IMPACTS OF LOWERING RIVERBED ON WATER DEPTH DUE TO SAND MINING IN THE KELANI RIVER; REVIEW, NEW PERSPECTIVE, AND MODELLING

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1. INTRODUCTION

Environmental adverse impacts due to sand mining are reported in most regions. The adverse environmental impacts include river morphology changes, water and soil quality degradation, salinity intrusion, ecological changes, and riverbank and coastal erosion. The sand extraction from the major rivers along the west coast including the Kelani River, Ma Oya, and Kalu rivers is far more than the excess sand supply from their upstream, resulting in the sinking of the riverbed, impacting drinking and irrigation water supply, and lowering the water table. Further, coastlines are subjected to erosion because of the hindering river and inland sediment flows. The previous study revealed that the declined sand supply from the Kelani River, Ma Oya, and Kalu Ganga caused coastal erosion corresponding to approximately 5 – 6 hectares of land loss annually. The Kelani River was selected to study the impact on streamflow due to the declining riverbed.

2. SAND MINING IN SRI LANKA

In Sri Lanka, the sand demand has been increasing since the early1990s and has leaped significantly following the Indian Ocean Tsunami of 2004. As per the estimates by the Geological Survey and Mines Bureau (GSMB) of Sri Lanka which can be considered as best estimation, the current total annual sand demand is about 48.4 million cubic meters and is expected to increase to 63.2 million cubic meters in 2025 (Wickramasinghe, 2022) with an annual demand growth rate of 10%. Over 95% of sand demand by the construction industry relies on river sand (Gunaratne, 2015). In Sri Lanka, sand mining activities are practiced under the license system issued by GSMB according to the Mines and Minerals Act No. 33 (1992) of Sri Lanka. However, the study by (Weerakon et al., 2020) based on the theoretical usage of sand using sand to cement ratio since 2017 found that sand consumption is higher by 69% than the licensed mining amount by GSMB. The shortage of sand covers through illegal sand mining causes huge problems in the Sri Lankan Rivers. 40% of national sand demand is responsible for the Western province including Colombo, the capital of Sri Lanka, and supplies mainly by Kelani River and Ma Oya (Gunaratne, 2015). Fig. 1 illustrates the actual licensed sand mining quantity with the sand demand and illegal sand mining quantity based on the theoretical percentage of the difference between sand supply and demand. As per Fig.1, the shortage of sand for Sri Lanka's construction industry will be intensively increasing if alternative material is not promoted.

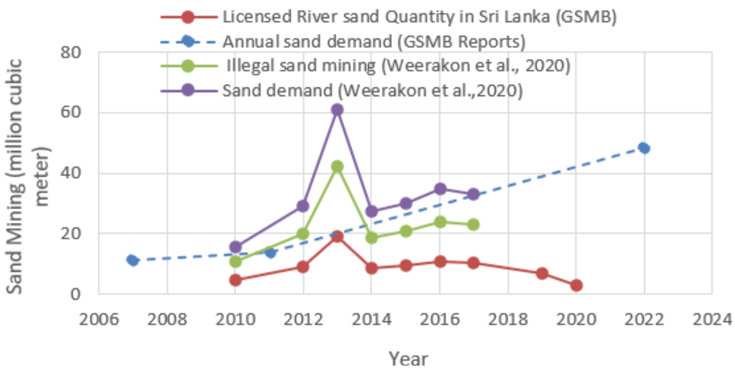

Fig. 1: Sand demand and Licensed River sand amount in Sri Lanka

3. IMPACTS OF LOWERING RIVERBED ON WATER DEPTH

3.1 Study Area

Kelani River is one of the major rivers in Sri Lanka which origins from central hills above 2,200 MSL and flows towards the west coast through Colombo Capital of Sri Lanka. It provides 80% of the drinking water necessity in Colombo. 25% of the country's population inhabits its basin with an extent of 2,314 km^2 located completely in the wet zone. Kelani River basin (Fig. 2.) is divided naturally based on terrains such as the mountainous upstream and downstream flood plain. Downstream is highly vulnerable to floods. Kelani river has been a major sand supplier nationwide since the early 1960s. Although sand mining operates under a licensing system by imposing periodical suspension or limitation to maintain the sustainability of the river, it is not effective due to excessive illegal sand mining.

3.2 Riverbed profile change

Fig. 3. shows the Kelani riverbed profile in 1961, 1988, 2005, and 2016. The riverbed in 1961 can be considered the natural river profile with a natural slope of 1/4167 m/m from Hanwella to sea outfall. From 1988 to 2005, the riverbed slope was in the range between 1/6250 m/m and 1/6667 m/m. However, according to the riverbed in 2016, the riverbed flattened to a slope of 1/7692 m/m and lowered by approximately 4.3 m with respect to the riverbed in 1961.

Keywords: Sand mining impacts, Sri Lanka, Kelani River, Sand supply, Sand demand
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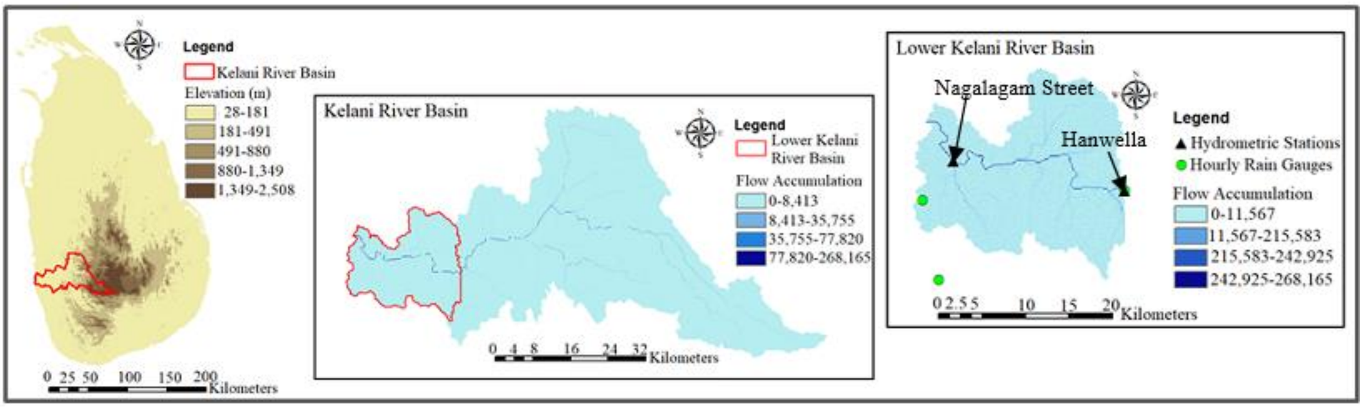

Fig. 2: Study Area, Kelani River Basin

It leads to a rise in downstream flood risk. The Kelani Riverbed sinks by 10 cm each year due to excessive sand mining (Abeysinghe & Samarakoon, 2017).

3.3 Water depth at Nagalagam Street for 10- and 50-year floods with riverbed lowering effects

Using the developed RRI model for the Lower Kelani River basin by (Sudeshika & Rajapakse, 2021), the variation in water depth at Nagalagam street was modeled considering the riverbed sink by 10 cm each year. Actual river geometry has been used to simulate the 2016 flood event. As per the results shown in Fig. 4, there's no significant impact due to lowering the riverbed on water depths of 10 and 50-year floods for the considered period from 2001 to 2016 due to sand mining.

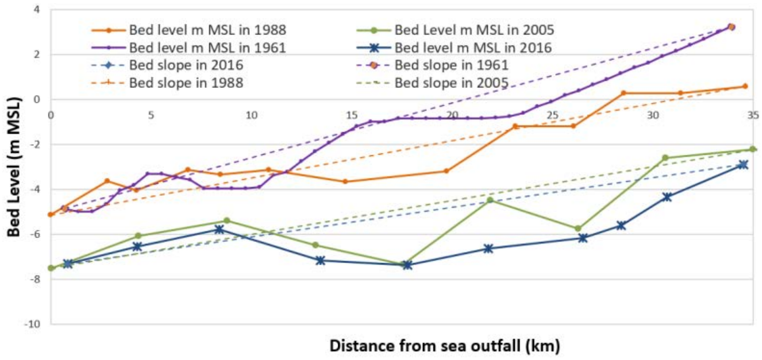

Fig. 3: Riverbed profile in 1961, 1988, 2005, and 2016

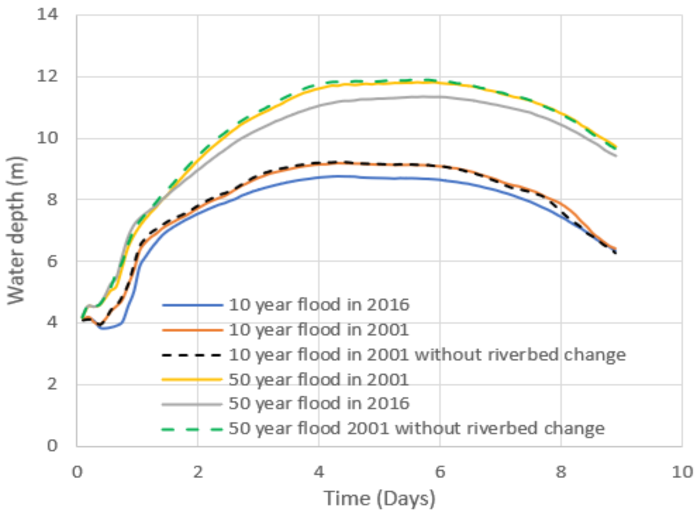

Fig. 4: Water depth variation at Nagalagam Street

4. CONCLUSIONS

Due to excessive sand mining, the Kelani riverbed has flattened and drastically lowered below Hanwella compared to the approximate natural riverbed in 1961. No considerable impact of lowering the riverbed on water depths of either 10 or 50-year floods. However, the shortage of sand will be increased exponentially in Sri Lanka. Therefore, the method to project river morphology changes should be developed to mitigate the adverse environmental impacts due to sand mining.

5. REFERENCES

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