

The Danube Delta – a unique place in Europe

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Abstract

At the end of a flowing route that exceeds 2,860 km, through an impressive catchment area that covers more than 80% of Europe, the Danube, the second largest river in Europe, intersects the Black Sea forming the delta which is known as one of the great wetlands of the planet. The stretches of water and land formed here offer good living conditions to many species of plants and animals. The purpose of this study was to create several maps that present these aspects of the Danube Delta wetland using a set of GIS technologies. Since the GIS technology is an important tool in the analysis of geographic areas, we managed to obtain the following maps: hypsometric, slope, slope orientation and flood direction. Since September 1990, the Danube Delta Biosphere Reserve has been recognised internationally as a wetland; specifically, the Danube Delta Biosphere Reserve has been recognised internationally as a wetland, especially for water birds habitat. The value of the World Heritage Site of the Danube Delta Biosphere Reserve was recognised in December 1990 by including more than half of its surface into the World Cultural and Natural Heritage List.

Keywords: Danube Delta, flood accumulation, natural heritage, slope, wetlands.

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1. Introduction

Nowadays, due to the fact that in large territories pressures of various uses of land on the planet's natural heritage have reached critical levels, the protection and nature conservation concerns are a priority for specialists from different fields of activity. The anthropic pressure had the biggest impact on the biodiversity of flora and fauna as plants and animals are the most vulnerable elements of the natural environment in relation to human activities.

Their existence is intrinsically linked to other components of landscape. The first intergovernmental modern treaty, as a global cooperation which is scrambling for the conservation and sustainable use of natural resources, is the 'International Convention on Wetlands' in which the most important step was the waterfowl habitat signed on 2 February 1971 in the Iranian city of Ramsar, in the region of the Caspian Sea.

Over the past decades, as a result of the anthropogenic impact, the regulated wetlands have undergone an intense process of degradation at all levels, including at the global level, thus leading to a decrease in wetlands spread. The consequences are dramatic for local communities that depend economically and socially on the richness of wetlands and also on the nature and its proper functioning.

Today, the remaining wetlands are faced with depletion resource and hydrological, ecological and environmental problems. The economic, social and ecological prices paid for the disturbance of wetlands' functions are huge.

The notion of wetlands includes a large variety of ecosystems that have in common the presence of land and water on the vast majority of the year. According to Ramsar, the definitions for wetlands are very diverse.

The Convention defines wetlands as expanses of 'swamps, marshes, natural or artificial rivers, permanent or temporary, where water stays or flows, as fresh or salt water, including stretches of sea water whose depth at low tide does not exceed six meters' (Balteanu & Serban, 2006).

Irrespective of their types, the wetlands have a fundamental feature in common: the complex interaction of their basic components – soil, water, animals and plants, being considered elements which jointly display multiple functions and provide multiple products that have served people over the years.

2. Study area

The Danube Delta is a unique place in Europe because of the richness of plant species, trees and many species of fish, birds and mammals. Some of these species were recognised as unique species and natural monuments (Figure 1).

The Danube Delta is the second largest delta in Europe, after the Volga River Delta, having about 4,180 km²; if we considered the Razim–Sinoe and the Danube estuary, this area extends over 5,500 km² approximately. To be more specific, 82% of the Delta is in Romania, whereas the remaining area is in Ukraine (Balteanu & Serban, 2006).

The Danube Delta surface is divided into three types of zones: 20 strictly protected areas, which have an area of 506 km², buffer zones with an area of 2,233 km² and economic areas of 3,060 km². Fixed vegetation areas occupy 43%, forests (natural and planted) occupy about 4%, agricultural land occupies 11.5% and grassland areas occupy about 6%. The number of lakes in the Danube Delta has reduced to 479, due to improvements in previous years, and lakes occupy only 7.8% of the Delta's surface.

Out of the total surface of the delta, half (312,440 ha) is represented by the natural aquatic and terrestrial ecosystems included in the list of heritage functional areas.

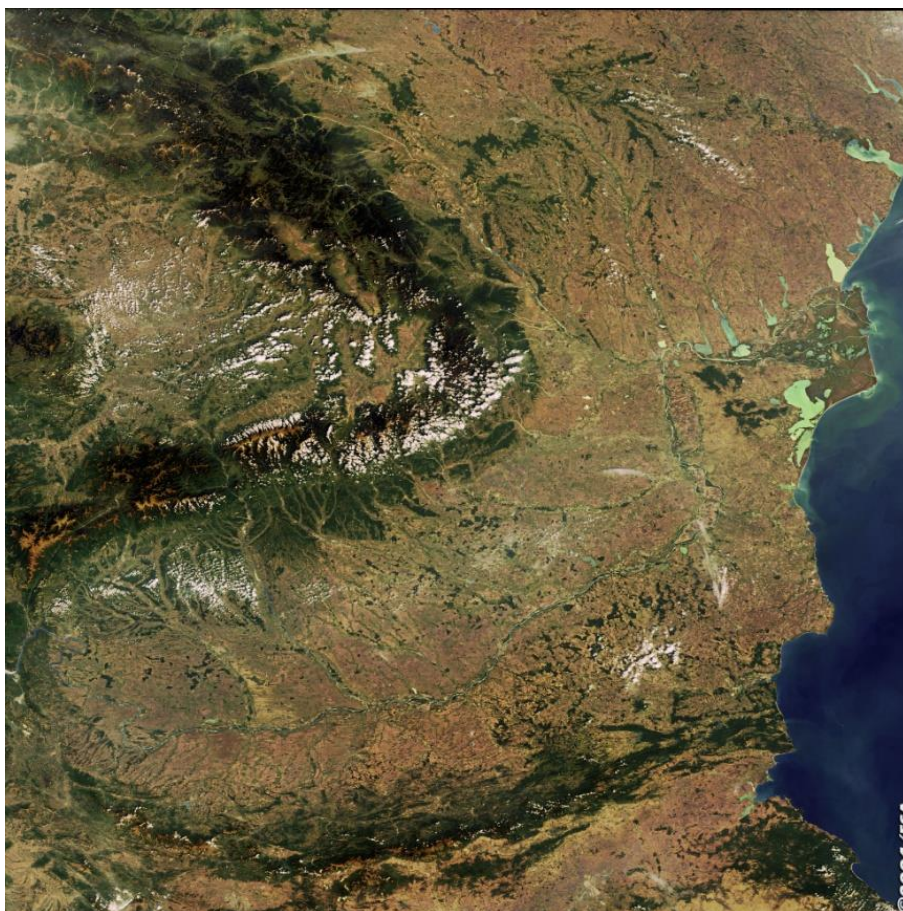


Figure 1. The Danube Delta

The remaining dammed areas include areas for fishery, agriculture and forestry (80,000 ha), areas provided by the Law 18/1991, which cover private or public properties for local interest (i.e., towns or municipalities) (about 29,000 ha) and a marina buffer zone of about 103,000 ha.

From a geographical point of view, the Delta is the wettest part of Europe, the lowest and the new plain region, where it is mainly dominated by areas with a small height in relation to the zero level of the Black Sea. The greatest heights are the marine areas on Letea (13 m) and 8 m on Caraorman. Compared with the zero level of the Black Sea, lesser than 21% has a negative share and the remaining 79% is situated above sea level. The altitude average of the Danube Delta is 0.52 m.

The Danube River splits near the Patlageanca city (to the west of Tulcea county) into two arms, Chilia in the north and Tulcea in the south. The Tulcea arm divides itself near Ceatalul Ismail village into the Sulina arm (west to east direction) and St. George's arm (NW–SE direction). The length of the Danube arms are: Chilia 120 km, Sulina 64 km and St. George's arm 70 km.

The Danube Delta water depths are 39 m in the Chilia arm, in the Tulcea arm it is 34 m, 26 m in St. George's arm and 18 m in the Sulina arm. The greatest depth in the Danube Delta, excluding the river arms, is in Lake Belciug where it reaches 7 m; in the other lakes the depth does not exceed 3 m (for instance, Lake Razim).

The geographic reserve's position is defined by the following coordinates: 28°10'50" (Cotul Pisicii) and 29°42'45" (Sulina) eastern longitudes; 45°27' (Chilia, 43 km) and 44°20'40" (Cape Midia) northern latitudes.

2.1. The Danube Delta morphology

Herodotus visited the inflow mouth of the Danube 2,400 years ago, and he left us a very different picture of the Delta's actual image, describing the place as a large estuary. The Persian fleet of Darius entered the Delta after a stop in Histria, which was described by the 'father of history' Herodotus, as the first historical evidence about this region.

According to scientific studies, the formation process of the Danube Delta started 16,000 years ago.

The current morphological appearance of the Danube Delta is due to the last removal of the Black Sea level which created conditions and had strong alluvial consequences on the Danube arms' ramifications (Giosan & Constantinescu, 2006).

The Delta has a temperate semiarid climate specific to the Pontic steppes in which winters are mild without snow and in summer it does not register the heat phenomenon. The precipitations are below the multiannual average of Romania (300–450 mm/year). The rainfall decreases in the east, and their absence is compensated by the moisture from water surface evaporation. In the Danube Delta, the dominant phenomenon is the wind – 300 days/year – the spring wind is prevalent and the storms are caused by the winds from the northeast. The autumn fog is a prevalent phenomenon.

The multiannual average temperature varies between 11°C and 11.5°C. The average temperature in January is –1.5°C in the west and over –1°C in the east, whereas in July the average temperature is 22°C in the river delta and 21°C in the river–sea. The multiannual average amplitude is between 23.5°C in the western part and 22°C in the eastern part.

2.2. The hydrographic network

The Delta's hydrographic network consists of the Danube Delta arms, lakes, marshes, ponds and channels.

The arms of the Delta are Chilia, Sulina and St. George, and they flow into the sea; the fourth arm is Tulcea and it is bounded between Chilia and St. George.

The first embankment works of the Danube Delta began in 1930 and the most and intensive dam and drainage was carried out during the period 1948–1980, when many enclosures for fish, reeds, agriculture and forestry were built, imposing the realisation of link channels. Therefore, the network of channels has become more complex and many streams dried up, affecting the natural habitat.

The arms of Sulina and St. George suffered significant changes: the Sulina arm, due to the action of achieving a maritime waterway, has been shortened and widened at the same time. St. George's arm has suffered major cuts and meanders between 17 km and 85 km and a shortening of 38 km. Instead, Chilia arm increased in length by advancing the delta's side with the same name.

Lakes are an important morphohydrographic category in the whole delta. The lakes and lake complexes were drained through the provision of numerous enclosures.

According to the publication elaborated by Ion Munteanu (1994) – Soil map – The Biosphere Reserve of the Danube Delta, in this area the main soil types are:

- The alluvial soils are very young soils pertaining to the fluvial delta sand banks (in the west), which regularly receive new alluvial sediments.
- The limnosols type, which includes lacustrine deposits at the bottom of lakes and lagoons. These sediments are mostly made up of mineral suspension brought by the Danube, resulting from chemical and biological processes that occur in the mass of water and sediments.

- The psamsoils and soil sands are associated with sand banks and dunes from the sea delta and the Razim–Sinoe lake complex. The psamosoils are defined by their sandy texture and the soil profile is underdeveloped. The general fertility of psamsoils is very low.
- The white soils are a characteristic of steppes with dry continental climate; these are only regional soils in the Danube Delta. Most of these soils are used as arable land by the inhabitants of the Chilia Veche village.

The Danube Delta, like all the deltas, is a young formation.

3. Material and methods

To create maps using the Arc Map10.1, we used a digital elevation model (DEM) with a spatial resolution of 90 m. The DEM on 90 m spatial resolution is available free of charge on CGIAR-CSI geoportal. It has WGS84 projection and was transformed in the Stereographic 1970 projection.

The first map is the hypsometric map that shows the distribution of relief in the studied area (Figure 2).

The hypsometric difference (altitude) in the Danube Delta is a geographical terminal unit; the border between the river and the Black Sea is extremely small and the absolute value is very close to the '0' marine level or the world ocean level.

The altitude difference is much smaller in Razim–Sinoe, if the islands Popinele and Popina (48 m), churches (9 m), Istria and Gradistea are not taken into account. The average altitude varies across the three delta units (the largest being in the Letea unit, 0.81 m), specifically Letea (1.07 m), Chilia (2.55 m) and the subunit Sireasa (1.56 m), which is located on top of the delta and is in a more advanced stage of alluvial sediment.

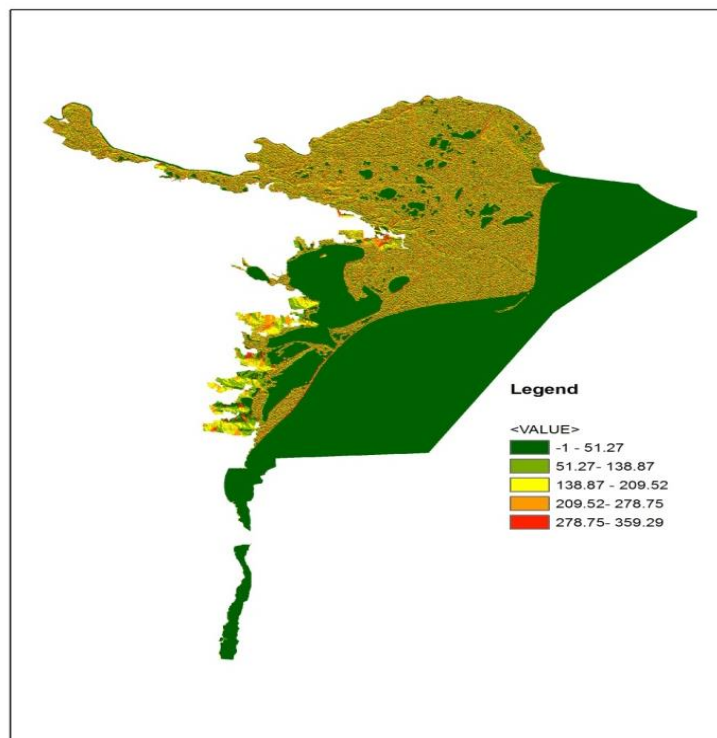


Figure 2. The hypsometric map of the study area

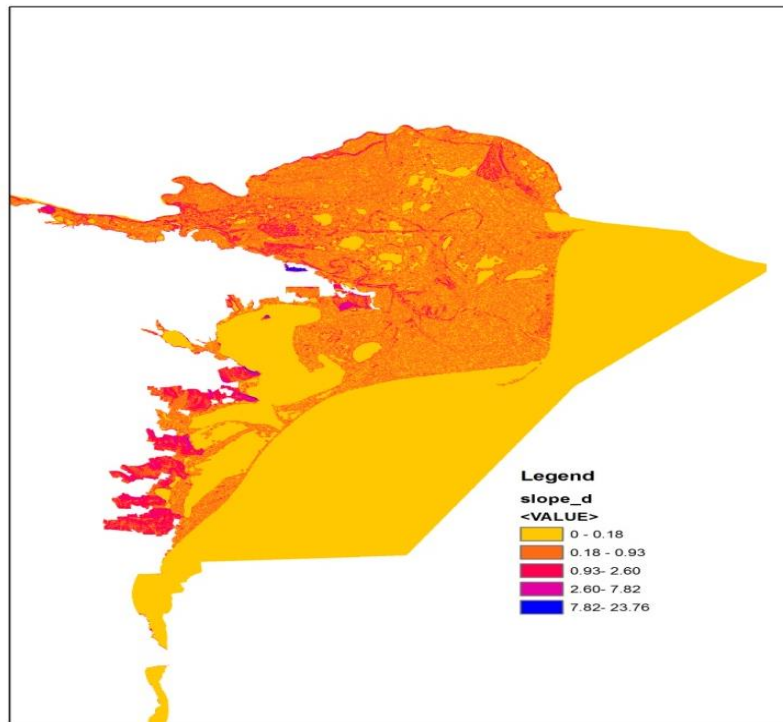


Figure 3. The slope map of the study area

The relief declivity shows that the plain delta area is represented by very small slopes.

From the map analysis, it shows that most of the Delta has a surface between 0% and 2%, and in the western part, there are areas that have a slope range between 9% and 23% (Figure 3). In the Danube Delta there are only riverbed phenomena; they are generally due to the fact that the Danube arms are very meandering.

The maps of relief show the orientation to the geographical cardinal points.

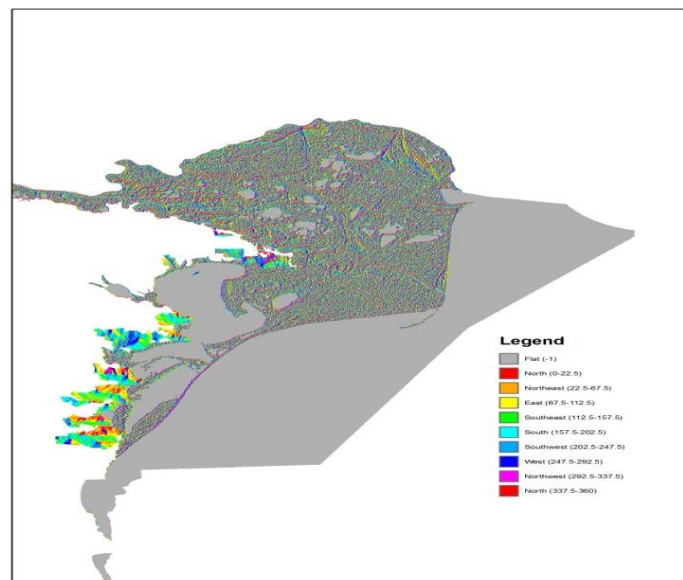


Figure 4. Map of the study area

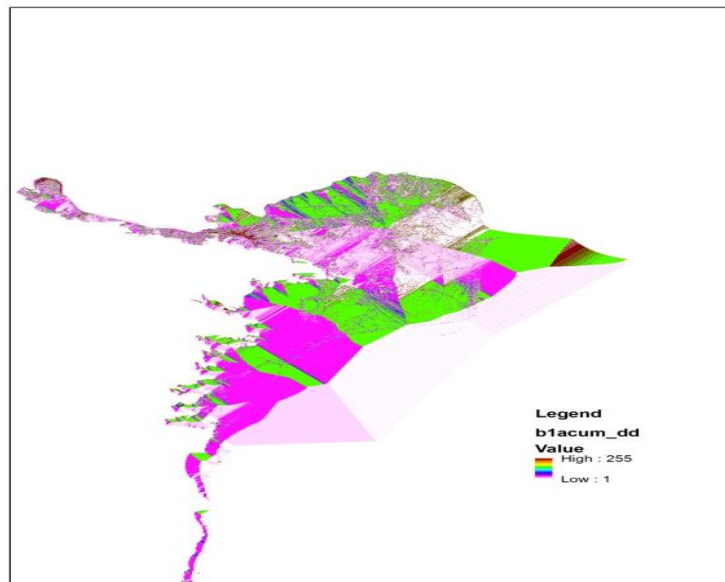


Figure 5. Flood direction map of the study area

It was made after the analysis of altitudes through a numerical model that analyses the orientation of slopes. Looking at the map, one can observe in the south the predominance of slopes. The aspect of relief is important for the analysis of the impact of solar radiation, the insolation and temperature on fostering development of geomorphological processes or morphogenesis of the relief.

The southern slopes and southeastern slopes get the strongest solar radiation, being the warmest and driest slopes which favour the appearance of geomorphological processes. The west and southwestern slopes are not very hot and not very dry, less than the previous ones and they facilitate the appearance of erosive phenomena.

The map of flow direction was created using Spatial Analyst. To obtain the final map, we firstly created three maps: the fill map, the flow direction map and the flood direction map. The latter shows how water is collected in the existing sub-basins.

4. Conclusion

Since the Danube Delta is the largest wetland in Europe, we can outline the following conclusions on the Danube Delta and its wetlands:

The negative aspects have played a major role in inoculating the belief that wetlands are places unusable in their natural state. One way to make them useful is draining them.

The surface obtained was exploited through classical techniques, intensive agriculture, forestry and fisheries.

The lack of floods led to the impoverishment of soil, the emergent salinisation and low or no profit result on dammed soils; therefore, the activities of the premises led to the necessity of reconsidering the position of man from wet areas.

The wetlands often fulfil a crucial role in flood prevention. By storing water in the soil or by retaining its surface, the lakes or marshes, wetlands reduce the need for expensive construction.

The coastal wetlands play a crucial role in terms of protecting the land from storms and other weather phenomena; these areas diminish wind, waves and tides, and the vegetation helps maintain the sediments in this area.

The wetlands are among the most threatened habitats, which are drastically affected in recent decades due to the regularisation of rivers' courses, the construction of dams and the transformation of flood plains in farmland and agriculture-related activities.

The multiple roles of wetland ecosystems and their value linked to humanity have begun to be better understood and to arise the interest of researchers in recent years. This has led to numerous charges to restore hydrological and biological functions of the lost and degraded wetlands.

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