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Environmental Impact Assessment of Sediment Removing in Sefidroud Dam in Iran

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ABSTRACT

Sefidroud River is one of the important rivers in the south of Caspian Sea, which has a favorite amount thirty percent of charge to the southern part the Caspian Sea. Not very long ago, the river was the main center for the migration and the breeding of the caviar fish (Acipen seridae). And since 1962 after building of the reservoir dam and other coffer dams, the migration and habitat of fish came under stress. Also accumulation of sediment has added to the already stressed environment. Since 1980 the chase operation by opening the dams gates every year and about 40 million ton of accumulated sediments in dam gates every year and about 40 million ton of accumulated sediments in Dam Lake is conduct to the river and increases the total solid sediment (TSS) of the river. This would kill about 1 million fish, and change the phenomena of the ecological river. To assess the effects of sediment load and its indirect effects on environmental factors and biota, 6 stations were selected and sampling was conducted at 9 times in four seasons. In vitro experiment has shown that up to 900,000 mg/lit TSS in the environment can be tolerated by fish as amount of TSS increase and the fish tolerance decreases. Experiment has shown that the tolerance time only about one hour. Taken all this consideration it is recommended that forest should be protect , and by this , erosion of soil reduced and the TSS effect would not be so dramatic , the other recommendation is , to have sediment pool which is located before the dam and should be emptied continuously, and for solve this problem suggested several alternative.

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INTRODUCTION

Sefidroud River is one of the most important rivers in the south of Caspian Sea. The river supply 30 percent of total water in the south of Caspian Sea. The river situated in the north of Guilan province in Iran (Figure -1). The Sefidroud River average discharge is about 4.5 billion cubic meters per years and is one of the main agricultural water resources in Guilan province. Sefidroud Dam constructed in the year of 1962 with 110 years useful long on the river (Figure -2). After passing 17 years about 40 percent of the dam storage fills by sediment and reduce the water storage volume. Therefore from the year of 1980 with Chasse Operation by opening the bottom outlet the sediment on the back of the dam evacuate perfectly with hydraulic method named as flushing method to the river downstream (Figure -3). In this operation about 24 million ton sediment remove from the dam.

After successful experience of flushing methods in removing the sediment from the dam's storage the method performed every year till the year of 1990 and after that frequently. Today because constructed the others dams in the way of Sefidroud branches the river's water discharge decreased. Due to supply water demand of 180000 ha of agricultural farm in the area recovering the useful dam capacity is important. But flushing methods is challenging with negative long term and short term environmental impacts too like the death of thousands of fishes and aqua life and also altering the bed and delta of the river.

Physiographic and hydrology conditions:

Sefidroud basin with about 56000 km² area situate in Kordestan, Azarbajejan Gharbi, Azarbajejan sharghi, Zanjan, Tehran, Qazvin, Hamedan and Guilan (Figure -4).

The basin consists of two sub basins: Qazel ozan basin with 51000 km² area and Shahroud basin with 5000 km² area. The length of Qazel Ozan River is 500 km. the other branch of Sefidroud River named Shahroud River with a length about 180 km and supply 25 percent of sefidroud discharge. Shahroud River after joining to

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Qazel Ozan River in Manjil canyon in the place of sefidroud dam creates Sefidroud River. Sefidroud River after passing from Astaneh and Kiyahshar cities reach to the sea.

In Sefidroud canyon several ecological conditions exist from north to south because of various factors and the rainfall amount decrease from north to south. The highest rainfall amount is in the north about 1866 mm/year. The mean yearly temperature in the basin's stations is ranges from 7.6 to 18.3 centigrade degree (Arabany, E., 1995).

Soil condition and erosion:

One of the problems after dams construction, is erosion and sediment transport to the back of the dam. Sefidroud Basin has high erosion because of high slope and week plant coverage in the central and southern parts. Generally from total sediment that transport toward the dam 74 percent remains in dam's lake (Report of sediment removal in Sefidroud Dam, 2005).

The high amount of salt in Qazel Ozan River causes the sediment salty. A few organic materials exist in the sediment. About 10 percent of soil erosion in the country is in Sefidroud Basin. The average of erosion in Sefidroud Basin is 830 ton per km² in a year and about 47 million ton soil erode in this basin and transport to the dam's lake. The sediment compounds in the Sefidroud dam are as follow (Report of geology and topography condition in dam location in Iran, 1991):

- 1- Sand 40 to 45 percent
- 2- Silt 40 to 45 percent
- 3- Clay 10 to 20 percent

Sediment impact:

All projects are with several positive or negative impacts on environment. These impacts could be long term or short term, temporary or permanent and direct or indirect. Dams are always with sediment problems that is one of the main problems in dam operation in Iran and in the world. Sefidroud Dam also confront with the same problem because of the topographic and ecological conditions of the basin.

The sediment accumulate in the back of the dam, 80 percent of them is from Qazel Ozan River that causes several negative impacts are as follow (Soil conservation and erosion in Sefidroud watershed, 1973):

- 1- Air pollution by scattering the sand and sediment during the sever wind and interred the valley in the vicinity of the dame because the movement of sand in dame storage space.
- 2- Entrance the viscous sediment flow to the river during the flood and increasing the TSS, Turbidity and other physicochemical parameters of the water that affects on the biological conditions of the river.
- 3- Corrosion and damaging the bottom outlet conduit
- 4- Decrease the useful storage and water storage capacity

The negative environmental impacts of sediment removing in Sefidroud storage dam:

One easy and economical way to evacuate the sediment is flushing method. This method has a lot of impacts on biological conditions of the river like: sever changes of physicochemical parameters of the river. This method increases the TSS to about 900 g/lit Turbidity to more than 15000 FTU and Dissolve Oxygen to zero. Furthermore the flushing method changes the river rock bed to sand and clay that affect of ovipositor of the fishes. {Asan B. -2004}

Biological impacts:

One of the main negative impacts of flushing method is on biological environment especially on aquatic organism. Discharge 40 million ton sediment into the river at once during a week decrease Dissolve Oxygen to the zero and cause clogging of the aquatic organism and death of thousands fishes (Figure -5), (Figure -6).

Furthermore because of covering a layer of mud with clay, silt and sand on the bed of the river all benthos species will lifeless and by increasing the turbidity in several weeks the phytoplankton and zooplankton crowd decrease that are the foods for the others aquatic species (Research report about the reason of decreases in fishes in Caspian Sea, 1983).

Direct impacts of sediment load on fishes (Yousof, P., 1994):

- 1- Clogging and death of the fishes because of high amount of suspended load
- 2- Damage the most parts of fishes food
- 3- Change the environment of the species that lives in the gravel bed.
- 4- Cover the aquatic species with sediment.

In this regards the experiment have been done about the effects of TSS changes on Finger Ling fishes from cyprinoids class and the results are as follow:

The minimum death time of 50 percent of the fishes (LD50) in similar laboratory conditions in chase with different TSS are shown in table (1).

Table 1: TSS amount effect on cyprinoids fish tolerance {Asan B.-1997}.

LD ₅₀	TSS (mg/lit)
Trace	170
Trace	280
Trace	3000
5 hours and 30 minutes	6000
2 hours and 30 minutes	12600
1 hour and 45 minute	200000

As it can be seen in the table half of the fishes are death less than 2 hour in laboratory experiment in similar condition of the river after Chasse Method. When the TSS amount is 6000 mgr/lit the death time reaches to more than 5 hours and in 3000 mgr/lit the no fishes death observed. The experiment shows the threshold of increasing the TSS on fish tolerance. However the experiments have been done in the laboratory but show that with decreasing the TSS amount during the chasse operation the death of fishes will decrease significantly.

The results of autopsy in death fishes during the Chasse Operation are as follow:

- 1- Obstruction of fish's bronchi with tiny and sticky sediment.
- 2- Obstruction of fish's throat with grain, fine particle of wood and plants stem.
- 3- Existence of silt and clay in stomach and intestine of the fishes.
- 4- Necrosis of fish's meat because of oxygen absence and asphyxia.

As it said before the procedure have been done in laboratory conditions but according to the research studies because the river flowing and motion ability of the fishes the threshold of the fishes increase so that the TSS of the river reached to 4000 mgr/lit in Karun River dredging operation.

Positive impacts of sediment removing in Sefidroud Dam:

Since the Sefidroud Dam lose about 40 percent of the water storage capacity because of sediment the flushing method has positive effects on capacity and to increase the dam useful long.

Today according to the field data the water entrance to Sefidroud Dam decrease to half of the past years. So the only way to preserve the present conditions and store the water on the dam's lake is increasing the storage capacity and reaches to 1960s decade condition. Due to reach to this capacity the only way is removing the sediment from the dam's lake.

It is clear that the most negative impacts are on river and aquatic habituates. Therefore it is needful to use the others methods that put the less impacts on environment.

First choice - Chasse operation:

The easiest and an economic and the fastest way that could remove a lot of sediment in a short time in the dams are flushing method. Although this method is useful to recover the dam's storage capacity but confront with several negative impacts that analyzed perfectly in the research. Therefore it is necessary to consider the others method that maybe could used separately or with the flushing method.

Second choice - Dredging and sediment transport:

Dredging the sediment and use them for brick making and in fact using about 700 million ton sediment as a source for brick and ceramic making factories is a suitable way to conserve the water capacity of the dam and also create economical and employments opportunity. According to mineralogy, physic, chemistry and mechanical test and according to resistance pressure, tension, bend and water absorption of the baked samples the sediments of Sefidroud Dam are suitable to brick and ceramic making purposes. The tests have been done according to Iran standards number 1162 (Khodabandeh, N., *et al.*, 1994).

This operation can be done in different time by dredging tools or by trucks. The suction dredging tools used in the others countries like Russia and also in south of Iran in Karun River. In Karun River 23 million ton Sediment dredged and the sediment used for road and building construction (Figure -7).

It must be mentioned that in the present time 700 million ton sediment settled in reservoir of Sefidroud Dam. In this regards a brick factory constructed in the vicinity of the dams and this potential exist for the others factory (Figure -8).

Conclusion and results:

High sediment load in Sefidroud River affect on the water quality in addition to negative impacts on aquatic species. According to water discharge of Sefidroud River till 1998-99 the discharge always was more than 3000 million cubic meter and the mean was 4500 million cubic meter. But the discharge reached to about 2400 million cubic meter during the last decades that is nearly half of the mean of 40 years before. The results show the unsuitable water condition in Guilan Province (Surface water analyses in Sefidroud watershed, 1990).

Furthermore decrease the water discharge and the population growth rate in the past 40 years and also industries development caused more pollution in the river. {5} So decreasing the discharge of Sefidroud River

affected on agricultural and economical activities and also irrecoverably affected on biological habitats and cause significant decreases on aquatic species like decreasing in valuable and economical species (e.g. sturgeon-caviar fish) (The role of Sefidroud River in migration and reproduction of sturgeon fish and White fish in Caspian Sea, 1994). In conclusion it must be mentioned that improving the plant coverage and planting trees in the lands without plant coverage upward the dam is a way to prevent from sediment transport to dam's lake in addition to reduce the settled sediment and increase the water capacity of the dam.



Fig. 1:



Fig. 2:



Fig. 3:



Fig. 4:



Fig. 5:



Fig. 6:



Fig. 7:



Fig. 8:

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