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PHYSICO-CHEMICAL STUDIES OF AMARAVATHI AND ALIYAR RESERVOIRS, TAMIL NADU, INDIA

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Abstract

Water is the elixir of life, a precious gift of nature to mankind and millions of other species living on the earth it is under pressure and must be managed for human survival. The fresh water habitats have their own physical, chemical and biological characteristics which are molded by local conditions and physiography (Mukhaerjee, 1997). High levels of pollutants mainly organic matter in river water cause an increase in biological oxygen demand, chemical oxygen demand, total dissolved solids, total suspended solids and they make water unsuitable for drinking, irrigation and other purposes. In our present study focuses on the physical parameters such as temperature, electrical conductivity, colour, odour, dissolved oxygen and chemical parameters such as pH, total alkalinity, bicarbonate, total dissolved solids, total hardness as Caco3 and Calcium hardness as Caco3. Nutrients Calcium, Magnesium, sodium, potassium, sulphate, chloride and nitrate also analysed in both the reservoir.

Key words: Water, Physico-chemical parameters, Nutrients.

Introduction

The ever increasing demands of water for domestic, industrial and commercial consumption have strained this resource considerably. In olden days man was content to survive and exits with basic needs, however, as civilizations progressed his needs also increased. Water is the best solvent used in many industries steam generation, textile, paper and pharmaceutical industry. Water resource is one of the major components of environmental resources that are under threat by exploitation and pollution (Efe, 2001a). Several river systems in the country have been developed by constructing dams and barrages across the river for the purpose of irrigation, flood control, navigation and power generation. As time advances, a number of reservoir projects come into existence as chief sources of lentic fresh water bodies.

In India, all the major rivers are subjected to various forms of pollution with regular declining water quality as well as level of underground water. The flow of river in downstream can be augmented during dry periods by releasing extra water from the dams to ensure a continuous supply. The construction of dams in certain upstream regions can check the floods in the downstream region during the rainy season (Goel, 1996). The substances such as industrial and commercial solvents, metal and acid salts, sediments, pesticides, herbicides, plant nutrients, radioactive materials, decaying animal and vegetable matter and living microorganisms, algae, bacteria and viruses are given water a bad taste, colour, odour or turbidity and cause hardness, corrosiveness, staining or frothing (Mahananda *et al*.,2010).

Materials and Methods

Description of Study area

Present study is carried out by collecting samples from two different reservoirs namely the Amaravathi reservoir and Aliyar reservoir for a period of six months from April 2015 to September 2015.

Amaravathi Reservoir

Amaravathi Reservoir at Amaravathi Nagar, 25 km South on NH-17 from Udumalpet is located in Indira Gandhi Wildlife Sanctuary and National Park in Tiruppur District, Tamil Nadu, India. The reservoir was created by the steep Amaravathi Dam built across the Amaravathi River.

Table 1. Details of Amaravathi Reservoir

Official name	Amaravathi Dam
Impounds	Amaravati River
Locale	Amaravathinagar in Indira Gandhi Wildlife Sanctuary, Tiruppur district, Tamil Nadu,India
Length	1511 ft (0.30 m)
Height	2090 ft (27 m)
Width (at base)	s1 ft (0.30 m)
Opening date	1957
Creates	Amaravathi Reservoir

ISSN: 2249-6661
Vol-43, No.-04 (IV) July-September (2020)

Geographical Data	
Coordinates	10°24.64′N 77°15.6′E / /

The Amaravathi River about 25 km (16 mi) upstream and South from Thirumoorthi Dam. Capacity of the dam has shrunk 25% from 4 feet to 3 feet due to siltation. The dam was built primarily for irrigation and flood control and now also has four megawatts of electrical generating capacity installed. This place is being developed as a District Excursion Centre for tourism.

The associated Amaravathi Reservoir is 9.31 square kilometers in area and 33.35 meters deep. It is notable for the significant population of Mugger Crocodiles living in its reservoir and catchment basin.

Aliyar Reservoir

Aliyar Reservoir is located near Pollachi town in Coimbatore District, Tamil Nadu, India. The dam is located in the foothills of Valparai, in the Anaimalai Hills of the Western Ghats. It is about 65 kilometres from Coimbatore. The scenery is beautiful, with mountains surrounding three quarters of the reservoir.

The Aliyar Dam was constructed during 1959-1969 across the Aliyar River, mainly for irrigation purposes. Aliyar Lake receives water from Upper Aliyar Reservoir through the hydroelectric power station in Navamalai and the Parambikulam reservoir through a contour canal. Aliyar dam, built as a part of Parambikulam aliyar project (PAP), retains a large reservoir. The dam is around 2 kilometres (1.2 mi) in length.

Table 2. Details of Aliyar Reservoir

Official name	Aliyar Dam
Impounds	Aliyar River
Locale	Aliyar in Indira Gandhi Wildlife Sanctuary, Coimbatore district, Tamil Nadu, India.
Length	2 Kilometres (1.2 mi)
Height	41 metrs (135 ft)
Width (at base)	1 ft (0.30 m)
Opening date	1969
Creates	Aliyar Reservoir

The lowest level outlet of the reservoir is 930 feet (280 m) above mean sea level (MSL) and the canal intake is 980 feet (300 m) above MSL. The spillway is 1,040 feet (320 m) above MSL and the FRL (Full Reservoir Level) is 1,050 feet (320 m) above MSL. The surface area is 48 hectares (120 acres) (1,600 acres). The volume of water at FRL is 3.864 Tmcft (88,705 acre feet (109,416,000 m^3). The depth is 41 meters (135 ft) and the volume development is 1.2 m. The highest inflow usually occurs during July and August. The shoreline is poorly indented, the shore development is poor and shallow and the Aquatic plants and limnology of the littoral zone is also very limited.

Collection of Water Samples

Water samples were collected from the Amaravathi and Aliyar reservoirs for a period of 6 months from April 2015 to September 2015. The water samples were collected from the surface layers between 9 am to 2 am during the first week of every month. The samples were collected in sterilized containers completely to exclude any air space sealed tightly and transported to the laboratory within 24 hours. All the parameter were estimated following method (APHA, 1999).

Results and Discussion

The physico-chemical characteristics of the water samples collected from Amaravathi and Aliyar reservoirs were studied for a period of six months from April 2015 to September 2015.The results were presented in the form of tables and graphs. The interrelationships between the parameters were analyzed statistically using Karl Pearson's correlation co-efficient method and the values are given in the tables.

Physical Parameters

The colour of water in all these two reservoirs was uniform throughout the study period. In all these two reservoirs the water was odourless from April 2015 to September 2015. Temperature is important physical parameters of the water body. The temperature fluctuates from 28±1.52ºC (April) and 31±0.54ºC (July) in Amaravathi reservoir. Aliyar reservoir the temperature fluctuates from 26±0.63ºC (September) to 29±1.35ºC (May). It was noticed that the temperature was recorded higher in the month of July and May in all these two reservoirs. Electrical conductivity of Amaravathi reservoir was recorded maximum 82±1.25 µmhos/cm in the month of July and minimum 49±0.58 µmhos/cm in the month of August. In Aliyar reservoir the electrical conductivity value ranged from 45±0.44 µmhos/cm to 61±0.46 µmhos/cm. The maximum value was found in August and minimum values in July. The amount of dissolved oxygen in Amaravathi reservoir was noted maximum level 6.23±0.45 mg/l in the month of July. The

ISSN: 2249-6661
Vol-43, No.-04 (IV) July-September (2020)

minimum value 4.10±0.58 mg/l in the month of May. Aliyar reservoir was containing maximum value of dissolved oxygen 6.23±0.48 mg/l and minimum value 4.72±0.82 mg/l in the month of May and June.

Table 2: Correlation Co-efficient in Amaravathi reservoir

	Temp	EC	D O	pH	TA	HCo3	TDS	TH	CaCo3	Ca	Mg	Na	K	So4	Cl	No3
Tem	1															
E.C	.477 .339	1														
D O	.695 .125	.457 .363	1													
pH	-.195 .712	-.100 .851	- .340 .510	1												
TA	.432 .392	.940** .005	.400 .432	.13 4 .80 1	1											
HCo3	.265 .611	.828* .042	.368 .473	.37 0 .47 1	.944** .005	1										
TDS	.482 .333	.936** .006	.354 .492	.22 4 .67 0	.926** .008	.880* .021	1									
TH	.075 .888	-.201 .703	.000 1.00 0	- .78 5 .06 5	-.504 .308	-.705 .118	- .378 .460	1								
CaCo3	-.126 .811	.483 .332	.504 .308	- .40 2 .43 0	.437 .386	.461 .358	.248 .636	- .094 .860	1							
Ca	-.389 .445	.155 .770	- .521 .289	.42 4 .40 2	.053 .920	.134 .800	.327 .527	.000 1.00 0	-.209 .692	1						
Mg	.386 .449	.628 .182	.778 .069	- .48 2 .33 3	.417 .411	.365 .477	.476 .339	.269 .606	.685 .134	- .01 8 .97 4	1					
Na	-.524 .286	.122 .817	- .176 .738	.48 7 .32 7	.095 .858	.328 .525	.263 .614	- .286 .583	.244 .641	.76 6 .07 6	.223 .670	1				
K	.272 .602	-.027 .959	.418 .409	.56 2 .24 6	.241 .645	.430 .395	.126 .812	- .777 .069	.021 .969	- .43 0	- .109 .837	- .02 0	1			

ISSN: 2249-6661
Vol-43, No.-04 (IV) July-September (2020)

										.394		.970				
So4	.118 .824	.659 .154	.612 .196	-.546 .262	.503 .309	.446 .376	.422 .404	.151 .775	.917* .010	-.082 .877	.890* .017	.211 .688	-.179 .735	1		
Cl	.120 .821	.494 .319	-.386 .450	-.144 .786	.368 .473	.145 .784	.468 .350	.259 .620	-.202 .701	.489 .325	-.035 .947	-.082 .877	-.671 .145	.027 .960	1	
No3	.670 .145	.811 .050	.511 .300	-.474 .342	.747 .088	.502 .311	.632 .178	.066 .901	.372 .468	-.320 .537	.481 .334	-.465 .352	-.096 .857	.546 .262	.488 .327	1

****. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).**

Table 3: Correlation Co-efficient in Aliyar reservoir

	Temp	E.C	Do	pH	TA	HCo3	TDS	TH	CaCo3	Ca	Mg	Na	K	So4	Cl	No3
Temp	1															
E.C	-.056 .916	1														
D.O	-.288 .580	-.706 .117	1													
pH	.539 .270	.369 .472	-.591 .217	1												
TA	-.071 .893	.876* .022	-.843* .035	.612 .197	1											
HCo3	-.331 .521	.847* .033	-.687 .132	.381 .457	.911* .011	1										
TDS	.602 .206	.554 .254	-.791 .061	.846* .034	.694 .126	.364 .479	1									
TH	-.448 .373	.777 .069	-.480 .335	.415 .413	.872* .024	.908* .012	.351 .495	1								
CaCo3	.164 .756	.963** .002	-.801 .055	.406 .425	.831* .040	.733 .097	.674 .142	.607 .201	1							
Ca	-.252 .630	.874* .023	-.505 .307	.042 .938	.698 .123	.631 .179	.391 .444	.656 .157	.838* .037	1						
Mg	.605 .203	.569 .239	-.423 .404	.763 .077	.480 .336	.347 .500	.682 .136	.329 .524	.605 .203	.238 .649	1					

ISSN: 2249-6661
Vol-43, No.-04 (IV) July-September (2020)

Na	**.571 .237**	**.718 .108**	**- .724 .104**	**.793 .060**	**.713 .111**	**.445 .377**	**.939** .005**	**.433 .391**	**.806 .053**	**.527 .282**	**.848* .033**	**1**				
K	**-.445 .376**	**-.049 .926**	**- .197 .708**	**.331 .522**	**.392 .442**	**.396 .437**	**.090 .865**	**.514 .297**	**-.179 .735**	**- .114 .829**	**- .260 .618**	**- .118 .824**	**1**			
So4	**-.515 .296**	**.794 .059**	**- .524 .286**	**.306 .556**	**.879* .021**	**.925** .008**	**.314 .544**	**.984** .000**	**.636 .175**	**.723 .105**	**.212 .687**	**.380 .457**	**.505 .307**	**1**		
Cl	**.055 .918**	**-.145 .784**	**- .148 .779**	**.686 .132**	**.293 .573**	**.121 .820**	**.404 .427**	**.328 .525**	**-.203 .700**	**- .273 .601**	**.131 .805**	**.204 .698**	**.806 .053**	**.238 .650**	**1**	
No3	**-.379 .458**	**.312 .547**	**- .292 .575**	**- .302 .561**	**.233 .656**	**.549 .259**	**-.319 .537**	**.225 .668**	**.260 .618**	**.139 .793**	**- .162 .759**	**- .243 .642**	**.027 .960**	**.310 .550**	**- .460 .359**	**1**

**** Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).**

Table 4: Physical parameters in Amaravathi and Aliyar reservoirs.

Month	Reservoir	Temperature O°C	Electrical conductivity µmhos/cm	Odour	Colour	Dissolved Oxygen
Apr 2015	Amaravathi	26±1.52	56±0.57	Odourless	Colourless	5.11±0.25
	Aliyar	27±0.57	54±0.83	Odourless	Colourless	5.45±0.78
May 2015	Amaravathi	28±1.00	67±1.30	Odourless	Colourless	5.65±0.12
	Aliyar	29±1.35	59±.0.40	Odourless	Colourless	6.23±0.48
Jun 2015	Amaravathi	30±0.84	57±0.34	Odourless	Colourless	4.10±0.58
	Aliyar	29±1.15	46±0.57	Odourless	Colourless	4.72±0.82
Jul 2015	Amaravathi	31±0.54	82±1.25	Odourless	Colourless	5.23±0.77
	Aliyar	27±0.81	45±0.44	Odourless	Colourless	5.55±0.54
Aug 2015	Amaravathi	29±0.43	49±0.58	Odourless	Colourless	6.23±0.45
	Aliyar	28±0.76	61±0.46	Odourless	Colourless	4.92±0.84
Sep 2015	Amaravathi	29±0.64	58±0.73	Odourless	Colourless	5.12±0.72
	Aliyar	26±0.63	58±0.83	Odourless	Colourless	4.78±0.28

ISSN: 2249-6661
Vol-43, No.-04 (IV) July-September (2020)

Table 5: Chemical Parameters in Amaravathi and Aliyar reservoirs.

Month	Reservoir	pH	Total Alkalinity mg/l	Bicarbonate mg/l	TDS mg/l	TH mg/l	$CaCo_3$ mg/l
Apr 2015	Amaravathi	7.2±0.11	20±0.44	24±0.57	33±0.68	20±0.54	10±0.81
	Aliyar	7.1±0.28	20±0.98	25±0.57	30±0.69	20±0.94	10±0.50
May 2015	Amaravathi	7.7±0.01	25±0.72	31±0.81	39±0.95	20±0.72	10±0.81
	Aliyar	7.4±0.20	23±0.54	28±0.96	38±0.84	23±0.83	12±0.57
Jun 2015	Amaravathi	7.8±0.17	15±0.70	16±0.44	33±0.47	29±0.52	9±0.93
	Aliyar	8.1±0.05	13±0.95	15±0.57	26±1.08	13±0.57	7±0.47
Jul 2015	Amaravathi	7.9±0.09	40±0.50	39±0.95	43±0.69	17±0.49	10±0.83
	Aliyar	8.8±0.28	14±0.56	15±0.96	25±0.61	18±0.73	5±0.71
Aug 2015	Amaravathi	7.4±0.56	17±0.57	23±0.53	34±0.49	17±1.28	7±0.68
	Aliyar	7.7±0.39	19±0.75	23±0.57	31±0.63	20±0.56	13±0.68
Sep 2015	Amaravathi	8.1±0.49	23±0.93	29±0.44	34±0.42	17±0.90	11±0.36
	Aliyar	7.9±0.42	20±0.57	31±0.73	24±0.81	24±0.98	10±0.78

Table 6: Monthly variations of Nutrients in Amaravathi and Aliyar reservoirs. (April 2015-September 2015)

Month	Reservoir	Calcium mg/l	Magnesium mg/l	Sodium mg/l	Potassium mg/l	Sulphate mg/l	Chloride mg/l	Nitrate mg/l
Apr 2015	Amaravathi	3.7±0.09	2.5±0.20	4.5±0.15	2.1±0.14	1.5±0.13	7.4±0.21	1.5±0.17
	Aliyar	3.5±0.05	2.1±0.39	3.4±0.80	2.8±0.17	1.3±0.10	5.3±0.05	1.8±0.27
May 2015	Amaravathi	4.5±0.15	4.2±0.26	6.4±0.42	2.3±0.23	1.8±0.35	7.1±0.12	1.3±0.14
	Aliyar	3.3±0.14	3.3±0.23	6.6±0.17	2.7±0.70	1.4±0.12	6.2±0.14	1.1±0.32
Jun 2015	Amaravathi	3.2±0.24	3.8±0.17	3.1±0.20	2.0±0.05	1.6±0.05	7.3±0.21	2.1±0.07
	Aliyar	2.4±0.34	2.6±0.12	2.9±0.20	1.7±0.35	0.4±0.04	4.7±0.05	1.4±0.17
Jul 2015	Amaravathi	3.4±0.27	3.8±0.32	3.7±0.39	2.5±0.04	1.8±0.27	7.8±0.34	3.2±0.75
	Aliyar	2.8±0.08	2.3±0.04	2.4±0.25	2.6±0.14	0.9±0.21	5.8±0.30	0.6±0.07
Aug 2015	Amaravathi	3.6±0.14	1.9±0.14	4.0±0.14	2.7±0.25	0.7±0.01	6.9±0.21	1.0±0.14
	Aliyar	4.1±0.15	2.9±0.34	5.3±0.36	1.4±0.08	1.2±0.32	4.3±0.24	1.3±0.02
Sep 2015	Amaravathi	2.6±0.03	3.8±0.15	4.1±0.18	2.9±0.05	1.8±0.10	5.9±0.02	1.7±0.19
	Aliyar	3.4±0.21	2.6±0.13	2.9±0.34	2.6±0.13	1.6±0.04	5.0±0.24	2.4±0.13

ISSN: 2249-6661
Vol-43, No.-04 (IV) July-September (2020)

Chemical Parameters

The pH of Amaravathi reservoir was recorded maximum 8.1±0.49 and minimum 7.2±0.11. In Aliyar reservoir the pH values were recorded the maximum 8.4 ±0.28 and minimum values 7.1±0.17 during the study period. The amount of total alkalinity in Amaravathi reservoir was noted maximum level 40±0.50 mg/l in the month of July. Aliyar reservoir was containing maximum value of Total Alkalinity 23±0.54 mg/l and minimum value 13±0.95 mg/l in the month of May and June.

The value recorded for the estimation of bicarbonate in the Amaravathi reservoir is maximum level 39±0.95 mg/l and minimum value noted 16±0.44 mg/l in the month of July. The value of bicarbonate in Aliyar reservoir is ranged from 31±0.73 mg/l to 15±0.96 mg/l. The maximum value was noted in the month of September and minimum value recorded in the month of July. The value recorded for the estimation of total dissolved solids in the Amaravathi reservoir was found maximum 43±0.69 mg/l in the month of July. The minimum value recorded 33±0.68 mg/l in the month of April. In Aliyar reservoir recorded in maximum in May and minimum value found in September.

The value obtained for total hardness recorded maximum 29± 0.52 mg/l in June. The minimum value recorded 17± 1.28 mg/l during August in Amaravathi reservoir. In Aliyar reservoir the total hardness was found to be maximum 24±0.98 mg/l in the month of September and minimum 13±0.57 mg/l in the month of June. The value recorded for the estimation of calcium hardness in Amaravathi reservoir was maximum 11±0.68 mg/l in the month of September and the minimum value was found 9±0.93 mg/l in the month of June. The calcium hardness value was lowest in Aliyar reservoir during August 5±0.71 mg/l and the highest value 13±0.98 mg/l was recorded in July.

Nutrients

The nutrients of the water samples in Amaravathi, Thirumoorthi and Aliyar reservoirs were presented in table: 6. The quantity of calcium in the Amaravathi reservoir was noted as maximum 4.5±0.15 mg/l May and minimum 2.6±0.03 mg/l September. The calcium value was maximum 4.1±0.15 mg/l in the month of August and minimum value 2.8±0.08 mg/l in the month of July in Aliyar reservoir. The amount of magnesium estimated in the Amaravathi reservoir was maximum level 4.2±0.26 mg/l in the month of May .The minimum value 1.9±0.14 mg/l in the month of August. The amount of magnesium in Aliyar reservoir was between 2.9±0.34 mg/l to 3.3±0.23 mg/l. The minimum value was found in the month of August and maximum value in May.

The amount of sodium estimated in the Amaravathi reservoir fluctuates between 3.1±0.20 mg/l to 4.2±0.26 mg/l where as the values fluctuates between 2.3±0.04 mg/l to 3.3±0.23 mg/l in Aliyar reservoir. The minimum value of sodium was recorded in June and July. The maximum value was found in May and June in Amaravathi and Aliyar reservoir. The content of potassium estimated in the Amaravathi reservoir ranged from 2.0±0.05 mg/l in June to 2.9±0.05 in mg/l in September. In Aliyar reservoir the potassium level 1.4±0.08 mg/l to 2.8±0.17 mg/l during the month of August and April. The fluctuation in sulphate level was between 0.7±0.01 mg/l to 1.3±0.10 mg/l in the month of August and April in Amaravathi reservoir. In Aliyar reservoir in sulphate level recorded in maximum value 1.6±0.04 mg/l in September. The minimum value was recorded 0.4±0.04 mg/l in June.

The value recorded value estimation of chloride in Amaravathi reservoir was found to be varied from 5.9±0.02 mg/l to 7.8±0.34 mg/l. The minimum value was recorded in the month of September and maximum in the month of July.The amount of chloride estimated in Aliyar reservoir was between 4.3±0.24 mg/l to 6.2±0.14 mg/l. The minimum value was found in the month of August and maximum value in the month of May. The water sample from Amaravathi reservoir was found to contain 1.0±0.14 mg/l to 3.2±0.75 mg/l of nitrate. The minimum value was found in August and maximum value was found in July. The amount of nitrate recorded in Aliyar reservoir was noted 0.6±0.07 mg/l to 2.4±0.13 mg/l. The minimum value was found in the month of July where as maximum value was recorded during September.

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