REPORT

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT OF INCREASING THE WATER LEVEL AT PERIYAR LAKE IN PERIYAR TIGER RESERVE

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1. INTRODUCTION

The Mullaperiyar dam across the headwaters of Periyar in Thekkady was constructed in 1895 to provide water to Tamil Nadu (erstwhile Madras Presidency). The height of the dam was fixed to store water at a full reservoir level (FRL) of 152 feet from bed level. The total water spread area at this height is 25.527 sq .km. During 1979 the Central Water Commission instructed the Tamil Nadu PWD to keep the FRL at 136 feet as the dam was weak. During the years from 1979 to 2000 the area below 152 feet but above 136 feet was put to different uses both by man and wildlife. Further a Tiger Reserve was constituted in the area and wildlife conservation and tourism attained priority. At present the Tamil Nadu PWD is of the view that the height of FRL can be raised to 152 feet. Both the governments viz., Kerala and Tamil Nadu are negotiating on this issue. The present report is to determine the impact of raising the water level in Mullaperiyar dam on the land, vegetation, wildlife, tourism and communities.

2. Objectives: The Rapid Environmental Impact Assessment was carried out wit the following objectives:

1. Determine loss of land
2.. Assess the impact on flora
3.. Determine the impact on wildlife
4. Assess the impact on tourism
5. Assess the impact on human settlements

3. Methodology

Surveys were conducted for two days on 22 and 23 March 2000 by team of EIA specialist, Botanist, Wildlife Biologist and Cartographer in the field. Survey of India toposheets and satellite imageries were used to assess the loss of land . Plant specimens were identified and their use value was assessed in the field. Transects were laid to study the wildlife through indirect evidences. The impact on tourism and communities was assessed through participant observation and secondary data. Experience of Staff of Periyar Tiger Reserve and Ecodevelopment Project was used gainfully in the field and otherwise.

4. Results

4.1 Loss of land and its features

The total area of Periyar Reservoir as per 870m contour (Ref: SOI Toposheets 1:25,000 58 G2/SE Published in 1997) was estimated using Planix 5000 electronic planimeter and it was calculated as 25.527 km^2. As per the information available with Tamil Nadu PWD the Reservoir bed level is at 2709 ft. and FRL is at 2861 ft. (ie. 867 m.). From the SOI Toposheets 58 G2/SE of 1:25,000 scale it was observed that the reservoir level marking is at 870 m. contour, and the reservoir area was estimated accordingly as 25.527 km^2. Again the area of water-spread region alone was also calculated and it was found to be 14.308 km. Thus the submergible area at 152 ft. level above 136 ft is 11.219 km^2. It is also noted from the map that there are 25 islands (Fig. 1) in the reservoir covering an area of 7.158 km^2.. During the field trips conducted on 22nd and 23rd March 2000 it was also observed that marshes and grasslands adjacent to the reservoir are of higher importance in the food/fodder availability. By raising the water level these marshes, developed because of the continuous top soil deposits, along the reservoir banks will be destroyed, which may seriously affect the food/fodder availability of wild animals in the area. Again, this may affect the animal sighting aspects of the Tourism zone. For getting more precise information it requires a detailed impact study of the area.

4.2 The impact on flora

The Periyar Tiger Reserve is the largest protected area in Kerala with an extent of 777 km^2. The flora of Periyar Tiger Reserve has been studied recently (Sasidharan, 1998), resulting in documenting 1965 species of flowering plants. Dicotyledons dominate with 1440 species in 613 genera under 137 families. Monocotyledons are represented by 525 species in 210 genera under 22 families. Poaceae with 168 species among Monocots and Fabaceae with 155 species among dicots are dominant families. Among the 159 families, 28 dicot and 6 monocot families are represented by single species each.

The floristic analysis shows that the Family Poaceae consisting of grasses and bamboos has a representation of 168 species is the richest assemblage of the

family in any protected area or even in a district in Kerala. Similarly, the occurrence of 155 species of Leguminosae and 143 Orchids including a new species *Habenaira periyarensis* Sasi *et al* (1998), are the highest number recorded from any protected area in the Western Ghats. Some of the largest Genera of Western Ghats such as *Impatiens, Strobilanthes, Crotalaria, Cyperus, Desmodium* are represented by more than 20 species in the Periyar Tiger Reserve.

The diversity and richness of the flora is also revealed by the endemic species. The Periyar Tiger Reserve comes under the Anamala High Range endemism in the Western Ghats. Among the 1965 species 515 are Western Ghats endemics, which forms about 25% of the flora. Western Ghats is considered a biodiversity hotspot because about 460 species among the 1500 endemics are placed under various threatened categories (Nayar, 1986). From Periyar Tiger Reserve 150 species belonging to the threatened categories including 15 species considered 'possibly extinct' are recorded. The occurrence of 1965 species in an area of 777 km^2 indicates the richness and diversity of flora of the Tiger Reserve. So far, from no where in the subcontinent such a large number of taxa have been reported from an area comparable to that of Periyar Tiger Reserve.

The dominant species in the reservoir area and its immediate vicinity are the grasses and sedges. Among the 168 species of grasses and 91 species of sedges, majority of them are occurring in the reservoir area and the marshy areas or 'vayalas' (Anakuthivayal, Kokkarakandom and Nellipparakandom). The grasses and sedges form an important food source for the wild animals. The Periyar Tiger Reserve is known for its rich fauna, and has the highest concentration of two larger herbivores, the elephant and the Gaur. The Sambar deer is also very common in the reserve. These animals are frequently sighted along the reservoir banks during boat trips. Their sightings are attributed mainly due to the fodder availability along the reservoir banks. Among the food species found in the reservoir area, *Panicum repens, Cynodon dactylon, Eragrostis tenuifolia* and species of *Cyperus* spp. are the preferred food species. These species grow abundantly along the reservoir banks were there is good soil. *Panicum repens* and *Cynodon dactylon* are perennial species and will be available throughout. *Panicum repens* is a

hydrophilous species and has a tendency to grow towards water. As the water level recedes, new shoots are produced from the rhizomatous root stocks, thereby fresh shoots will be available during all seasons. This species is also capable of withstanding flooding. *Panicum repens* is eaten by elephants, Gaur, Sambar deer and wild boar which are very frequently sighted along the reservoir bank. The wild boars dig out the fleshy rhizome and eaten. The elephants uproot the whole plant and eat. While the Gaur and Sambar deer browse only the aerial part of the plants. The other fodder plants seen along the reservoir banks are *Paspalum scrobiculatum, Alloteropsis cimicina, Aristida hystrix, Bothriochloa insculpta, Brachiaria ramosa, Brachiaria semiundulata, Cyrtococcum muricatum, Digitaria griffithii, D. ciliaris, D. longiflora, D. setigera, Dimeria lawsonii, Echinochloa colona, E. crusgalli, Eleusine indica, Eragrostis nutans, E. unioloides, E. viscosa, Imperata cylindrica, Isachne walkeri, Ischaemum indicum, I. Nilagiricum, Ottochloa nodosa, Panicum brevifolium, Paspalum conjugatum, P. scrobiculatum, Perotis indica, Sacciolepis interrupta, Setaria paniculifera, S. verticillata.* The important fodder sedges are *Carex filicina, Cyperus compressus, C. difformis, C. diffusus, C. digitatus, C. distans, C. haspan, C. oatesii, C. zollingeri, Eleocharis congesta, Fimbristylis dichotoma, F. littoralis, Lipocarpha chinensis, L. sphacelata.*

The trees along the reservoir banks support the growth of an endangered orchid, *Taeniophyllum scaberulum* which was recently rediscovered after a gap of 140 years. *Taeniophyllum scaberulum* is found only on the trees growing along the banks of the reservoir of the Tiger Reserve (Rajesh *et al*, 1997).

The vegetation above the present water level of 136 feet is of moist deciduous and semi-evergreen forests. The reservoir and moist deciduous forests ecotone is often dominated with the growth of *Imperata cylindrica* and *Themeda cymbaria.* The newly formed leaves of the former are an important delicacy for Sambar deer and Gaur. Commonly, seen trees along the border areas are *Terminalia paniculata, Olea dioica, Syzygium cumini,* etc. The trees in this region are smaller in size and obviously established after the water level was brought to 136 feet level. The trees along the margins of semi-evergreen forests are

Actinodaphne malabarica, Chionanthus mala elengi, Croton malabaricus, Symplocos cochinchinensis, Glochidion ellipticum, etc. These species were also established after the reservoir level was brought to the present level of 136 feet. These secondary growth are obvious at Thekkady, Edappalayam, Manakkavala, Swamikkayam and up to Mullakkudi. There is not much apparent changes along the margins of the trees at the upper reaches of the reservoir, probably the inundation period is very short here.

The raising of the water level from the present level of 136 feet will adversely affect the fodder availability of wild animals and they are likely to move away from the present tourism zone. The present reservoir level has provided habitats for luxuriant growth of the important fodder plant, *Panicum repens*. The semi-marsh areas developed at place like Edappalayam may be the result of deposition fine soil particles like clay, which is more conducive for the growth of sedges. By raising the water level, the host plants of the endangered orchid, *Taeniophyllum scaberulum*, particularly *Terminalia paniculata, Psidium guajava, Catunaregam spinosa, Osbeckia lawsonii*, growing along the reservoir margins will be destroyed. *Taeniophyllum scaberulum* is not observed on the plants growing in the interior forests.

4.3. Impact on Wildlife

A rapid survey was conducted along the fringes of the lake in March, 2000, by laying 13 numbers of 500 m long transects to assess the intensity of utilisation of these areas by different species of mammals. The indirect evidences along the transects were recorded and analysed for their density. The earlier records of animal observations in PTR were also scanned for information on the distribution of animals.

The results of the rapid survey clearly indicate the high utilisation of the lake fringes by different mammalian species even up to about 400 m away from the lakeside. However, high concentration of elephants were observed up to 100 m, of gaur up to 450 m and sambar deer up to 500 m. (Tables 1, 2, 3 and 4).

Table 1. Overall dung density in the submergible area

Animal	Density	%CV	n	CIL	CIU
Barking deer	769.23	44.72	5	256.62	2305.80
Sloth bear	5768.40	18.57	48	3984.10	8351.80
Elephant	8253.10	10.57	231	6712.50	10147.00
Gaur	7156.00	20.23	91	4807.20	10652.00
Porcupine	3930.60	21.69	29	2535.50	6093.50
Sambar	6242.60	15.00	62	4633.80	8410.00
Wild boar	637.33	34.62	9	297.72	1364.30
Wild dog	1057.70	30.15	11	552.58	2024.50

CV – Coefficient of variation, n – Number, CIL – Confidence Interval Lower Limit, CIU – Confidence Interval Upper Limit

Table 2. Elephant dung density at different transect points

Position (M)	Density Km^{-2}	%CV	n	CIL	CIU
0-50	20248.00	24.10	51	12569.00	32617.00
50-100	11860.00	19.20	42	8078.60	17411.00
100-150	4858.70	25.65	23	2881.80	8191.90
150-200	7522.80	23.19	22	4679.80	12093.00
200-250	7576.30	39.88	14	3323.50	17271.00
250-300	7231.90	23.45	22	4475.80	11685.00
300-350	5322.70	26.80	15	3036.40	9330.70
350-400	5874.50	65.08	11	1413.60	34663.00
400-450	7000.00	82.13	10	1413.60	34663.00
450-500	4255.04	93.28	9	710.69	25480.00

Table 3. Gaur dung density at different transect points

Position (M)	Density Km^{-2}	%CV	n	CIL	CIU
0-50	9191.50	53.87	17	3168.20	26666.0
50-100	14074.00	48.41	15	5286.30	37472.0
100-150	45867.00	48.94	19	17391.00	0.12097E+06
150-200	6293.70	190.26	7	337.51	0.11736E+06
200-250	854.70	70.71	2	55.189	13237.0
250-300	1153.80	57.74	3	209.38	6358.5
300-350	15289.00	109.34	2	336.63	0.69439E+06
350-400	3076.90	50.00	4	829.11	11419.0
400-450	72804.00	58.77	8	20733.00	0.25565E+06
450-500	1398.60	50.00	4	376.87	5190.0

Table 4. Sambar pellet density at different transect points

Position (M)	Density Km^{-2}	%CV	*n*	CIL	CIU
0-50	7692.30	35.36	8	3486.2	16973.0
50-100	4273.50	44.72	5	1425.7	12810.0
100-150	6730.80	37.08	7	2836.2	15793.0
150-200	4615.40	57.74	3	837.53	25434.0
200-250	4807.70	44.72	5	1603.9	14411.0
250-300	4615.40	57.74	3	837.53	25434.0
300-350	8653.80	33.33	9	4152.8	18034.0
350-400	4395.60	35.36	8	1992.1	9698.9
400-450	6730.80	37.80	7	2836.2	15973.0
450-500	16321.00	35.56	9	7477.1	35624.0

Though the animals were seen widely distributed in the Reserve, the records of animal sightings in different parts of the Tiger Reserve also indicate a higher usage of the areas around the lake. The analysis of the data collected during

the study on gaur had also indicated intense utilisation of these areas due to the higher availability of palatable food species especially the grasses.

The elephants, the largest animal in the Reserve with larger area requirement has almost got used to the system after about 100 years since the reservoir has come into existence. Observations of elephants in the Reserve has shown that they swim across the lake only at specific points with less number of dead tree stumps and gradual slopes. The alteration in the height of the reservoir will be confusing the elephants, which may take a long time again to get used to the changes before getting stabilised. There could be even accident deaths in the process.

The water level if raised could also submerge the trees stumps used by the aquatic birds. This could be detrimental to the already dwindling population of the snake bird and the little cormorants

The lake and its associated streams support 37 species of fishes. Periyar trout, Periyar latia and Periyar barb are seen only in Periyar. The endangered game fish, Deccan Mahseer is mostly in the up streams.

Temperature, rainfall and canopy cover can be some of the limiting factors in the distribution of fishes (as far as the physical factors are concerned); water temperature could be a limiting factor in the distribution of fishes like *Tor khudree*, *C. periyarensis* and *P. ophiocephalus* while food resources and habitat characteristics can limit the distribution of other fish species like loaches. The loaches are generally benthic, the distribution and abundance of which are greatly influenced by the presence of organic matter in the form of leaf litter, debris, dead twigs etc.

The eels (*Anguilla bengalensis* and *A. bicolor*) which was reported by Chacko (1948) from Periyar lake was found to be missing in the subsequent surveys (Arun *et.al.*, 1996). The absence of eels and some other species has been reported to be due to the negative impact of high-headed dams on fish life.

A change in the water level of the reservoir will lead to a loss in the stream areas available to the stream fishes forcing them to move further up. The complex

lake system may be in a stabilised stage after inundation for over 100 years. A change in the water level could destabilise the system threatening the native fishes.

4.4 Impact on Tourism

Thekkady attracts an ever increasing flow of tourists every year with an estimate of 4.5 lakhs of tourist visits during the year 1998-99 (see Tables 5 and 6). This major tourist spot is also known as the ultimate tourist destination in Kerala. An estimate of Rs. 6.6 million has been generated related to tourism activity by the forest department alone from this region during the year 1998-99. Tourist activities have also lead to the development of a township in Kumily which is just 5 kms. away from Thekkady. This township and a relatively big population which it supports has developed an intricate relationship with the tourism activities and is greatly dependent on these activities.

Major fascination for the tourists here is boating which enable animal sightings on the lakeshore grass lands. Raising the existing water level from 136 to 152 feet will result in the submergence of approximately 11.2 km^2 of forestland with in the Periyar Wildlife Sanctuary. Area of submergence also includes the area under lakeshore grasslands and its environs, which serve as sightings points for wildlife. Loss of wildlife viewing will reduce tourist visits and will be detrimental to the Tourism Industry at Kumily.

When the water level is raised to 152 feet the feeding grounds of large herbivorous will be submerged and will be shifted to areas beyond the timberline resulting in non-visibility of them from the lakeside. This will have a long term and irreversible damage on the ecosystem integrity, wildlife and the aesthetics of the environs with a direct adverse impact on tourism. The very existence of Kumily township and its life support activity will be at stake with long-term negative influences.

Table 5. Number of vehicles entered into PTR during the year 1997

Month	No. of buses	No. of Vans	No. of Jeep/Car	No. of Auto/Bike
January	229	598	2411	712
February	235	443	2094	499
March	140	307	1694	381
April	190	393	2081	389
May	215	499	2490	396
June	44	204	1252	343
July	41	118	768	188
August	89	284	1234	312
September	102	276	1854	445
October	125	308	1772	361
November	153	429	1700	310
December	180	386	2222	368

Table 6. Details of tourists visited Periyar Tiger Reserve during the last fourteen years

Year	Indians	Foreigners	Total	Revenue (Rs.)
1986-87	1,87,321	17,391	2,04,712	6,77,549
1987-88	2,11,894	11,723	2,23,617	8,56,169
1988-89	2,17,490	16,164	2,35,654	10,45,678
1989-90	2,00,899	13,943	2,14,842	11,12,077
1990-91	2,53,118	11,425	2,64,543	15,45,919
1991-92	2,17,898	20,149	2,38,047	16,52,446
1992-93	2,33,896	19,434	2,53,330	21,92,008
1993-94	1,70,365	7,315	1,77,680	22,62,060
1994-95	1,85,182	11,073	1,96,255	24,00,792
1995-96	2,52,473	9,911	2,62,384	55,80,967
1996-97	2,77,278	10,145	2,87,423	665,48,118
1997-98	3,19,984	22,253	3,42,237	64,09,212
1998-99	4,32,396	23,883	4,56,279	66,16,239
1999-2000	-04-99	10-10-99		30,07,917

4.5 Impact on settlements and human life support systems

After 1979, when the water level was maintained below 136' feet, as much as 11.219 km^2 of land was exposed. New settlements and allied activities were developed in these areas during the past 21 years (Table 7). Tribal settlements and their agriculture lands at Mannan kudi where activities of the ecodevelopment project are underway will be affected. In most sites Ecodevelopment committees are active and definite and immediate success in reshaping the life of the people in conjuction with conservation efforts is expected.

This will affect 7 sites with over 1000 households and a population of 3500-4000 people. Both tribals and non tribals will be affected, houses and agricultural land will be submerged. Thus raising the level from 136' to 152' will have implication on population and their life support system.

5. Conclusion and recommendation

Conclusion

1. A total area of 11.219 km^2 will be submerged if the water level is raised from 136 feet to 152 feet.
2. The vegetation in the submergible area is a major source of food and fodder to the wildlife. It will threaten the existence of endangered flora especially the orchid Taeniophyllum scaberulum.
3. The change in water level will shift large numbers of larger mammals from the lakeshore which is being used today as feeding and breeding grounds. A negative impact on lower forms of animals, fishes etc is also predicted.
4. Loss of wildlife viewing will have a detrimental effect on Tourism industry of Kumily which is the backbone of the economy of the township.
5. An increase in the FRL to 152 feet will displace people from seven sites involving tribals and non tribals to the tune of 3500-4000 people with a detrimental impact on their economy and life support system.

Table 7. Abstract of findings of Impact on human settlements

Sl. No	Site	Characteristics	Households/ population	Tribal/Non-tribal	Agriculture	Non agri. Activity	Years of occupation	Use pattern
1.	Kulathupalam	Streamlet from wetland	10/50	Non -tribal	Homesteads pepper	Shops, Repair	From 1979	(Forest land) KSRTC bus station
2.	Mannan kudi	Tail of reservoir	80/400	Tribal	Pepper/ homestead	--	1979	EDC activities
3.	Periyar colony	Streamlet	34/200	CC Non-tribal	--	Wage labourer	1979	EDC activities
4.	Labbakandam	Streamlet of Kulathupalam	100/500	Non - tribal	Homestead	Wage labour employees	--	EDC activities
5.	Thekkady	Tail reservoir (Swamp)	Households/ 60300	Non-tribal	Agricultural land/homestead	Wage labour tourism, employees	1979	EDC/play ground grazing
6.	Rosapookandam	Slum	700/2000	Non-tribal	--	Wage labour	--	Fire wood, thatching grass, user group/EDC
7.	Anavachal	Swamp – grazing	Nil	Nil	Nil	200 cattle grazing	1979	--

Recommendation

It is strongly recommended that the reservoir level be not raised to 152 feet due to the harm and injury the same inflicts on the land, biodiversity of the area and the people.

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