THE DANUBE-HYDROGRAPHIC POLARISATION EUROPEAN AXIS. STATE-OF-THE-ART

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Abstract.- The Danube- hydrographic polarisation european axis.State-of-the-art The Danube has more „international" character than any other great river, strung along water course four national capitals (Vienna, Bratislava, Budapest,Belgrad), several other cities and hundreds of towns and villages, passes through human habitation of widely varying levels of development. The Danube is the second largest water course in Europe (after the Volga) in terms of length (2860 km), drainage basin (817,000 km^2) and multiannual mean dischrge (6,510 m^3/sec. entry into Danube Delta).Through the latitudinal development of the Danube River Basin, in the Western and Central European space with different climate conditions (ocean and continental temperate), the liquid discharge regime, with high waters during spring and early summer is reflecting a moderate variation (K=Qmax/Qmin-8.9 at Ceatal Chilia).The Danube is a navigable waterway of significant importance and since ancient times it has helped form links between the populations inhabiting its banks.Traces of settlment date backs thousands of years as people were attracted by fertile floodplains and terraces,the wildlife in wilow forest and the wealth of fish populating the river itself and many great lakes. Unfortunately, this was not always been a bridgeway.There had been times,and they spaned five hundred yeares,when the lower course divided peoples. The Romans turned the river into a political frontier,not easily surmounted because of the force resistance put up by the autochtonous populatoin, the Dacians, in particular. Therefore, the Empire set up a fleet on the Danube,built strategic roads and bridges-one at Drobete-Turnu Severin(Traian`s Bridge), due to Appolodorus from Damascus, and another at Celei,near Corabia. The European Danube Commission (EDC),set up in 1856,was assigned the task of management of navigation on the river and undertaking of correction works to this end.The Commission discharged its duties until 1948, when the Belgrade Convention legiferated the rights of riparian states.This form of organization stimulated the development of several city-ports.Plans for connecting the Danube to Rhine and North Sea, respectively,go back to the reign Charlemagne(AD 793),realised and corrected in a few stages (1836-1845,1959,1992).Another goal was to shorten the distance to the Black Sea by having a canal built on the lower reaches of Danube, between Cernavodă and Constanța(1974-1984). International cooperation in addressing water problems of the Danube took great steps forward through the Bucharest Declaration of 1985 and Helsiki Treaty of 1992.These paved the way for cooperation among the Danube basin countries.Danube River Basin Management Plan follows the deadlines set out in

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the EU Water Framework Directive (WFD) of December 2000.The achievement of good water status in the water bodies of the Danube region by 2015 is coordinated by the ICPDR..The EU Strategy for Danube Region is to ensure the economic, social and cultural development of states and countries, situated in the drainage basin of the Danube River, by observing environment protection norms.

Key words: Danube -river, hydrology, hystory, management

1. GENERAL CHARACTERISTICS

The Danube river springs from the central-western part of Europe, in the Schwarzwald, where two of its tributaries –the Breg and Brigach – bringing their waters together at Donaueschingen. Thence the Danube crosses the central part of the Europe, the Pannonian Depression down to the confluence with the Drava, then pierces the Carpathian Mountains through the Iron Gate Gorge. Farther down it separates the southern part of the Romanian Plain from the Prebalkan Tableland, and the eastern part of the Romanian Plain from the Dobrogea Plateau. The last sector of the river, up to the Black Sea, encompasses the Delta area(Foto 1).

Foto 1.Donauescingen- the confluence of the Brege and Brigach rivers in the Fürstenberg Park

The Danube drainage basin occupies 8% of Europe (805,300 km²) and has different lengths on the territory of several states – Germany, Austria, Czech Republic, Slovakia, Hungary, Slovenia, Croatia, Serbia, Montenegro, Bulgaria, Romania, the Republic of Moldova and Ukraine (Fig.1.).

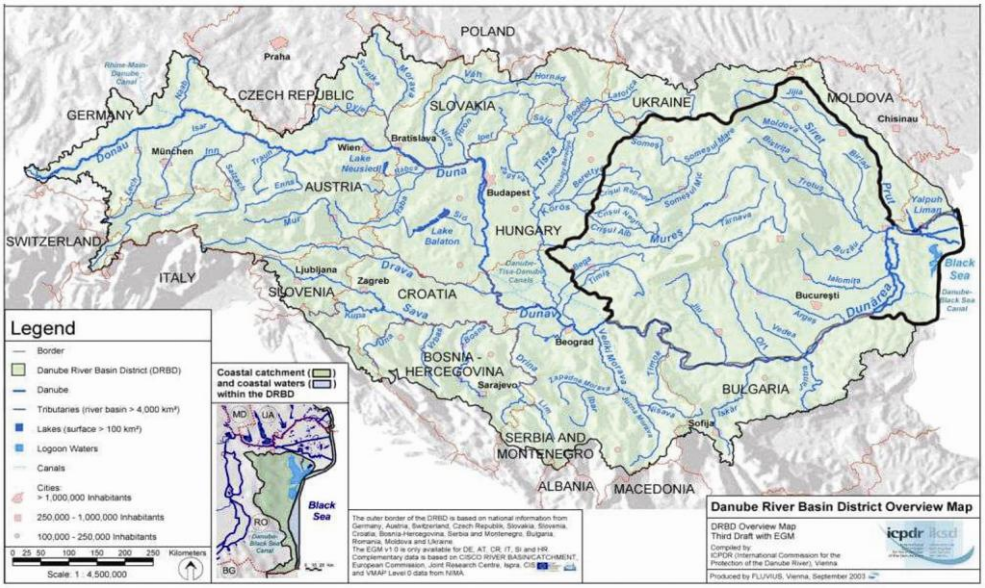

Fig. 1. The Danube river drainage basin

The upper Danube sector (1,060 km) extends from the sources-Schwarzwald to the Devin Gate in the vicinity of Bratislava.In this sector, the Danube flows between the Hercynian Swabo-Franconian Jura range, on the left, and the Prealpine heights, on the right, into the Münich Basin at Ulm, from where its channel become navigable. The major right bank tributaries (Iller,Lech, Isar, Inn, Traun, Enns) issue from the northern slopes of the Alps Mountains,accounting for the alpine discharge of this sector (Gâştescu,1998)..

The middle sector (725 km) from Devin Gate to Baziaş-Romania, represents the passage of the river from the Vienna Basin to Panonian Depression. From the southern section of this sector, the Danube receives its largest tributaries, substantially increasing its flow- Drava,Tisza and Sava.

The lower sector (1075 km) represents Romania's natural border with Serbia, Bulgaria, Ukraine and the Republic of Moldova. Here the river forms the longest and most beautiful gorge area – the Iron Gate (144 km), a sector with an asymmetric valley (Drobeta Turnu Severin – Călăraşi, 566 km), a large floodplain sector (Rom. "baltă") between Călăraşi and Brăila (195 km), and a sector of maritime navigation, Brăila – Sulina, 170 km, also including the Danube Delta. In Romania, the Danube drains 97% of the country's territory.

Foto 2.The Iron Gate Gorge (http://www.ghiduri turistice).

The Iron Gate Gorge (144 km long) a name already used in the international specialist literature, unfolds in the Carpathian Mountains, between Baziaş and Gura Văii, narrows down in some sections and becomes winder in others,where small basins are formed. In the Iron Gate was built a of the dam at Gura Văii with largest reservoir and hydropower station (capacity ,2100 MW),is shared jointly by Romania and Serbia, commissioned in 1970(Foto.3).

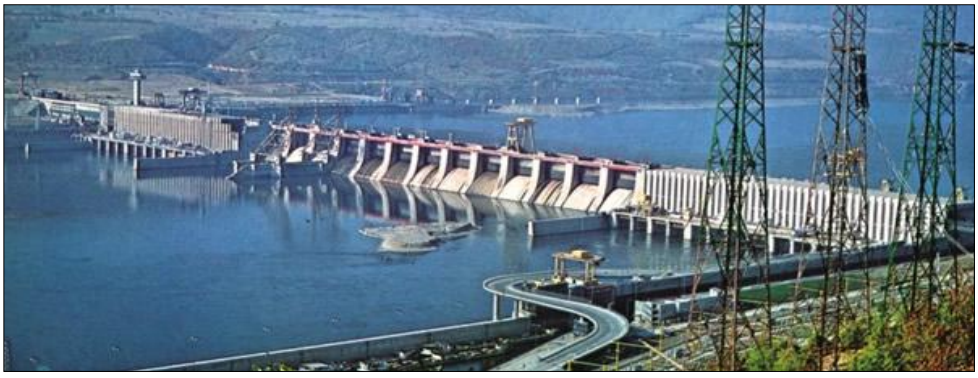

Foto 3. Iron Gate Gorge dam (http://www.ghiduri turistice).

In the so-called *Pontic sector* (Drobeta-Turnu Severin – Călăraşi) the stream gradient falls from 0.045 to 0.06‰, forming some islets (Rom. "ostrov") (Ostrovul Mare, Păpădia, Calnovăț, Băloiu and Ostrovul Păsărilor) and a 4 – 13 km-wide floodplain on the lefthandside, which before dyking and draining had encompassed numerous lakes.

In this sector, the lefthandside tributaries of the Danube in Romania – the Jiu, Olt and the Argeş, are bigger than in Serbia and Bulgaria, but there they are

more numerous (the Timok, Ogosta, Iskar, Vit, Osam, Iantra and Lom). A second hydro-electric power station was built at Ostrovul Mare in cooperation with Serbia. A road-and-rail bridge (commissioned in 1954) spans the river between Giurgiu (Romania) and Ruse (Bulgaria). In this sector was built in 2015, a new bridge for vehicle traffic between Calafat (Romania) and Vidin (Bulgaria).

The *floodplain lake sector (Rom."bălți"*) between Călăraşi and Brăila features the Danube branching out into several arms and encompassing the floodplain proper.

Because of the numerous lakes, backwaters and frequent flooding, the area was suggestively named *Balta Ialomiței (Borcea).*

It extends between the Dunărea Veche and Borcea branches; *Balta Brăilei* between Dunărea Nouă (with several ramifications – Vâlciu, Mănuşoaia, Cremenea, Pasca, Calia and Arapu), forming smaller islets in the west, and the Măcin Arm (Dunărea Veche) in the east. These two areas (except for the Balta Mică a Brăilei) were dammed and the terrain used for agriculture.

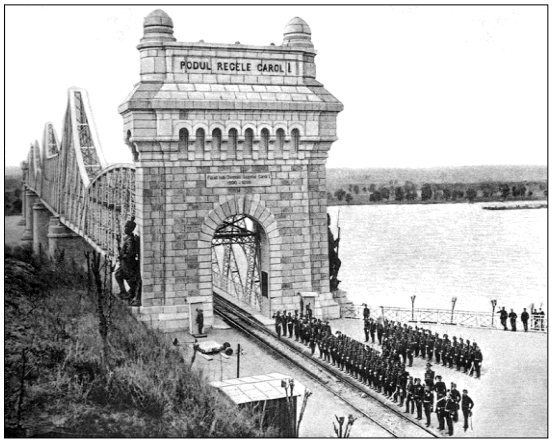

Foto.4. Anghel Saligny rail bridge
(http://art-historia.blogspot.com).

A famous *rail bridg*e between Feteşti and Cernavodă was built by Anghel Saligny in the years 1890 – 1895. It was the longest bridge across the Danube, and the eighth in the world at that time. A second road-and-rail bridge, parallel to it, was commissioned in 1987 (Foto 4).

Downstream, where the river forms one single stream-channel, stands a *road bridge* that spans the distance between Giurgeni and Vadu Oii (1,450 m long of which 750 m are suspended over the river was realised in 1970

The final *maritime sector* derives its name from the management works performed towards the end of the 19th century to allow big tonnage sea vessels to

sail through the Sulina Arm and farther on to the Danube up to the town of Brăila (170 km). The major tributaries in this sector are the Siret and the Prut, both on the lefthandside of the River Danube.

The sub-sector of the Danube Delta extends between the arms of Chilia in the north (117 km), Tulcea (19 km) and Sfântu Gheorghe (109 km; what has remained after corrections to its meandering course is 70 km) in the south. All in all, the Danube Delta covers 2,540 km^2 of Romanian territory.

The territory of the Danube Delta is steadily evolving, due on the one hand, to the action of the river and its flow of 6,510 m^3/sec (multiannual mean) and the sediments transported by it, and on the other hand, to the battering of sea waves on the coast.

In 1990 this geographical unit, with its unique fauna and flora in Europe, was declared a *biosphere reserve* by the Romanian Government.

2. THE HYDROLOGICAL REGIME

The Danube flows through regions of distinct morphology, e.g. the old Hercynian Mountains, the young Alpine-Dinaric-Carpathian-Balkan chain, tablelands and plains, regions affected by Oceanic, Baltic, Mediterranean and temperate-continental climatic influences that stamp their mark on the morpho-hydrographic and hydrologic characteristics of the river.

In the upper course, the hydrological regime is determined by its alpine tributaries which spring from the Alps with high June waters. In its middle and lower course it depends on the Drava and the Sava, with high waters in spring (April –May) and lower ones in autumn (September – October).

The Danube's *multiannual mean discharge* increases downstream as follows: 1,470 m^3/sec at Passau, after confluencing with the Inn; 1,920 m^3/sec in Vienna; 2,350 m^3/sec in Budapest and 5,590 m^3/sec after its junction with the Drava, Tisa and Sava, at Baziaş at the entry ito the Iron Gate gorge and increases, only 920 m^3/sec with the contribution of the lower Danube tributaries (Timok, Isker, Iantra on the right side and Cerna, Jiu, Olt, Vedea, Argeş, Ialomiţa, Siret and Prut on the left side), up to 6,510 m^3/sec at Ceatal Chilia, entry into the Danube Delta(Fig.2)..

Maximum flow is recorded during the high spring waters, but occasionally in summer, too: 15,800 m^3/sec at Baziaş; 16,200 m^3/sec at Oltenița and 16,100 m^3/sec at Ceatal Chilia in 2006 (Gâştescu, Ţuchiu, 2012).

Minimum flow rates occur in autumn and occasionally in winter: 1,200 m^3/sec at Baziaş in 1954; 1,490 m^3/sec at Oltenița in 1954, and 1,350 m^3/sec at Ceatal Chilia in October 1921.

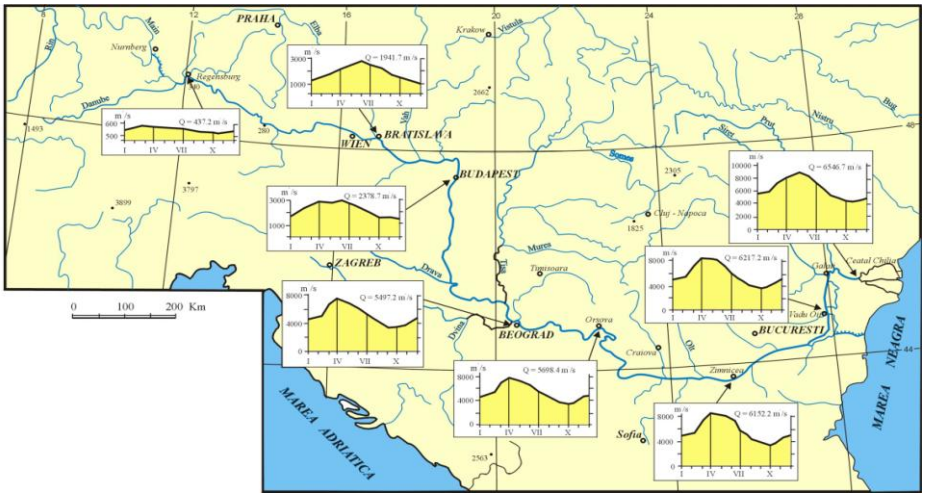

Fig. 2. The Danube River. Multiannual mean of monthly flow rate variation (Romania. Space, society, environment, 2006)

The alluvial discharge (1840-2000) was 53 million tons/ year, respectively 1,681 kg/sec, of which 2.81 million tons /year represented coarse alluvia (sands). The extreme values during that interval were 4,470 kg/sec (141 million tons/year) in 1871 and only 229 kg/sec (7.2 million tons/year) in 1990. Throughout that period there was a tendency to decrease at an annual rate of 8.3 kg/year, naturally with fluctuations in terms of the liquid discharge (Bondar, 2004, ms.).

The mineralisation degree is still moderate despite the higher quantities of polluting wastes being spilled into the river in front of large cities – Vienna, Bratislava, Budapest and Belgrade (values coming close to 350 – 400 mg/l due mainly to chlorine and natrium). The Danube's great self-purification capacity makes it recover in the lower course.

3. HISTORY AND NAVIGATION

From ancient times, the River Danube has been an important transport waterway, a link between the populations living on its banks. Traces of settlements date back thousands of years as people where attracted by fertile floodplains and terraces, the wildlife in willow forests and the wealth of fish populating the river itself and its many great lakes.

Traces the Greek and Roman cities situated on the Danube bank, many of them in Dobrogea, stand proof to the intense activity that had been going in the lower course of the Danube river ex.the settlements: "daves" Traco-Dacian ex. Capidava (today Topalu), Sucidava (Celei), fortresses Dacian, Greek, Roman ex.

Salsovia (Mahmudia), Aegyssus (Tulcea), Noviodunum (Isaccea), Păcuiul lui Soare (Lipnița), Drobeta (Drobeta-Turnu Severin) etc.(Foto 5,6)

Foto 5. Sucidava Fortresse
(http://www.travel.descopera.ro)

Foto 6. Păcuiul lui Soare Fortresse
(http://www.ziuaconstanta.ro)

Unfortunately, this was not always the case and there were times, spanning some 500 years, when the lower reaches divided the people. The Romans turned the river into a political frontier,not easily surmounted because of the force resistance put up by the autochtonous populatoin, the Dacians, in particular. Therefore, the Empire set up a fleet on the Danube,built strategic roads and bridges-one at Drobeta, Turnu Severin, *Traian`s Bridge*, constructed by Appolodorus from Damascus, and another at Celei,near Corabia(Foto 7).

Foto 7.The ruins and clay-model of the Trajan's Bridge raised by Appodorus from Damascus at Drobeta-Turnu Severin (http://www.ghiduri turistice)

The walls of Cazane (Iron Gate Gorge) still preserve some stone inscriptions known by the name of *Tabula Trajana* and *Tabula Domitiana*,

marking the construction of the Roman road on the right bank of the river under *Emperor Trajan* (98 – 117 AD) (Foto 8).

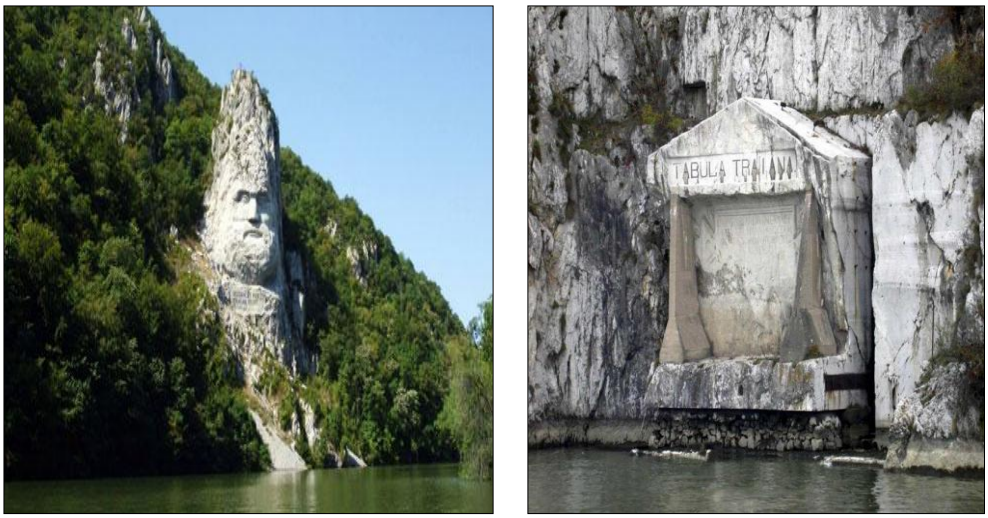

Foto 8. Tabula Traiana (1) and the Decebal dacian king(2) in the Iron Gate Gorge (http://www.ghiduri turistice)

According to *Herodotus from Halicarnassus* (about 485 – 425 BC.), the author of nine books tilted *"Histories"*, tells about the inroads made by *Darius I, emperor of the Persians*, presumably chasing the Scitians as far as Isaccea on the Danube (514 BC.), which is an indication, of the Danube having also been navigable in those days.

In the period of migrations (late 1st-early 2nd millennia), the Danube became a gateway in to the Balkans.In the 14th century the *Wallachian ruler Mircea the Old* strengthend his cities on the Danubian -Dristor (present-day Silistra), Giurgiu and Turnu Măgurele. The expansion of the Ottoman Empire and the establishment of some Turkish dominations on the river bank (Rayahs- Turnu, Giurgiu and Brăila) put limitations to navigation on the Danube the situation being solved only in 1829 by the *Treaty of Adrianople* (Giurescu,C.,Giurescu, D.,1975).

In the Iron Gate it was a difficult sector and a very trying experience for naviagators. In order to remedy the situation, management works (1890 – 1898) targeted a former canal route 75 m wide, 2 m deep and 2 km long dating from Roman times.This the navigation difficuties were resolved in 1970 by the construction of the Gura Văii dam and storage-lake, raising the water level and the backwater at the dam, which under certain conditions, reached beyond Belgrade, up to the junction of the Danube with the Tisa (cca. 230 km long).

The river started being managed for navigation in 1856, when the *European Danube Commission (EDC)*, including also non-riparian countries such as Great Britain and France, was established. The Commission was assigned the management and maintenance of this waterway until 1948, when the rights of the Danube riverine countries were legalised by the Belgrade Convention.

In a view to facilitating *maritime navigation* from Brăila to Black Sea (170 km), have been preferred Sulina arms on the basis of Danubian European Commission's studies,situation which favourized the correction of meanders and deepening of the river bed during 1862-1902. As a result, the length of the Sulina arm was reduced from 92 km to 63.7 km,and flow of water increased from 7-8% to 18.8% (Foto 9).The Romanian sector fell under the *Fluvial Administration of the Lower Danube* sited in Galați, as part of the Budapest-based Danube Commission. Navigation on the Danube led to the development of several port-towns which, beside commercial and transport functions, built their own ship-yards for the construction and repair of river and sea vessels, (for exemple at Sulina, Tulcea, Galați, Brăila, Oltenița, Giurgiu and Drobeta-Turnu Severin).

Foto 9. The sea vessels on the Sulina Arm-Canal

The idea of having a link between the Danube and the Rhine, hence with the North Sea, dates back to the time of the *French King Charlemagne* (793), but it materialised only in 1836 – 1845, when the 177 km-long "*Ludwig – Donau – Main"* Canal was built, and was operated until 1945. The Main – Danube Canal was remade and commissioned in 1999. Its new dimensions (55m wide on the water surface, 4 – 4.5 m deep, 12 m wide and 90 m long spill locks) allow the passage of 90 m-long ships of 1,500 dwt and tug-boats of up to 3,300 dwt (Fig.3).

Fig. 3.The Danube River from Schwarzwald-Germany up to Black Sea

In order to shorten the navigable channel to the Black Sea, a *canal was built* (1976 – 1984) Cernavodă– Basarabi – Agigea axis, reducing the distance to the sea by some 400 km. The secondary branch from Basarabi (Poarta Albă) – Năvodari was commissioned in 1988. The Danube – Black Sea Canal is 64.2 km long (Poarta Albă – Năvodari 30 km), 70 – 80 m wide on the water surface, and 7 – 7.5 m deep, allowing for the passage of ships of 5,000 dwt, 6m draught, speeding at 8 – 9 km/hr. The Canal was commissioned on May 26, 1984, and since then the Danube has become the most important *water avenue in Europe (Black Sea – Danube – Rhine – North* (Foto 10).

Foto 10..The harbor lock on the Danbe-Black Sea, canal-Năvodari(http://www.anc.ro)

3. HUMAN IMPACT, BIODIVERSITY, PROTECTION

Economic development in the Danube region brought not only prosperity, it also led increased environmental pressures: industrial activities, intensive agriculture and growing municipal communities are all potential sources of pollution if not properly managed. In particular, pollution from nutrients and toxic substances has become a serious problem as it affects not only the Danube but also the Black Sea.

The loss of longitudinal continuity lateral connectivity and other morphohydrographical modifications, the construction of hydroelectric power plants on the river accelerated the transformation of the original riverbed and floodplain and led to a dramatic changes in riverine biota.The river regulation activity to improve navigation and flood control is still attention of the Danubian countries.

In these conditions it was therefore imperious to protect what remains of it natural treasures. The effective nature conservation and protection in the Danube river requires active transboundary cooperation among all the countries the river flows through.

The impact of this human activity, in term of morphohydrographic course and hydrological regime, of the Danube river and drainage basin, changes in landscape, loss o biodiversity, has been a matter many concern since the 1980s.

Conservation is also an increasingly important public issue as awareness of environmental quality increases throughout the region.Each proteced area along the Danube must be in accord with local features and accommoate the needs of people who have a long traditional connections with the Danube

For transnational cooperation concerning the protected areas along the Danube was officially founded with signing of the Declaration of Vienna in 2009-DANUBEPARK(Danube River Network of Proteced Areas). DANUBEPARK has become a widely recognized nature conservation network. The permanent parteners are International Commission for of the Danube River(ICPR) and the EU Strategy for Danube Region(EUSDR).

DANUBEPARK, now embrace ***20 conservation areas***, from source to delta, in nine countries which working together to protect the precious natural heritage of the Danube(e.g.Donauwald Neuburg-Ingolstadt, Donau-Auen National Park, Dunajske Iuhy Proteced Landscape Area, Duna-Ipoly National Park,...Djerdap National Park (Iron Gates,...Danube Delta Biosphere Reserve).

4. EU STRATEGY FOR DANUBE REGION (EUSDR)

The *Danube River Basin Management Plan* follows the deadlines set out in the *EU Water Framework Directive (WFD).* As a coordinating body, the development of a comprehensive management plan for the entire Danube river basin is based on the principles of the WFD.The *WFD* requires water management on a basin-wide scale, thus setting the scene for international and cross-boundary implementation of water regulation

With the aim of the *EUSDR* is to ensure the economic, social and cultural development of states and countries, situated in the drainage basin of the Danube River, by observing environment protection norms. The three pillars of the Danube Strategy are: *connectivity* (transport, energy, communications); *environment protection and water* management; social-economic development (culture, education and rural development). The *EU Strategy* was elaborated by the *EU Commission* jointly with the riparian countries, the final form dating to 2010. In the light of this EU Strategy, Romania has the following priorities: *transport*, to elaborate projects for the European Corridor 7, contributing to securing the safety of navigation all along the Danube River; *energy,* to develop energy capacities in the Danube Basin; *environment protection*, to create and expand the utilities infrastructure (drinking water supply and sewerage networks), waste-water purification for all human agglomerations with over 2,000 inhabitants, biodiversity protection, preservation and expansion of forested areas, etc.

The *Danube Strategy Point(DSP)* has been established in 2015 to improve the implementation process of the *EUSDR* supporting the Commission in its coordination tasks of the *EUSDR*. The *DSP* with four pillars and 12 *Priority areas coordinators (PACs)* are: *connectivity the region*(transport, energy, communications); *protecting the environment; building prosperity*(culture, education and rural development); *strengthening the region.* Priority Area Coordinators and National Coordinators in their tasks and promotes the Strategy predominatly at the European level.The *DSP* also administraters funds in the framwork of Tehnikal Assistace for the Priority Areas in the *EUSDR* for the years 2015-2016.

5. CONCLUSIONS

The Danube River has a more “international” character than any other great river. Strung along the river are four national capitals, several other large cities and hundreds of towns and villages. The Danube passes through human habitation of widely levels of development.

From the ancient times the Danube River was a transport waterway which linked the riparian peoples, today states –Germany,Austria, Hungary, Slovakia, Serbia, Croatia, Romania, Bulgaria, Republic of Moldova,Ukraine.

Through the latitudinal development of the Danube River Basin, in the Western and Central European space with different climate conditions (ocean and continental temperate), the liquid discharge regime, with high waters during spring and early summer is reflecting a moderate variation

From the hydrological regime the analysis of average, maximum and minimum flows for the period 1931-2010, the significant increasing/decreasing trends are not noticed. The high discharges of the 1970, 2006 and 2010 years, which produced floods, were also caused by the limitation of *free space* of the lower Danube sector through floodplain embankment

The reconsideration of the complex function of the Danube floodplain is necessary from many points of view - hydrological, ecological, economical and human safety.

The river started being managed for navigation in 1856, when the *European Danube Commission (EDC)*, including also non-riparian countries such as Great Britain and France, was established.

The Commission was assigned the management and maintenance of this waterway until 1948, when the rights of the Danube riveraine countries were legalised by the Belgrade Convention..

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The *Danube River Basin Management Plan* follows the deadlines set out in the *EU Water Framework Directive (WFD).* As a coordinating body, the development of a comprehensive management plan for the entire Danube river basin is based on the principles of the *WFD*. The *WFD* requires water management on a basin-wide scale, thus setting the scene for international and cross-boundary implementation of water regulation.

The *EU Strategy Danube Region(EUSDR)* is to ensure the economic, social and cultural development of states and countries, situated in the drainage basin of the Danube River, by observing environment protection norms.

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