Water Quality Management of Kala-Oya Basin in Sri Lanka.

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1. Introduction

1.1 Background of the Mahaweli Authority of Sri Lanka:

Mahaweli Authority of Sri Lanka (MASL) was established under a Parliamentary Act No. 23 of 1979, to implement the Accelerated Mahaweli Development Programme. Under the Act, Mahaweli Special Area was demarcated and it covers 39% of the land area of the country and 55% of its' Dry Zone.

The Master Plan for Mahaweli Ganga Development Programme was developed by a UNDP/FAO team in 1968, on the invitation made by Government of Sri Lanka. To implement this massive Master Plan then Government has formed Mahaweli Development Board (MDB) in 1970, with the aim of completing the project within 30 years. In 1977, with the liberalization of the economy , then the new Government decided to address all burning issues prevailed in the country such as huge unemployment problem and shortage of energy and irrigation water , revisited and decided to revise the existing programs and implement the series of development activities simultaneously within a limited time frame. As a result of this innovative thought, Mahaweli Authority of Sri Lanka was borne. With the new Act, MASL was assigned a huge responsibility of achieving holistic development in the country, keeping the benchmark as the Mahaweli River which is the longest river in Sri Lanka (310km). Mahaweli Authority of Sri Lanka was given very high legitimate power to undertake any kind of development activity in the Project Area.

Major components of the programme were; Providing irrigation facilities for dry zone by developing new lands in Mahaweli system B, C, H, L, and rehabilitate existing systems D, E, F etc and the conveyance system for agriculture, Generation of hydro-electric power, Ensure drinking water for major cities located in the basin or it's vicinity,

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Settlement of displaced and landless families by providing required economic and social infrastructure for human habitation, Providing marketing facilities for agricultural produce and social facilities for sports, cultural and religious purposes. Broad objective was holistic development of the area/country.

1.2 Project Funding/Output

Accelerated Mahaweli Development Programme (AMDP), was implemented with the donor assistance from all the major donors such as World Bank, European Commission, JICA, OECF(JBIC) , SFD, Kuwait Fund etc totaling amount approximately SLR 90 billion (year 2000). At the end of the AMDP following physical output were generated.

- Five Major Dams(03-Rockfill Dams + 02 Concrete Dams.)
- Trans-basin Canals/ Anicuts-02 Nos.
- Irrigation Canals (All Types)-8350km
- New Irrigable Lands-120,000Ha
- New Roads(All Grades A, B C &D)-1350km
- New Schools –310Nos
- Other Service Buildings-592Nos

Maduru-Oya

1.3 Significant Achievements of Mahaweli Authority of Sri Lanka under the AMDP.

- At the end of the AMDP, Power generation capacity of the country was increased by 137% with the operation of above 5 major Multipurpose Dams which broadly regulate water for irrigated agriculture and generation of Power. Cumulative value of electricity generated by Mahaweli Power Stations are Rs. 87 billion(year 2000). Mahaweli Energy/Power Contribution - 55 % of National Requirement (1994-95)

- Newly developed Mahaweli Lands cover 16% of the Total Paddy Cultivation Area of the Country. But Mahaweli Contribution is 25 % of the National Rice Production. This indicate high productivity of the Mahaweli Lands. Cumulative value of crops (Paddy/OFCs) produced by Mahaweli lands were Rs 94 billion(year 2000)

1.4 Diversification of the Role of the Institution , MASL

As implementing agency Mahaweli Authority of Sri Lanka has now passed more than two decades and for the sustainability perspective GOSL has decided to transfer it's role from implementation to management . Therefore Now Mahaweli Authority of Sri Lanka moving towards River Basin Management to address related to sustainability:

- Inter-Sectoral Allocation of water resources among diverse users/uses.
- Management of Multi-Purpose Water Infrastructure.
- Watershed / Water Quality/ Riverine Management.
- Reliability of Water Availability to meet all demands.
- Demand Management through conservation measures.
- Impacts on Environmental and Health concerns.
- Institutional Development - Public - Private sector Partnership, awareness creation and education.

1.5 Water Quality Mangement of Mahaweli and it's Adjacent Basins.

Water Quality Management is one of the key area which was taken renewed focus under the new role of MASL. Und er the Mahaweli Program 120,000Ha of new lands were developed for irrigated agriculture of which System-H covers 31,500 Ha which is located in the Kala

Oya Basin. Since there are key signs of water pollution in most of the natural water bodies MASL decided to commence water quality assessment studies in the Mahaweli and Adjacent river Basins. To begin with Kala-Oya Basin (KOB) was selected as pilot project.

2.0 Water Quality Assessment –Kala Oya Basin.

Land use plan shows clearly that major part of the basin is covered by agricultural lands and there were two main objectives of the assessment study.

(i) Identify ecologically important ecosystems in the basin, which are under stress due to water quality problems and recommend measures for their sustainability.

(ii) Identify how far WQ parameters vary from BM limits and recommend measures to mitigate current and potential threats on the performance.

2.1 Scope of the Water Quality Assessment Study

Identification of ecosystems under stress due to water quality [objective (i)] requires an assessment of water quality inputs to such systems over a sufficient period of time so that seasonality and trends can be clearly determined. For this assessment entire basin was divided into three sub-basins namely upper, middle and lower . The 33 sampling stations were established covering all 3 sub basins and just over one year of monthly

records provided adequate special and temporal space to develop a useful picture on water quality related problems of the Kala Oya Basin.

The data for the water quality status assessment were obtained from three sources. They are a) Water quality data from previous studies made by University of Colombo (b) Water quality measurements made by the various Consultants, and (c) Field observations that provide information on water quality. Field observations are based on three types of indicators: Biotic, Aesthetic and Chemical. Biotic indicators are based on established links between water quality and fauna, Aesthetic indicators are based on visual factors such as clarity, colour, etc., and Chemical indicators included DO, pH and Salinity.

2.2 Waster Quality Assessment Objectives, Tasks and Methodology

Table-1

Objective	Task	Methodology
Identify ecologically important ecosystems in the basin, which dare under stress due to water quality problems and recommend measures for their sustainability	Identify the water quality criteria for sustainability of different ecosystems in the "Kala Oya" Basin	Ambient water quality guidelines are used as the water quality criteria for sustainability

2.3 Freshwater Eco-Systems

According to the Central Environmental Authority of Sri Lanka there are six classes of water uses (CEA, Guidelines, 2003) as follows.

1. Nature conservation
2. Drinking with simple treatment
3. Bathing and Recreation
4. Fish and Aquatic life

5. Drinking with conventional treatment
6. Irrigation and Agriculture

The water quality status of the fresh water ecosystems are evaluated using the ambient water quality criteria that best describe the water quality requirements for each ecosystems. Following table-2, reports the water quality criteria for freshwater systems for different classes of water uses. Additional water quality requirements for agro-ecosystems are defined in FAO (1985) report.

Table-2

Water Use Class	pH		Con.	Turb.	DO	COD	P	F	SAR	SO_4	C1
	Low	High									
1	6.0										
2	6.0	8.5		5	6	15	0.7	1.5		250	200
3	6.0	9.0			5	20	0.7				
4	6.0	8.5			3	15	0.4				
5	6.0	9.0			4	30	0.7	1.5		250	200
6	6.0	8.5	700		3		0.7		6-15		

Except for nature conservation, water quality requirements for other uses have been established.

2.4 Water Quality Status

2.41 Human habitat

The surface water bodies that supports human habitat includes Kala-Oya and Streams that connect to it as well as Natural Ponds, Irrigation Tanks and Canal System in the area. Domestic uses such as Drinking and Bathing are important uses of the surface water-bodies in the basin. The area is poorly served in terms of pipe borne water supply. Therefore the people depend on surface sources including consumptive uses.

The Water Quality of Kala Oya Basin was evaluated keeping the above-mentioned ambient requirements as bench mark values. Analysis was done based on the monthly records collected during the period of October, 2002 to December, 2003.

3.0 Results/Outcome of the WQ Assessment Study.

During the study it was made effort to measure the number of violations of each parameter against ambient values of sampling points established in Upper, Middle and Lower sub basins of KOB respectively. Results are given in the Table-3.

Table-3

Water Use Class	Basin Location	Water Quality Parameter No of Violations							
		DO	COD	pH(L)	pH(H)	So_4	Tur	P	F
Drinking with simple treatment	Upper	32	38	0	9	0	94	37	0
	Middle	53	75	0	34	0	115	59	13
	Lower	54	69	0	27	0	73	42	1
Bathing	Upper	16	28	0	0			37	
	Middle	28	49	0	11			59	
	Lower	29	44	0	8			42	
Drinking with conventional treatment	Upper	9	8	0	1			37	0
	Middle	17	14	0	12			59	13
	Lower	15	14	0	8			42	1

3.1 **Drinking Water with Simple Treatment**

Drinking Water with Simple Treatment is the most stringent of the water quality criteria for human use. As illustrated in table-3 lower limit for pH and sulfate concentration do not violate this requirement throughout the basin.

The complexity of comparison between different reaches of the basin was reduced using a Water Quality Index, which is given below. As stated above these results indicate continued deterioration of water quality along the Kala Oya towards its lower reaches. The increase in the index values from the upper to middle basin is higher than the increase from middle to lower reach. Therefore, it can be reasonably concluded that the pollution is high in the middle region compared to upper and lower regions.

3.2 Agro-Ecosystems – Irrigated Agriculture

Major part of the lands were converted to the agricultural lands under the Mahaweli Development Project , we had to focus more on the impact of agricultural inputs on Water Quality of KOB and take remedial action on it. Following are the key parameters considered to understand the quality of water with new agricultural inputs.

a) Salinity
b) Water Infiltration Rate
c) Ion toxicity
d) Excessive nutrients

a) The water quality data show that conductivity is less than 0.7 dS/m for most of the sampling stations. It can be concluded that water salinity does not affect the irrigation system.

The recommended pH range for irrigation water is 6.5 to 8.5 . Reported pH values are higher than 6.5 for the 33 sampling stations throughout the year. Therefore acidity in irrigation water is not an issue. In general it can be concluded as pH is within the acceptable range for most parts of the basin throughout the year.

The conductivity and the Sodium Adsorption Ratio (SAR) together affect the infiltration of water into soil structure. Accordingly both parameters are used together to evaluate the irrigation water.. This study uses only the SAR values to evaluate the impact of irrigation water on the infiltration capacity following the procedure explained in FAO 1985. Accordingly, severe infiltration problems can be expected at 7 to 8 sampling stations and moderate infiltration problems are expected at all other sampling stations.

3.21 Fresh Water aquatic ecosystems

According to the result the major water quality problem is the Phosphorus content. This parameters is violated in a significant manner across the basin and through out the year. Although COD is somewhat frequently violated the frequency of violation of Dissolved Oxygen is less. The results show rapid deterioration of water quality in middle basin.

3.3 The Seasonal Behavior of water quality violations.

As illustrated in the study an important drop in water quality violations is seen in October- December periods. Also a drop in WQ violations can be seen around April-June period. The October –December is the main wet season resulting annual floods. April – June is also a wet season with relatively high rainfall. Therefore, data indicates important water quality improvement associated with floods and high rainfall. Therefore water quality of the system shows seasonality in association with rainfall and water quality improves with the rainfall. Therefore, it is evident that dilution plays a major role in water quality improvement.

The visual inspection of individual parameters showed an improvement in DO levels and drop in concentration of COD, P during the wet periods. Turbidity does not illustrate a major difference between months.

3.4 **Geographic Variation**

The results show that ambient water quality requirements are violated through out the basin. Water Quality Index was used to compare the violations between upper, middle and lower reaches of the basin. The result indicates two aspects about the water quality violations of these geographic areas.

WQ Index values show major increase from upper to middle basin, comparatively the increase from middle to lower basin is less. Accordingly, it can be reasonable to argue

that water quality is significantly impaired in the middle basin and remain so in the lower basin with slightly more deterioration. Middle basin is the most populated extensively cultivated of the three geographic regions considered. Therefore it is expected that most of water quality deterioration to take place in this Middle Basin of KOB.

4.0 Conclusion.

During the design and implementation stage of Mahaweli Development Program these significant impacts on water quality and as a result of that the negative impact on human health would not be forecasted . Majority of the issues has arisen due to human activities and negligence . For example excessive use of agro-chemicals and fertilizer for their crops and allowing large part their inputs to be washed away (without their knowledge) and flows to surface water bodies in the same system can be highlighted.

After the transformation the role of Mahaweli Authority of Sri Lanka from development to management , it has focused more on conservation and long term sustainability of the system. This pilot is a beginning of such initiation. Based on the out come of this study number of environment management programs are now being planned by MASL.

Reference: Water Quality Assessment of Kala-Oya , RBP&MD of MASL.

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