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OPERATIONAL POLICY OF THE RESERVOIRS IN MALWATHU OYA RIVER BASIN TO MINIMIZE FLOOD DAMAGES IN ANURADHAPURA, VAVUNIYA AND MANNAR DISTRICTS IN NORTHERN SRI LANKA

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ABSTRACT

The need for water is universal. It is present everywhere, and without water, life, as we know it, will simply cease to exist. Water is constantly in motion, passing from one state to another, and from one location to another, which makes its rational planning and management a very complex and difficult task under the best of circumstances. Water may be everywhere, but its use has always been constrained in terms of availability, quantity and quality. When the quantity of flood water released from the reservoirs in the upper catchment of Malwathu Oya river basin reaches a certain level, social, economic and environmental damages occurs to the people living in the downstream of the reservoir area. Further unplanned human activities in the Malwathu Oya river bank area crate a threat on the natural bio diversity of the river. It is essential to create a master plan to in cooperate construction of buildings for various purposes, crop production, livestock and tourism. To address these effects a study is being carried out. It gives a scientific emphasize on the necessity of modified / improved reservoirs operation.

1.0 INTRODUCTION

The Malwathu Oya river which is also called Aruvi Aru at the lower reaches has a total length of 162 km. It is the second largest river basin in Sri Lanka. It originates at Ritigala Hills (766 m MSL) in the North Central Province and flows to the sea at Arippu in Mannar District. About 70% of the upper catchment of Malwathu oya is located in the Anuradhapura District while the lower catchment is located in Vavuniya and Mannar Districts. Though it is the second largest basin, the amount of yield from the basin is not very large as it is located in the dry zone. The upper catchment of Malwathu Oya is intercepted by five major reservoirs, namely Nachchaduwa, Mahakanadarawa, Nuwarawewa, Tissa wewa and Pavatkulam together with a host of medium / minor tanks. Currently Nachchaduwa, Nuwarawewa and Tissa wewa irrigation schemes are augmented with Mahaweli water diverted from Kalaoya basin through Kala Oya Yoda Ela.

The lower part of the basin is very dry as it lies in a semi –arid zone where the average annual rainfall is around 1000mm. There are two ancient reservoirs in the lowest reach of the basin namely Giants tank and Akathimurippu tank in the right bank and left bank respectively of Malwathuoya. These two tanks are fairly shallow as they lie in a very flat terrain and have large water spread areas.

However in 2011/2012 and in December 2014 upper catchment of Malwathu Oya received comparatively high rainfall. Subsequently all the reservoirs started spilling and spill gates were opened according to the standing orders. Due to the accumulation of spill water of the major reservoirs in the basin, water level of Malwathu Oya increased unexpectedly. Due to this,

- Major part of Anuradhapura city went under water.
- Part of Vavuniya district specially Venkala Cheddikulam area inundated.
- Main land of Mannar District were severely affected as all flood water flows through this area even though it received not very high rainfall.

As a result, social, economic and environmental damages occurs to the people living in the area.

2.0 LITERATURE REVIEW

The specific objectives of this study are

- Demarcating the boundaries of water spread area along Malwathu Oya at selected locations with time of operation of the major reservoirs located at upper catchment of Malwathu Oya.
- Identifying the pattern of flood water with related to operation of major reservoirs during North East monsoon.
- Identifying cultivation programme / cultivation performance of all the reservoirs in the Malwathu Oya river basin.
- Tabulating a correlation between the flood water level at selected locations and the reservoir operations.
- Suggesting improved operational procedures for the major reservoirs.
- Demarcating differential flood zone in the Malwathu Oya river basin after regulating the operation of the major reservoirs.

3.0 LITERATURE REVIEW

3.1 River flow Management

Batalla (2000) says the effects of a given reservoir on flow regime will depend on its capacity in comparison with river runoff, its purpose (e.g. irrigation diversions, hydro electric generation, flood control), and its operating rules, precluding simple generalizations about the post-dam discharge distributions.

In the case of reservoirs built for flood control, a consistent relationship between degree of impoundment and change in flow variables can be expected. However, for reservoirs built for irrigation and hydroelectric generation, we should expect the relation to be noisy because flood reduction is not a purpose and the volume of floodwater stored will be a function of how much water happens to be in the reservoir when the flood begins (Walker, 1985). Floods will tend to be reduced more in dry years and early in the season, when reservoir levels are lower. Moreover, it can be expected that reservoir effects are more pronounced in drier climates because of greater storage needs and greater likelihood that the reservoir will be drawn-down when floods enter.

Andrés Calizaya (2010) pointed out that the Integrated Water Resources Management has been recognized worldwide as the only currently feasible way to ensure a sustainable perspective in planning and managing water resources systems. It is the main reference for all water related activities in third world countries. Sufficient water supply might be considered to be one of the most important factors for improving quality of life in these countries.

3.2 Methods for Flood Analysis

Pistocchi explained the model package "River Analysis System" (RAS) by the US Army Corps of Engineers – Hydrologic Engineering Center (HEC) includes:

- a steady flow model
- an unsteady flow model
- the consideration of a wide range of hydraulic works, bridges, storage areas
- facilities for hydraulic design such as computation of localized scour at the piles of a bridge

Due to its capability of describing that wide range of physical processes it has proven very helpful in supporting all phases of river management planning.

4.0 METHODOLOGY

4.1 Study area description

The Malvathu River (Sinhalese: මල්වතු ඔය Malvathu Oya, Tamil: □□□□□ □□□ Aruvi Aru) is a 164 km (102 mils) long river in Sri Lanka, connecting the city of Anuradhapura, which was the capital of the country for over 15 centuries, to the coast of Mannar. It currently ranks as the second longest river in the country, with a great historic significance. The northern part of the river, and sometimes the whole river, was once been known as Aruvi Aru, given in Figure 4.1. The figure 4.2 shows the effect of heavy flood in the city of Anurathapura within the catchment of the Malwatta oya river basin.

4.2 Demarcating the boundaries of water spread area along Malwathu Oya at selected locations with time of operation of the major reservoirs located at upper catchment of Malwathu Oya.

Cross sections of water spread area at predetermined locations along Malwathu Oya is being collected using Digital Total Station and GPS. Spilling data and radial gate / flood gate operational data is collected from Irrigation Department.

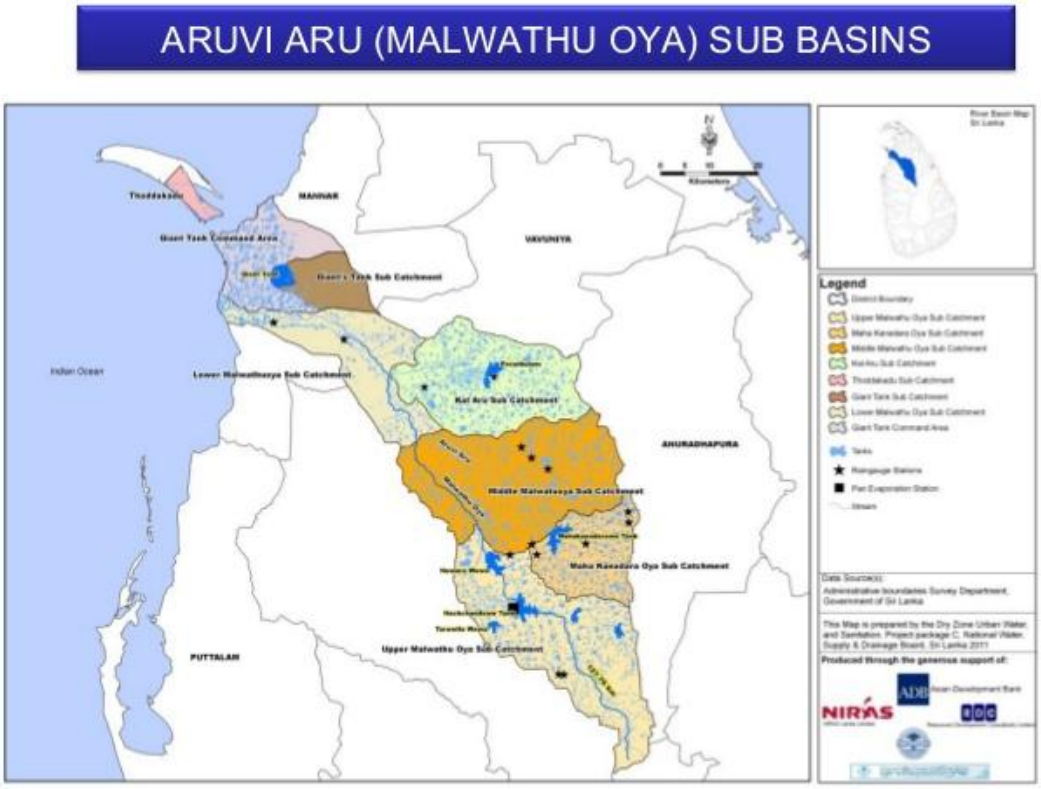

Figure 4.1. Study area – Malwathu Oya (Aruvi Aru) River Basin

Figure 4.2. Study area Anurathapura under flood in December 2014

4.3 Identifying the pattern of flood water with related to operation of major reservoirs during North East monsoon.

HEC-RAS model is being used to analyze the pattern of flood water with related to operation of reservoirs in the catchment of Malwathu Oya considering the existing reservoir network and the proposed reservoirs in near future which is shown in Figure 4.3 Considerable amount of water is transferred from Kala Oya basin to Malwathu Oya basin. This also will be considered in the flood water analysis.

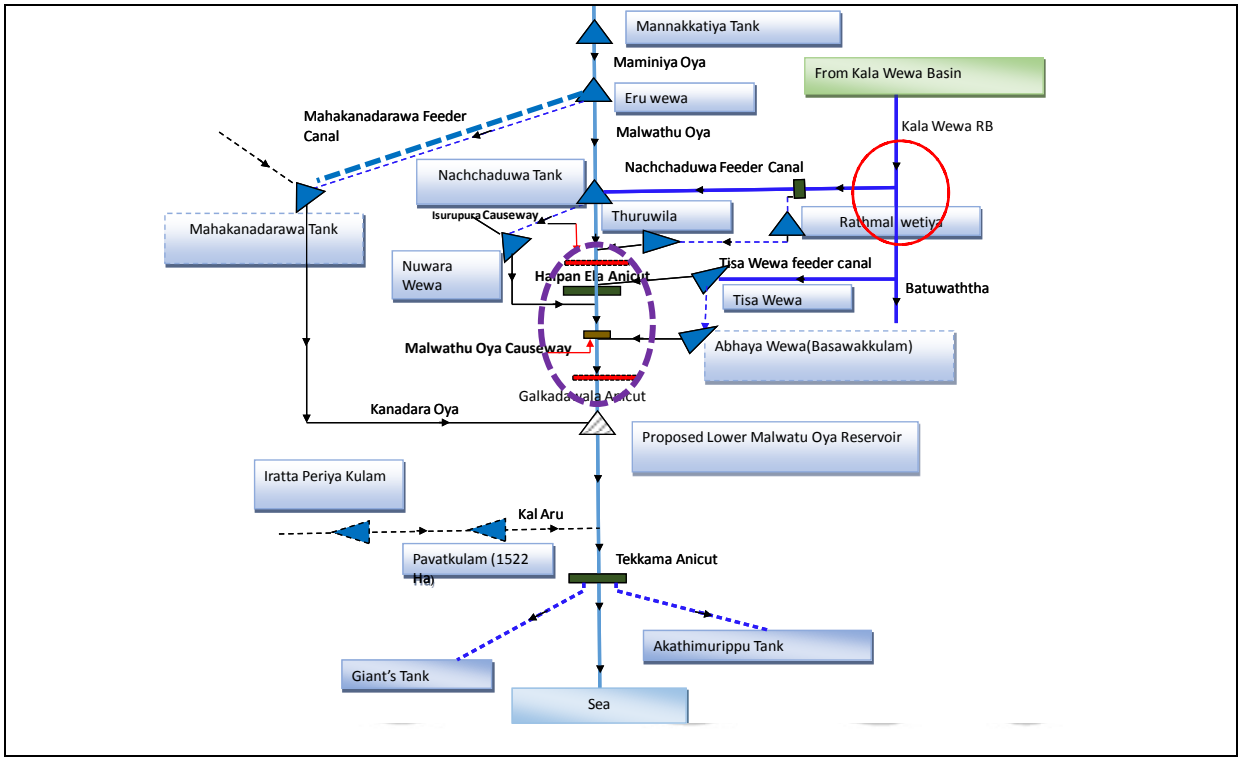

Figure 4.3. Main Reservoir network of Malwathu Oya river basin

4.4 Identifying cultivation programme / cultivation performance of all the reservoirs in the Malwathu Oya river basin.

Cultivation programme and cultivation performance of all major reservoirs for past 10 years are collected and the relationship between water level in the reservoirs during North East monsoon and the cultivation performance will be identified. This is used to identify the suggestion whether the reservoirs could be operated in a modified way to minimize the flood water levels in the downstream of reservoirs without affecting the cultivation performance.

4.5 Tabulating a correlation between the flood water level at selected locations and the reservoir operations.

Correlation between the flood water level at predetermined locations and the major reservoirs operation will be tabulated. Different scenarios will be considered to find out the minimum flood water level in the downstream of reservoirs. Modifications / improvements to existing standing orders also will be considered to find out the possibilities of minimizing the flood water level in the downstream of reservoirs specifically in Anuradhapura city, Venkala Cheddikulam area and main land of Mannar district.

4.6 Suggesting improved operational procedures for the major reservoirs.

Based on the results obtained above modified / improved operational procedures is being drafty suggested considering the entire major reservoir network and the cultivation performance?

4.7 Demarcating differential flood zone in the Malwathu Oya river basin after regulating the operation of the major reservoirs.

Inundation area with time of operation of reservoirs (spilling, radial gate / flood gate opening) is identified and marked in maps to provide advance information to general public and other interested parties.

5.0 Data Collection and Analysis

The following data are being collected for this research (for past 10 years)

- Daily Rainfall of upper catchment of Malwathu Oya river basin
- Daily water levels of the Major reservoirs in Malwathu Oya river basin
- Radial gates / flood gates opening of the major reservoirs
- Standing orders for operation of these major reservoirs during North East monsoon
- Cross section of Malwathu Oya at selected locations
- Flood level of Malwathu Oya during 2014 December in selected points
- Cultivation programmes and Cultivation performance of all the reservoirs in the Malwathu Oya river basin

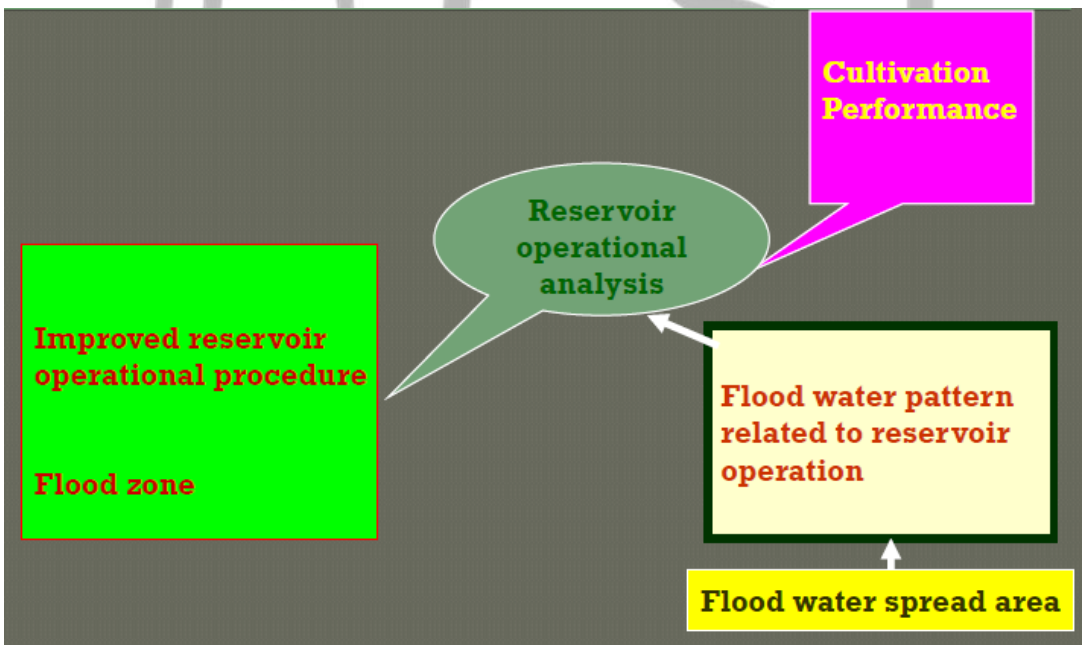

Figure 5.1. Schematic diagram of analysis

Flood water level analysis are carried out for predetermine sample points selected already. Data collected for past years are correlated with reservoir operation system. All these data are first analyzed for consistency and put in to the model formulated to get the good correlation. Formulated model to represent the reservoir operation in the entire river basin is calibrated and validated. This model is used for various studies related to reservoir operational strategy for different conditions.

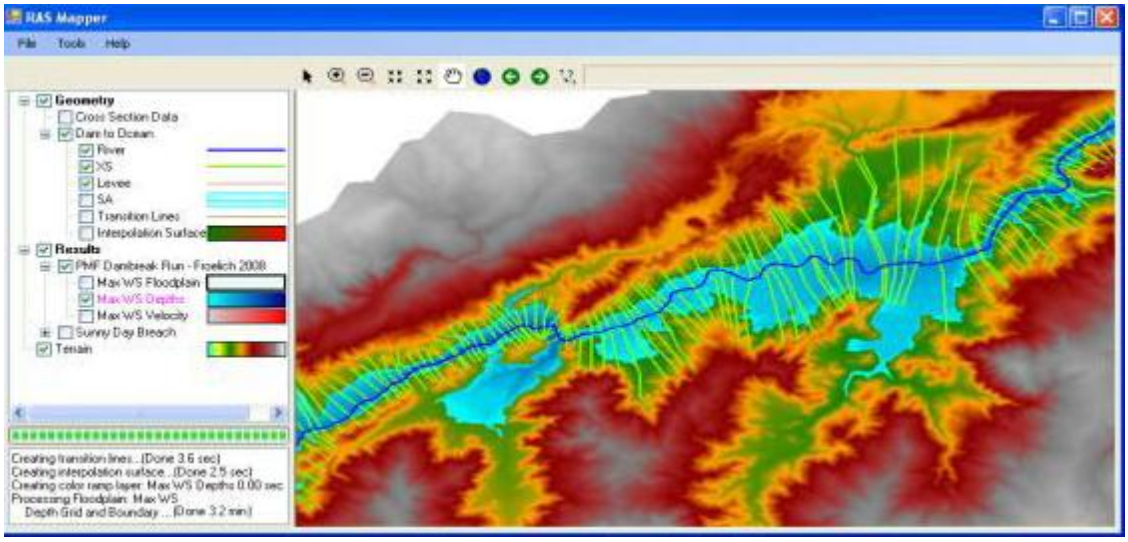

Figure 5. HEC-RAS model analyze the pattern of flood water with related to operation of reservoirs

6.0 RESULTS AND DISCUSSION

There is a direct relationship between the operation of major reservoirs in the upper catchment of Malwathu Oya and the level of water in Malwathu Oya during Norst East monsoon period. Finding the flood water level with time and the integrated operation of the major reservoirs will minimize flood damages in Anuradhapura, Vavuniya and Mannar Districts. The final results of the study will facilitate to understand the flood water level at selected locations along Malwathu Oya during North East monsoon. Through this study the importance of timely operation of radial gates / flood gates of the major reservoirs in the upper catchment of Malwathu Oya. Modification and improvements to the existing standing orders to the reservoir operation is suggested. Flood damages to the downstream of reservoirs will be minimized by understanding the reservoir operation considering integrated water resources management at river basin level. When the water resources are managed in the river basin level social, economic and environmental damages due to flood water will be minimized. Finally land and water productivity will be increased due to technically improved reservoir operation.

7.0 RESULTS AND DISCUSSION

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