Geographical Water Resources Information System as an Essential Element of the IWRM

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IWRM is a highly interlaced procedure

covering different spatial scales

and

various fields of expertise.

This management is **impossible** to be **effective**

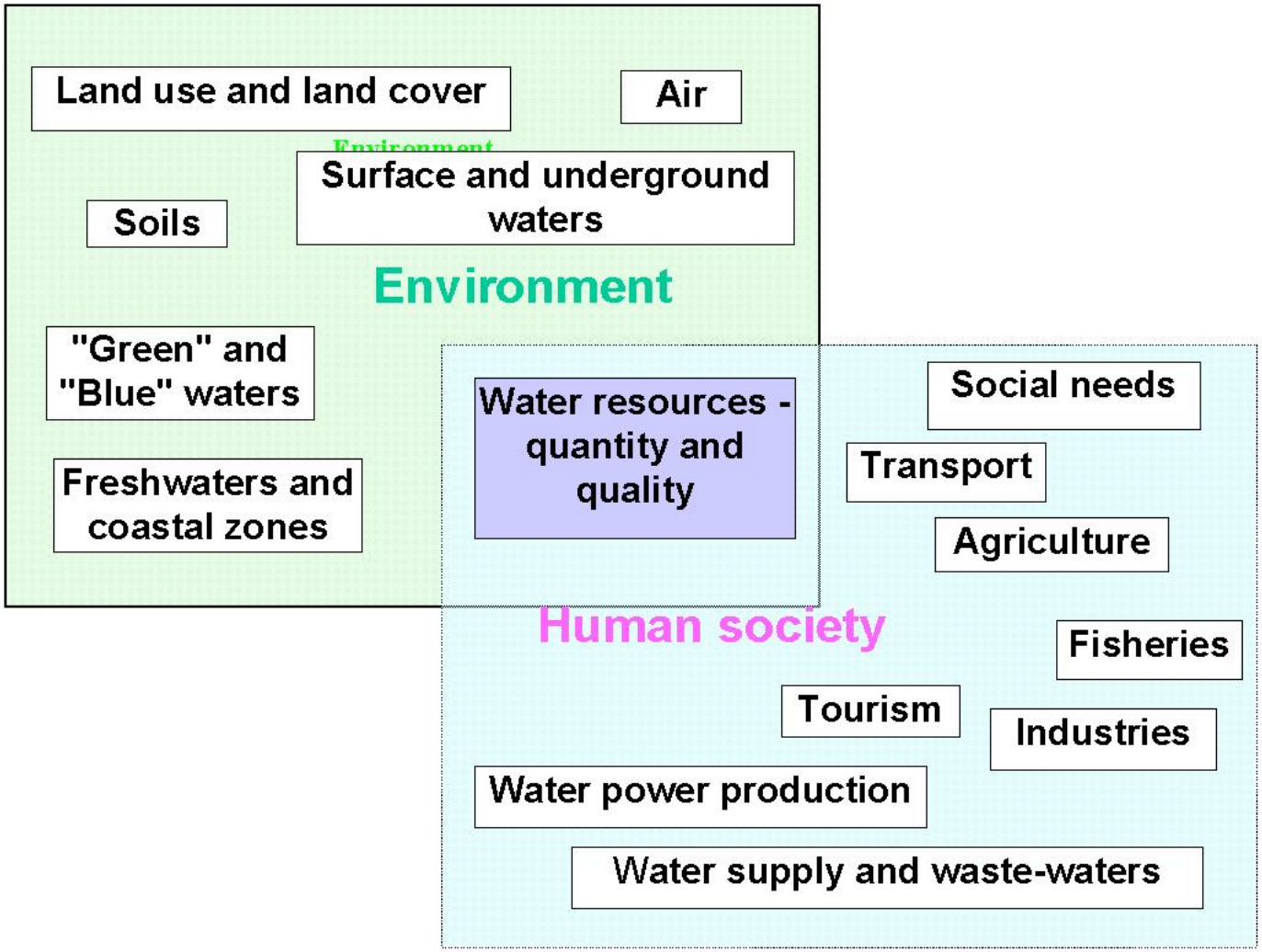
in the case

of a **lack of information** of the state and

the use of the water resources in the past,

for the time being,

and without prognosis for near and distant future.



The interdependence between water, on one side, and sustainable environment development and human society, on the other side.

The typical feathers of **the available data** in Bulgaria:

- **Large volume** covering long periods of time;

- **Scattered** in different institutions, **not well structured**, and usually **gathered in unusable formats** and **files**;

- **Incompleteness** of the records. **Inaccuracy** and **errors**;

The Geographical Information Systems (GIS's) are

very important suitable device for easy communication

between the different groups of data interested

in the assessment of the water resources

distribution and utilization.

They must be **sophisticated**

by inclusion of procedures and models

to process

the primary data

to more expressive information

for assessment of the water resources.

- The structure of Geographical water resources information system for Bulgaria is composed by river basins,

  the layers are formatted and

  the system is applied

  to the Yantra River basin

Basic principles of a structure of Geographical Water Resources Information and Assessment System

- **Strong system of database**, covering all the necessary information;

- **Containing models** for data interpretation and analysis;

The requirements to the data in a water resources **IS**:

- To cover different areas of the nature and the society;
- To be reliable;
- To be well structured;
- To be easy used;
- To be generated in long synthetic time series needed for the mathematical simulation of the water resources systems functioning;

Data structure required by IWRM

- The **watershed** as a **basic logical unit,** an ideal unit to balance production and conservation ;

- The **combined use of the data**

  in the visualization,

  in the procedures and in the models of processing,

  in the analysis and the prognosis;

- The specific requirements of the basic GIS.

The data in the System are:

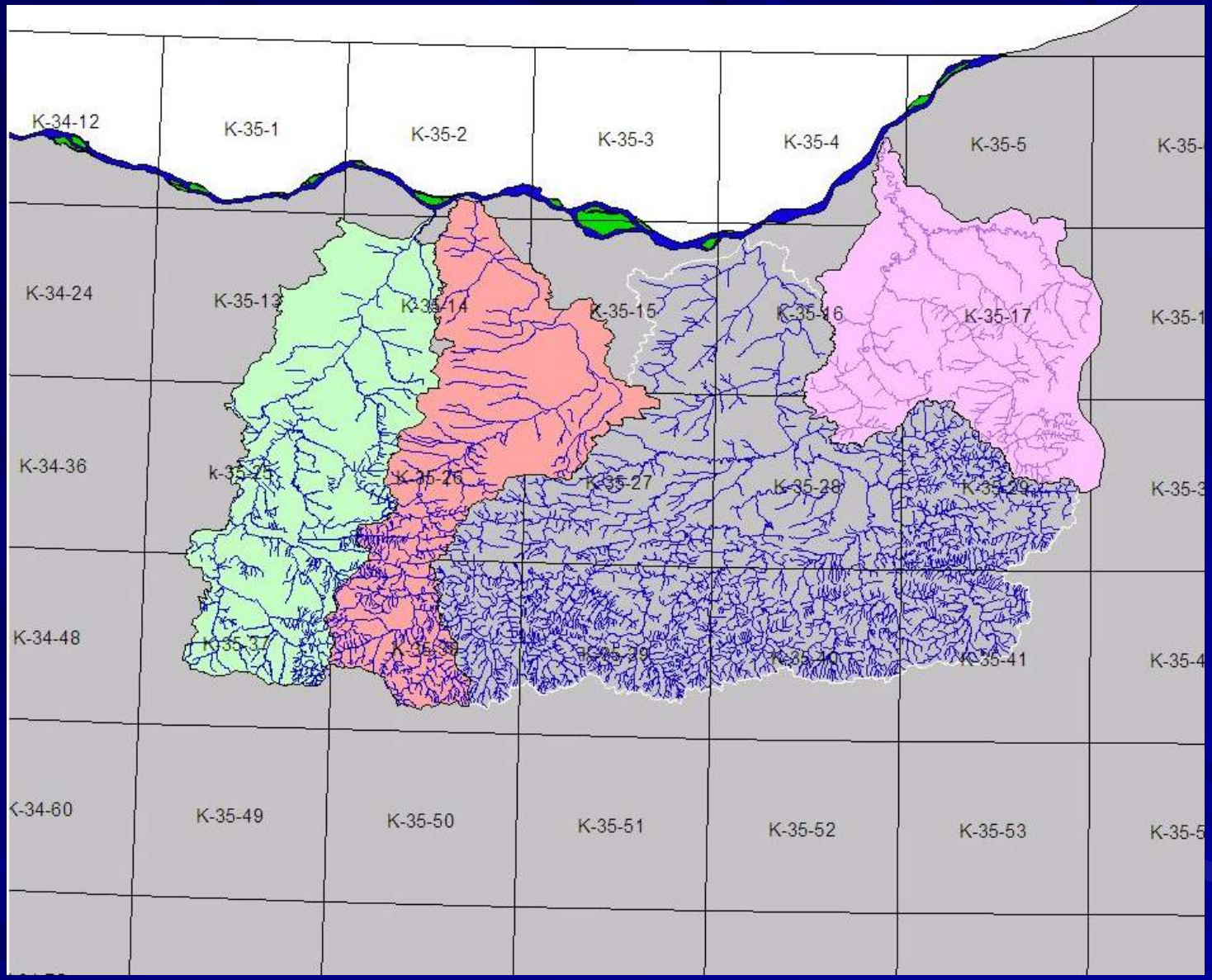
- ✓ **Primary data** - in result of direct measuring;

- ✓ **Processed (generalized) data** -

received from the primary data
by digital processing
depending
some rules and models.

"GeoWateRIAS"

Watersheds on the territory of Bulgaria



"GeoWateRIAS "

Combined use of data for several watersheds in Bulgaria.

"GeoWateRIAS "

The general groups of data, proceeding from the requirements of IWRM are:

- Data defining the topography of the watershed;
- Meteorological data;
- Hydrological data;
- Geological and hydro-geological data;
- Land use and vegetable cover data;
- Water quality data;
- Demographic data;
- Data for the man-made water systems and hydraulic structures;
- Data for national parks, reserves and protected zones;
- Gravel and sand pits;

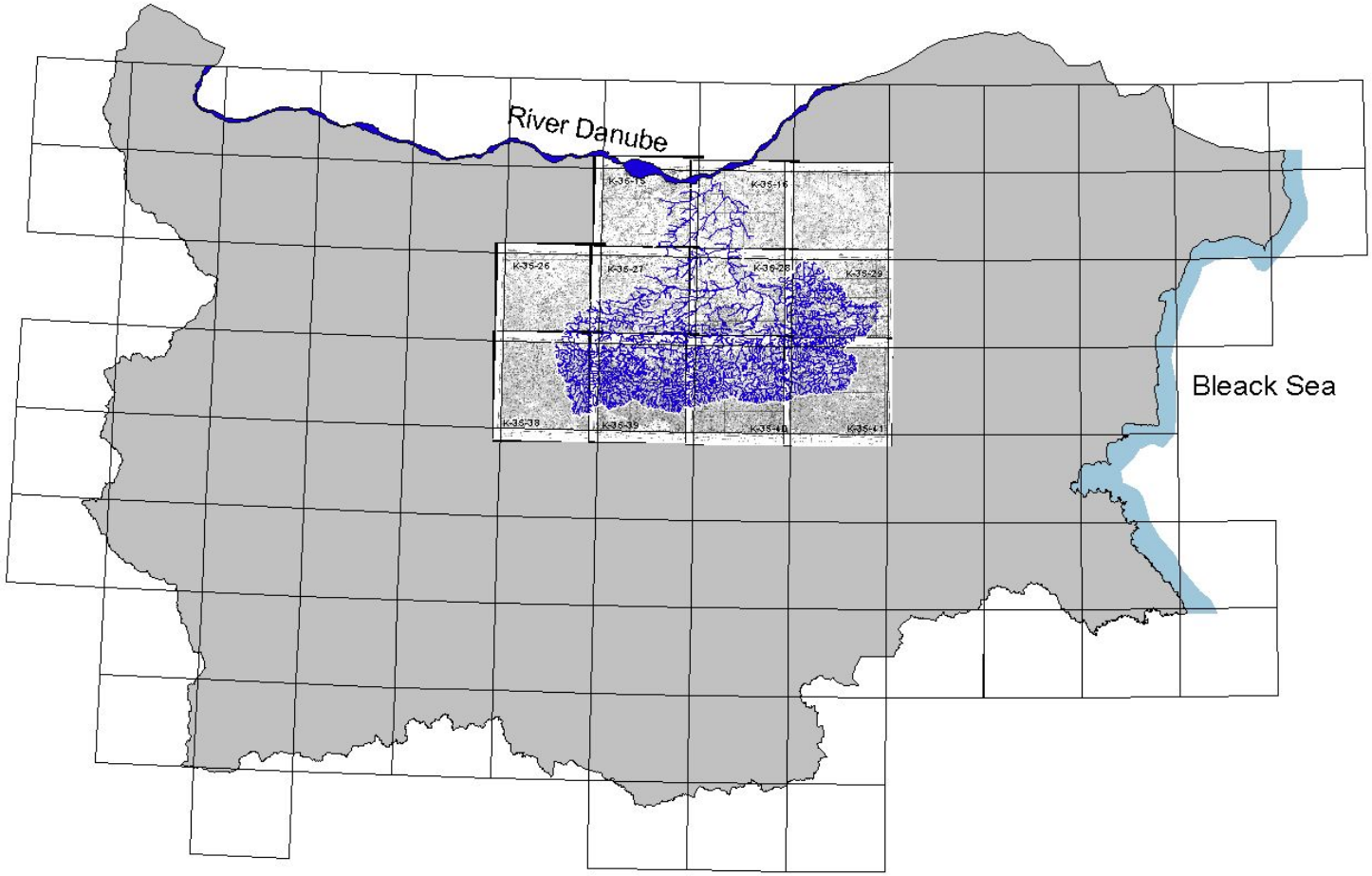
Data defining the topography of the watershed:

A) Topographic maps, satellite and aerial photographs,
- ***primary data*** for the ***IS***.

The practice permits to identify the scale of **1:50000**
as satisfactory for IWRM,

but often
the **operation management** requires more detailed maps.

"GeoWateRIAS "



Set of topographic maps of Bulgaria, scale 1:50000 and map sheets of the Yantra river watershed activated

B) Contours and digital elevation model (DEM)

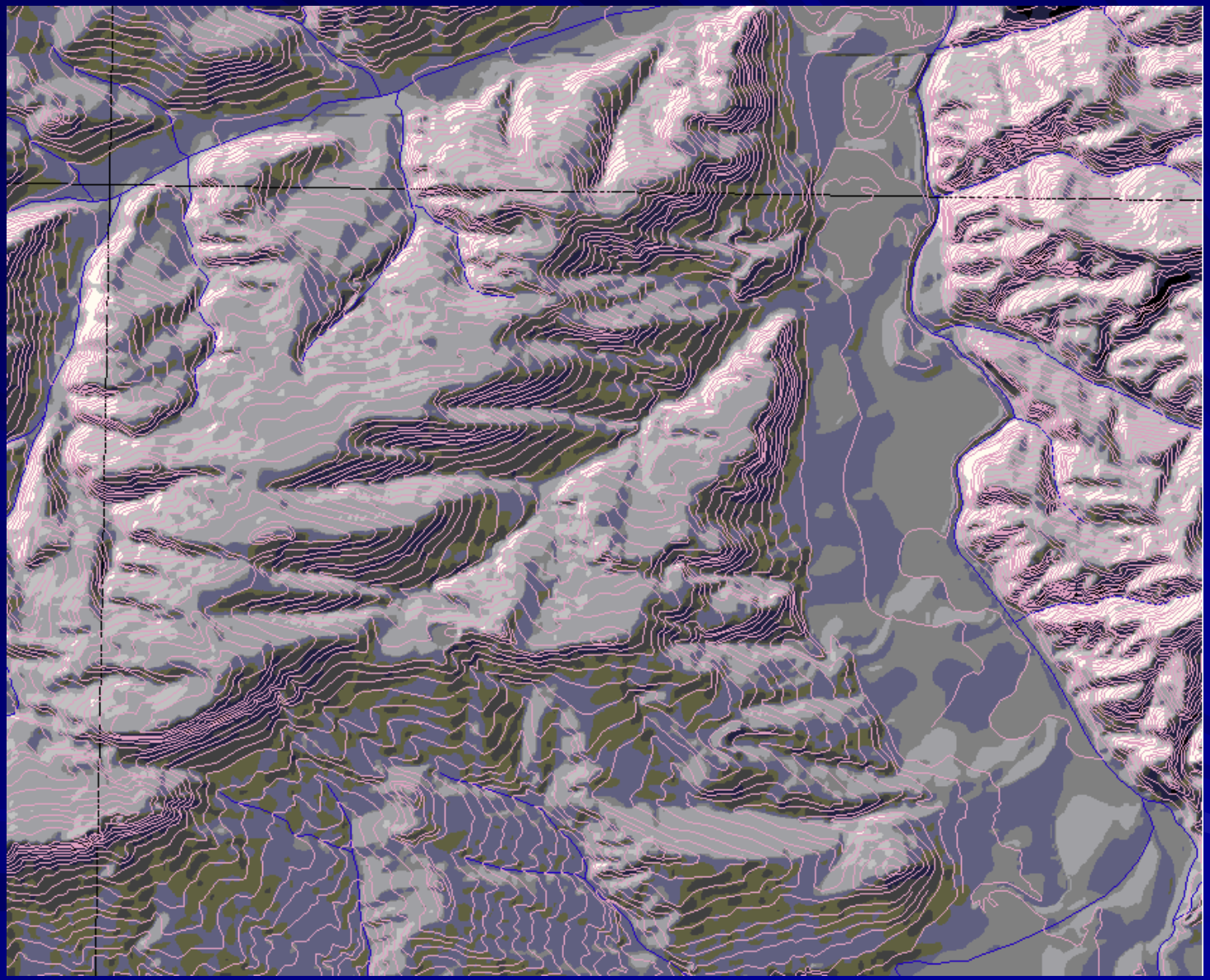
The contours are primary data for the ***IS,*** extracted from the topographic maps.

DEM is received by processing the contours data and is

used for:

- **Visual presentation of the watershed surface;**
- **Source of information of the different objects level**;
- Automatic drawing of the watershed divides;
- Automatic defining:
  - the flood surfaces;
  - the surface slope in the simulation models of the non-point water pollution;
  - the river bed slope.

"GeoWateRIAS"

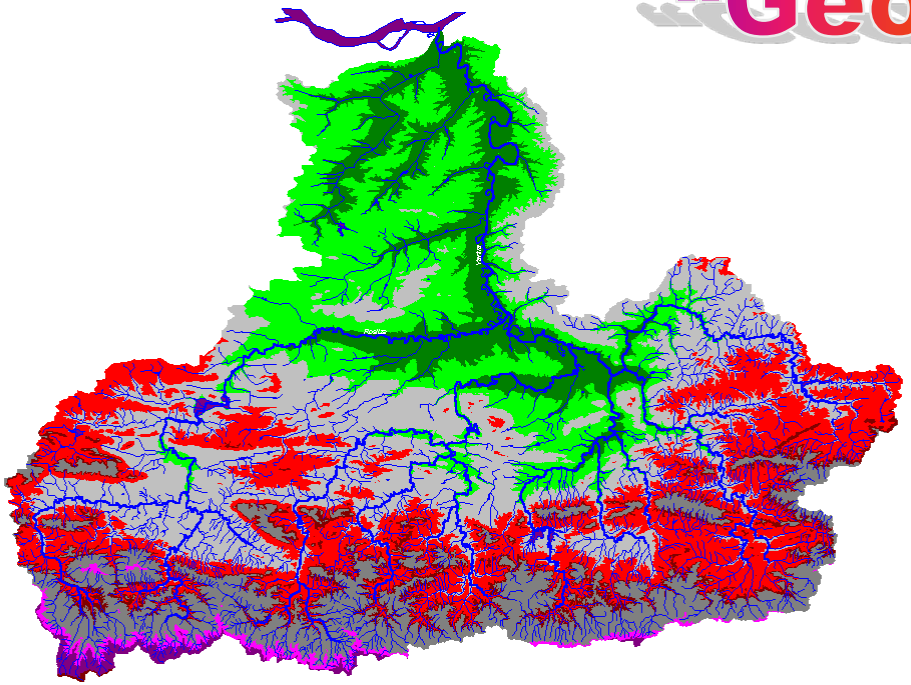


Yantra river watershed

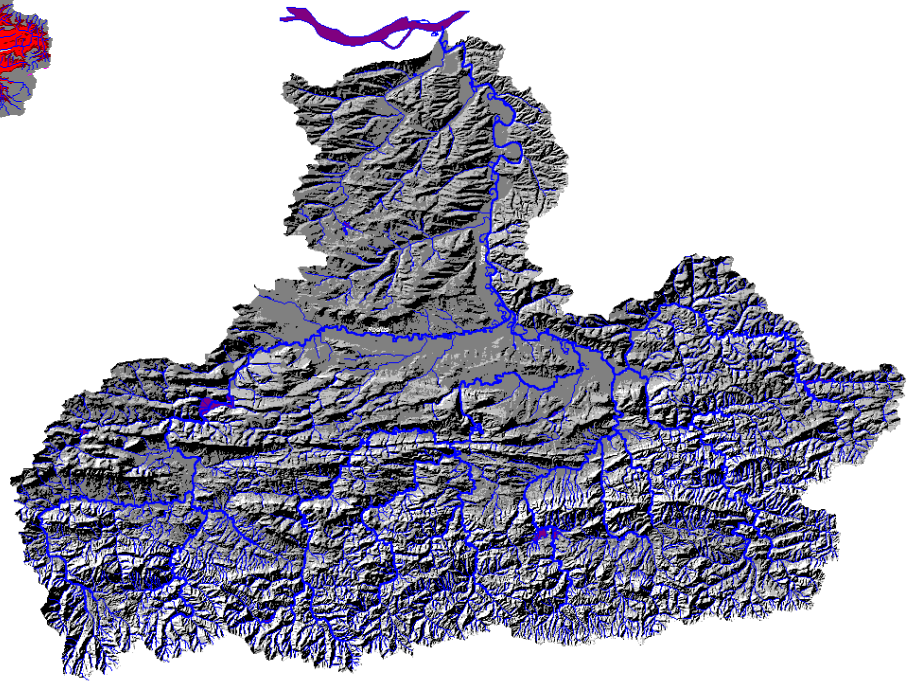
Fragment of the contours layer and resulting DEM

Yantra river watershed

"GeoWateRIAS"



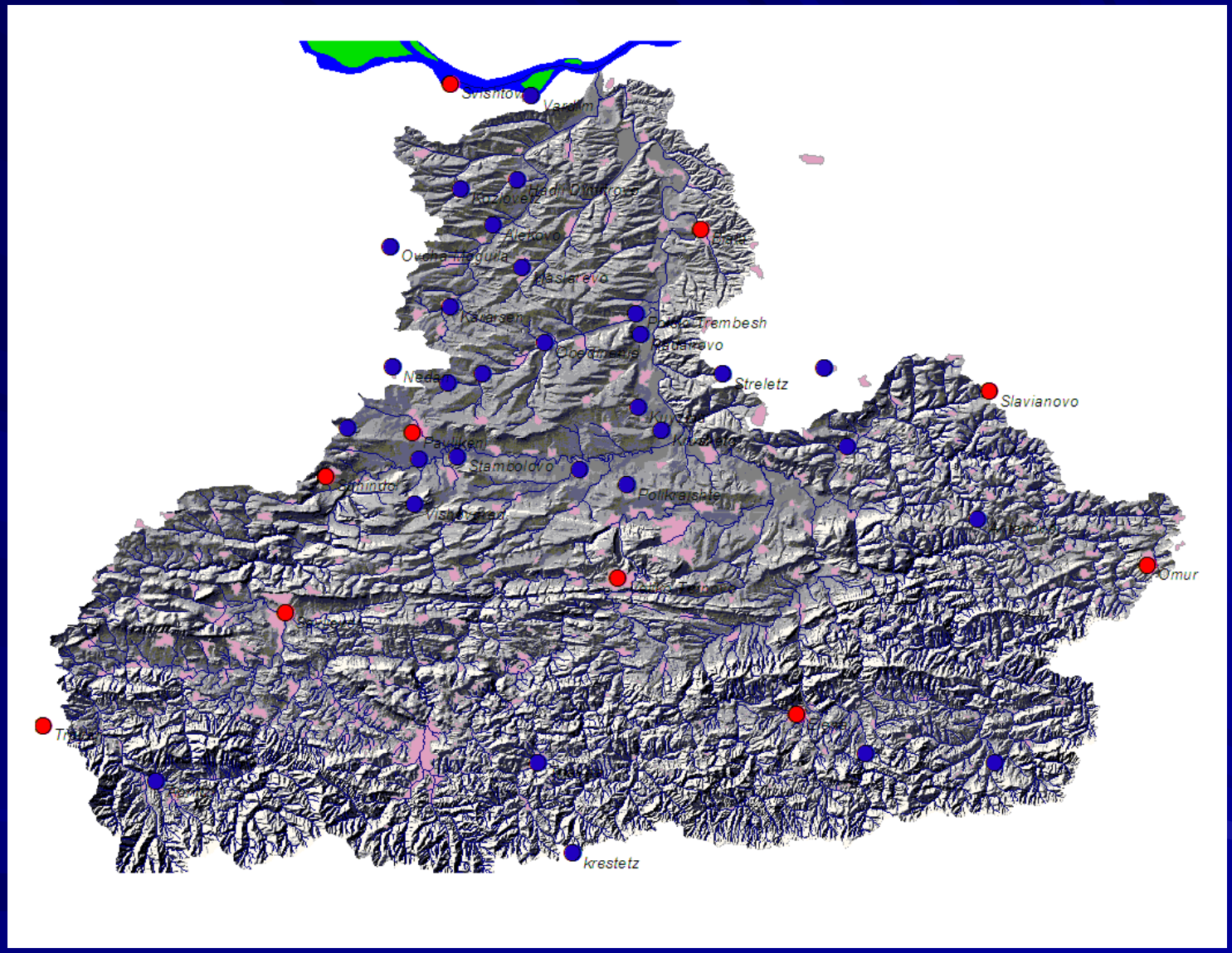
DEM. Color image



DEM. Hill shade image

Meteorological data:

Yantra river watershed



Meteorological monitoring points. Blue points – precipitation monitoring, Red points – precipitation and temperature monitoring

“GeoWateRIAS ”

Meteorological data:

Microsoft Excel - Rain_Svishtov.xls [Read-Only]

File Edit View Insert Format Tools Data Window Help

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Year	Day	Months											
2			1	2	3	4	5	6	7	8	9	10	11	12
3	1984	1					0,2	0,0		0,0	0,0	0,0	0,0	
4	1984	2		0,0	1,1	0,0	0,0	21,8		0,0	0,0	0,0	0,0	
5	1984	3		0,5	0,2			0,0			0,0	0,2		
6	1984	4	0,0		0,1		0,0			7,6	0,0	0,0		
7	1984	5	0,0	0,0	5,3			0,4		0,3	0,0	0,0		0,0
8	1984	6	3,4	0,8	27,0	0,0		0,0		0,0	0,0	0,0		0,0
9	1984	7	12,2		66,5		0,0	9,8		0,0	0,0	0,0	0,0	
10	1984	8	6,9		13,8				0,0			0,0	0,3	0,0
11	1984	9		0,6	0,0	3,6		3,3	5,1		0,0		1,9	
12	1984	10		10,2	6,8	8,7	0,0		5,0		22,3	0,0	0,2	0,0
13	1984	11	11,1	6,2	12,7	1,1	0,0	0,2			0,0	0,0		
14	1984	12		2,8	5,1	0,0	1,7	0,0		0,2		0,0	0,0	
15	1984	13	0,6	1,1	4,2	0,0	3,3	7,5			0,0		0,0	0,0
16	1984	14	0,3	0,0	1,5	0,0	3,9	0,0		3,9	0,0		0,0	0,0
17	1984	15	0,0	0,0	1,7	0,0	13,4	0,0		0,0	0,0		0,0	0,4
18	1984	16	1,4		0,0	0,0	0,0	0,2			0,0	3,1	0,0	0,0
19	1984	17	0,2	0,0	0,0		0,0				0,0	1,2	2,2	
20	1984	18	0,0	6,0	0,0		1,1	0,0	2,8		3,4	0,0	0,6	
21	1984	19		15,4	0,0	3,7	0,0	5,7	1,0	12,2	0,0	0,0	14,5	0,0

Валежи-Свищов

Ready

start C:\Prog... FP-160... Microso... SA Dicti... ArcVie... 4 Micr... BG 97% 13:02

Fragment of precipitation data for meteorological station “Svishtov”

“GeoWateRIAS ”

Meteorological data:

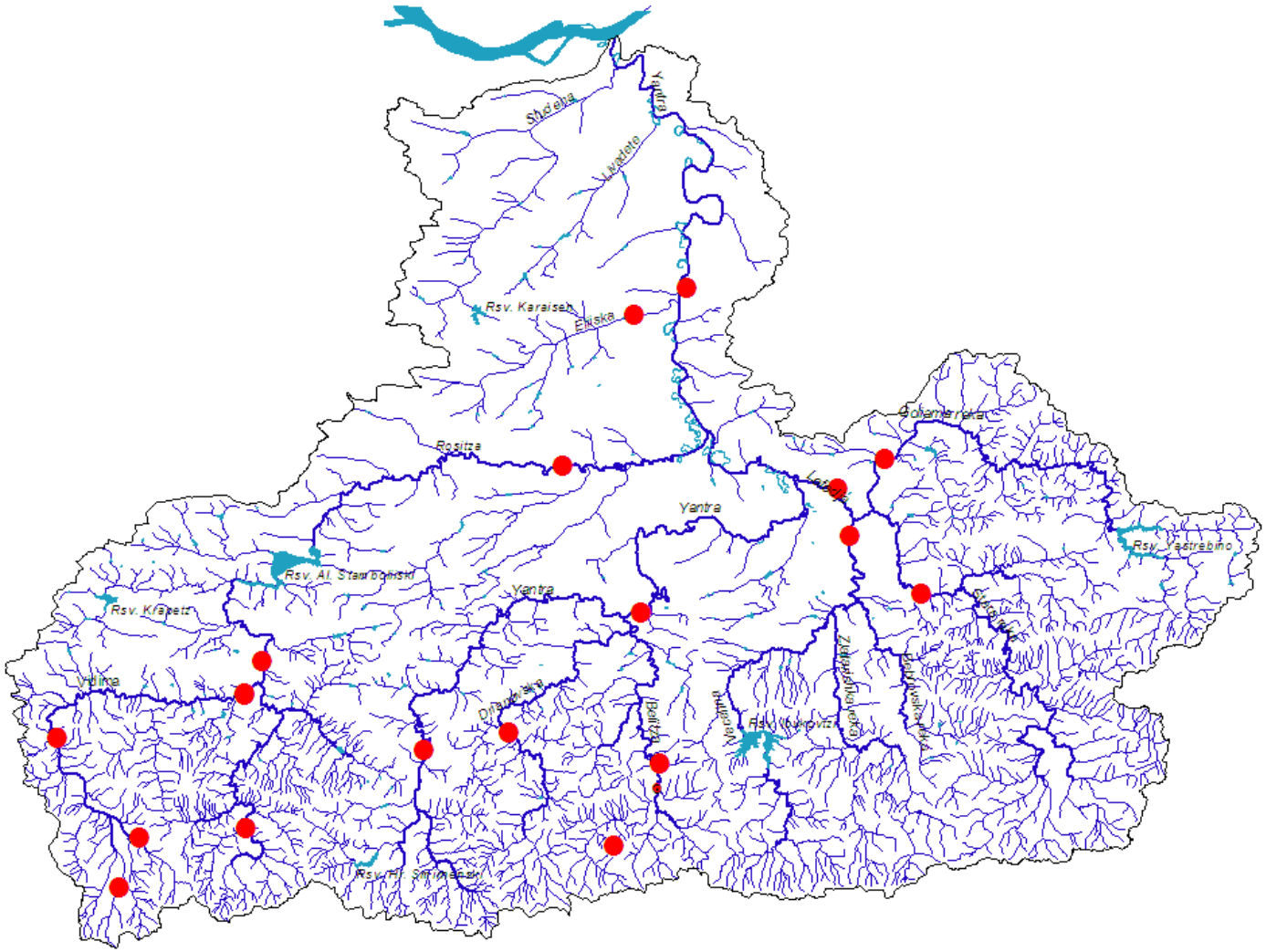
Microsoft Excel - Temp_Svishtov.xls [Read-Only]

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Year	Day	Months											
2			1	2	3	4	5	6	7	8	9	10	11	12
3	1984	1	7,6	0,1	4,1	9,5	14,7	18,6	25,1	24,6	20,1	19,8	5,7	2,3
4	1984	2	12,9	3,5	4,7	12,8	11,4	21,0	24,2	25,7	22,0	19,3	4,0	5,8
5	1984	3	7,4	5,1	4,7	13,6	15,7	21,5	25,0	20,1	21,4	19,3	7,4	4,2
6	1984	4	7,2	4,4	4,8	13,6	19,0	22,7	18,9	23,7	22,4	21,1	9,3	2,1
7	1984	5	5,3	4,8	3,9	12,1	18,6	22,9	18,5	24,6	22,3	19,7	9,1	-2,1
8	1984	6	2,2	4,6	0,7	13,6	17,0	22,8	18,8	23,0	22,5	24,1	9,5	-2,3
9	1984	7	0,5	4,3	1,5	11,4	17,2	26,2	17,9	24,8	23,8	22,7	8,1	-1,1
10	1984	8	0,8	3,5	3,7	10,0	20,0	17,0	15,6	24,0	24,1	18,9	10,6	0,9
11	1984	9	0,0	5,2	1,8	8,6	20,1	19,4	20,0	24,4	21,5	16,3	10,8	0,9
12	1984	10	1,7	2,3	1,0	8,8	17,2	19,5	22,6	24,5	20,1	16,3	10,7	2,6
13	1984	11	1,0	-0,8	2,0	10,5	19,4	19,2	24,3	24,7	18,3	16,0	7,5	5,8
14	1984	12	-1,5	-3,0	0,8	10,7	16,3	15,3	27,0	24,6	17,6	18,9	3,4	2,7
15	1984	13	-0,6	-3,6	1,4	10,3	17,0	15,9	26,2	21,9	20,6	16,0	-1,9	1,1
16	1984	14	-3,8	-4,9	1,1	11,4	13,9	18,6	28,8	20,4	20,3	13,7	-4,0	-0,7
17	1984	15	-0,2	-4,9	2,2	13,5	19,0	21,8	30,3	22,0	22,3	15,9	2,2	-0,3
18	1984	16	2,5	-5,2	2,3	14,2	22,5	19,8	30,1	21,5	22,2	10,9	2,1	0,1

Fragment of temperature data for meteorological station “Svishtov”

Hydrological data:

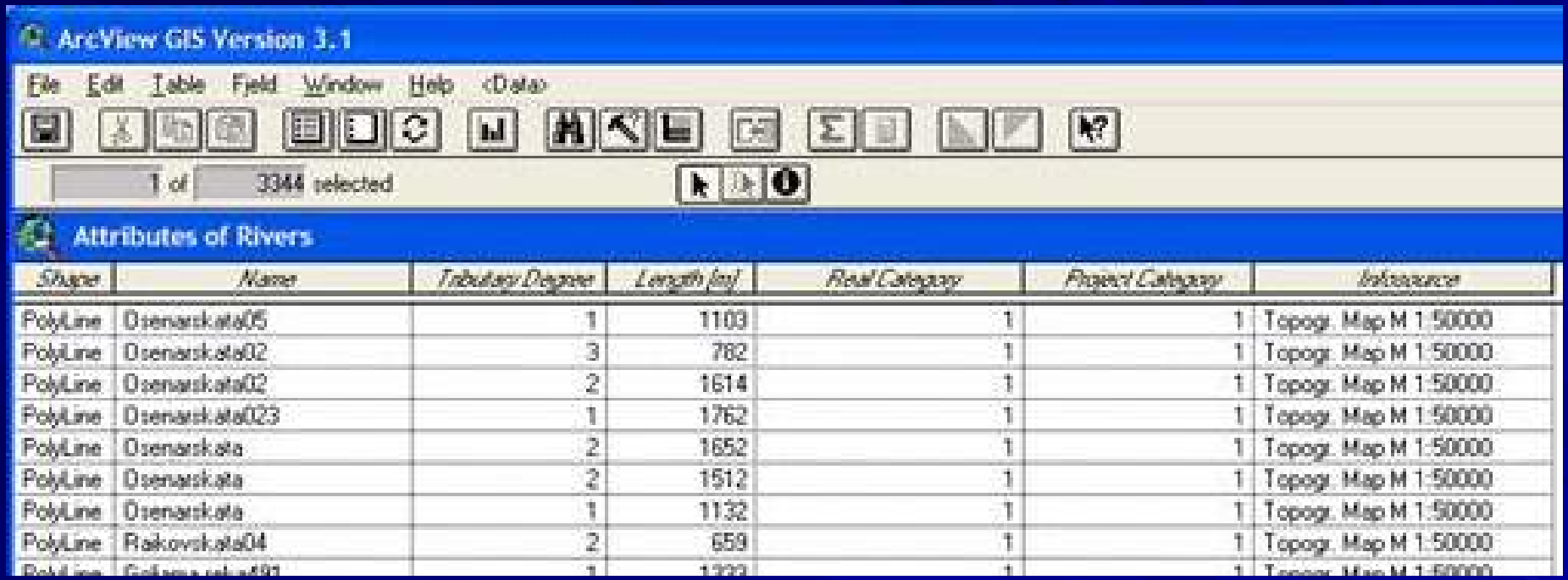
- Rivers net;
- Lakes, reservoirs and marshlands;
- Hydrometric stations;
- Watersheds;



River net and Hydrometric stations

YANTRA river watershed

"GeoWateRIAS "



Shape	Name	Tributary Degree	Length [m]	Real Category	Project Category	Information
PolyLine	Osenarskata05	1	1103	1	1	Topogr. Map M 1:50000
PolyLine	Osenarskata02	3	782	1	1	Topogr. Map M 1:50000
PolyLine	Osenarskata02	2	1614	1	1	Topogr. Map M 1:50000
PolyLine	Osenarskata023	1	1762	1	1	Topogr. Map M 1:50000
PolyLine	Osenarskata	2	1652	1	1	Topogr. Map M 1:50000
PolyLine	Osenarskata	2	1512	1	1	Topogr. Map M 1:50000
PolyLine	Osenarskata	1	1132	1	1	Topogr. Map M 1:50000
PolyLine	Rakovskata04	2	659	1	1	Topogr. Map M 1:50000

View of Attribute table of the **rivers layer**

Name;

Tributary Degree;

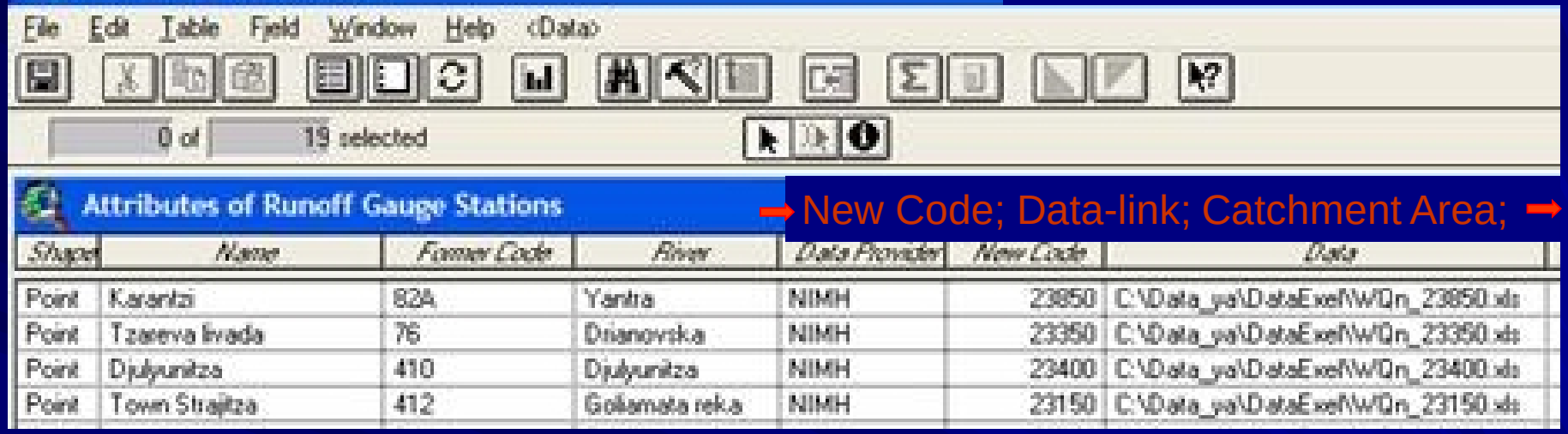
Length;

Real and Project Category;

Info source;

"GeoWateRIAS "

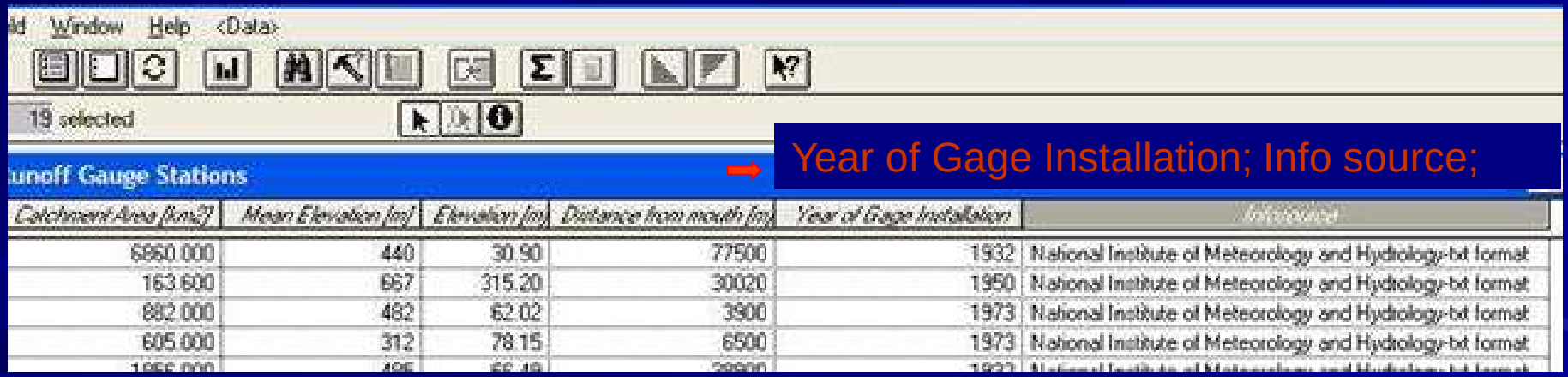
Name; River; Data Provider;



Shape	Name	Former Code	River	Data Provider	New Code	Data
Point	Karantzi	82A	Yantra	NIMH	23850	C:\Data_ya\DataExel\WQn_23850.xls
Point	Tzareva livada	76	Dryanovska	NIMH	23350	C:\Data_ya\DataExel\WQn_23350.xls
Point	Djulyunitza	410	Djulyunitza	NIMH	23400	C:\Data_ya\DataExel\WQn_23400.xls
Point	Town Strajitza	412	Golamata reka	NIMH	23150	C:\Data_ya\DataExel\WQn_23150.xls

Continuation

Mean Elevation; Elevation; Distance from mouth;

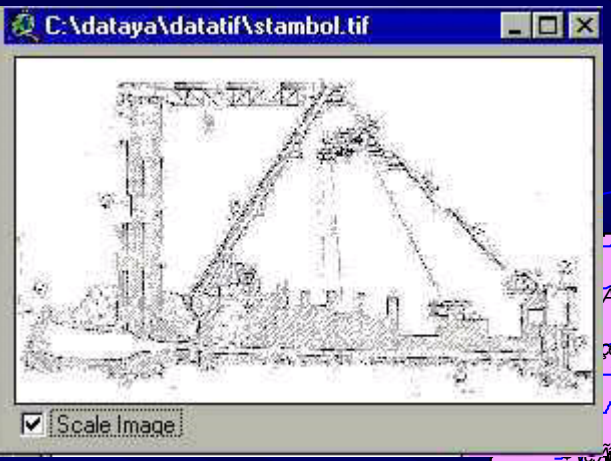


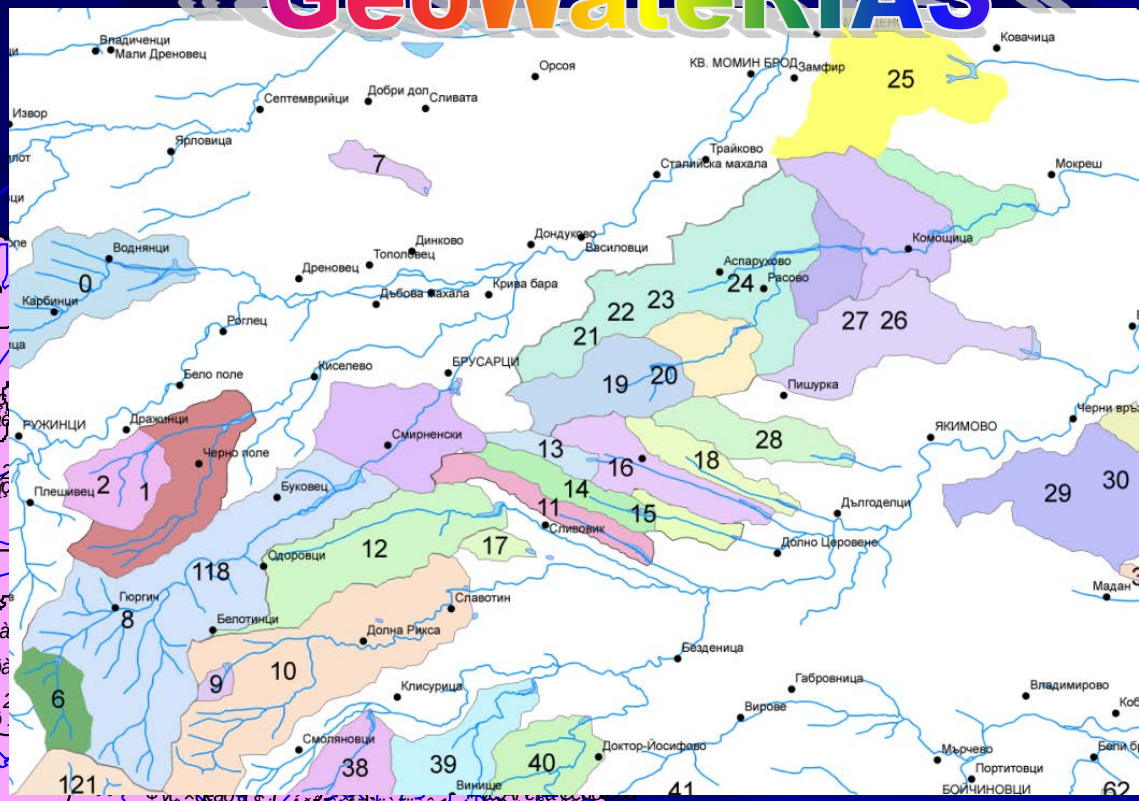
Catchment Area [km2]	Mean Elevation [m]	Elevation [m]	Distance from mouth [m]	Year of Gage Installation	Info source
6860.000	440	30.90	77500	1932	National Institute of Meteorology and Hydrology-txt format
163.600	667	315.20	30020	1950	National Institute of Meteorology and Hydrology-txt format
882.000	482	62.02	3900	1973	National Institute of Meteorology and Hydrology-txt format
605.000	312	78.15	6500	1973	National Institute of Meteorology and Hydrology-txt format

Attribute table of the **runoff gauge stations**

Lakes and reservoirs layer

"GeoWateRIAS"





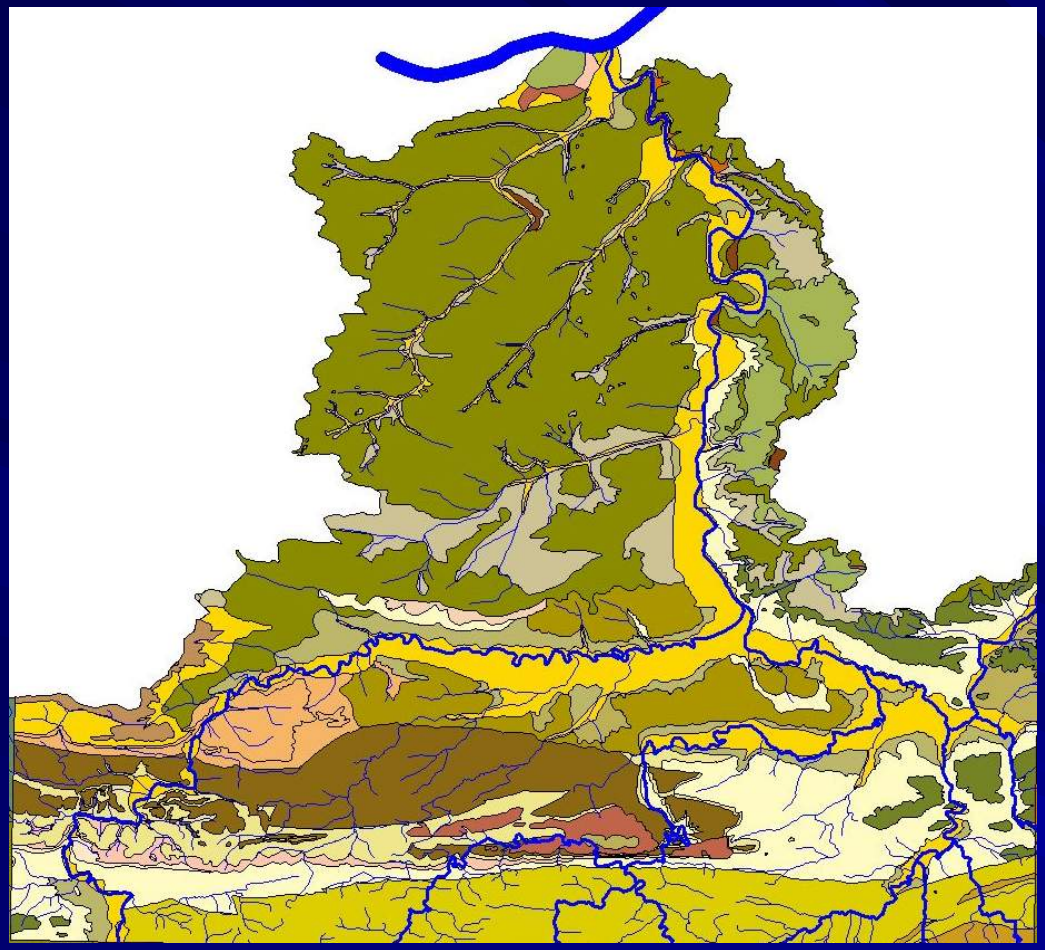
Watersheds layer of the dams

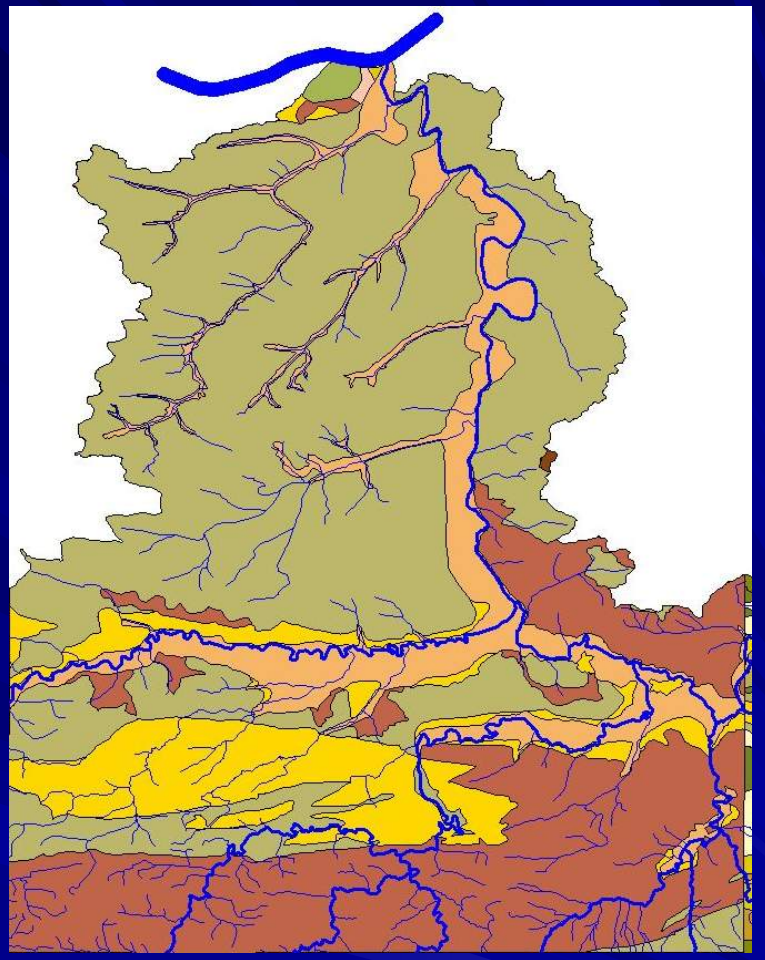
Geological and hydro-geological data:

The polygons of:

- the geological structure;
- the water saturated geological layers;
- different kinds of soils.

"GeoWateRIAS "



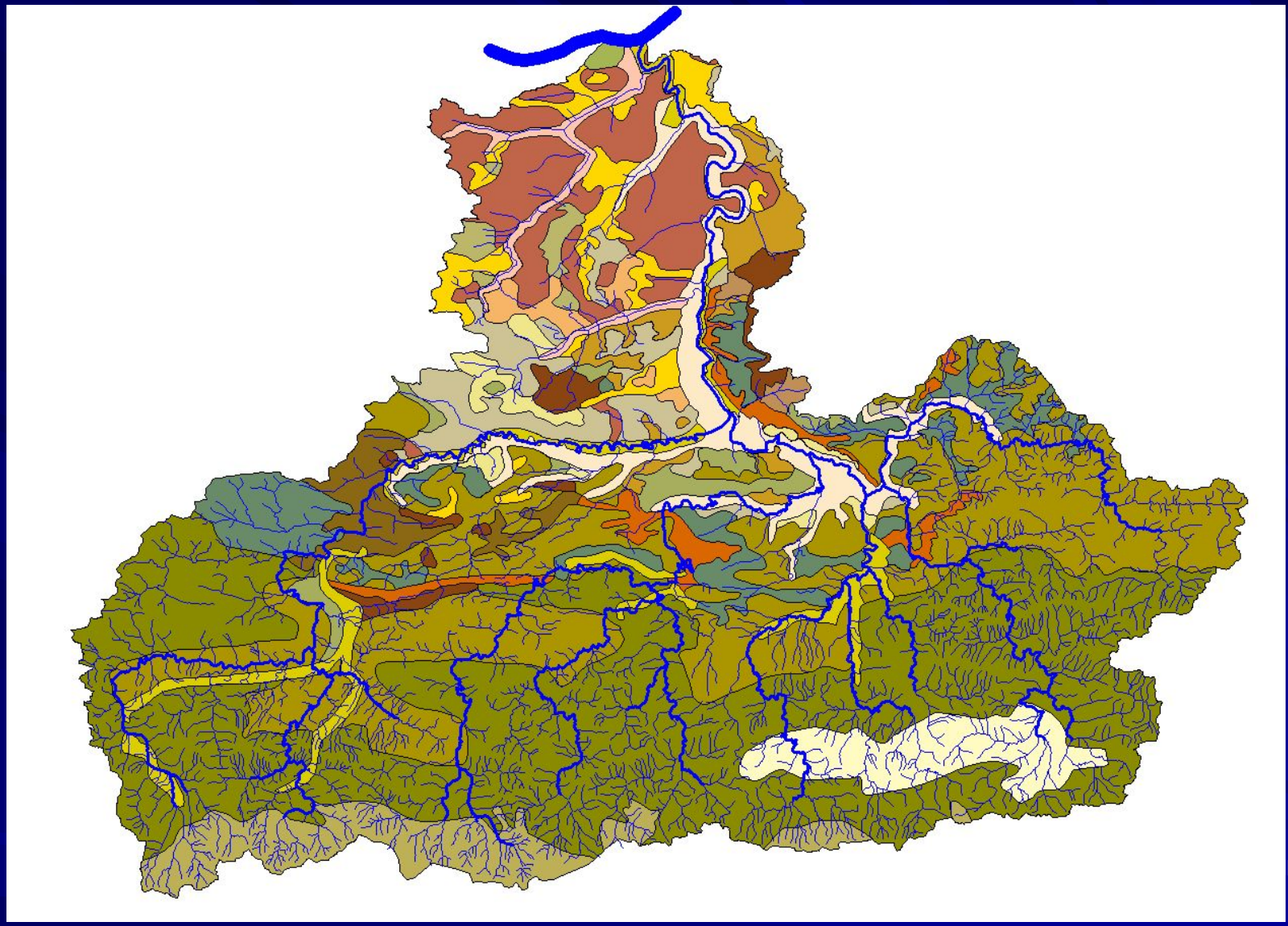


Fragment of the

- geological layer
- Hydro-geological layer

Yantra river watershed.

Yantra river watershed

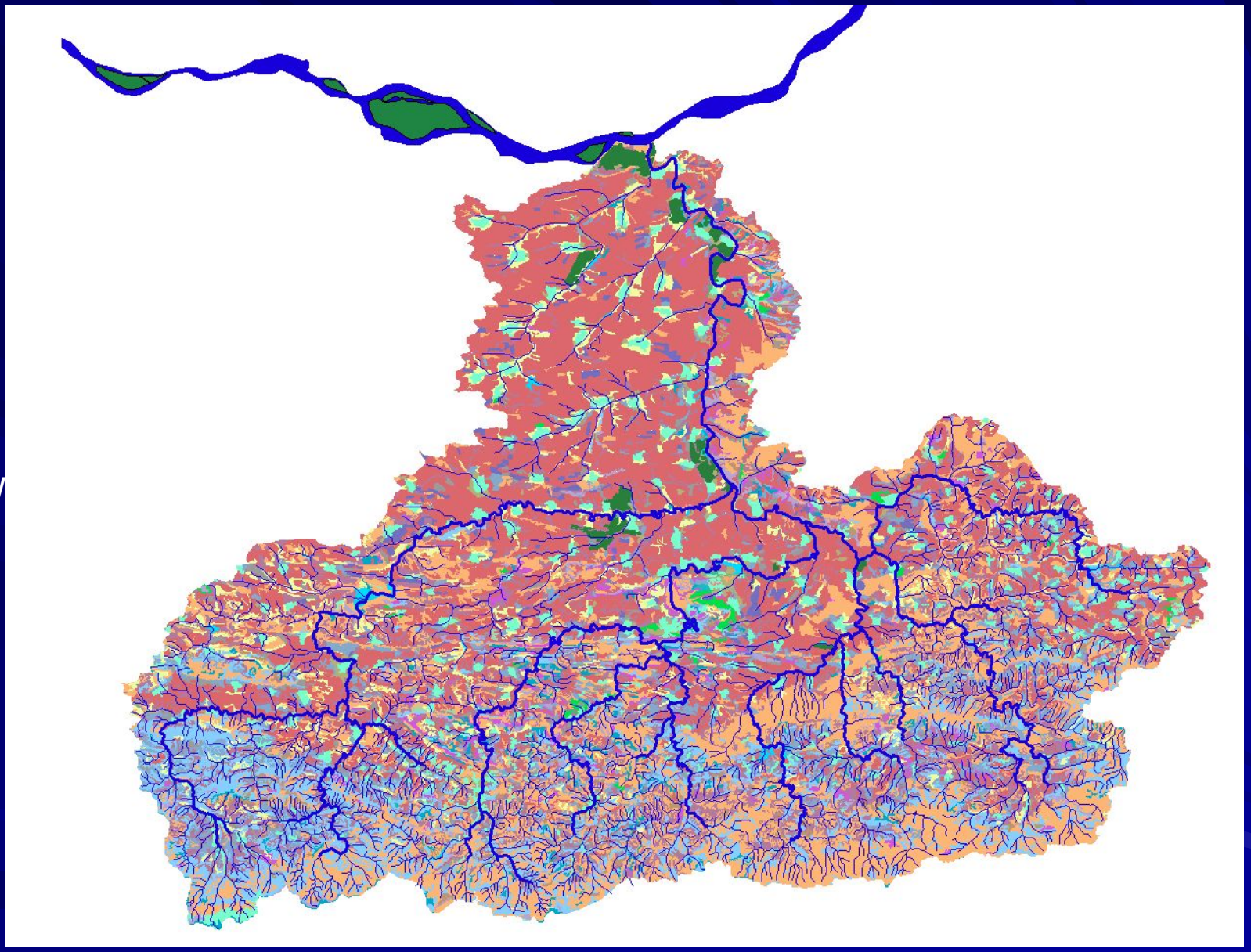


Soil vector layer

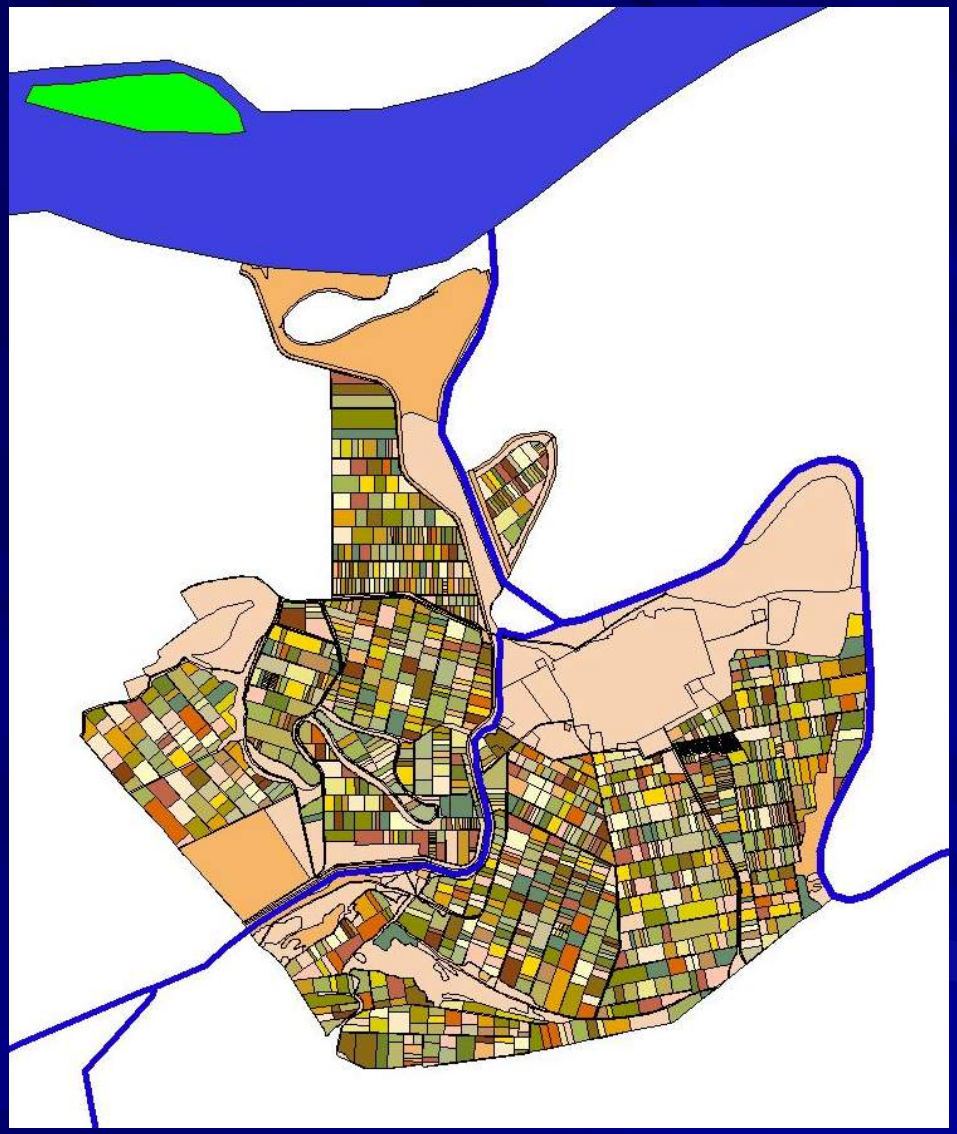
Land use and vegetable cover data

- Raster layers containing the satellite and air photographs
- Raster layers containing the specialized map sheets of land use
- Vector layers containing the drawing maps of land use parcels.
- Vector layer containing the polygons of the land areas specified by kind of use and the vegetable cover.

Yantra river watershed



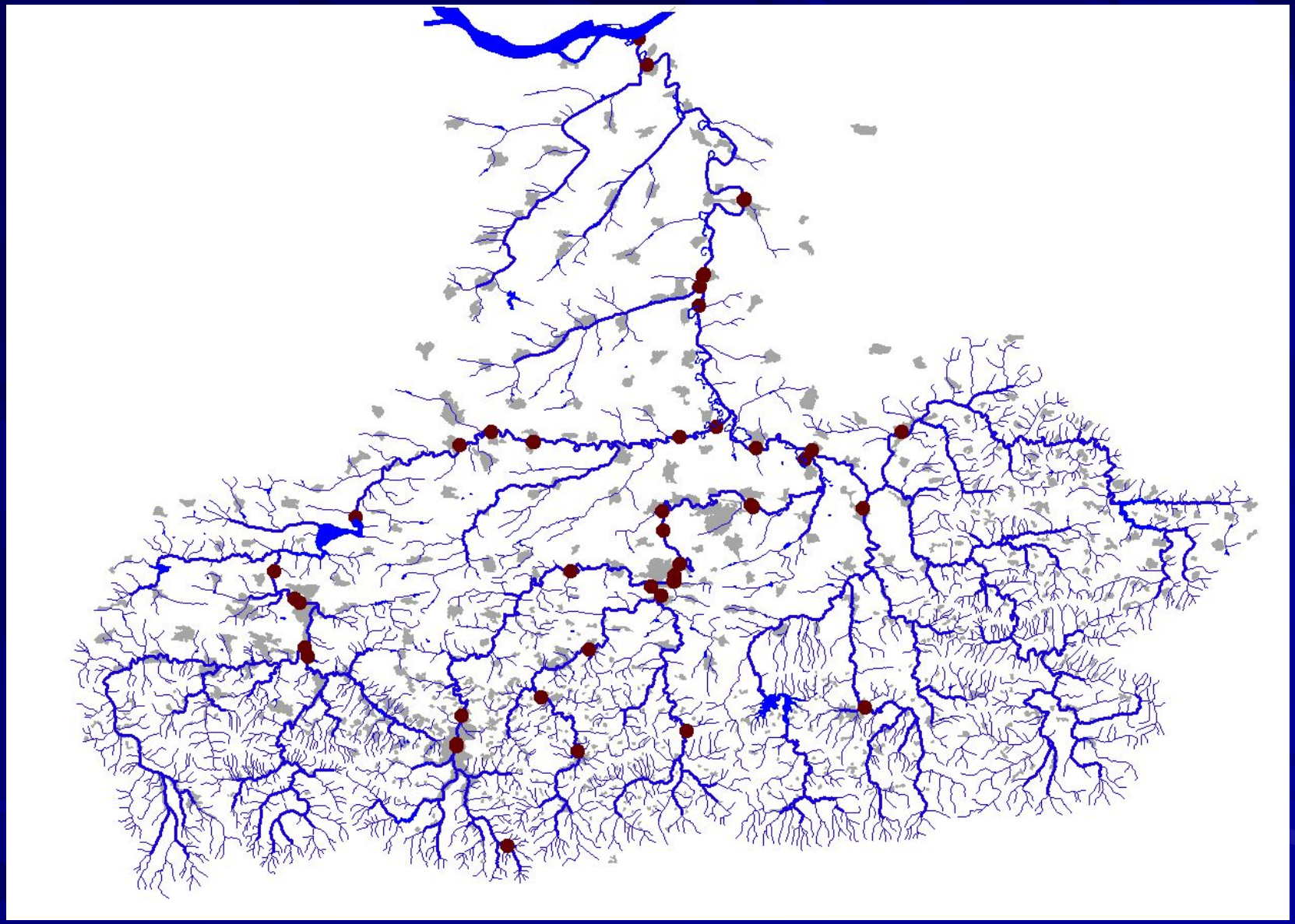
Land use layer



Yantra river watershed. Land parcels of the settlement Novgrad

Water quality data

- Layer of water quality monitoring points;
- Layer of wastewater outlets.



Yantra river watershed

Water quality monitoring points

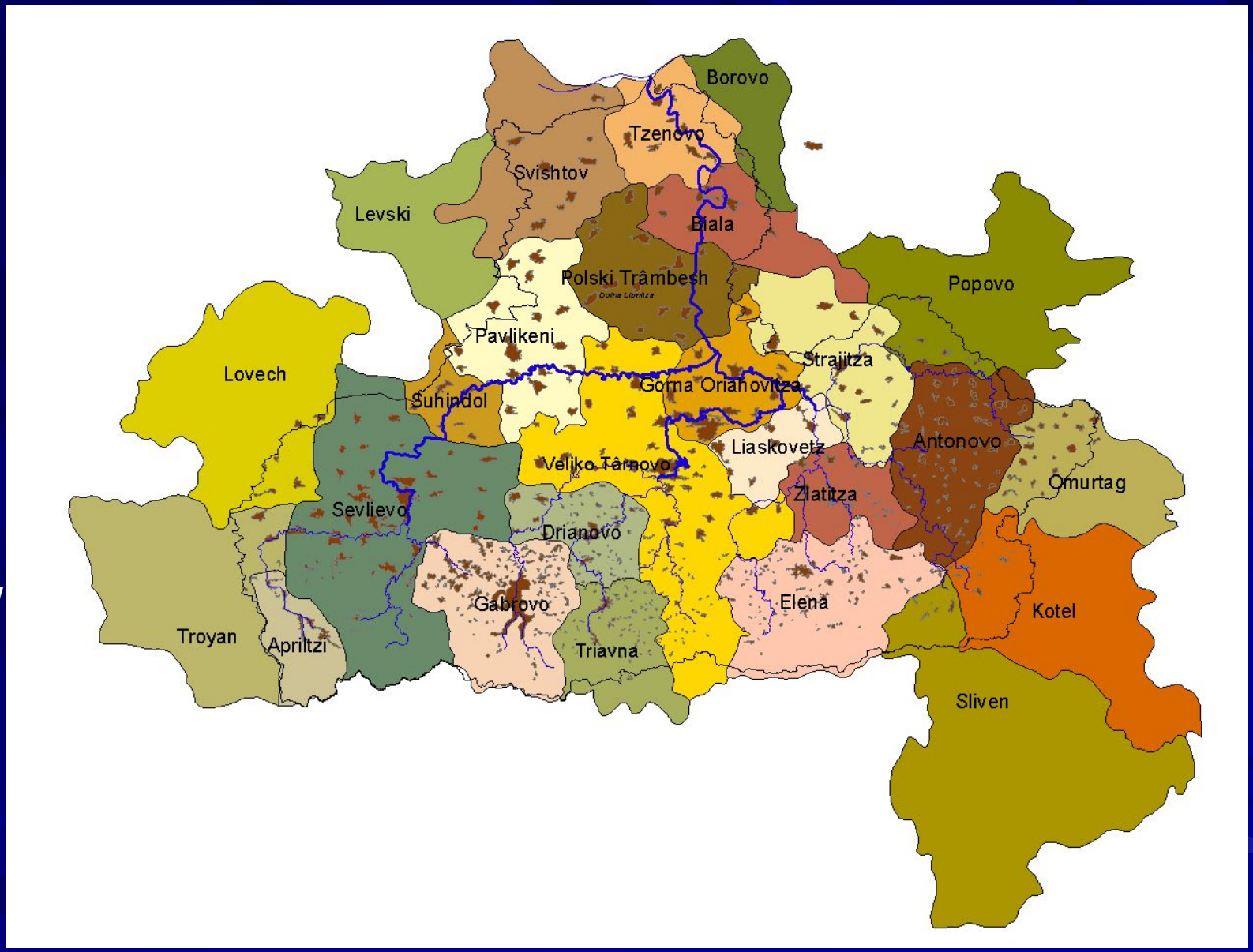
The parameters, subject of the monitoring are:

Date of reading
Total Dissolved Solids Dried at 105°C [mg/l]
Magnesium [mg/l]
Chromium 6+ [mg/l]
Water capacity [m3/sec]
Total Suspended Solids Dried at 105°C [mg/l]
Sodium and potassium [mg/l]
Chromium 3+ [mg/l]
Air temperature oC
Chloride [mg/l]
Phenols [mg/l]
Chromium total [mg/l]
Water temperature oC
Sulfate [mg/l]
Cyanide [mg/l]
Zink [mg/l]
pH
Ammonia Nitrogen (NH3-N) [mg/l]
Detergents [mg/l]
Nickel [mg/l]
Dissolved oxygen [mg/l]
Ammonium nitrogen [mg/l]
Oil and grease [mg/l]
Common Hardness mgeq/L
Dissolved oxygen %
Nitrite Nitrogen (NO2--N)[mg/l]
Manganese total [mg/l]
Saprobity Electroconductivity [mS/cm]
Nitrit nitrogen[mg/l]
Total Iron [mg/l]
Colititre [ml]
BOD5 [mg/L]
Nitrate [mg/l]
Lead [mg/l]
Carbonates [mg/l]
Potassium Permanganate Consuming Capacity mg/L
Nitrate Nitrogen (NO3--N) [mg/l]
Cadmium [mg/l]
Hydro carbonates [mg/l]
Chemical Oxygen Demand mg/l
LHydrogen Sulfide [mg/l]
Arsenic [mg/l]
Bicarbonates [mg/l]
Dry materials Total Solids (Dried at 105 °C) [mg/l]
Phosphate [mg/l]
Copper [mg/l]
Alkalinity [mgeq/L]

Demographic data:

- Districts;
- Municipalities;
- Settlements.

Yantra river watershed



"GeoWateRIAS"

Municipalities and settlements

Data for the man-made water systems and hydraulic structures:

From point of view **the water use** - the man-made water systems can be: water supply systems (drinking and industrial), irrigation systems, draining systems, hydropower systems, or sewage systems.

From point of view **the information system** - they are composition of functionally related hydraulic structures.

The man-made water system is presented in the information system by the combination of hydraulic structures and their parameters.

Layers of hydraulics structures:

Layers of point objects:

- Water intakes;
- Wells;
- Dams;
- Hydropower stations;
- Pump stations;
- Drinking water;
- Treatment plants;
- Wastewater treatment plants;
- Water supply tanks (reservoirs);
- Gravel and sand pits;

Layers of line objects:

- Water transport facilities;

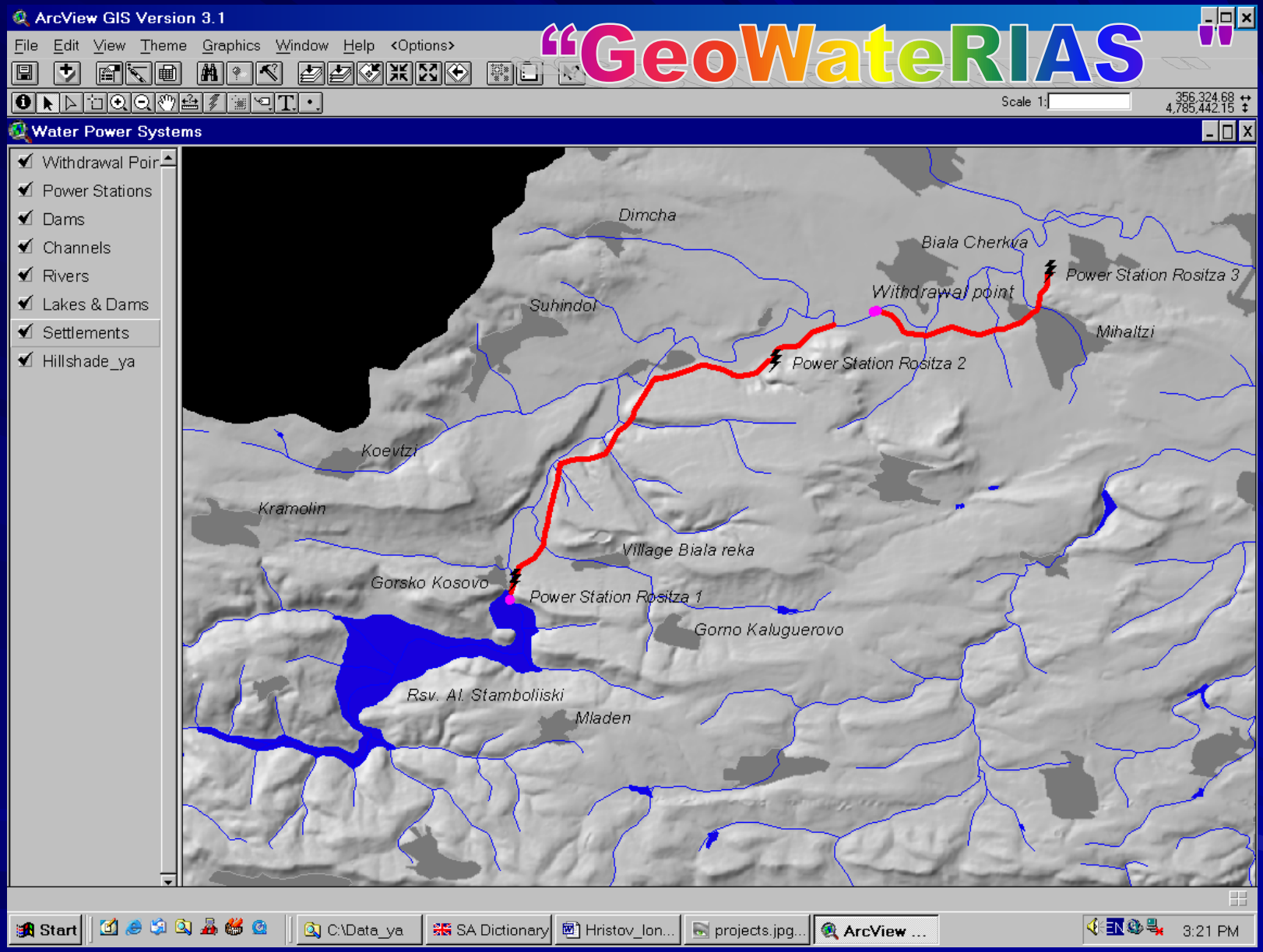
Layers of polygon objects:

- Reservoirs;
- Watersheds;
- Irrigated areas;
- Drained areas;
- National parks, reserves and protected zones;

Projects

With the intend to help **IWRM** in GeoWateRIAS V. 0 were created **scripts** which, activated, give to the user a combination of layers and objects, related to one or more watersheds.

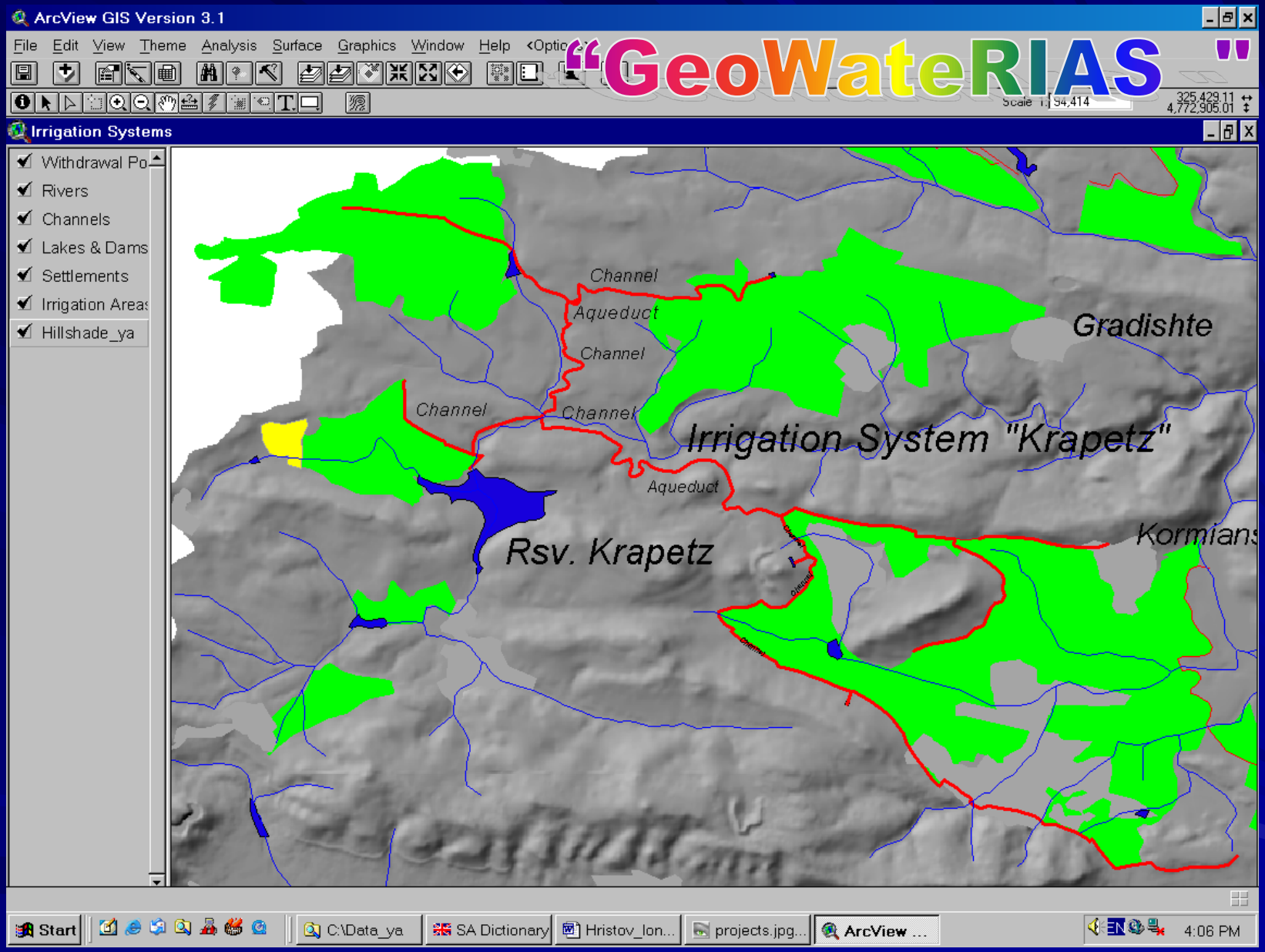
They can be edit and supplemented depending the desire of the user or created new ones using the standard procedures of GIS.



Yantra river watershed

Hydro-energy system “Rositza”.

Yantra river watershed



Irrigation system “Krapetz”.

Procedures and models for processing the primary data

The processing of data needs the creation and applying sophisticated models, based on scientifically grounded models and schemes.

Simulation models:

- **Hydrological;**
- **Non-point pollution and point pollution;**
- **In-stream water quality and**
- **Water distribution.**

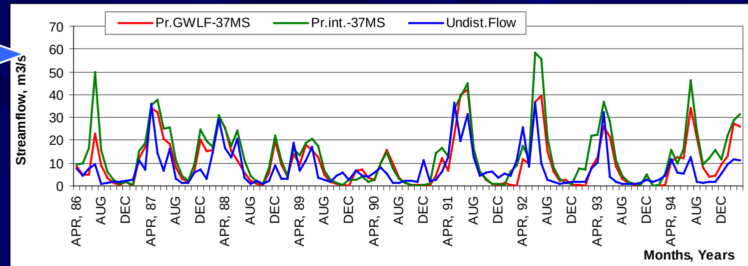
The simulation models and codes are created and imbedded in the IS. They are calibrated and validated for a given watershed on the base of the entered data.

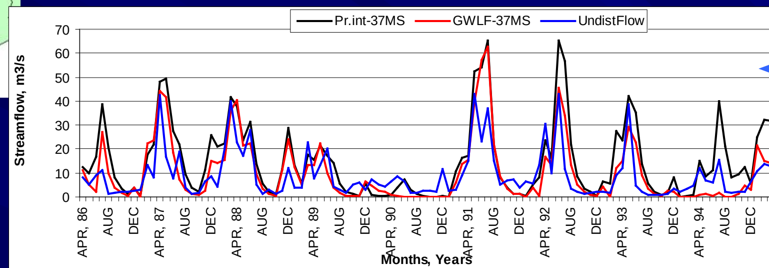
Application

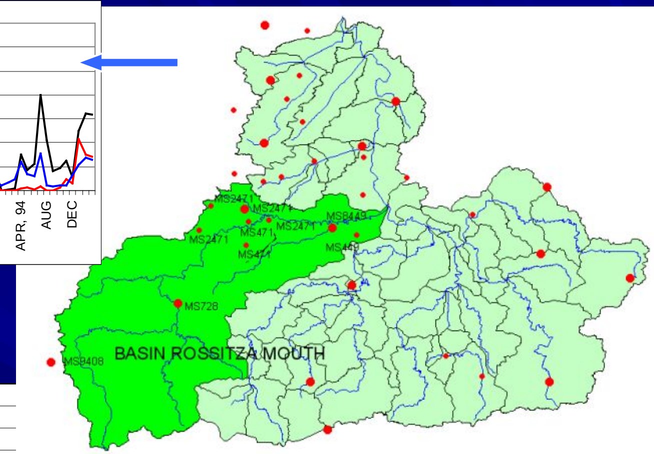
of the hydrological model

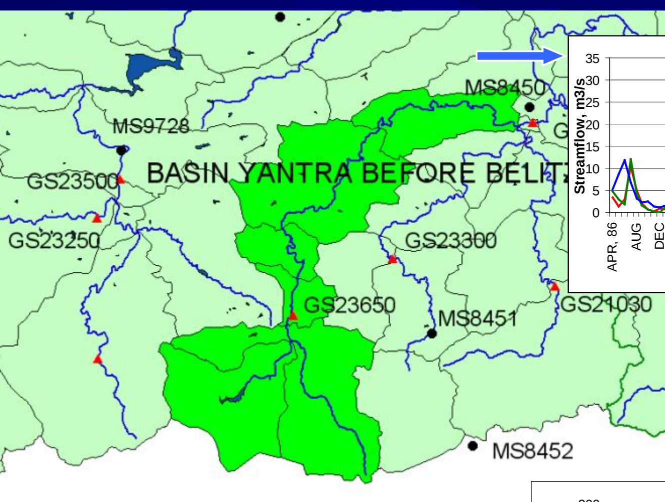
for

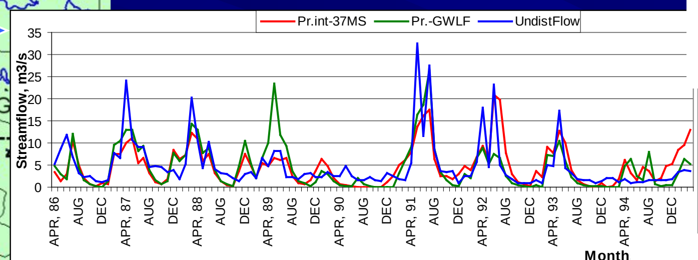
stream flow simulation of Yantra river basin

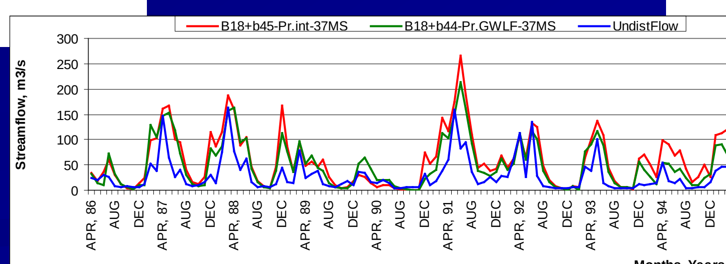


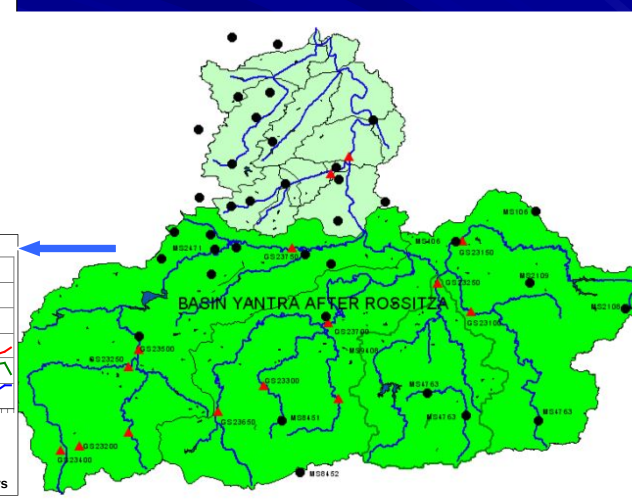




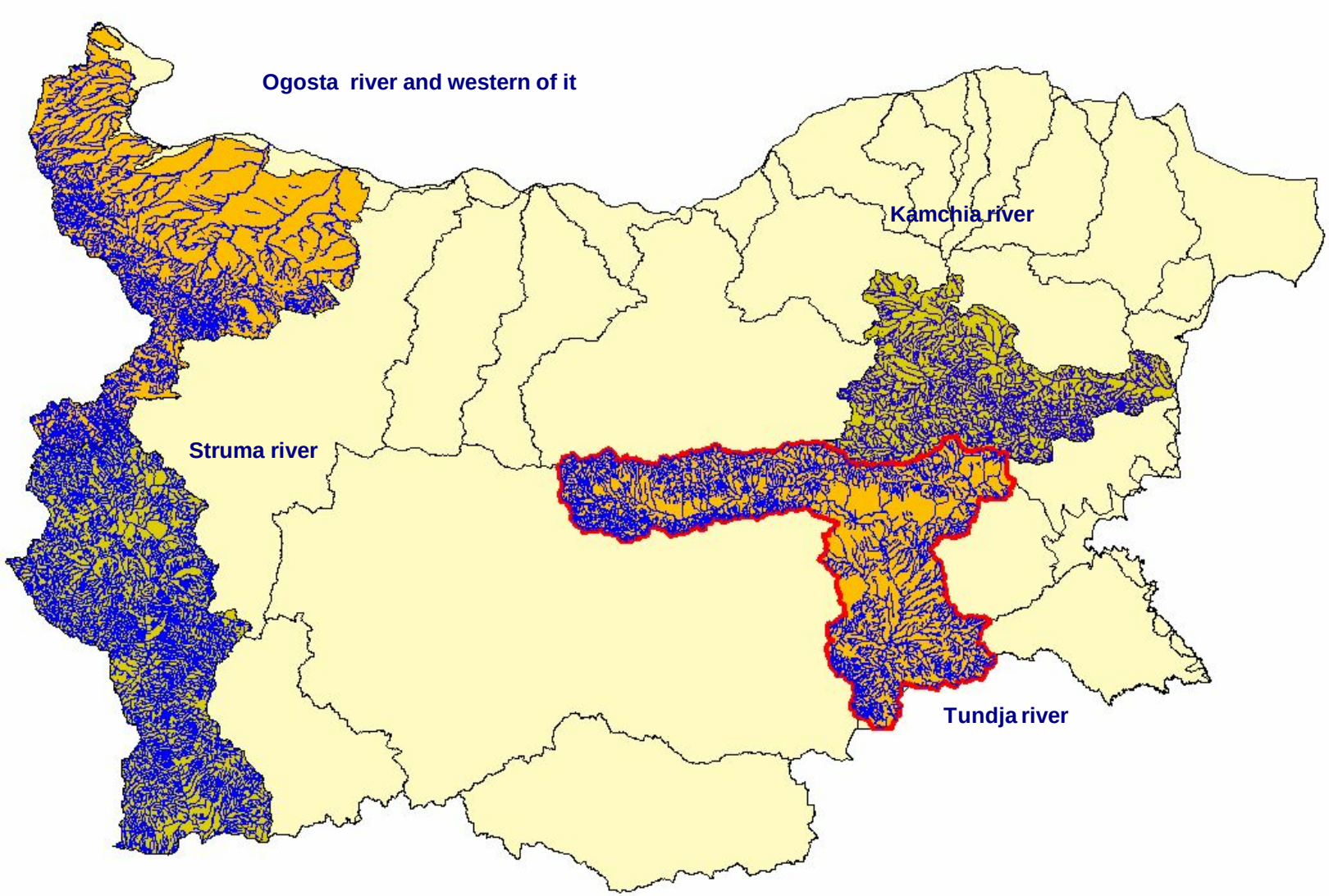








"GeoWateRIAS " is used for creation of the Water resources system balances for the follow Bulgarian river watersheds:



Conclusion

The rational use of the water resources for sustainable development of the society and the environment is **impossible** without new approach to the water resources management as is the IWRM and the inseparable database and tools for their interpretation.

In the same time it is necessary to tell that the inquiry of the needed data and their preparation in suitable format to enter in the system is an expensive activity and it must be provided sufficient funds and technological time.


Thankyou!