Assessment of Sediment Transport in the Devolli River

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ABSTRACT

Devolli river is one of the biggest rivers of Albania which is characterized by large stream flow but also during the full stream flow it bring a lot of sediments and this paper consists precisely to calculation rough of sediments transport of this river.It is important to recognize that present conditions in the Devoll valley are not necessarily the original natural conditions. Deforestation has been reported to be a major problem in Albania (e.g. and based on personal communication with stakeholders in the Prespa and Skadar regions, cf. The erosion wounds may be caused by years of cutting down trees for firewood. If so, then hydropower development may assist in reducing the present high erosion rates in this country by reducing the pressure on trees for firewood, although long time is probably needed before stable hill slopes can be established. However, there may also be other reasons for loss of vegetation that hydropower will probably not assist in reducing: Shuka et al. (2008) referred to degradation of original vegetation cover in the Albanian parts of the catchment area of Lake Prespa, and suggested that the main causes were traditional farming of livestock, uncontrolled grazing and fires. Clearly, the variations are very high. Variations are higher after May 1st than before this date; this may be due to the steady high water discharges in the beginning of the year, which will give less variation in loads (cf lower panel). It should be noted that a single high concentration will have a major impact on the calculated total load transport, especially if the water discharge is also high at the same time.

INTRODUCTION

The area is characterised by active erosion processes. In some areas entire mountain sides have been eroded away, and the remaining slopes are steep, instable and will most likely continue to produce eroded soil material regardless of any attempts to revegetate. In fact, revegetation may in many places be fruitless since the underlying rock is expected to weather before the vegetation becomes mature. At some other sites, however, revegetation may have an effect, but this will most probably only give local benefits and not abate the presently enormous sediment-generation processes of this valley.The result of this erosion is rivers with high sediment yields. Devoll River has in fact been referred to as the most turbid river draining to the Mediterranean Sea. Consequently, the river valleys are filled with alluvial sediments, and the rivers often follow a so-called braided river system Such braided river systems are usually found in mountain areas or in the front of glaciers, where gravel and sand material is transported from steeper hills into areas of lower topography. In the broader valleys of the Devoll River, wide reaches of such sediment plains have been filled up through the years.

METHODOLOGY AND DATA USED

Table 4.2-1 gives an overview of the sediment and water discharge data used in this part of the study. Shows the locations of the hydrological and water sampling stations.

Table 4.2-1 Characteristics of stations with suspended sediment data.

Sediment station	Period of operation	Discharge station used	Q	Prec.	Catchment area
	Years**		m^3/s	mm	km^2
Kozare	1955-85***	Kozare	47.3	1059	3122
Kokel	1965-96	Kokël	27.1	907	1884
Gjinkas	1973-95	Gjinkas	12.4		1355
Shequeras	1974-90	Gjinkas*	4.9	806	431

*scaled according to the discharge area with a ratio of 431/1355
**Years with sampling every day
*** Water discharge data only until 1983.

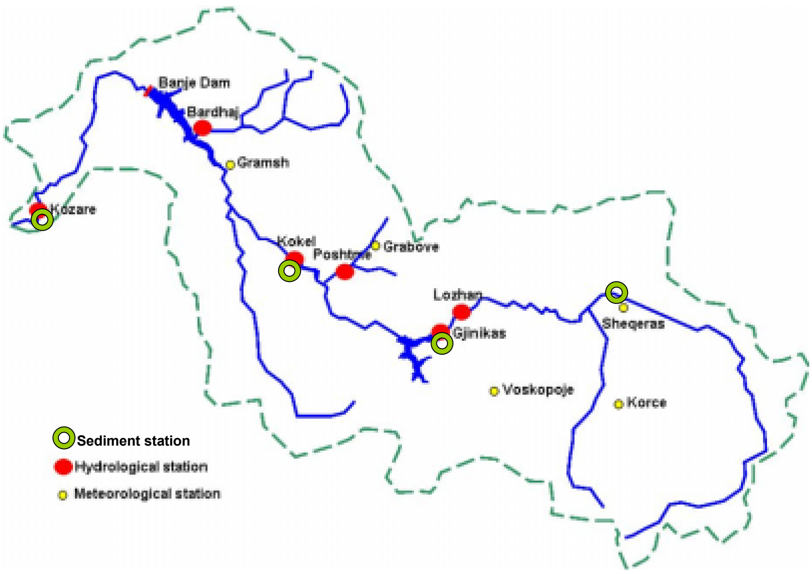

Figure 4.2-1. Map of River Devoll with stations for hydrology and meteorology and water sampling for suspended sediment analyses (labelled "sediment station").

Kozare will to some extent give information on the load at Banja, since no major tributaries are entering between Banja and Kozare. The station at Kokel is at the bridge where the hydrological station is, (and close to where the Kokel dam site is planned). This station therefore gives information on the sediment load going into this reservoir. The station at Gjinkas gives information on material entering the uppermost dam, although only from the Devoll branch, and not from the Malsise tributary. Shequeras is situated where the river leaves the Korce plateau and enters the Devoll valley.

In addition to the historical data, the study team sampled 13 bottles of water during a field trip in October 2009, these were analysed for sediment concentration and grain size at NTNU, Trondheim, Norway.

Table 4.3-1: Suspended sediment concentrations of samples collected in 2009

o	Site, description	d ate	ti me	m g/l
	Verces, downstream bridge (just after rainfall)	0 3.10	0 9:45	1 9607
	Devoll at Kokel. Upstream bridge at gauging station.	0 3.10	1 6:15	4 918
	Verces, same site as 1.	0 4.10	0 9:45	3 245
	Graboves before outlet in Devoll. East side.	0 4.10	1 0:30	9 06
	Tributary coming into Devoll from the south (40.938 on map); just downstream of Moglicë	0 4.10	1 1:45	2 71
	Devoll, just upstream of confluence with tributary where sample 5 was taken.	0 4.10	1 1:45	6 50
	Devoll, just downstream of road bridge leading towards southern branch of the coming Moglicë reservoir.	0 4.10	1 3:00	3 64
	Moglicë, just upstream of confluence with Devoll, Northern bank. Ca 50 m below HRV.	0 4.10	1 3:15	6 3
	Lozhan viewpoint. Tributary to Devoll coming in from the north.	0 4.10	1 4:00	4 4
0	Devoll just downstream of the Korche plain.	0 4.10	1 4:30	6 1
1	Tomorricë at bridge just upstream of confluence with Devoll	0 5.10	0 8:30	6 41
2	Tomorricë at the former proposed dam site	0 5.10	1 2:00	2 431
3	Graboves close to the proposed intake, at footbridge.	0 3.10	1 1:30	3 605

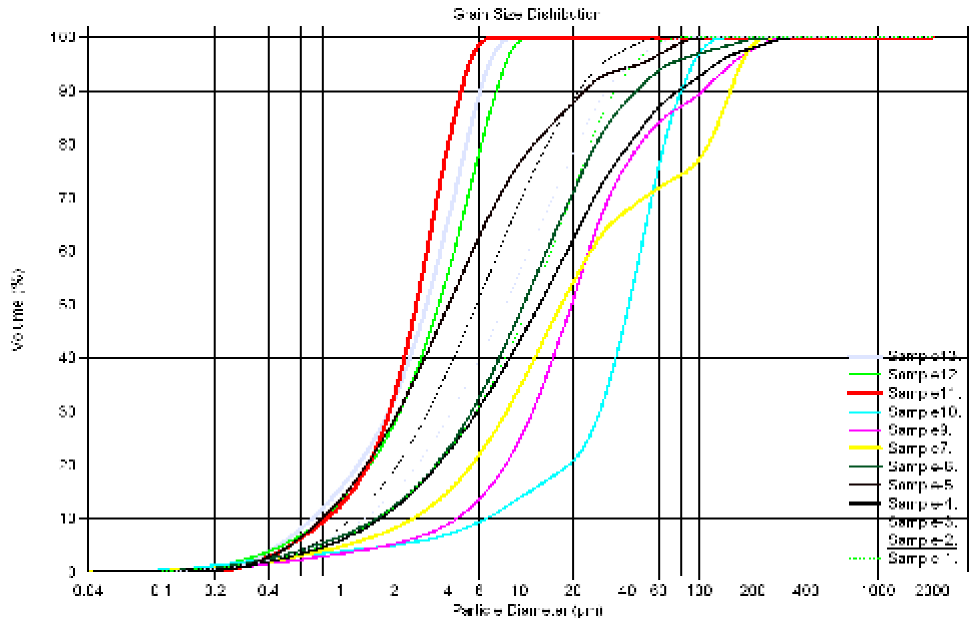

Figure 4.3-7 Grain size analyses of suspended sediments sampled in 2009. Sample numbers refer to Table 4.3-1.

Suspended Sediment Load

The pattern is characterised by rapidly increasing and decreasing loads. In the summertime, loads are in general low, with higher loads in the autumn and winter. Highest average loads were found in the period October – January. The lower panel of the same figure shows maximum loads pr day. The pattern during the year is more or less the same as for average concentrations. As much as 7000 kg/s can be transported in extreme events at the Kokel station.

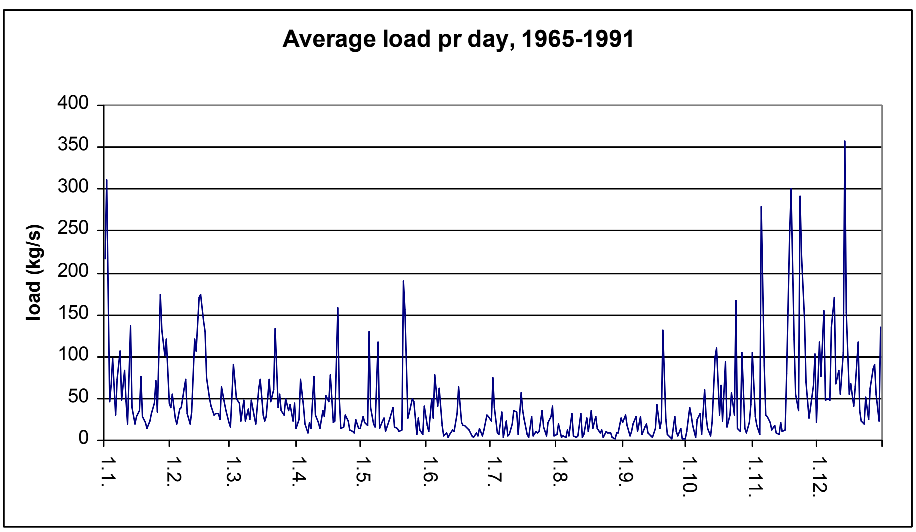

Table 4.3-2 Total annual water discharge (10^6 m^3/yr) and load (tonnes/yr) for four sediment stations.

	Kozare*		Kokel		Gjinkas		Shequeras	
	Q	Load	Q	Load	Q	Load	Q	Load
	10^6 m^3/yr	ton/yr	10^6 m^3/yr	ton/yr	10^6 m^3/yr	ton/yr	10^6 m^3/yr	ton/yr
1955	1565	3 106 244						
1956	1931	4 751 637						
1957	1033							
1958	1929	15 992 974*						
1959	1723	8 269 697*						
1960	1880	6 971 950						
1961	947	1 863 384						
1962	1820	6 068 860						
1963	2878	9 559 793						
1964	1387	3 069 452						
1965	1735	2 691 468	790	1 469 162				
1966	1848	2 353 068	1172	4 678 534				
1967			965	2 910 883				
1968	1233		816	1 605 728				
1969	1896	2 981 718	958	1 779 785				
1970	2404	2 942 150	1067	1 367 789				
1971	1553	2 185 307	1046	2 096 397				
1972	1117	1 934 209	1292	2 489 851				
1973	1178	1 131 771	1018	1 490 302	529	678 094		

	Kozare*		Kokel		Gjinkas		Shequera s	
	Q	Loa d	Q	Lo ad	Q	L oad	Q	L oad
	10 ^{6} m^{3}/yr	ton/ yr	1 0^{6} m^{3}/yr	ton /yr	1 0^{6} m^{3}/yr	t on/yr	1 0^{6} m^{3}/yr	t on/yr
1 974	1 875	2 043 987	1 169	1 553 293	6 26	7 24 117	1 99 154	1 55 455
1 975	72 1	284 498	6 67	97 6 919	3 36	4 19 782	1 06 837	7 2 761
1 976	95 5	2 193 390	6 57	1 230 417	2 81	4 00 804	8 9 376	6 7 062
1 977	92 4	1 845 458	5 73	90 0 024	2 91	1 61 958	9 2 614	3 9 090
1 978	1 347	2 926 747	8 13	1 237 162	4 62	3 83 597		
1 979	1 814	4 828 150	1 087	2 509 670	5 95	7 28 255		
1 980	1 614	4 698 735	1 051	2 508 254	6 17	3 57 705	1 99	1 23 310
1 981	1 562	5 983 393	1 113	2 140 464	6 75	5 25 913	1 07	1 24 037
1 982	78 8	1 676 357	7 05	74 5 716	3 70	2 58 337	8 9	7 8 661
1 983	70 9	2 033 929	6 59	70 0 467	3 03	1 93 740	9 3	6 2 381
1 984			7 65	46 6 079	3 93	1 30 156		4 2 432
1 985			6 92	39 9 064	3 83	2 91 323		8 1 663
1 986			7 87	20 8 391	4 74	2 98 126	1 96	8 9 735
1 987			6 04	32 4 437	3 44	2 11 406	2 15	9 7 010
1 988			4 33	28 4 607	2 04	9 8 878	1 18	2 5 333
1 989			3 71	49 0 446	1 68	1 17 433	9 6	1 1 433
1 990			3 03	38 2 151				
1 991			8 71	1 052 239				
1 992			3 77					
1			4					

	Kozare*		Kokel		Gjinkas		Shequeras	
	Q	Load	Q	Load	Q	Load	Q	Load
	10^6 m^3/yr	ton/yr	10^6 m^3/yr	ton/yr	10^6 m^3/yr	ton/yr	10^6 m^3/yr	ton/yr
993			16					
1 994			4 05	88 385**				
1 995			6 39	82 6 959				
1 996			1 118					
Average	1 513	4 014 936	7 94	1 386 614	4 15	3 51 743	1 24	7 6 454

* In Kozare, sediment data seem to be interpolated on missing days, several consecutive days have the same, high concentrations. The calculated load in year 1958 should probably be disregarded, and the loads in the other years treated with care.

**Sediment data on 2 days are missing

Estimate of Loads from Unmonitored Tributaries

Estimating loads from unmonitored areas is subject to even higher uncertainties than those listed in the above section, but an attempt has been done based on area specific loads. In the 10-year period 1974-1983, complete data series existed for both suspended solids and water discharge for all four monitoring stations (Shequeras, Gjinkas, Kokel and Kozare). These data were used to calculate average load and average area specific load of each station in this period. Table 4.3-4 shows the result of this calculation.

Table 4.3-4 Average loads and average area specific loads for the period 1974-1983 For the four stations with suspended sediment measurements.

Period:	**1974-1983**	
Load:	**Average load (tons/yr)**	**Average area specific load (tons/km² and yr)**
Shequeras	90 344	210
Gjinkas	415 421	307
Kokel	1 450 239	770
Kozare	2 851 464	913

It was then assumed that the area specific load in each of the stations corresponded to the area specific load in the tributaries upstream of this station. Thus, the area draining to Devoll between Shequeras and Gjinkas was assumed to have a specific load equal to that at Gjinkas (307 tonnes/km^2), whereas the tributaries Malsise, Graboves and the smaller catchments draining to Devoll between Gjinkas and Kokel were assumed to have a specific load equal to that at Kokel (770 tonnes/km^2). Following the same assumptions, the tributaries Tomorrice, Verces and Holtet, and the smaller catchments draining to Devoll between Kokel and Kozare were given an area specific load equal to that at Kozare (913 tonnes/km^2).

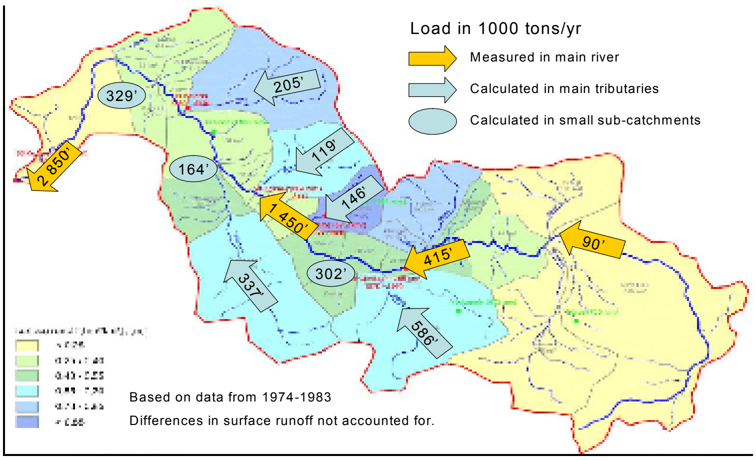

Figure 4.3-17. Map showing calculated and estimated annual sediment load based on data from 1974-1983 and area specific loads. The calculations are subject to uncertainty (cf. text).

CONCLUSION

The current erosion processes will probably not be much affected by the Devoll hydropower scheme, as the sediment generation is expected to continue in the steep hills. Possible erosion impacts from the hydropower scheme may be wave erosion of reservoir shorelines, and wind erosion of the reservoir beds during low water levels. Downstream of the dams the present sediment load will decrease due to sedimentation in the reservoirs. No estimates have yet been made for this decrease. The decreased sediment load to the coast (suspended and bed load) will probably have consequences for the beaches along Albania. The sedimentation of material in the reservoirs is expected to be significant. Preliminary estimates have been made for the lifespan of the large reservoirs at Moglicë Dam and Banja Dam as well as the need for sediment flushing of the Kokel reservoir. These estimates are based on the historical data and should be reviewed at a later stage based on future monitoring data from the proposed monitoring programme outlined and must also be related to the changes in sediment transport and accumulation patterns caused by the Devoll hydropower scheme.

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