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RIVER SEDIMENT TRANSPORT AND COASTAL EROSION IN THE SOUTHEASTERN BLACK SEA RIVERS

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In the Southeastern Black Sea Region, rivers are dammed for hydroelectric power and irrigation. The natural course of fluvial alluvium transport is almost completely altered because of planned and constructed dams and coastal protection measures. Decreasing volume of sediment carried to the sea cause intensification of the shore erosion. The Black Sea Rivers and coastal areas of Turkey and Georgia are under heavy anthropogenic pressure because of the bed material extraction and coastal erosion rate. In this study, environmental effects of dams and related effects of sediment transport on coastal erosion in the Eastern Black Sea region are discussed.

KEY WORDS: Black Sea, Coruh River, Sediment Load, Dams, Coastal Erosion.

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Rieky v juhovýchodnej časti regiónu Čierneho mora sú prehradené priehradami, ktoré slúžia na výrobu elektrickej energie a na závlahy. Prirodzený transport plavenín a splavenín sa v dôsledku výstavby plánovaných a realizovaných priehrad takmer úplne zmenil. Znížený objem sedimentov dopravovaných do mora spôsobuje intenzifikáciu erózie brehov riek. Rieky ústiace do Čierneho mora v oblasti pobrežia Turecka a Gruzínska sú výrazne ovplyvnené ľudskou činnosťou, ako je ťažba materiálu z riek a eróziou brehov. V tejto práci sa analyzuje vplyv priehrad na životné prostredie krajiny vo východnej časti Čierneho mora.

KĽÚČOVÉ SLOVÁ: Čierne more, rieka Coruh, sedimenty, erózia pobrežia.

Introduction

Generally speaking, river load is the least studied hydrological element. This is largely because of the complex nature of its formation and the difficulties involved in measuring it. The movement and transport of load occur discretely, only in particular hydraulic conditions.

Further, the ways solid substances are transported constantly vary throughout the whole length of all the rivers, from source to mouth, and the processes of erosion and accretion occur everywhere. Active accumulation of alluvial material commences with a fall in the river's carrying capacity, near the mouth and in the shore zone, but the main mass of the load still accumulates in the seas and oceans where it plays a role in the process of contemporary sedimentation. The seacoasts protection measures don't depend on standard solutions. Each part of the shore should be considered with its hydrodynamic, lithodynamic, geological, geomorphological and other peculiarities and must be thoroughly studied for each particular situation. Complex scientific approaches are necessary for local features and for the reaction of whole lithodynamic system within limits of the planned coast protective activity, bearing in mind the calculated hydrodynamic parameters (waves, sea level, etc) (*Sui* et al., 2009; *Ran* et al., 2008). Modern coastline systems in the eastern Black Sea are increasingly impacted by anthropogenic interference in the natural dynamics. One result in the coastal zone is serious depletion of beach-forming sediment, with the shore eroded and in retreat. Dikes, breakwaters, buttressing walls, blocks and tetrapods, which have long been deployed to reinforce the coastline, not only disrupt sediment transportation behavior but also cause severe bottom abrasion and erosion. In addition to producing clean power, reservoirs at hydropower projects have a large recreational value. Environmental impacts associated with large dams are well documented, and recently there has been an increased emphasis on the social and economic effects of these impacts. These impacts vary in extent and gravity, but it should be stressed that the impacts of large dams are often basin-wide. The Black Sea Rivers of Turkey are under heavy anthropogenic pressure. Dozens of large and small dams and reservoirs have been constructed along them. Their flow is controlled and the waters are used in hydroelectricity schemes, for industrial and other needs and for improvement and reclamation. The natural course of fluvial alluvium transport is therefore completely altered. Studies are further complicated by the paucity and inaccessibility of data. Of the total amount of alluvium a certain proportion undoubtedly remains in the coastal zone and forms littoral marine deposits. Approximate calculations suggest that at present around 2–3 million m^3 of river load is involved in shore formation within Turkish borders. Marine sediments make up 5.6 million m^3 (*Algan* et al., 2000; *Hay*, 1994; *Milliman*, 1981; *Milliman*, 1983) (Tab. 1).

T a b l e 1. River loads: rivers of the southern littoral, Turkey (*Jaoshvili*, 2002).

River basins	Sediment load		
	[x10^3 t/year]	[x10^3 t/year]	[m^3/km^2year]
From Chorokhi to Harsit		(750)	(80)
Harşit		(300)	(85)
From Harsit to Yesilırmak		(850)	(75)
Yesilırmak	330 / 12500*	195 / 7350*	— / 205*
From Yesilırmak to Kızılırmak		(175)	(70)
Kızılırmak	440 / 16700*	260 / 9800*	125* / —
From Kızılırmak to Filyos		(600)	(60)
Filyos (Yenice)	3700	2170	170
From Filyos to Sakarya		(220)	(60)
Sakarya	3800 / 4600*	2230 / 2700*	— / 50*
From Sakarya to Rezovska		(250)	(50)
*Before control			

Coruh multiple dams project consists of 27 planned dams and hydro electric power plants (Fig. 1). Because of favorable topographical conditions, Coruh project has the potential to provide some 13% of the usable hydroelectric power in the country, which to date, remains largely untapped. Besides numerous expected benefits from these projects, also a multitude of substantial social, economical and environmental impact potentials exist. Research, development, education, and streamlined regulation are important. Coruh River is located in northeast Turkey and is shared by just two countries, Turkey and Georgia. Approximately 91% of the basin's drainage area (21100 km^2) is in Turkey while Georgia's share amounts to 9% only. Coruh River originates in the western part of the Mescit mountains at a height of over 3000m and lies to the northwest of the Erzurum-Kars Plateau. It leaves Turkish territory near the village of Muratli. Near Batumi, the capital city of the Georgian semiautonomous province Ajaria, the river empties into the Black Sea through a delta which is largely composed of the accumulated alluvium because of climatic conditions. The principal tributaries of the Coruh River are Tortum and Oltu rivers in Turkey, and Adzharis and Tsakali rivers in Georgia. In total, Coruh River is 426 km long and 400 km of which lies within Turkey's borders. It also forms a short border (3 km) between Turkey and Georgia. Finally, the river flows for 24 km through Georgia. Coruh River carries plenty of water in all seasons albeit with remarkable seasonal variations (*Milliman* and *Syvitski*, 1992). According to the long-term observations measured at the flow monitoring station in Muratli, the average flow rate is 202 $m^3 s^{-1}$. The highest run-off measured at this station was 2431 m^3 s^{-1} and the lowest 37.6 m^3 s^{-1}. In total, according to Turkish long-term observations, annual flow rates of the Coruh River ranges from 3.3 BCM/year (1955) to 11.2 BCM/year (1968). The median annual flow rate determined through ~70 years measurements is 6.3 BCM/year, which corresponds to the 3.4% of the total water potential in Turkey. Apart from the comparatively high and variable flow rates, the river carries high levels of sediment and deposits (estimated at 5 MCM/year) which stem from erosion in the Turkish mountain regions. Despite the rather small drainage basin area, Coruh River has high hydropower production potential due to the topographic conditions and in particular, the sharp fall of the river from high mountains to sea level. In contrast to reliable monitoring of the river's flow, accurate and dependable water quality data are lacking and are not easily accessible. Pollution of the river is relatively small. At present, urban waste water and solid wastes are the sources of pollution because of the insufficient wastewater treatment and disposal facilities. Limited to specific sites, industrial pollution plays a certain role (e.g. copper mining discharge). In contrast, pollution from agriculture is of minor importance because of the little farming.

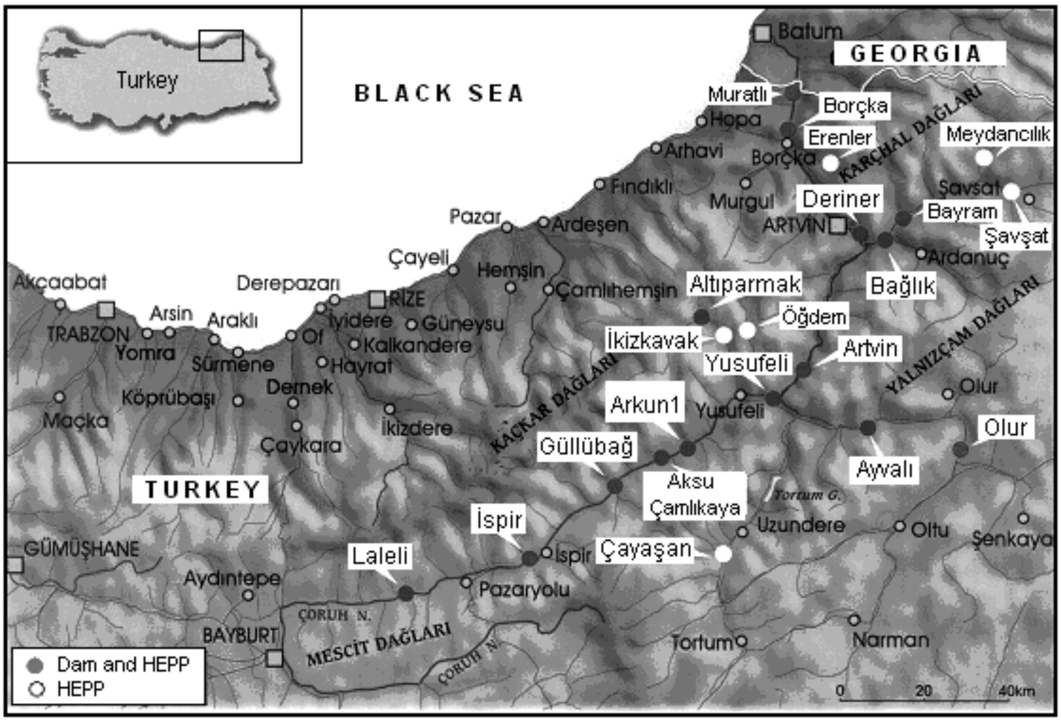

Fig. 1. Dams and Hepp's in Coruh River basin project.

Today, the most important pressures on freshwater ecosystems come from the development of hydropower generation installations. According to the Coruh Basin Development Plan, five large dams are to be built on the main branch of the river (Fig. 2). These dams include the Deriner Dam and hydroelectric power plant (HEPP) with 670 MW, the Yusufeli Dam and HEPP with 540 MW, the Artvin Dam and HEPP with 332 MW, the Borcka Dam and HEPP with 300 MW, and finally the Muratli Dam with 115 MW installed capacities. Deriner and Yusufeli Dams rank among the most important dams in Turkey in terms of size and hydropower potential. The Turkish authorities consider the Coruh Basin Development Plan and associated dam constructions as vehicles to support economic development in northeastern Turkey. Although the programme predominantly focuses on the hydropower generation and supply of electricity, an irrigation component also runs in parallel. With the construction of the dam cascade, 30000 ha of land are planned for irrigation, mainly along the upper and middle streams of the river. This rather modest objective for agricultural development is due to the basin's topographical limits. A full realization of the planned development of irrigation could however significantly increase agricultural water use and change settlement patterns in the area. Georgia does not use water from Coruh River for its domestic water supply, industrial demands, and agricultural irrigation does not play any significant role, but fishing has importance.

Even though Turkish coastline is intersected with a multiplicity of rivers with a substantial volume of discharge, the coast has not acquired an alluvial relief and there is no extensive alongshore drift (Fig. 3). In general, the Turkish coasts of the Black Sea run straight, for most of their length, have no deep bights into the landmass and are not protected from northerly or northwesterly storms. Like all other Black Sea coastlines, these southern ones are subject to erosion and retreat, leading to a proliferation in massive stone coast reinforcement installations along almost the whole length of the Turkish coastline. At the present time, more than 17 million m^3 of sediment is captured in reservoirs in the major rivers of the Turkish Black Sea basin. Under natural conditions the sediment load reaching the Black Sea from rivers in Turkey would be a minimum of 25–26 million m^3.

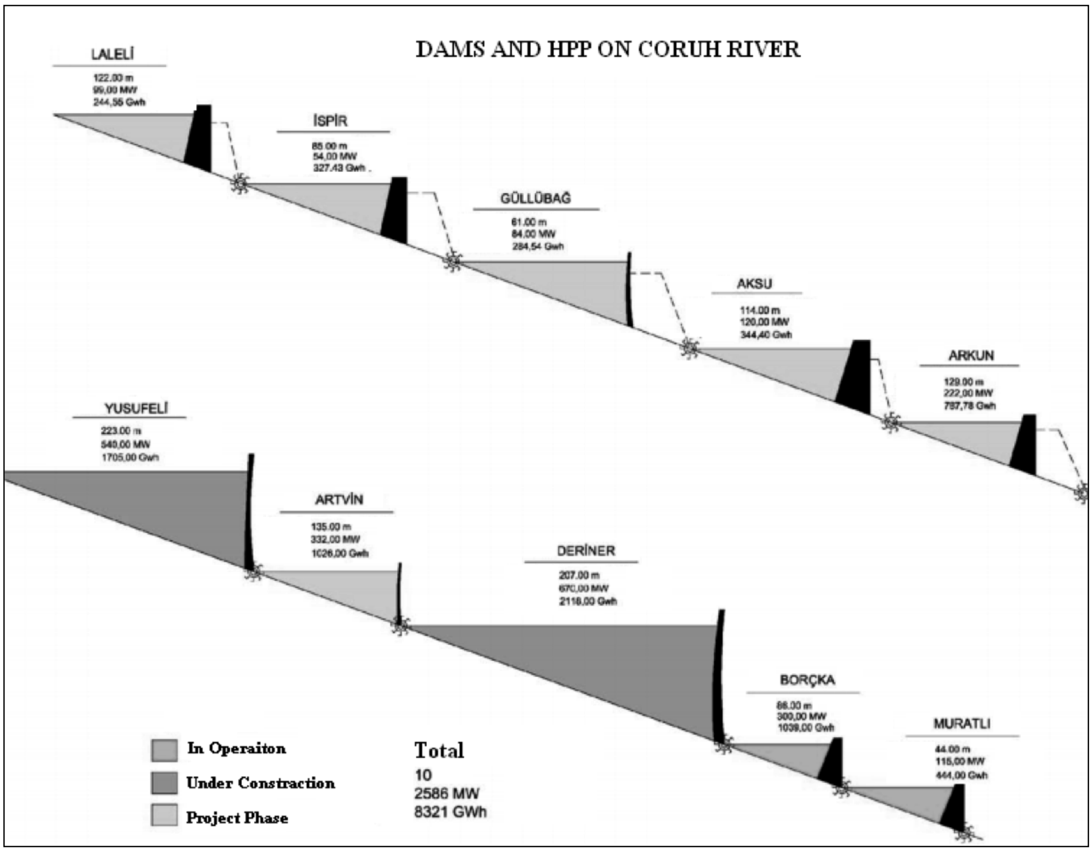

Fig. 2. Longitudal profile of the Coruh River development plan.

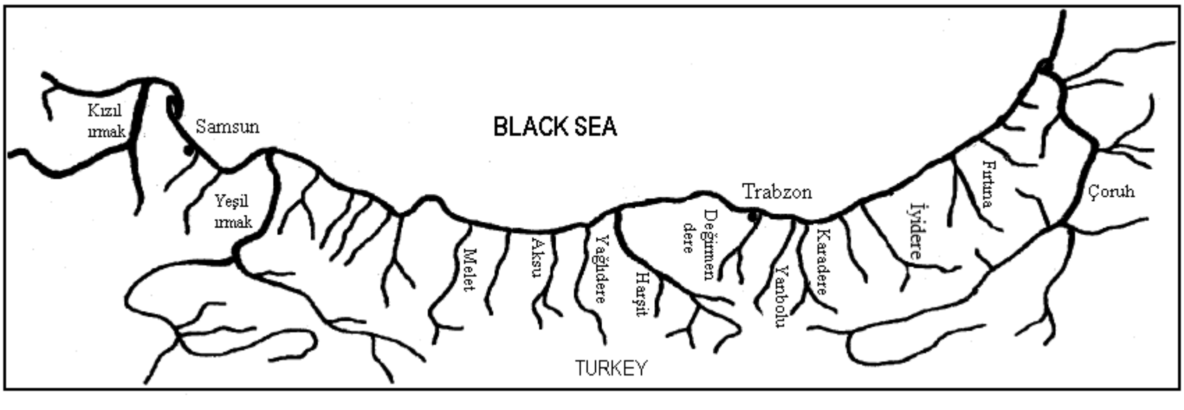

Fig. 3. Rivers of the eastern part of the Turkish coastline.

The formation and dynamics of estuaries and shores along the Georgian coastline of the Black Sea are dominated by river factors as the bulk of bank-forming sediments which are brought down by the rivers during the spring, with high water levels, when there is no storm activity (Fig. 4). Submarine canyons receive abundant discharge from the associated eastern Black Sea rivers. There is a concentration of them, either as groups or as a series of isolated canyons, between the estuaries of the Mzymta and the Coruh. The crests of most of these canyons lie at depths of 15–25 m. Several of them cut into the coastal zone, where they begin to slope steeply at 6–10 m. The crests of all the canyons lie in a Holocene unit and in contemporary silt, sand and pebble deposits. Offshore, the canyons run out to depths of more than 1000 m. While it is difficult to be specific about the genesis of these submarine canyons, their origin and contemporary dynamics are undoubtedly dependent on a multiplicity of fluvial processes. They exert an effective braking action on the deposition of coastal sediment by swallowing up part of the river discharge. Their effect is cyclical and depends on storms over the sea and the amount of fluvial discharge penetrating offshore. When there is a superfluity of river discharge and insignificant transportation along the coastline, river load is lost in the canyons. In counterpoint to this, when river discharge is low and alongshore drift is particularly active, canyon processes have no impact (*Jaoshvili*, 2002).

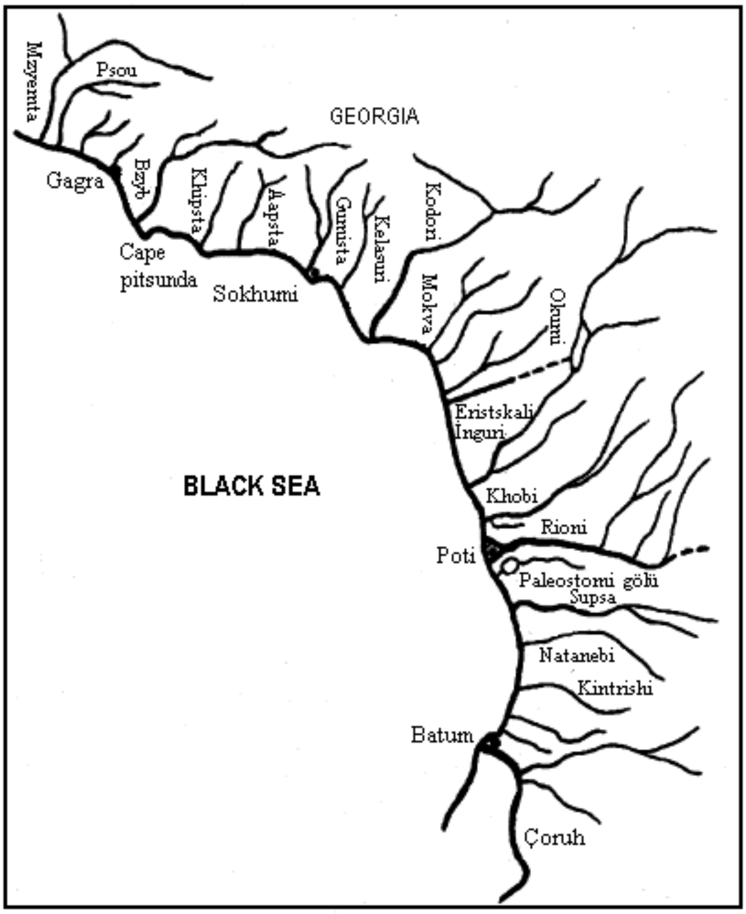

Fig. 4. Rivers of the Georgian coastline (*Jaoshvili*, 2002).

River sediment loads and coastal erosion

The Black Sea coastline of Georgia is one of the few places where the relationship between river discharges, the shore zone and contemporary marine deposition exist. Determining factor in shaping the coastal zone and submarine slope of the eastern shores of the Black Sea is the abundance of alluvial material. The presence of rivers discharging large amounts of coarse sediment into the sea produces a qualitative shift in the morphology of the coastline. Alluvial and deltaic plains, fluvial terracing, flooded deltas, alongshore drift and the whole interrelated system of formation associated with river load all these factors indicate that the most important feature of coastal zone development in the eastern part of the Black Sea is deposition of the river load. This process is long-established and the shore is built out so much that the shelf overlaps it (Tab. 2).

T a b l e 2. River load distribution of the Black Sea Region (*Jaoshvili*, 2002).

Region	Current river load volume [x10^6 m^3]			River load volume before flow control [x10^6 m^3]
	Total	Shoreline	Marine	
Northeastern part	0.93	0.32	0.61	1.00
Eastern part	11.1	4.30	6.80	14.5
Southern part	8.00	2.50	5.50	25.5
Western part	0.45	0.10	0.35	0.85
Danube	30.0	3.00	27.0	50.0
Northwestern part	1.66	1.50	0.16	3.00
Crimea	0.075	0.025	0.050	0.09
Total	52.2	11.7	40.5	94.0

Despite the significance, the sediment load of the Black Sea basin has not been researched in all regions to the same level. The influence of fluvial, estuarine and marine factors as well as the specific geographical factors of the coastal zone should be taken into consideration, since the inflow of load to the sea is a complex and diverse process. In modern conditions, anthropogenic factors must also be included. Only such a multilateral approach can produce results which reflect the actual situation as closely as possible. Investigations indicate that about 83% of the total suspended sediment (sand and other alluvial materials) carried by Coruh River to its mouth which constitute the characteristics of the river and shape the coastal region (6.22 million ton/year) will be trapped by the Coruh River cascade. The coastline around Batumi is strongly characterized by these alluvial materials whereby the river flow deposits sand, stone, and debris at the river mouth and the nearby coastal streches, which then counteract the erosive action of the sea. Consequently, the most serious of the anticipated effects of the dams upstream in Turkey could possibly be increased coastal erosion that might not only threaten ecosystems and beaches in the vicinity of the river's delta but also fisheries, and urban areas in the agglomeration of Batumi. Clearly, it is not only the river Coruh that is posing problems for the coastal protection in the region of Batumi, dams built on the Georgian rivers Enguri and Rioni have had the same effect in allowing erosion by the Black Sea to outpace the natural replenishment provided by the rivers (*Kibaroglu* et al., 2005). The fact that the dams will change the sediment flow of the Coruh River in one or another way is largely acknowledged by both Turkey and Georgia, however the expected and precise impact on the Georgian coast line and the possible acceleration of erosion in the Batumi region. In general, it is not easy to foresee the direct effects of the planned Turkish infrastructure because coastal erosion is a multifaced problem with a variety of causes and effects generated by a variety of human interventions. Thus, even within Georgia there is enormous variation in expense estimates required for additional coastal protection.

The amount of river load increases markedly in the eastern part of the sea, in Georgia. The overall amount is over 11.1 million m^3 and of this 4.3 million m^3 remains in the coastal zone and 6.8 million m^3 is carried out to the open sea. In this region the particle size is typically larger than in river sediments in Russia. In Abkhazia and Adjara, fluvial detrital material is of larger particle size than in other regions round the sea. Of the total amount, over 90 % of the load discharged into the sea comes from the larger rivers, the Bzyb, Kodori, Inguri, Rioni and Coruh (Tab. 3). Along the Georgian coast large river loads contribute to eight independent alongshore drifts which move towards the centre of Colchis where the Rioni delta spreads out. At maximum spring high water levels, the fine dispersion component of the suspended load in the rivers is here dispersed over large areas. The suspended matter may be carried as much as 15–20 km from the shore. In the area where the Coruh has a direct impact, where load concentrations in the surface layer of the sea can be as much as 1000–2000 g/m^3, sediment can be transported further north, for almost 50–60 km. Suspended loads from Abkhazian rivers travel south; here the turbidity is 100–300 g m^{-3} (Bzyb) and 300–500 g m^{-3} (Kodori). In Colchis (where the Rioni flows into the sea) turbidity varies between 1000 g m^{-3} and 1500 g m^{-3}. A major counterbalance to this, in the Georgian sector of the sea, are the submarine canyons along which around 2 million m^3 large particle size loads are carried to great depths. The greatest amount of beach-forming sediment is swallowed up by the Chorokhi canyon, and under natural conditions losses could be as much as 1.8 million m^3 a year, while 0.1 million m^3 is lost to the Kodori canyon. Smaller amounts disappear into the Bzyb, Rioni and Supsa canyons. In addition to these estuarine canyons, loads also disappear into lateral canyons. Landslips have several times been observed in Batumi Canyon, when an excess of river load accumulating near the mole in Batumi port has slipped into the canyon at the slightest push. The volume of a single loss may be in excess of 50000 m^3. Shore sediments are lost in the submarine canyons of the Pitsundi and on the steep slopes of the headland itself. It must be remembered that canyon activity is cyclical in nature. Where there is excess of river alluvium and weak alongshore drift the canyons capture part of the beach forming material. When the reverse holds, when the amount of alluvium is reduced and alongshore drift is more active, the canyons play a lesser role.

T a b l e 3. River Loads: rivers of the eastern littoral Georgia (*Jaoshvili*, 2002).

River		River Discharge		Coastal deposits	Marine deposits
	[x10^3 t/year]	[x10^{3}m^3/year]	[m^3/km^{2}year]	[x10^3 m^3/year]	[x10^3 m^3/year]
Psou	158	90.8	215	38.0	52.8
Khashupse	80.5	46.0	230	23.8	22.2
Zhove-Kvara	53.7	30.7	426	15.3	15.4
Bzyb	767	445	295	133	312
Mchishta	20.2	11.7	69.2	2.2	9.5
Khipsta	34.4	19.7	119	11.0	8.7
Aapsta	37.7	21.6	88.8	9.5	12.1
Gumista	264	153	265	46.0	107
Besleti	12.0	6.85	84.0	2.5	4.35
Kelasuri	84.2	48.5	220	27.4	21.1
Madzharka	15.9	9.05	79.3	5.0	4.05
Kodori	1295	754	371	362	392
Tumush	3.35	1.9	30.5	0.85	1.05
Dgamysh	9.0	5.1	42.5	1.85	3.25
Mokva	46.8	27.5	81.9	8.3	19.2
Galidzga	94.7	54.6	113	21.6	33.0
Okumi	34.5	19.7	74.5	7.2	12.5
Khobi	221	130	97.0	40.0	90.0
Rioni-north	3390	1990	264	610	1380
Rioni-south	2630	1550	–	450	1100
Supsa	246	143	126	46.0	97.0
Natanebi	146	84.9	129	36.2	48.7
Kintrishi	22.3	12.6	43.2	6.9	5.7
Chakvistskali	19.0	10.6	61.4	8.5	2.1
Chorokhi	8440	4920	222	2310	2610

*Before control

In Georgia, due to the way river load is regulated by reservoirs and other industrial installations, the natural dynamic of the river load is severely disrupted. Control of river flow was begun some time ago, in the 1930's. Use of river water for irrigation and utilization of river load has been going on for centuries. Hydroelectric power stations have been built on the banks of the Rioni and its tributaries (Rioni, Gumati, Ladzhanuri, Vartsikhe). While the Rioni, Ladzhanuri and Vartsikhe power stations have had little impact on the flow of river load, the construction of the Gumati power station has had some considerable effect on the Rioni. Since 1958 river load has almost halved. Extraction of sediment and exploitation of river bed quarries for sand (up to 15 % of the load) has also led to loss of river sediment in the estuary. With the filling up of the Gumatskoe reservoir with alluvium, in the 1980's, river load reached previous levels (before the river was controlled). Since the beginning of the 1990's there has been a trend in the Rioni for a decrease in the amount of river load, probably due to cyclical fluctuation. With the construction of the arch-shaped dam for the hydroelectric station on the Inguri, the volume of river load at the estuary has decreased by 83 %. The construction of the Sokhumi power station has also had a negative impact on the load in the Gumista. Even though the upper reaches are scoured, 51900 m^3 alluvium was accumulated in the reservoir at East Gumista between 1948 and 1964, and the river load at the mouth was reduced by 20–25 %. At present, in the river Gumista, there has been almost total regeneration of the amount of river discharge and its natural dynamic. In addition to these rivers, there has also been some regulation of flow in the Adzharistskali, Abasha, Bzhuzha (tributary of the Natanebi) and Zheobse (tributary of the Khashupse).

The exploitation of river bed quarries for inert materials and direct extraction of sediment from river beds have had an enormously negative impact and deleterious effect on the natural dynamic of river loads and these practices still continue. One inert materials plant, 7 km from the mouth of the Coruh, has been operating since 1972 and has extracted 600000 m^3 of large particle alluvium from the river bed. Near the village Sadzhevakho, 50 km from the mouth of the Rioni, up to 0.5 million m^3 sand and gravel have been extracted each year. Extraction from the Kodori has reached 0.15 million m^3. Small amounts of alluvium have been extracted almost everywhere. This has had a particularly deleterious effect on small rivers where occasional, one-off extraction has sometimes exceeded the annual volume of sediment load, and this has of course severely affected the dynamic of the river course. At the beginning of the 1990's, with the collapse of the Soviet Union and the economy, extraction volumes fell sharply. By the end of the century however, volumes began to rise again. In 1997–98, for example, 40000 m^3 of alluvium were removed from the Supsa for the construction of an oil terminal. In the near future major changes can be expected at the mouth of the Coruh and along the coastal zone of Ajaria, due to flow control measures in Turkey. For almost 10 years now there has been a steady trend towards a reduction in the quantity and particle size of the sediment. Once construction is complete, the flow of river load will virtually come to an end. The sediment loads of the Machakhela and Adzharistskali are insignificant (the volume of large shore deposits is less than 80000 m^3 from both rivers); these rivers are now filling up the troughs left by river bed quarrying and hardly reach the sea any more. All these factors intensify the existing erosion rate. If appropriate measures are not taken, waves will soon wash away the heavily populated area between the mouth of the Coruh and Batumi.

Discussion

There is no comprehensive bilateral agreement on the management of the Coruh River between Turkey and Georgia. Although there is still no adequate legal or organizational approach to water management in place, water cooperation over the Coruh River benefits from generally good political relations between the sole riparians Georgia and Turkey.

Turkey and Georgia should be assisted in carrying out a state-of-the-art environmental impact assessments for the planned dam cascade on the Coruh River. In this context, besides the sediment question, upstream effects have to be addressed and carefully studied. The ecological state of the Coruh River and the related coastal ecosystems should be subject to supplementary scientific studies and analyses. Based on careful assessment of the sediment management issues, various technical cooperation measures could be designed and implemented in order to reduce negative downstream and upstream effects. However, the planned dams could also cause serious environmental damage in upstream Turkey and downstream Georgia, in particular on the Black Sea coast in the Adjaria province. Although a debatable EIA report was prepared for the Yusufeli dam, cumulative environmental effects of the Coruh multiple dam project have not been investigated.

EIA reports and related research indicate that the construction of Yusufeli Dam which is the second biggest dam of the Coruh multiple dams project will cause important effects on the ecological balance in the whole Coruh River basin. In Turkey EIA reports, their preparation and application rules and procedures have weak sides. The cumulative impacts of the projects on the aquatic and terrestrial ecosystem should be taken into account using basin approach having interaction of the various effects. Dams and hydroelectric power plants are part of bigger schemes of hydropower projects and irrigation cannot be separated from the whole picture. Three things are needed to keep hydropower among valued energy sources. These are research and development, education, and streamlined regulation. Although there is an officially prepared EIA report about the Yusufeli dam project, extensive analysis of the biological impacts is lacking. EIA reports prepared by some unofficial organizations point out some important potential effects on the existing rare endemic flora, fauna and on the cultural heritage in the Coruh River' basin environment. Although estimated construction, resettlement and flooded roads rebuilding costs are given in the officially prepared EIA report, an extensive cost analysis between the dam construction costs and impact related costs does not exist. Sufficiency of the EIA report on the impacts on cultural heritage and the suitability of the applications of the mandatory policies which have been in place since the early to late 1980's environmental assessment; natural habitats; cultural property; involuntary resettlement; indigenous peoples; forestry; pesticides; safety of dams; projects in international waterways; projects in disputed areas fort this river basin seem as important controversial topics (*ENCON*, 2006; *Berkun*, 2010a; *Berkun* 2010b).

Trapping of %83 of the suspended sediments in Coruh Cascade might create changes in the River mouth. Presently the mouth is moderately delta shaped. The trapping of sediments in reservoirs is known to have the potential to cause significant effects on river deltas, especially when the dam is the first on that river. With reduced sediments arriving gradually the mouth of the Coruh may morphologically transform towards an estuary shape. However, the formation of morphodynamic processes and their dynamic interactions and consequences are very difficult to predict. In order to approach this issue since 1996, Turkey and Georgia have agreed on and implemented survey and monitoring work on the Coruh River including the Georgion river section, the Coruh mouth and the Black Sea coastline up to Batumi in order to establish a status quo documentation, and to further monitor changes which may occur after implementation of the dams on the Turkish side. With respect to possible relevance of potential impacts on sensitive areas, regarding the actual status of the reach towards the delta, no protected areas have been established in the lower reach of Coruh. There are studies of the Georgian Authorities with regard to Coruh delta to put the area under protection as a nature conservation area. It should be noted that there are already major structures in the vicinity of the Coruh Delta, such as the Batumi airport to the east of the river mouth.

Conclusions

Eastern Black Sea coast has suffered significantly because of the use of beach deposits as construction material for cities, summer resorts, and roads**.** These resulted in very extensive narrowing of the beaches and in some cases, complete loss of the beaches. The situation has became even worse as rivers were dammed for hydroelectric power and irrigation of arable land, thereby abruptly decreasing the volume of sediment carried to the sea, and the subsequent intensification of shore erosion. Flow control measures on Coruh River will improve the development of the Turkish part of the region by enhancing the living conditions, mobilizing regional resources, increasing productivity and creating employment opportunities for the local people, but they also carry potential to radically change the social structure, traditional productivity and urbanization patterns. The conflict surrounding the Coruh River is mainly about the sediment. Dams on the Coruh River are expected to seriously affect the sediment regime of the river and as a result, increase erosion in the Georgian coastline. Large quantities of land derived materials reaching southeastern Black Sea are delivered by Coruh River as sediment load. Once dam constructions on this river are complete, sediment load will virtually come to an end. All these factors intensify the existing environmental, social and economical effects and the coastal erosion rate of the region. In the near future, major changes can be expected at the mouth of the Coruh River and along the coastal zone of Ajaria, the heavily populated coastal area between the mouth of the Coruh River and Batumi in Georgia. For this region, a precise assessment of the economic, ecological, social and coastal problems is needed on the basis of environmental impact and cumulative effect reports.

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