

Effects of catchment characteristics and landuse practices on
water quality of Kotmale, Victoria, Randenigala, & Rantambe
reservoirs using GIS.


By

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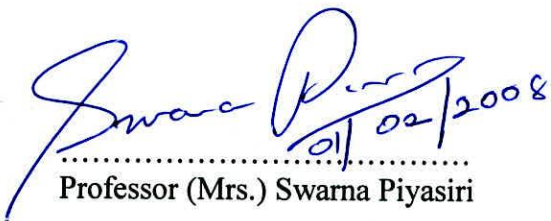
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"The work described in this thesis was carried out by me under the supervision of Professor (Mrs.) Swarna Piyasiri and Professor K.W.D. Nandalal and a report on this has not been submitted in whole or in part to any university or any other institution for another degree".


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“We certify that the above statement made by the candidate is true and that this thesis is suitable for submission to the University for the purpose of evaluation.”


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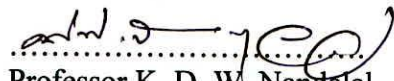

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ABSTRACT

The Upper Catchment of Mahaweli Ganga is located within the mountainous core of the central highland of Sri Lanka, which covers 3110 km²; about 29.8 % of the Mahaweli river basin, and 4.5 % of the country. Study area of the present investigation is the Upper Mahaweli catchment and the four major hydropower reservoirs, namely Kotmale, Victoria, Randenigala and Rantambe. The water quality of the reservoirs was investigated since 1987 and the results indicated deterioration of water quality of the reservoirs with the time.

The main objective of the present study was to find out the effects of land use patterns and the interactive catchment characteristics, on water quality of Kotmale, Victoria, Randenigala & Rantambe reservoirs using GIS as an analytical tool.

In order to achieve the objectives, the physical, chemical & some biological data of the reservoirs were analyzed to identify the major water quality problems of the reservoirs and the analysis of catchment characteristics was conducted to find out the effect of catchment characteristics on the water quality deteriorations.

The water level fluctuations of the three reservoirs played an important role in the lake metabolism. During monsoons the reservoir water levels were high with the tendency for direct stratification whereas there was a tendency for mixing during droughts due to drop down of water levels. However Rantambe reservoir was subjected to frequent mixing due to its shallow nature.

Secchi depth transparency values of the four reservoirs were 1.8-2.5m in Kotmale, 2.3 to 3.2 m in Victoria, 2.8-4.1 m in Randenigala & ≤ 1.0 m in Rantambe during the 15 year investigation period. Out of the four reservoirs, Kotmale reservoir was the most sensitive reservoir towards eutrophication & Rantambe indicated high turbidity due to soil erosion in the catchment. Randenigala indicated mesotrophic to oligotrophic condition.

The vertical temperature readings indicated the direct thermal stratification in Kotmale, Victoria & Randenigala reservoirs. However there was no thermal stratification in Rantambe reservoir due to its shallow nature. In Kotmale, Victoria and Randenigala reservoirs, Dissolved Oxygen concentrations at the bottom region dropped below 1 mg /l during 1990 & 1991 sampling periods. The dissolved Oxygen concentration in Rantambe at the bottom region was well above 3 mg/l. The mean conductivity values indicated an increasing tendency with their altitudes from Kotmale to Randenigala. In Kotmale, Victoria & Randenigala reservoirs, pH values of the surface waters indicated values expected from natural fresh water bodies. However the pH values of the bottom hypolimnetic waters indicated slightly acidic conditions. Alkalinity of the four reservoirs ranged from 0.2 to 1.2 mg/l. and the total carbon dioxide levels ranged from 0.2 – 1.8 mg/l. There was an increasing trend of hardness with decreasing altitude of the reservoirs, which ranged from 0.2 – 1.2 m mol/l. Chloride levels in the four reservoirs closer to the dam varied from 6 – 15 mg/l. Sulphate fluctuations closer to the dam region of the reservoirs ranged from 0.2 – 2.5 mg/l. Distribution of Nitrate along the vertical profile of the reservoirs closer to the dam indicated increasing trend with the time indicating nutrient loading effect. Phosphate concentration closer to the dam of the reservoirs ranged from 0.1 – 0.7 μ g/l. Distribution of Nitrite of the reservoirs indicated increasing tendency with the time.

Out of the tributaries of Kotmale reservoir, the Kotmala Oya tributary indicated high Nitrate values of 0.8 to 1.2 mg/l and 0.7 to 1.37 mg/l by Kuda Oya indicating their contribution towards nutrient loading effect during the 15 year investigation. Most of the tributaries in left & right banks indicated high Phosphate levels. Tributaries in the right bank of Victoria reservoir indicated significantly high alkalinity, chloride,

conductivity , hardness, nitrate, nitrite, phosphate, pH, total carbon dioxide and turbidity compared to the left bank tributaries.

According to the GIS analysis of the morphometric features of the catchments of the reservoirs, (based on catchment area, compactness factor bifurcation ratio, length of overland flow, drainage density, perimeter etc) the highest effects towards water quality deterioration was indicated by the Rantambe catchment & the least effect from Randenigala reservoir catchment. Other natural factors such as rainfall, geology, and soil characteristics, and anthropogenic activities such as population density, waste density, changing land use pattern indicated a significant influence on the water quality according to the GIS analysis of the catchment characteristics.

Based on the analysis of digital data of UMC area, soil erosion of the catchments indicated an extent of 70.37 km² of extremely high erosion, 307.0 km² of very high erosion, 716.19 km² of high erosion and over 1065 km² of moderate erosion areas. Low erosion areas were distributed over 949.62 km² of the four catchments.

The overall analysis of the digital data of natural & anthropogenic activities of the four catchments indicated the potential for the deterioration of water quality of the reservoirs due to catchment characteristics & the land use practices.