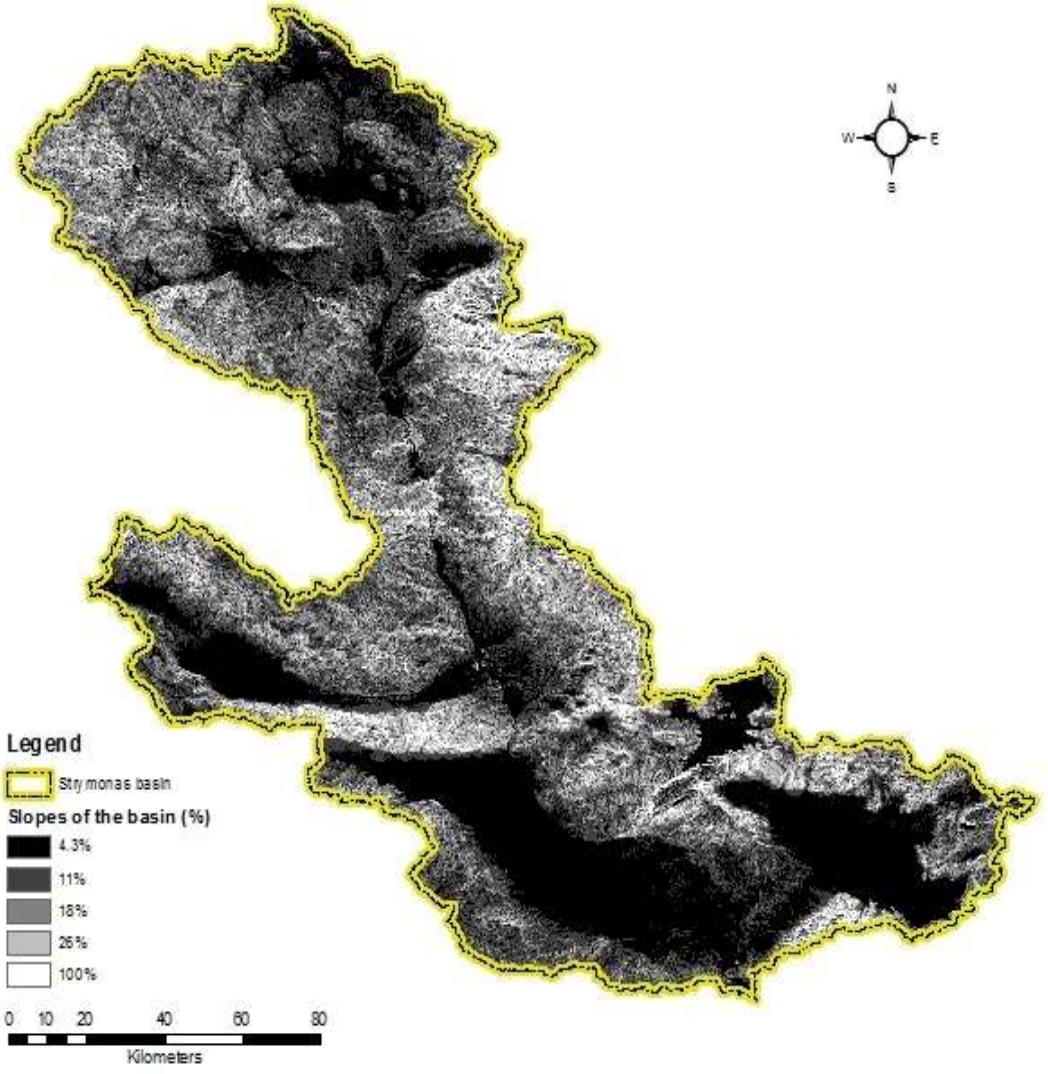


Basin area: 17,276 km²
8,734 km² (51%) in Bulgaria,
6,439 km² (38%) in Greece

Geographic Information Systems (GIS) on water resources

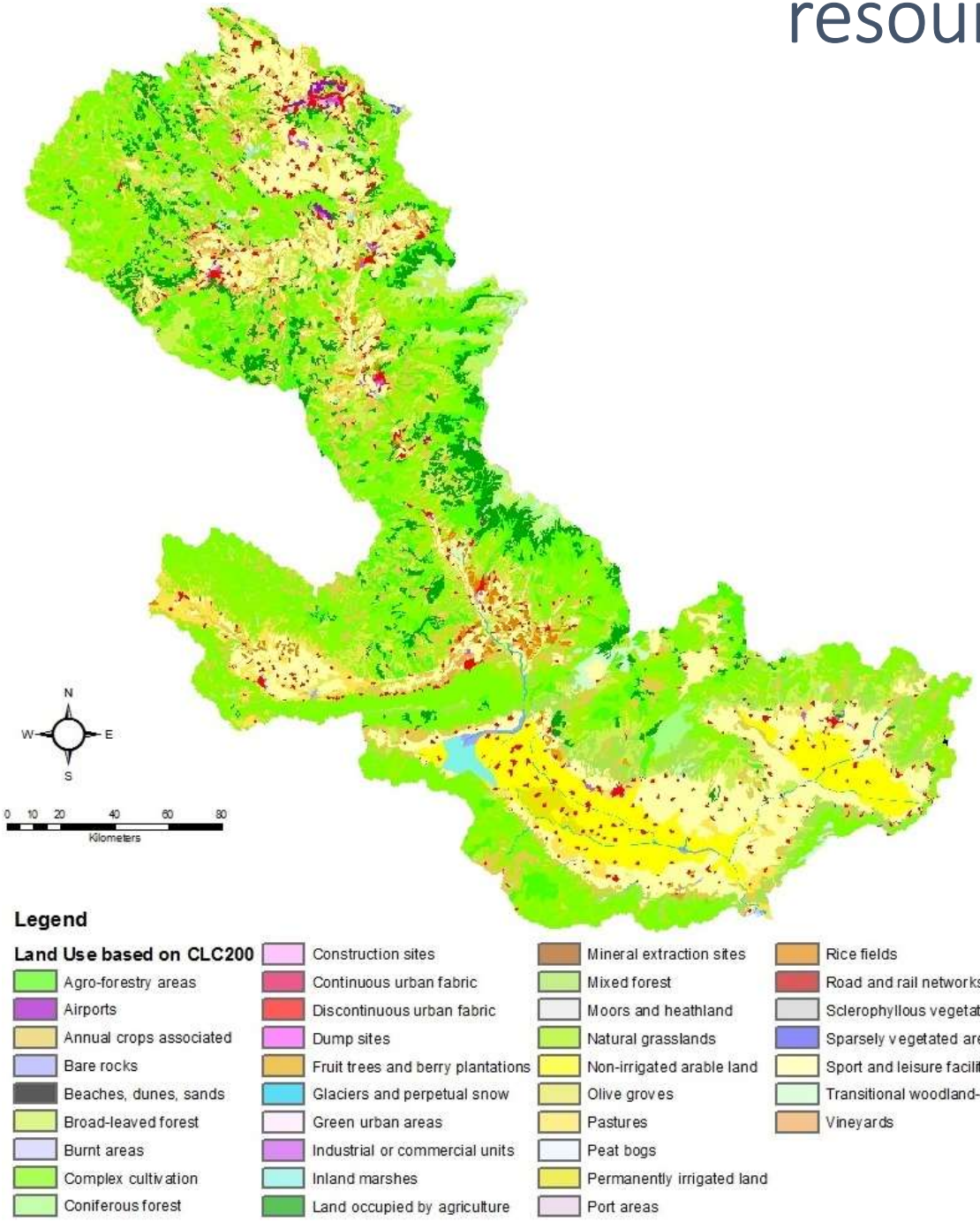


Elevation (contour lines of 400m)



Basin slopes

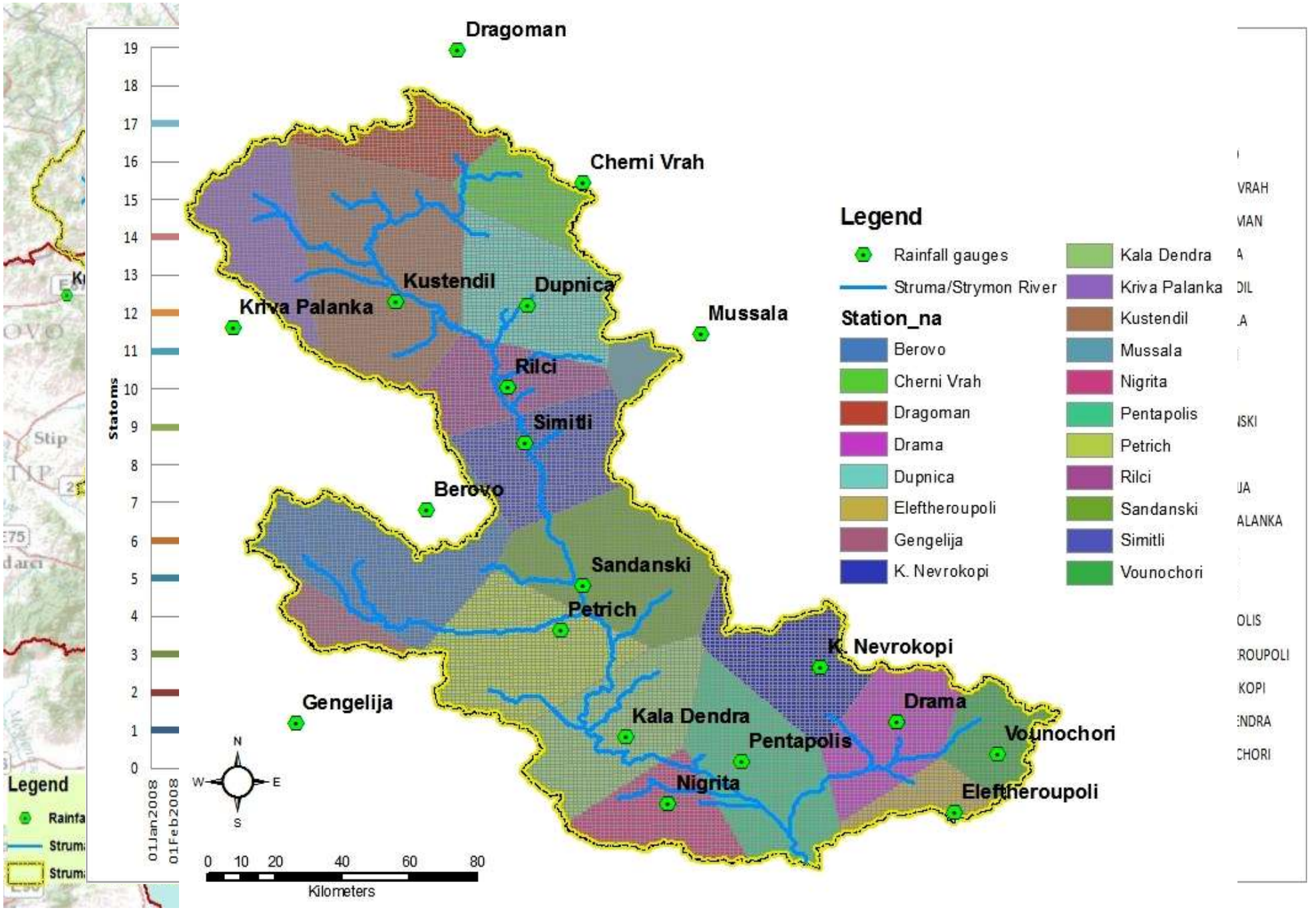
Geographic Information Systems (GIS) on water resources



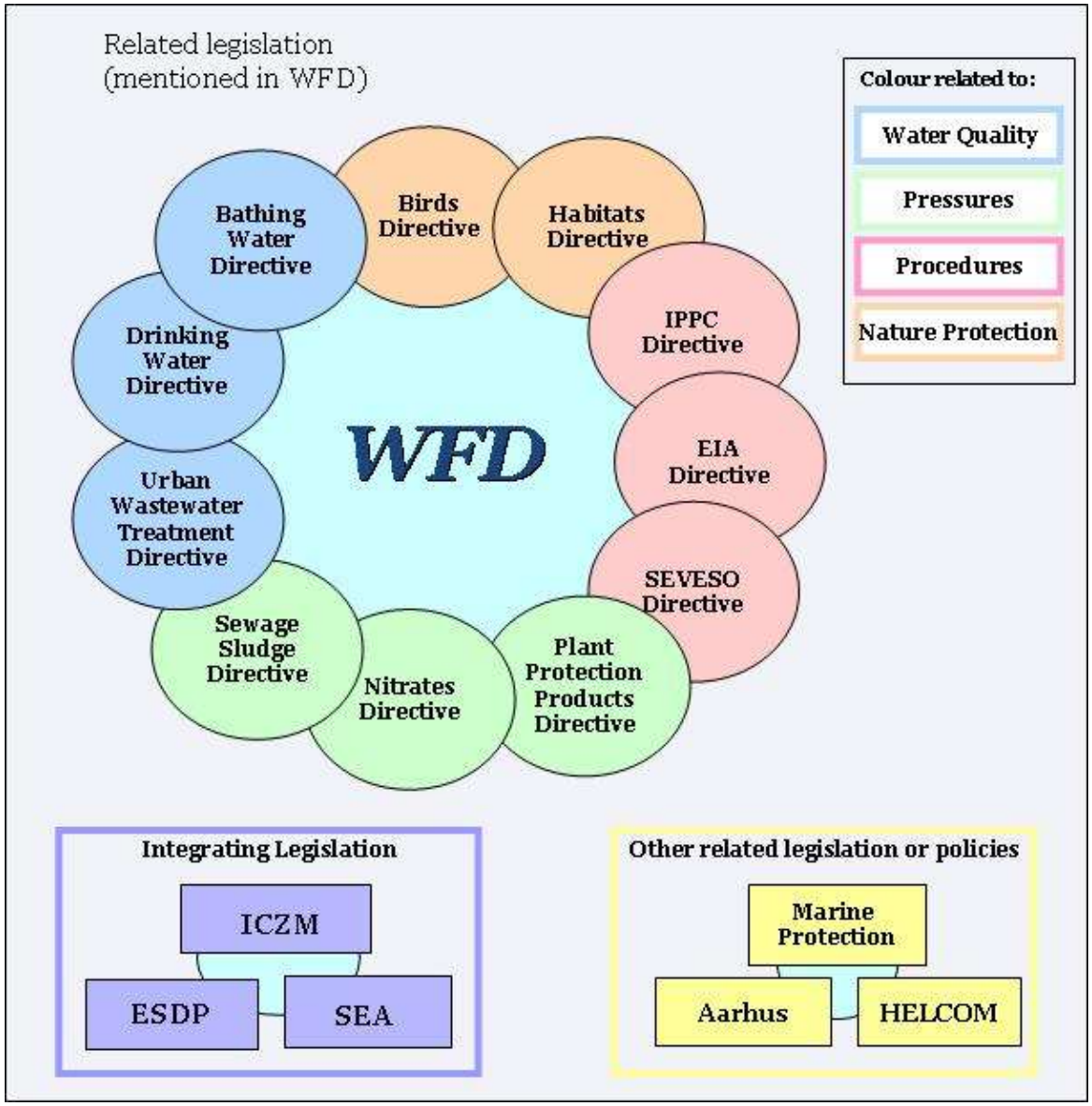
The Struma/Strymon basin can be characterised as a natural basin:

- **Forested areas (36.25%)**
- **Scrub/herbaceous vegetation areas (22.65%)**
- **Arable agricultural areas (21.95%)**
- **Pastures and the heterogenous agricultural areas (13.10%)**
- **Urban areas (1.95%)**

Precipitation distribution



Application in EU's WFD



The Water Framework Directive (WFD)

Water Framework Directive (WFD) 2000/60 is considered to be one of the most ambitious and comprehensive pieces of European environmental legislation to date.

The WFD aims at the integrated management and protection of the water resources

- Identifying and analyzing of environmental pressures and risks at river basin scale,
- **Identifying water bodies and protected areas**
- **Creation of monitoring networks for water resources (Article 8)**
- Defining environmental objectives, classification systems and environmental standards
- **Creation and storage of environmental data in geodatabases with use of GIS**
- Stakeholders participation (Article 14)

Definition of water body

The "water body" is a coherent sub-unit in the river basin (district) to which the environmental objectives of the directive are being applied.

The identification of water bodies is, first and foremost, based on geographical and hydrological determinants.

- ***"Body of surface water" means a discrete and significant element of surface water such as a lake, a reservoir, a stream, river or canal, part of a stream, river or canal, a transitional water or a stretch of coastal water***

- ***"Body of groundwater" means a distinct volume of groundwater within an aquifer or aquifers.***

Typology of water body

Classification: Typology A or Typology B

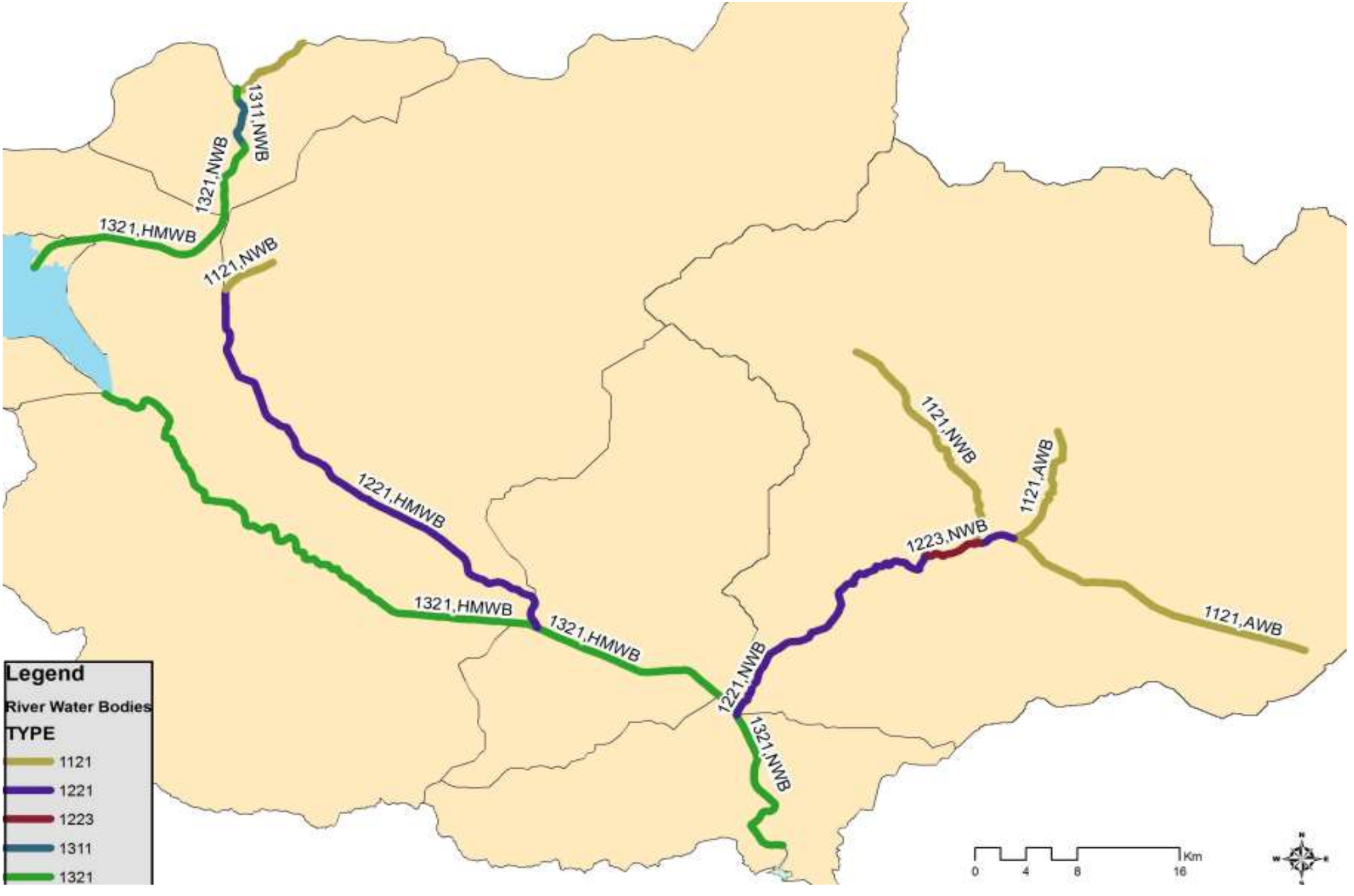
Example of Typology System B for Strymon River, Greece

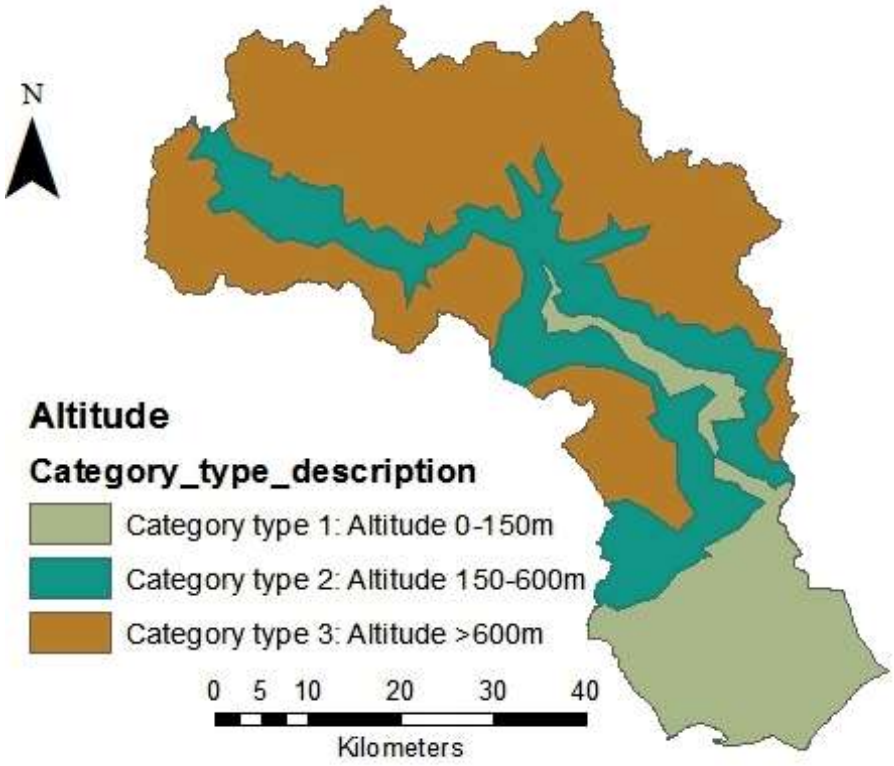
A four-digit numerical system was adopted to present the types

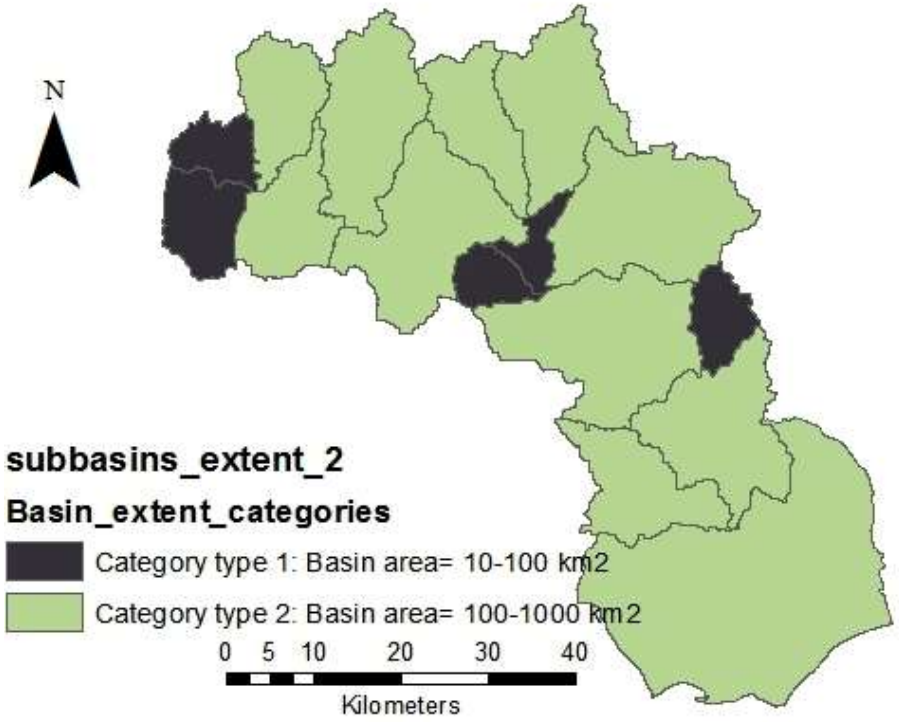
- 1st digit = altitude category
  - (1=0-150m or 2=150-600m or 3=>600m)
- 2nd digit = catchment area category
  - (1=0-100km2, or 2=100-1000km2 or 3=1000-10.000km2 or 4=> 10.000Km2
- 3rd digit = geology category
  - (1= Calcareous (Ca) or 2= Siliceous (Si) or 3= Organic (C))
- 4th digit = slope
  - (1=0-5^{o} or 2=5^{o}-15o or 3= >15^{o})

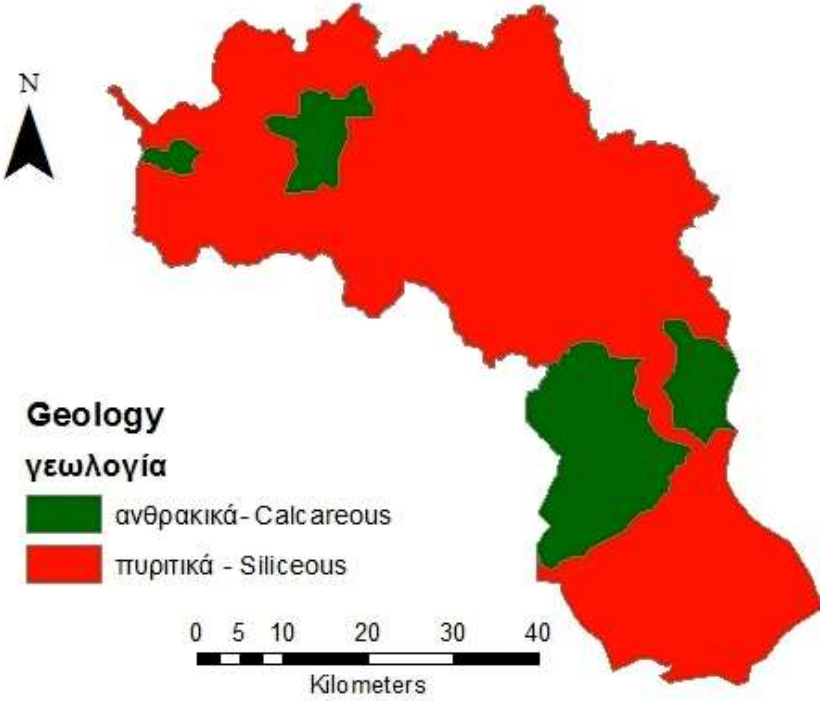
Example: 1211 = Altitude 0-150m, Catchment 100-1000m2, Geology Ca, Slope 0-5o

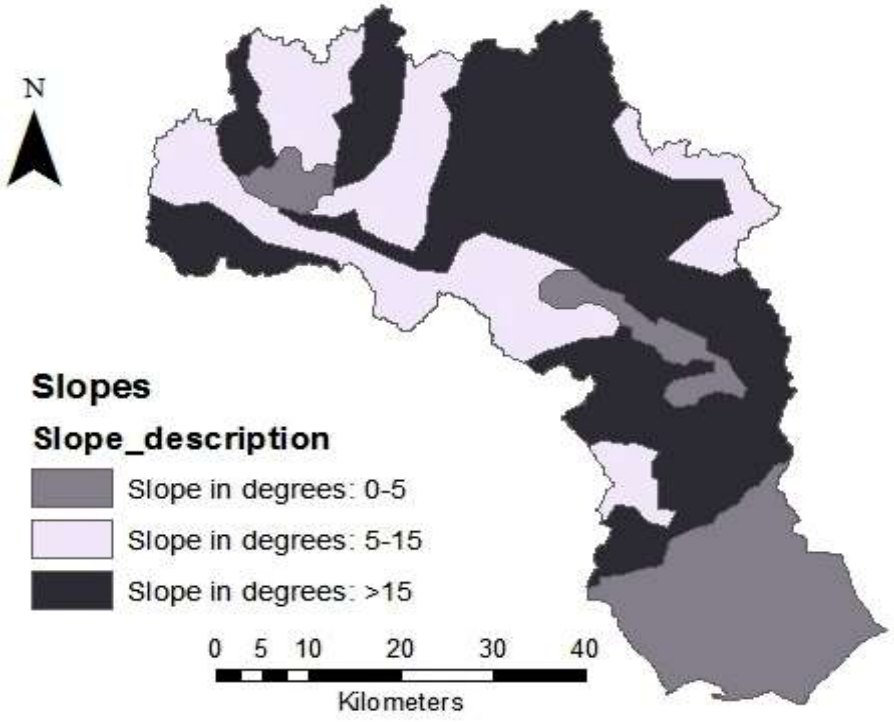
Results of application of Typology B

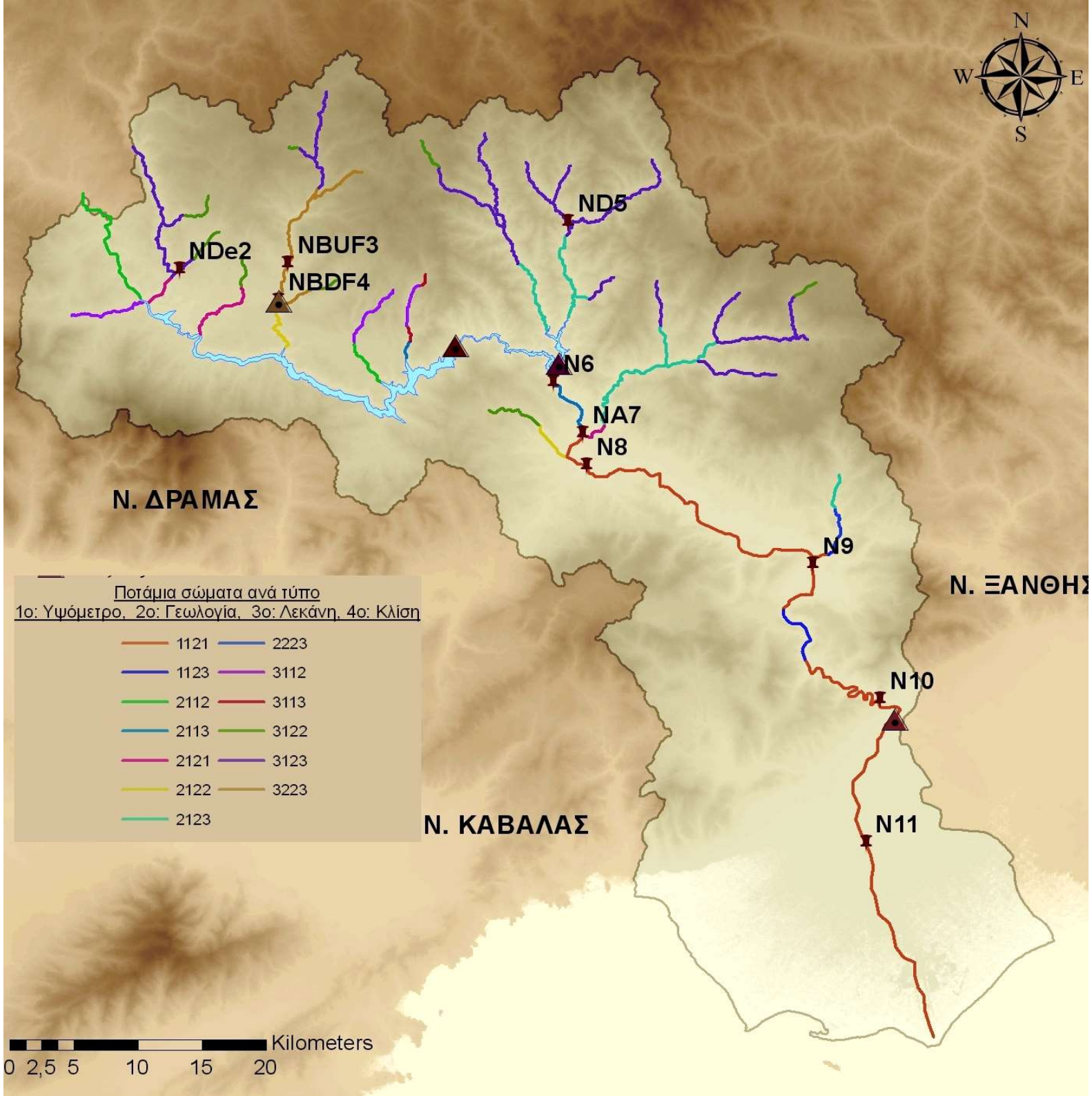


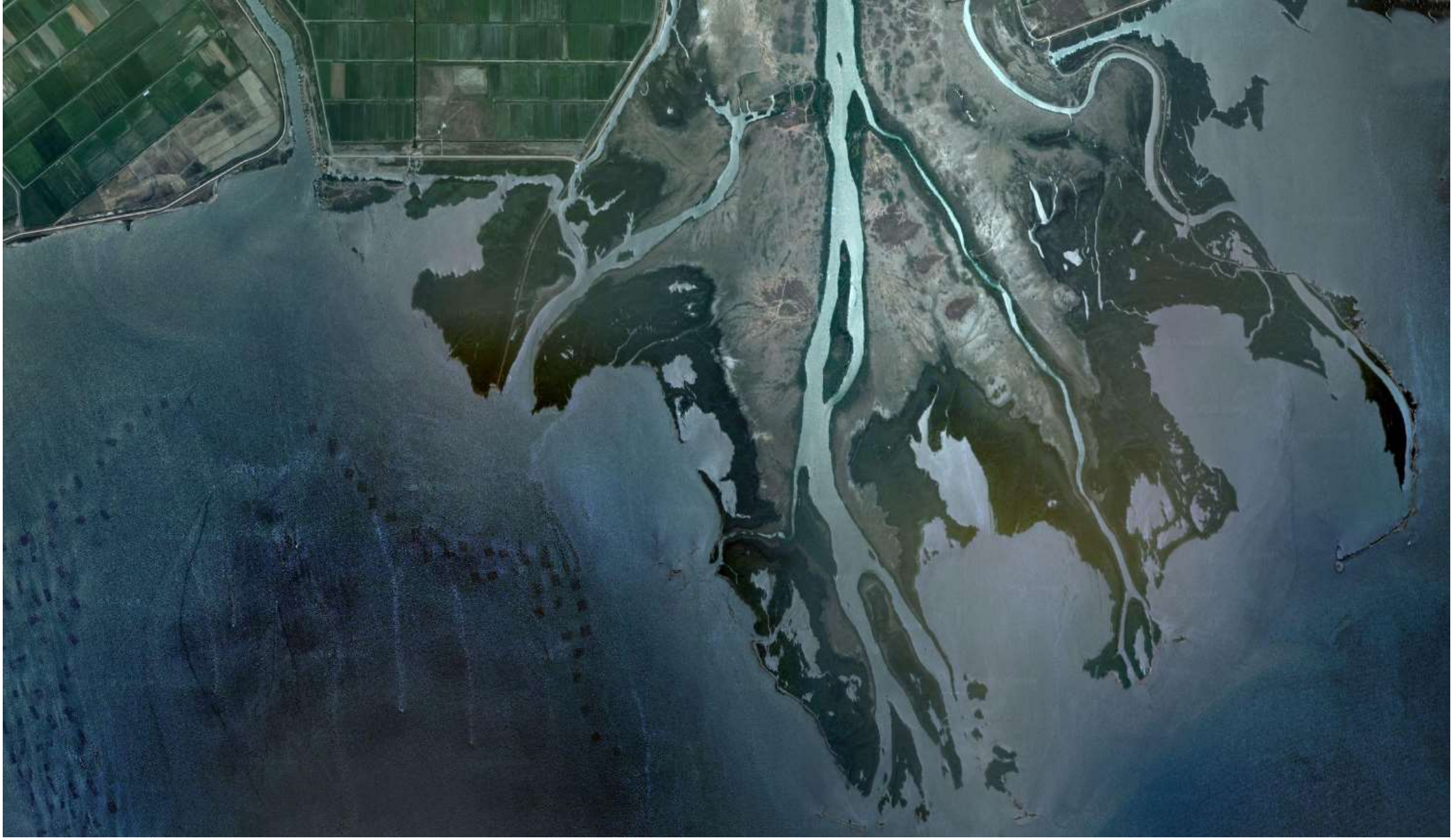

N
Altitude
Category_type_description
Category type 1: Altitude 0-150m
Category type 2: Altitude 150-600m
Category type 3: Altitude >600m
0 5 10 20 30 40
Kilometers


N
subbasins_extent_2
Basin_extent_categories
Category type 1: Basin area= 10-100 km2
Category type 2: Basin area= 100-1000 km2
0 5 10 20 30 40
Kilometers


N
Geology
γεωλογία
ανθρακικά - Calcareous
πυριτικά - Siliceous
0 5 10 20 30 40
Kilometers


N
Slopes
Slope_description
Slope in degrees: 0-5
Slope in degrees: 5-15
Slope in degrees: >15
0 5 10 20 30 40
Kilometers


N
W
E
S
NDe2
NBUF3
NBDF4
ND5
N6
NA7
N8
N9
N10
N11
Ν. ΔΡΑΜΑΣ
Ν. ΞΑΝΘΗΣ
Ν. ΚΑΒΑΛΑΣ
Ποτάμια σώματα ανά τύπο
1ο: Υψόμετρο, 2ο: Γεωλογία, 3ο: Λεκάνη, 4ο: Κλίση
1121
1123
2112
2113
2121
2122
2123
2223
3112
3113
3122
3123
3223
Kilometers
0 2,5 5 10 15 20



Thank you for your attention!

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