DELTAS OF ALBANIA (W BALKANS)

Emre ÖZŞAHIN

Mustafa Kemal University, Art-Sciences Faculty,
Department of Geography, Antakya/Hatay, TURKEY
eozsahin@mku.edu.tr

Abstract

Albania is situated in the west of Balkan Peninsula and in the eastern shores of Adriatic and Ionian Seas. The shoreline length of the country which has a surface area of 28.784 km² is 400 km. The country composed of relief mountains dominantly has coastal prairies with lengths changing between 8-35 km along the shores. These coastal prairies hosting about 50% of the total population (1.5 million) are also deltas with different characteristics formed by the prominent rivers of the country. From the north to the south, these are the deltas of Bojana-Buna, Drin, Mat, Ishm, Arzen, Shkumbin, Semeni, Vijose and Vlores rivers.

The study aims to explain the general features of Albanian deltas with the help of 1/1.000.000 and 1/250.000 scale topography maps and Landsat satellite images supported by the related literature. In this framework, the related visual data was analyzed and interpreted with the help of Geographical Information Systems (GIS) and Remote Sensing (RS) methods and techniques.

The questions "How many big deltas are present in Albania?", "How can these deltas can be classified according to their general characteristics?", "How are these general features interpreted in detail?" and "Which of these deltas are similar in terms of their features?" are answered separately for each delta in the framework of the study.

As a result, it was identified that the natural conditions dominant in the country in general create a suitable environment for delta formation. The most dominant of these conditions is the high levels of erosion caused by geological and geomorphologic features. Due to this fact, the rivers of the country cause more sediment input compared to those of the neighboring countries. Consequently, Albanian Deltas are monogenic in terms of lithology, sediment provision, geomorphology and developmental process whereas they display polygenic characters in their geometries.

Key Words: *Delta, Geomorphology, Geographical Information Systems (GIS), Remote Sensing (RS), Albania.*

Introduction

Albania is located on the west of Balkan Peninsula and on the eastern shores of Adriatic and Ionian Seas. It is situated in the north geographical latitude 420 39' (Vermosh), south geographical latitude 390 38' (Konispol), eastern geographical longitude 210 40' (Vernik) and west geographical longitude 190 16' (Sazan) (Samimi et al., 1997; Abazi and Kupe, 2012; Figure 1).

Albania, located in the torque point of the Alps (Samimi et al., 1997; Ekinci and Özşahin, 2011), is a member of the Periadriatic foredeep basin which has the biggest share in Adriatic coastal area geologically (Meço and Aliaj, 2000; Eftimi, 2003). Hence, it is situated in a location where various age and type of rock formations (sediments, magmatic and metamorphic formations) can be observed.

Figure 1: Location map

The country with a surface area of 28,784 km² has a coastal line of about 400 km (Ciavola et. al., 1999; Brew, 2003; Mihnea et. al., 2006). The dominant relief consists of mountains and there are coastal prairies whose lengths change between 8 and 35 km. these coastal prairies which house about the 50% of the total population (1,5 million) are also deltas of different characteristics formed by the main rivers of the country. In addition to being marshy in some parts, these coastal areas are densely used for agricultural purposes due to their fertile characteristics.(Güner and Ertürk, 2005; Atalay, 2011; Özey, 2012).

In Adriatic coasts, the sediment load carried by rivers is higher in Albany, whose coastal zone characterized by various deltas to a great extent, than those of other countries (Simeoni et al., 1997; Ciavola et. al., 1999). Erosion caused by geological or geo-morphological features is effective in the formation of this situation. Investigating the erosion concept in terms of ratio and distribution will explain it more clearly (Figure 2). Studies in this regard point to the fact that erosion is substantially common and high (Grazhdani and Shrunka, 2007, Marku et al., 2010).

Albania which carries Mediterranean climate conditions (Güner and Ertürk, 2005; Atalay, 2011; Özey, 2012) has an annual rainfall of 930-2200 mm in the coastal areas with annula average temperatures changing between 15-16.5 °C (Ciavola et. al., 1999).

Albania which is a rich country in both above and underground water resources (Çullaj et al., 2005; 2006; Abazi and Kupe, 2012) consists of 43,905 km² basin areas which form 65% of the whole land (Çullaj et al., 2005; 2006). Length of river networks in the country is generally above 49,000 km and the average density is about 1,7 km/km². Annual water amount carried by the rivers is 41,2 km³. there are 9 main rivers in the country: Buna (41 km), Drin (285 km), Mat (115 km), Ishm, Arzen, Shkumbini (181 km), Semeni (281 km) Vijose (272 km) and Vlores (Kabo, 1990-1991; Samimi et al., 1997; Çullaj, 2006; Figure 3). The rivers in Albania have very high flow (Stanner and Bourdeau, 1995; Çullaj et al., 2005; 2006). The rivers and their average discharges are as follows: Buna and Drin 680 m³/sec., Mat 103 m³/sec., Arzen 61,5 m³/sec., Shkumbini 61,5 m³/sec., Semeni 95 m³/ sec. and Vijose 195 m³/sec. (Kabo, 1990-1991; Samimi et al., 1997; Çullaj et al., 2005; 2006; Figure 3).

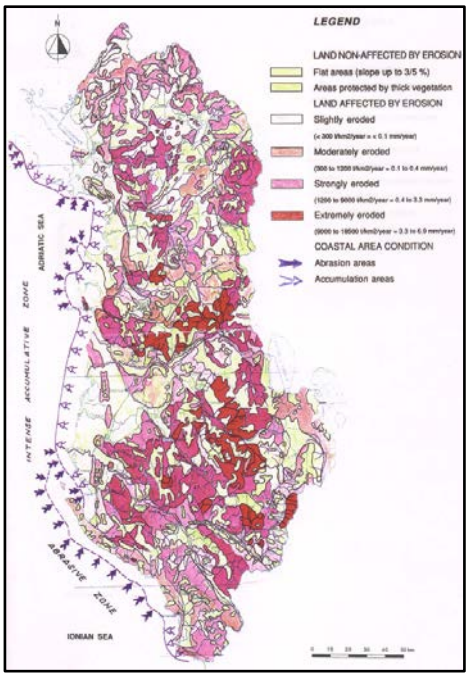

Figure 2: Erosion map

Figure 3: Basins of river in Albania

In Albania which has coasts in the Adriatic Sea, micro-tidal is common due to the shape of the sea basin. However, whereas the effect of high tide-low tide is 20 cm in Mediterranean, it can reach up to 90 cm in the Adriatic Sea. The reason of high degrees of the high tide-low tide are related to the fact that this sea is shaped like a canal between Balkan Peninsula and Italian coasts along with many small islands parallel to the coasts. In addition to high tide-low tide effects of this sea, sea currents formed by winds are apparent. The speed of these currents called “Southern Adriatic Cyclonic Gyre” is between half and three knots (Mihnea et al., 2006).

Material and Method

The study aims to represent the general features of Albanian deltas with the help of related literature, /1.000.000 and 1/250.000 scale topography maps and satellite maps of different specialties obtained at various dates. In this context, related visual data was analyzed and interpreted with the help of Geographical Information Systems (GIS) and Remote Sensing (RS) methods and techniques.

Research questions such as “How many large deltas are there in Albania?”, “How can these deltas can be classified in terms of their general features?”, “What are the details of these general characteristics?” and “Which of the deltas are similar in terms of their features?” were answered separately in the framework of the study.

Results and Discussion

As we know, deltas are deposition systems where erosion-transportation between the coasts and the backshore areas is balanced and large deposits are common as a result of this balance. The type of the materials deposited at these units change according to many factors. Hence, various types of delta systems are formed depending on the energy created as a result of the features of the deltas (Coleman and Wright, 1975; Galloway, 1975; Wright, 1985; Coleman and Roberts, 1988). The delta systems can be wave dominated, river dominated, tide dominated and in between according to their processes; clay, silt, sand, gravel, mixed (mud and argil) according to their lithological/sedimanetary structures; arcuate, bird foot, cuspate, estuarine deltas according to their geometries; lacustrine deltas in land facies, lagoon deltas in lagoon facies, continental shelf deltas in shallow sea facies and continental margin deltas in shallow sea facies according to their sea level phases and sediment provision; and type 1: wave induced, type 2: mixed wave and tide induced, and type 3: tide induced, deltas according to their geomorphologies and development processes (Galloway, 1975; Elliott, 1986; Wright, 1985; Coleman et al., 1986; Coleman and Roberts, 1988; Whateley ve Pickering, 1989; Oti and Postma, 1995; Galloway and Hobday, 1996; Hori et al., 2002; Gupta, 2007; Özşahin, 2009).

Albania is one of the Balkan countries that are rich in terms of deltas. The natural environment conditions in addition to the abundance and density of the rivers in the country have formed a delta rich environment.

The country with a dominant highland morphology has the dominant relief of deltas in the coasts developed in the form of prairies. The ratio of these deltas in the surface area of the country is 2.15%. These deltas from the north to the south are the deltas of Bojana-Buna, Drin, Mat, Ishm, Arzen, Shkumbin, Semeni, Vijose and Vlores rivers (Figure 5).

Figure 5. Deltas of Albania

The largest of these deltas are the deltas of Mat, Arzen and Vjosa rivers. These dense and heterogeneous reservoirs were created by collecting the materials transported by largest and highest energy rivers of Albania. However, other rivers such as Shkumbin and Semeni only have reservoirs consisting light materials and they have formed smaller deltas (Eftimi, 2003).

These deltas, which have similar but also different features when classified according to their general characteristics, are similar in their processes, sedimentary/lithological structures, sea level phases or sediment provision and geomorphologies and development processes. However they are different in terms of their geometries (Table 1).

Table 1. General Features of river deltas in Albania

DELTAS	AREA		CLASIFICATION OF RIVER DELTAS				
	km²	%	Dominant Process	Sedimentary structure	Geometry	Sea level phases	Geomorphology and development process
Bojana-Buna	90,7	14,6	River	Muddy	Prominent	Continental shelf deltas in shallow sea facies	1. Type wave induced
Drin	36,7	5,9	River	Muddy	Prominent	Continental shelf deltas in shallow sea facies	1. Type wave induced
Mat	121,8	19,6	River	Muddy	Prominent	Continental shelf deltas in shallow sea facies	1. Type wave induced
Ishm	78,0	12,6	River	Muddy	Blunt	Continental shelf deltas in shallow sea facies	1. Type wave induced
Arzen	94,8	15,3	River	Muddy	Prominent	Continental shelf deltas in shallow sea facies	1. Type wave induced
Shkumbin	47,6	7,7	River	Muddy	Prominent	Continental shelf deltas in shallow sea facies	1. Type wave induced
Semeni	55,1	8,9	River	Muddy	Prominent	Continental shelf deltas in shallow sea facies	1. Type wave induced
Vijose	81,4	13,1	River	Muddy	Prominent	Continental shelf deltas in	1. Type wave induced

Vlores	13,9	2,2	River	Muddy	Blunt	shallow sea facies Continental shelf deltas in shallow sea facies	1. Type wave induced
TOTAL	**620,0**	**100,0**	**River**	**Muddy**	**Prominent and blunt**	**Continental shelf deltas in shallow sea facies**	**1. Type wave induced**

One of the most important deltas of Albania is Bojana-Buna delta located on the northernmost part of the country. This delta is fan shaped or arcuate like Ebro and Po river deltas (Schneider-Jacoby et al., 2006). It has shallow lagoon lakes that are common to these types of deltas. These lakes have been observed in the last 100 years in this delta. The surface area of the river basin in which Bojana-Buna delta is situated is 6304,6 km². Water discharge to delta area from the main river branch is 672 m³/sec (Schneider-Jacoby et al., 2006). This river also borders Montenegro (Figure 6-7-8).

This delta with a surface area of about 90,7 km² (14,6%) is river dominant according to classification in terms of its processes; clayed (clay and silt) according to it sedimentary structure and ribbed according to its geometry (Table 1). Coastal line of the delta is 19 km and the delta width is 10 km is air distance in the east-west direction.

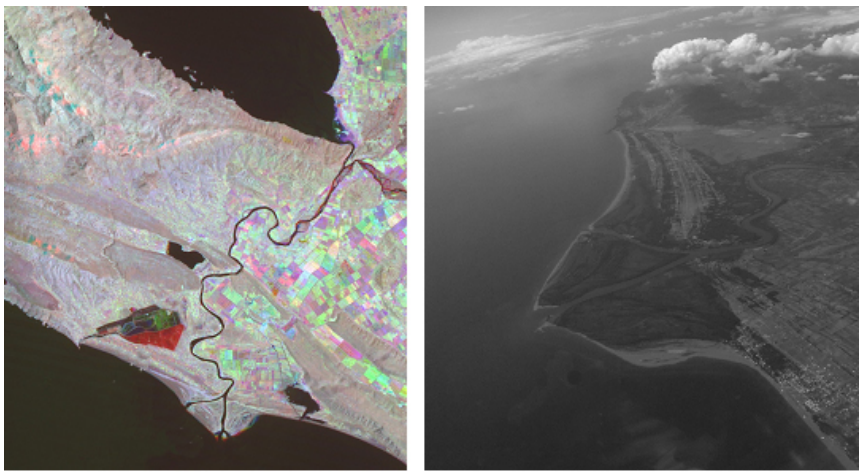

Figure 6: Deltas of Bojana-Buna river (Flasheri et al., 2010)

The second largest delta of Albania is located 20 km southeast of the Bojana-Buna delta (Figure 7-8). This delta was formed by the collection of sediments carried by Drin river. Drin river delta has a surface area of 36,7 km² (5,9%) and is similar to the Bojana-Buna delta in terms of its processes, sedimentary structure and geometry (Figure 7-8). Actually, Bojana-Buna and Drin rivers are interconnected and this connection was shaped until the end of the 19th century (Schneider-Jacoby et al., 2006). The river basin in which Drin river delta is situated has a surface area of 14723,7 km² and has a water discharge level of 672 m³/sec (Schneider-Jacoby et al., 2006).

Figure 7 *Figure 8*

Figure 7-8: Deltas of Bojana-Buna and Drin rivers

The largest delta in Albania is Mat ricer delta (Eftimi, 2003) which was formed by the Mat river with, 2656,3 km² basin area. The annual discharge of the river is 103 m³/sec. and it is the third biggest river of Albania in terms of its annual flow values (Marku et al., 2010). The alluvial thickness is 270 m in the delta area of 121,8 km² (19,6%) (Eftimi, 2003; Figure 9-10). The classification shows that the delta is river dominant in terms of its processes, clayed (clay and silt) in terms of its sedimentary structure and ribbed in terms of its geometry (Table 1).

Ishm river delta located in the south of Mat river delta is another delta area in Albania (Figure 9-10). The delta area which covers 78,0 km² (12,6%) area in the Adriatic coasts is river dominant in terms of its processes, clayed (clay and silt) in terms of its sedimentary structure and blunt in terms of its geometry (Table 1).

Figure 9 *Figure 10*

Figure 9-10: Deltas of Mat and Ishm rivers

Arzen river delta is another delta located in the southwest of capital Tirana. The thickness of alluvial created by the materials carried by Arzen river which drains an area of 1398,2 km² is about 15 m (Eftimi, 2003). Arzen river delta has an area of 94,8 km² (15,3%) and is river dominant in terms of its processes, clayed (clay and silt) in terms of its sedimentary structure and ribbed in terms of its geometry (Table 1; Figure 11-12).

Shkumbin river delta located to the south of Arzen delta is an important water mass in terms of delta forming factors (Figure 11-12). The river with a basin surface of 2444 km² has a water discharge of 61,5 m³/sec. and total sediment discharge of 7,2x106 tones/year (Pano and Frasheri, 1999). The delta of this river is another delta located in Albanian borders. It has a delta area of 47,6 km² (7,7%) and is , river dominant in terms of its processes (Brew, 2003), clayed (clay and silt) in terms of its sedimentary structure and ribbed in terms of its geometry (Table 1).

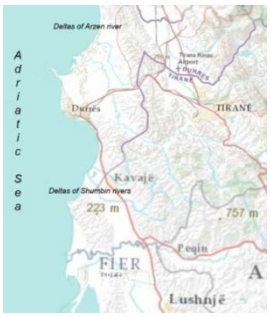

Figure 11 *Figure 12*

Figure 11-12: Deltas of Arzen and Shumbin rivers

Semeni River is the muddiest river of the Mediterranean. Semeni river delta developed at the mouth of this dynamic river has resulted in many changes related to this dynamic structure. These changes have totaled 25 km length in the last century. The drainage basin of this river is 5649 km², average river length is 753 m. averahe water discharge is 95,7 m³/s and total sediment discharge is 16,5x106 tones/year (Pano and Frasheri, 1999). Semeni River delta has a surface area of 55,1 km² (% 8,9). It is river dominant according to classification in terms of its processes (Brew, 2003), clayed (clay and silt) in terms of its sedimentary structure and ribbed in terms of its geometry (Table 1; Figure 13-14).

Figure 13 *Figure 14*

Figure 13-14: Deltas of Semeni and Vijose and Vlores rivers

Another delta located in the borders of Albania is Vijose river delta (Figure 13-14). Vijose river with a 6336,9 km² basin area is responsible from large amounts of sediment transportation. Hence, the alluvial thickness in its 81,4 km² (13,1%) delta area is 30 m (Eftimi, 2003). Vijose river delta is river dominant according to classification in terms of its processes (Brew, 2003), clayed (clay and silt) in terms of its sedimentary structure and ribbed in terms of its geometry (Table 1).

The southernmost delta which can be counted as the last delta in th Albqanian borders is Vlores river delta (Figure 13-14). This delta is the smallest of the deltas mentioned earlier with its 13,9 km² (% 2,2) surface area. It is river dominant according to classification in terms of its processes, clayed (clay and silt) in terms of its sedimentary structure and blunt in terms of its geometry (Table 1).

Conclusion

The general characteristics of large deltas in Albania formed by the main rivers in the country can be summarized as follows according to the details provided in the text for each delta:

Natural conditions in Albania have created suitable environments for delta formation. The most dominant of these conditions is the large extent of erosion caused as a result of geological and geo-morphological features. Hence, the rivers of Albania provide a higher amount of sediment input compared to neighboring countries.

All of Albanian deltas are natural systems that are river dominant according to classification in terms of their processes; muddy (clay or silt, sand, mixed with clay) in terms of their sedimentary/lithological structure; Continental shelf deltas in shallow sea facies and are Type 1: wave induced in terms of their geo-morphologies and development processes. Deltas can be regarded as monogenic since they represent a uniform/monotony in terms of their lithologies, sediment provisions, geo-morphologies and development processes. However, these deltas also show a polygenic character in terms of their geometries since Bojana-Buna, Drin, Mat, Arzen, Shkumbin, Semeni and Vijose river deltas are ribbed deltas in terms of geometry while Ishm and Vlores river deltas belong to blunt delta groups.

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