

SPATIAL INFORMATION MANAGEMENT IN CREATING OF DIGITAL ATLAS OF MOLDOVA

Ioana CHIRIAC, Ph.D. student, Technical University of Moldova, ioanna.chiriac@gmail.com
Livia NISTOR-LOPATENCO, Associate Professor, PhD. Eng., Technical University of Moldova, livia.nistor@fcg.utm.md
Ana VLASENCO, Lecturer PhD. in technical sciences, Technical University of Moldova, ana.vlasenco@gcg.utm.md

Abstract: *The article presents theoretical-experimental argumentation of the methodology for creating digital geographic atlas for schools of Moldova using GIS technologies. The theoretical part of the argumentation includes the development of the structure of the geodatabase. In this part is described the mathematical basis of the database, used for maps of Moldova and a list of features classes for thematic maps. The experimental part of the argumentation includes description of the process of geodatabase creation, collection, processing, and presentation of geospatial data. In the final part of the article, some of the thematic maps of the Atlas are presented.*

Keywords: *Digital Atlas, GIS technology, geodatabase, thematic map, geospatial data, school atlases.*

1. Introduction

For many years in Moldova, only textbooks, geography atlases and contour maps were used as teaching materials in geography lessons. In the period 2010-2015, a series of school atlases on paper were created at the State Enterprise Institute INGEOCAD. These atlases consist of thematic maps, according to Curriculum and represent geospatial data printed. That's why it is considered a necessity to develop a database for future digital school atlases.

Geoinformatics, represented by its most powerful technology - Geographic Information Systems (GIS) has become an important part of many disciplines and cuts across all areas of modern information society [1]. In the context of modern geography online education, from all geography sources the digital Geography Atlas for school may be the best one.

Currently, at the secondary education institutions (gymnasiums, high schools) of the Republic of Moldova at geography lessons only paper Geography Atlases are used. These atlases do not correspond to modern GIS mapping and are absolutely not convenient for online lessons. So, it became necessary to determine the methods, procedures and principles for creation of thematic maps of the Republic of Moldova in electronic form and to combine them guided by the requirements of the curriculum of Geography into Geography Atlas. The development of the structure of the Atlas and spatial information management which consists of Collection, processing, and presentation of Geospatial Data may be merged into one streamlined process, which is called the General procedure of Digital School Atlas production using GIS.

GIS database provides a comprehensive framework for organizing spatial and non-spatial data and is an analysis tool for educational database management and to support decision making.

The introduction of geospatial technologies is changing geography education very fast. Google Earth and many location based services are available from the Internet and offer the opportunity to study almost every place in the world.

2. Structure of the geodatabase

For the successful use of the atlas by teachers and students, it is necessary to carefully consider a laconic and convenient database structure. The elaboration of the structure of the school atlas begins with the study of the Geography Curriculum for grades VIII - IX. The current curriculum in Geography is the main normative document that outlines the vision on the educational path in the discipline. This document projects the society's expectations regarding the expected learning outcomes for level 2 - secondary education with reference to the Geography discipline. The Geography Curriculum is a component part of the National Curriculum, through which the systematic and gradual process of learning, development and training, based on educational purposes, through the rigorous selection of contents, learning, teaching, training methods and evaluation of learning outcomes [2].

According to the curriculum, the study of Moldova at school is divided into 2 sections: Physical Geography and Human Geography. Physical Geography of Moldova is presented by Physico-geographical position and relief, Climate and waters, Vegetation, the animal world and the soil, Natural areas and protected natural areas. After careful analysis of each of the topics, it was determined that 16 thematic maps are needed to visualize the geographic information in this section: Physical map, Geologic map and Mineral Resources, Seismic zoning map, Landslide hazard map, Flood hazard map, Climate map, Agroclimatic map, Surface waters, Hydrogeological map, Soil map, Physical Geographic Zones, Vegetation, Rare plant species, Typical plant species, Rare species of animals, State conservation areas (fig.1).

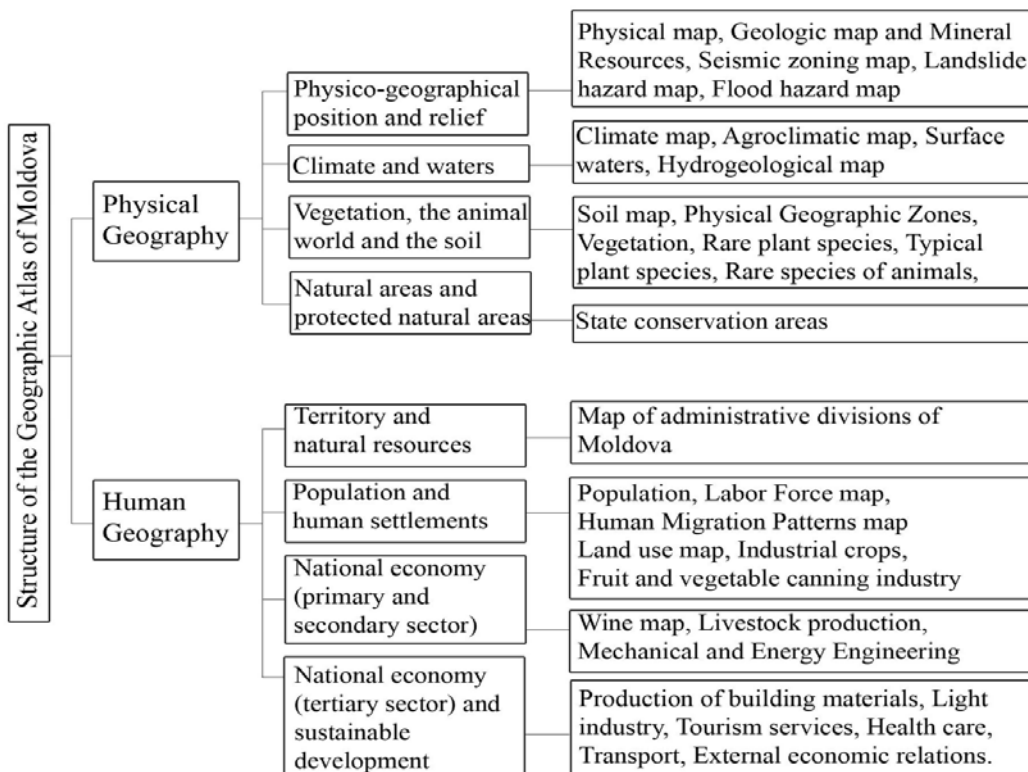


Fig. 1. Structure of the Geographic Atlas of Moldova

Human Geography is presented by Territory and natural resources, Population and human settlements, National economy (primary and secondary sector); National economy (tertiary sector) and sustainable development. As well as for Physical Geography, sixteen thematic maps are needed: Map of administrative divisions of Moldova, Population, Labor Force map, Human Migration Patterns map, Land use map, Industrial crops, Fruit and vegetable canning industry, Wine map, Livestock production, Mechanical and Energy Engineering, Production of building materials, Light industry, Tourism services, Health care and education, Transport and Communications, External economic relations. After the number and content of the necessary thematic maps has been determined, it is necessary to determine the database for each of the maps. For example, Fig. 2 presents the Soil Map Database.

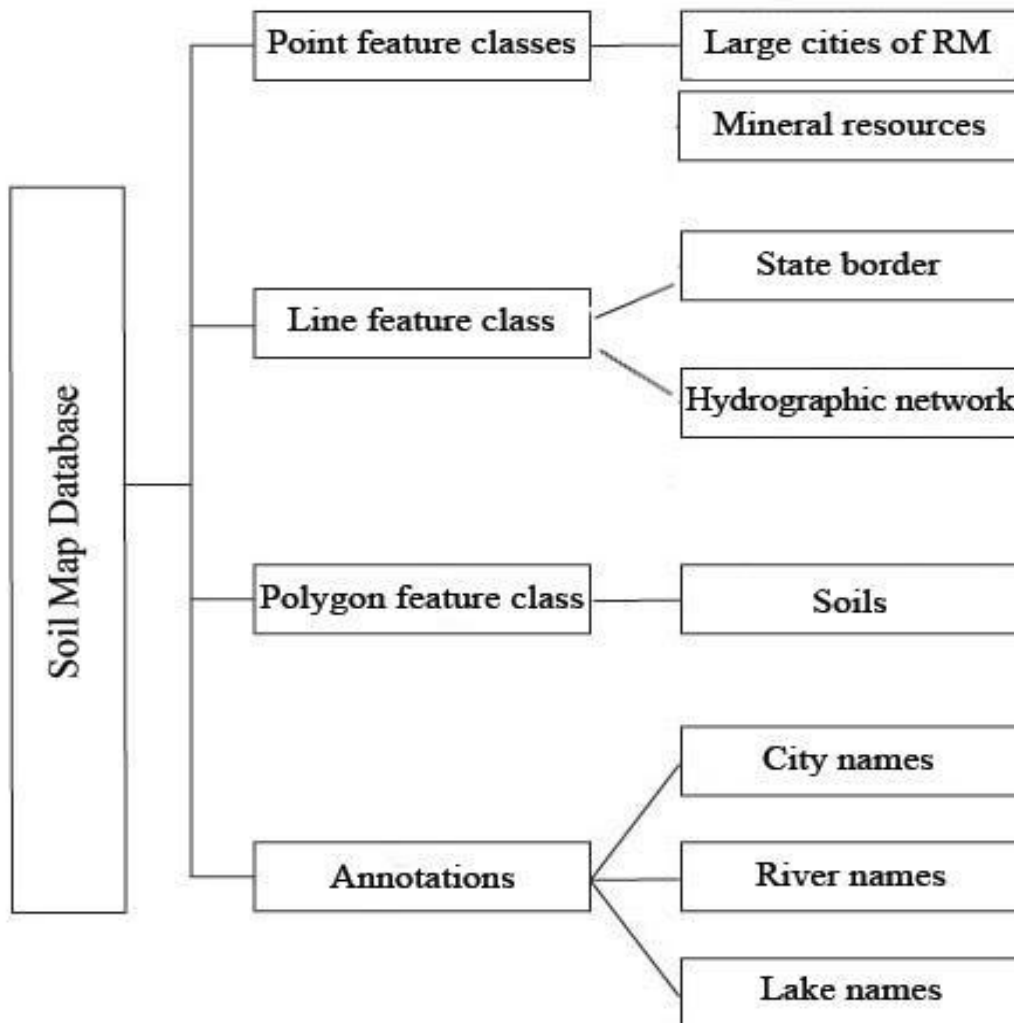


Fig. 2 Soil Map Database

For all of the thematic maps there are some common layers: Large cities of Republic of Moldova, State border, Hydrographic network, names of the cities, rivers and lakes. The map, represented by these layers, is called base map. (Fig.3) All geo data for these layers is imported from the State Institute INGEOCAD [6].

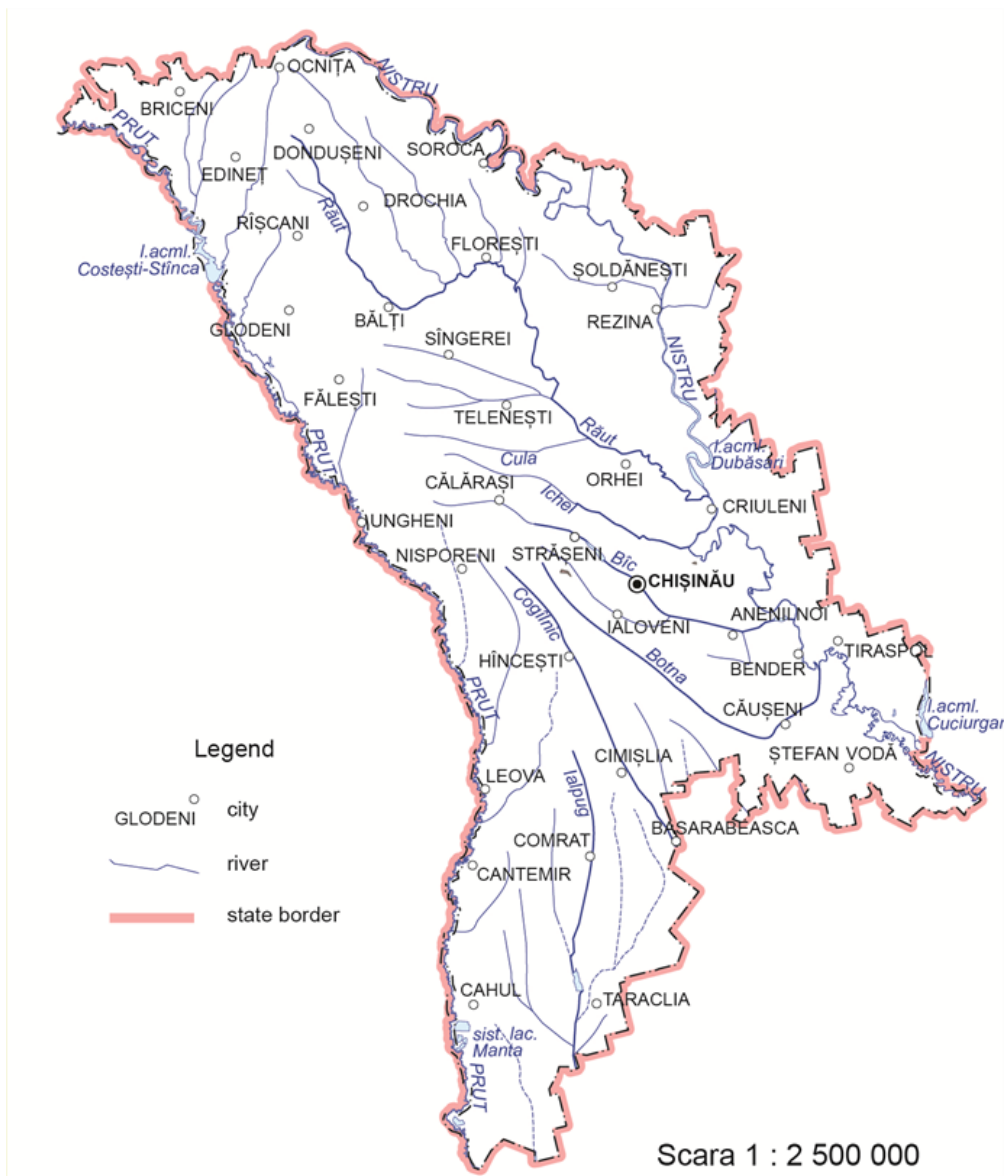


Fig. 3 Base Map of RM

This stage is one of the first in the technological scheme of the atlas creation [3]. Using the tool Generalization, it is possible to reduce the number of rivers and simplify the geometry of linear objects. But also, it is important to check the number and names of rivers with the curriculum requirements.

3. Creating a new Geodatabase

Creating a file geodatabase involves creating a special file folder on disk using ArcGIS. The Python script that calls the Create File GDB management function is usually used to create a file geodatabase from a machine where ArcGIS Server or ArcGIS Pro is installed [4]. After the Python command prompt is opened, the stand-alone script or type commands should be running directly into the interactive interpreter. The createfgdb.ru script contains the following information:

```
# Import system modules
import os
import sys
import arcpy

# Set workspace
env.workspace="Z: \home\user\mydata"

# Set local variables
out_folder_path="Z: \home\user\mydata"
out_name = "myfgdb.gdb"

# Execute CreateFileGDB
arcpy.CreateFileGDB_management(Atlas_Moldova)
```

Fig. 4 Python command

4. Creating a new feature dataset

A feature dataset is a collection of features that have the same spatial reference (coordinate system). The new feature dataset was created by right-click on the geodatabase and choose New –Feature Dataset. In the dialog box, the feature dataset was named Moldova Atlas. The next step is to select the coordinate system or to import it from an existing GIS file. The coordinate system for Moldova is WGS_1984_UTM_Zone_35N. After the coordinate system for a feature dataset is defined, any new feature classes imported into it will automatically be converted to the coordinate system of the feature dataset. The database tree for Base Map of Moldova is presented in Fig.5.

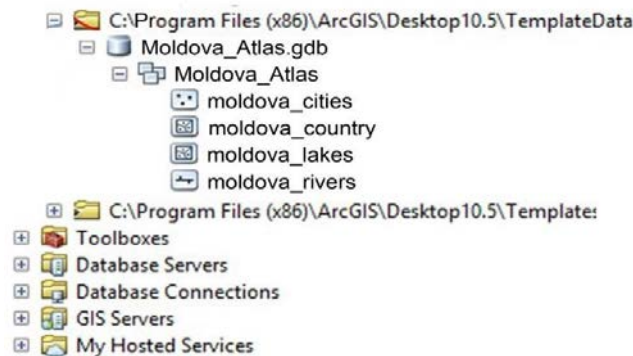


Fig. 5 The database tree for Base Map of Moldova

After the database of Base Map of Moldova is finished, it is possible to import thematic information. This process also includes collection, processing, and presentation of geospatial data using the same tools.

5. Collection, processing, and presentation of geospatial data

Not only different formats of source data are used for mapping, also there are different ways of data collecting and processing.

For example, to create the soil map, cartographic information from the Academy of Sciences of Moldova is needed. In ArcToolbox there are spatial instruments that convert raster images into scalable vector files. One of them is called Convert into Vector and is used when the source of information is a traditional paper map. After digitization, every area of the

soil map gets CodTip which helps to color the map automatically. For Soil Map is used Method of qualitative background. The Qualitative Background Method is used to characterize solid phenomena that occupy huge territories (for example soils) and in ArcMap can be easily implemented using the Add Representation geoprocessing tool [5]. Mineral resources have to be presented by Point objects with Conventional Signs. All these Conventional Signs for mineral resources may be created using the Add Representation geoprocessing tool in GIS application ArcMap too.

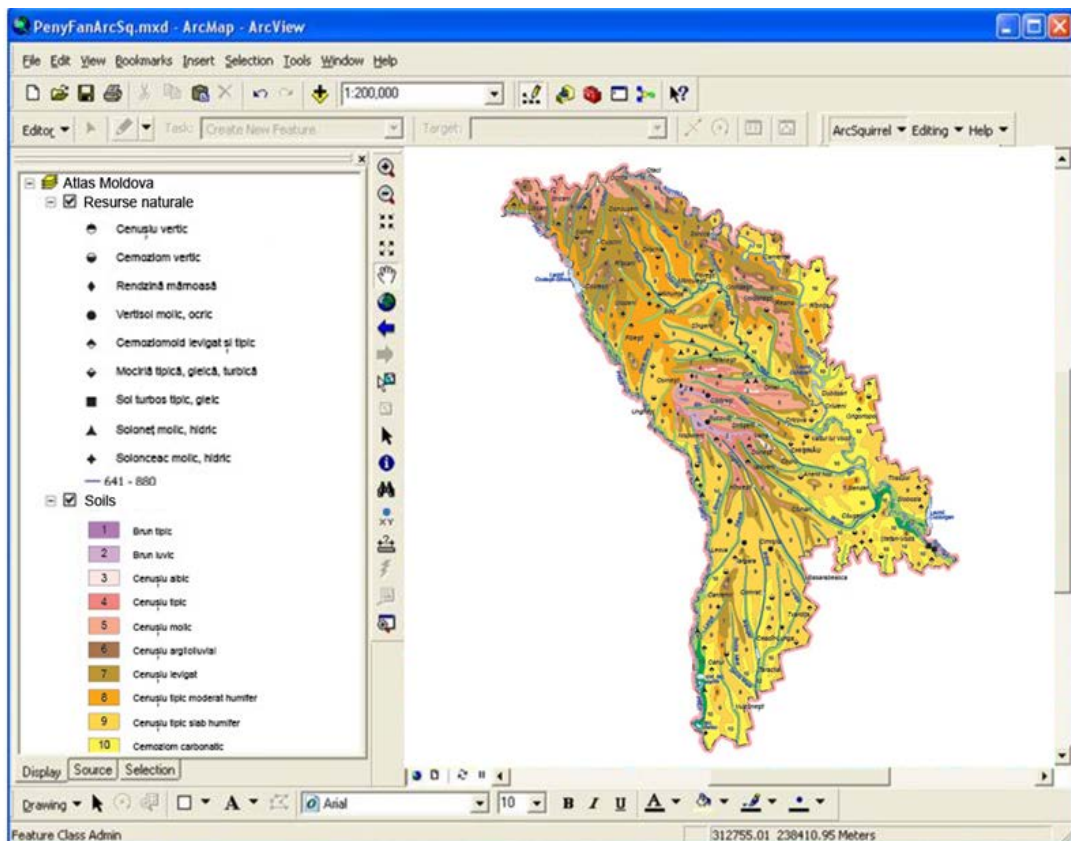


Fig. 6 The Soil Map of Moldova

For teachers it is easy to add or omit borders, place names, river names, points of interest, and more to create the new map. Thus, geospatial data management replaces flipping through the pages of a paper atlas.

Secondary school geography students can create their own maps, learn by doing, and if have an ArcGIS account, they can update the data, modify the visual representation (colors, shapes, ranks, etc.) or add a new layer with complementary geographic information to provide more details on the geographical place or the geographical process. Also it is easy to collect, georeference and share geographic information.

With the Image Analysis window in ArcMap, it is easy to display a shaded relief from DEM. This combines a hill shaded version of the DEM and the same DEM with a color ramp applied. The Shaded Relief button in the Processing section of the window adds a temporary raster dataset layer to the table of contents. The color ramp drop-down arrow in the Processing section helps to select a different color ramp. The new color ramp will be applied to the selected layer.

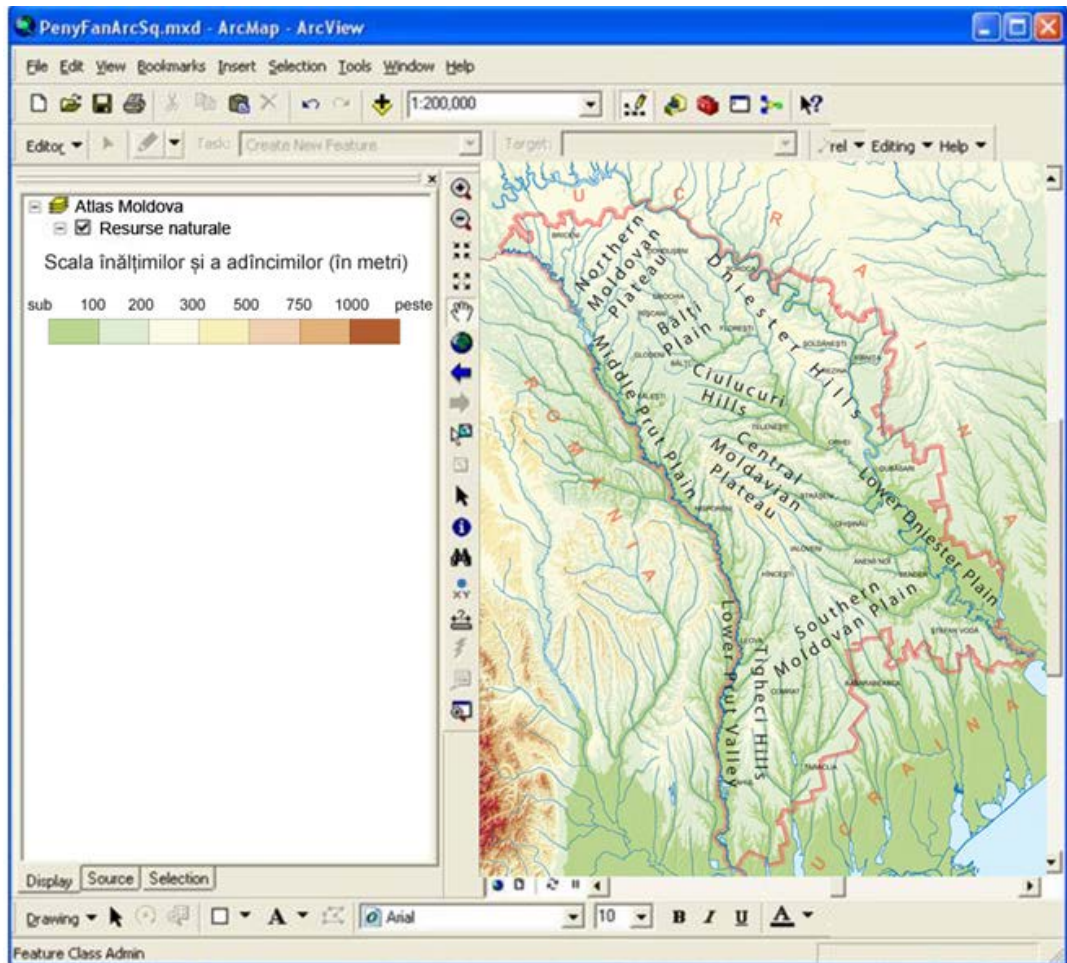


Fig.7 The Major Landforms of Republic of Moldova

All names of major landforms on the Physical Map of Moldova (Fig. 7) are taken from the curriculum on geography. All names of geographical objects listed in the curriculum must be presented on the maps in full, because each of the names can be subsequently included in the examination program.

Most of Moldova's territory is a moderate hilly plateau cut deeply by many streams and rivers. The northern landscape of Moldova is characterized by gently rolling uplands. These hills are divided into the Northern Moldovan Plateau and the Dniester Hills, and continue further occupying the northern part of the Chernivtsi oblast in Ukraine.

To the south are located the Bălți Plain and the Middle Prut Plain. The Central Moldavian Plateau are ridges interlaced by deep, flat valleys, ravines, and landslide-scoured depressions. In the south, the Tigheci Hills are a prolongation, and run to the south parallel to the Lower Prut Valley. To the south-east, the southern part of the Codri Plateau, which averages 150–200 meters, has numerous ravines and gullies, gradually merges into the Southern Moldovan Plain, continued in Ukraine by the Budjak Plain.

Using the digital Atlas, it is easy to analyze different thematic maps covering the same area. For example, it is easy to observe the relationship between soil types and landforms of the territory without using additional spatial tools, only by adding a Soil Layer on the Physical Map of Moldova [8].

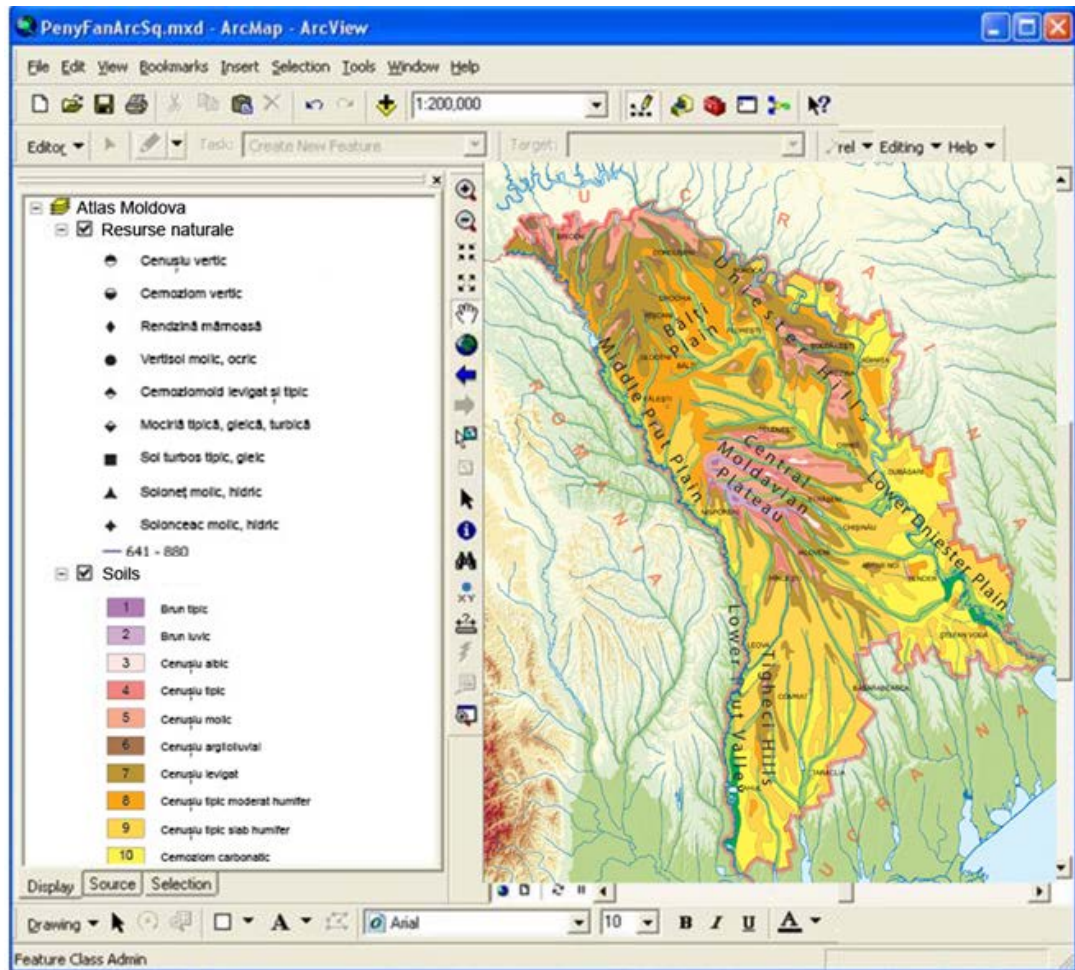


Fig.8 The Physical Map of Moldova with Soil Layer

The final map (Fig.8) shows that landform and topography influence pedogenesis and the spatial distribution of different types of soils, manifesting various soil-landform units in the landscape. So, there is an interesting relationship between landforms and types of soil. For example, the soils of the Central Moldavian Plateau, Northern Moldovan Plateau and the Dniester Hills are Polished Gray, Soft Gray, Typical Gray. These types of soils are represented by pink, red and brown colors. In the highest parts of the plateau there are luvic brown typical and luvic brown pseudogley soils. On the map these types of soil are colored by violet color. Alluvial soil with more sand and silt than clay is being deposited in the floodplain areas along the river courses. These types of soil are indicated by shades of green color.

In this way it is possible to analyze the relationship between other geographic phenomena. For example, the relationship between soil formation and climatic features of the territories, relationship between vegetation distribution and soil types, or relationship between soil types and land use. Some of these spatial analyzes, taking into account administrative divisions into districts, may form the basis of some maps: Landslide Processes from the section about Physical geography and the absolute majority of maps from the section about the Human Geography of Moldova.

This way of analyzing geographic data is not possible with a traditional paper atlas that may generate keen interest in young minds.

6. Conclusions

Spatial Information Management is an important practical part of creating the Digital Atlas of Moldova. Collection, processing, and presentation of geospatial data form represents an endless process in which students and geography teachers can participate too. For the research work of a school student as a source of geo information, not only official sources (institutes and the Academy of Sciences) can be used, but also open source sites. In the View Layers tab, it is easy to display or to turn off geospatial information to make new conclusions about the relationships between various geographic phenomena. Schools are incorporating emerging technologies to introduce children comfortably into our modern world.

The process of creating Digital Atlas of Moldova, like any educational material, requires special attention to the curriculum in Geography. When this document has been republished, it usually contains many changes. All changes and additions can be easily imported into the map database and keep the data on the maps up-to-date.

The methodology for creating digital geographic atlas for schools of Moldova using GIS technologies can be used for educational courses in other countries and it will significantly improve the education system in the field of geography, will lead to the development of society by improving knowledge in the field of ecosphere.

Once digital atlas maps were made within GIS, they can have more purposes and can be observed from more aspects: scientific-geographic aspect, economic aspect of certain atlas maps and cultural-educational aspect.

The ability of applying spatial thinking to real-world issues at a range of scales is essential for a responsible modern citizen and for an effective knowledge worker as well. Educators and students who can use geospatial technologies are more efficient spatial thinkers. That's why the geospatial education in high schools receives increasing attention worldwide.

Online learning has been on the rise in recent years. Traditional paper atlases are an outdated form of teaching material and are not suitable for online learning. It is the ability to make online presentations using gis maps that can help out teachers and students in this situation. Great opportunities for independent work and creating your own research projects is also an advantage for gis maps.

In terms of sustainable development, the creation of an electronic geographic atlas for schools also has advantages. One of them is significant reduction in the amount of paper required in the educational process. The development of digital geographical atlases for secondary education reduces the amount of paper needed for the educational process, which leads to combating pollution, conserving natural resources and corresponding to sustainable forest development. Also important is developing society by improving knowledge of the ecosphere, because without environmental education, we have no future.

The transition from a paper atlas to an electronic one can completely replace textbooks. Digital maps can have not only text inserts, but also sound accompaniments. Pictures and photographs may be linked externally and may be supplemented by students at school. Tasks for execution can also be set in electronic form. Perhaps in the future, teachers will not have to check their geography homework, because it is more convenient to check knowledge using electronic tests. We should also not forget about the usual coloring of contour maps adopted in geography courses for better assimilation of the educational material. The basemap discussed in this article can be successfully used as a contour map. This map contains enough information to navigate the territory: the largest cities in Moldova and the river network, which has undergone strong generalization. Generalization consisted in

the automated removal of small rivers and the removal of unnecessary nodes on linear objects using spatial tools.

7. References

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