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Improving flood management through future reservoir development and operation in the Tonle Sap largest tributary

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Introduction

Sen River Basin, which is the largest subbasin of Tonle Sap Lake Basin, has a large potential for dam development. Assessment of dam development and operation is quite profitable to the society, economy, and livelihood in the study area due to the rise of irrigation areas and reducing flood and drought impacts. Particularly, the proposed and ongoing dams along Sen River, which are medium-scale dams, are expected to reduce peak flow during the rainy season and increase discharge flows in the dry season.

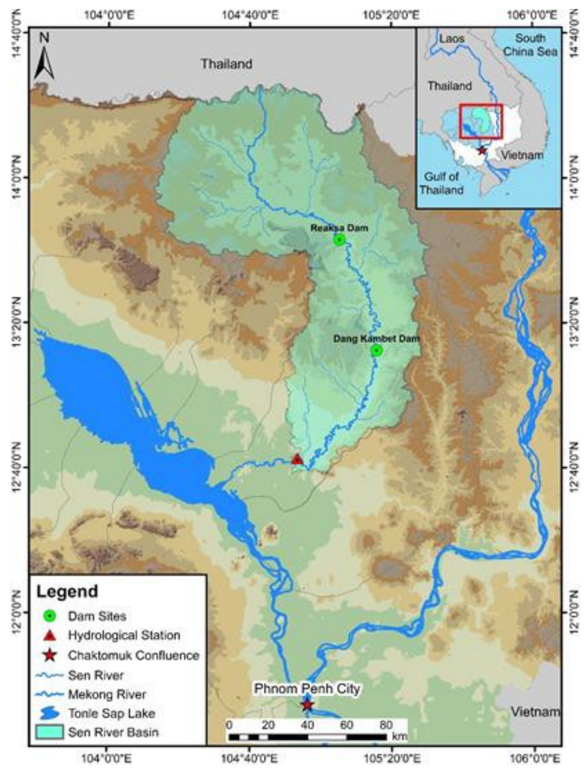

Fig. 1 Sen River Basin, tributary of Tonle Sap Lake

This study aims to assess the variation of peak flow at the downstream of the basin due to ongoing and future dam development and operation in Sen River.

Method

The impacts of dam development and operation on flow regimes was simulated using a semi-distributed and semi-physically based model, SWAT (Winchell et al., 2007) integrating with the HEC-ResSim model (Klipsch and Hurst, 2013). The simulation was based on the daily rainfall data from 1996 to 2019 throughout the basin from Tropical Rainfall Measuring Mission which were bias-corrected using linear scaling along with 3 stations of observed rainfall from 2011 to 2019. These data sets were input into the SWAT model for simulating daily flows at various locations within the basin.

Simulated flow from SWAT model were then used as inputs to the HEC-ResSim model to simulate regulated flows. A baseline scenario (BL), definite future scenario (DF) and indefinite future scenario (IF) were simulated to access the degree of changes inflows and to elucidate discussion on environmental, social, and economic effects. The target water level for multipurpose was defined by seasonal variation operation rule. These scenarios and operation aim to illustrate the possible range of the variation of flow patterns.

Table 1. Physical characteristics of Reaksa and Dang Kambet dams

Parameters	Reaksa	Dang Kambet
Easting	509593 m	528501 m
Northing	1516593 m	1460293 m
Catchment area	7,838 km^2	10,770 km^2
Dam crest length	7,900 m	3,564 m
Dam height	14 m	17.5 m
Full reservoir level	54 m	36 m
Reservoir area	110 km2	262 km2
Gross storage	453 mcm	1,109 mcm
Dead storage	47 mcm	59 mcm
Live storage	406 mcm	1,049 mcm

Results and Discussions

Simulation flows for each scenario (BL, DF, and IF) were computed using seasonal operation rule. Results showing the seven-day mean annual low and high flows are presented in Table *2*. The results demonstrate that the dam development will significantly decrease the seven-day mean annual high flow. Obviously, the high flows at both dam sites decreases approximately 300 m^3/s. Conversely, the seven-day mean annual low flow does not yield significant changes in all observed locations.

The reduction in peak flow and percentage for the years of extreme flood events was summarized in Table 3. The monthly regulated flows for each year are projected to be deceased in the rainy season and increased in the dry season. Particularly, the flow regimes reduce significantly in the late rainy season especially during the 2011 flood event which decreases at least 30%. Similarly, the 2019 flood event reveals a notable reduction in peak flow in August and September. However, for the 2017 flood event, the flows are largely to be declined during the mid-rainy season. Alternatively, in the early-dry season, the flow alteration is likely to be increased, while the late dry season does not yield significant changes for each year of extreme flood events.

Table 2. Seven-day mean annual low and high flows for development scenarios

Location	Flow	7-day mean annual (m^3/s)		
		BL	DF	IF
Reaksa	Low	8	10	10
	High	547	200	200
Dang Kambet	Low	14	18	18
	High	728	451	390
Stung Sen Town	Low	24	29	28
	High	838	633	610

Table 3. Reduction in peak flow and percentage for the years of extreme flood events

Month	2011 m^3/s (%)	2017 m^3/s (%)	2019 m^3/s (%)
May	-2 (-4)	-8 (-9)	-2 (-4)
Jun	-2 (-2)	-2 (-1)	-1 (-1)
Jul	-3 (-1)	-183 (-39)	-8 (-7)
Aug	-58 (-15)	- 134 (-19)	-85 (-23)
Sep	-502 (-48)	-42 (-8)	-399 (-41)
Oct	-324 (-33)	-95 (-18)	35 (7)
Nov	32 (6)	67 (20)	90 (35)
Dec	85 (30)	119 (62)	137 (95)
Jan	1 (1)	34 (25)	74 (82)
Feb	1 (2)	1 (1)	1 (1)
Mar	0 (0)	0 (0)	0.3 (1)
Apr	-1 (-4)	0 (0)	0.3 (-1)

Conclusion

The development of dams in the mainstream will significantly alter the flow regimes at the downstream region. The wet season flows are expected to be decreased, whereas the dry season flows will be increased.

In August, the water in dams is kept at 40% (5.5m and 6.5m of maximum 14m and 17m for Reaksa and Dang Kambet dams, respectively) of the full water level before receiving heavy rainfall in September. With this operation, the 7-day mean annual high flow reduces around 25%, about 200 m^3/s, at the downstream area compared to baseline. The reduction in peak flow has significantly reduced the flood in the downstream.

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References

1) Klipsch, J., Hurst, M., 2013. HEC-ResSim Reservoir System Simulation User's Manual Version 3.1. May, 556.
2) Winchell, M., Srinivasan, R., Di Luzio, M., Arnold, J.J.U.s., Blackland Research Center, Texas Agricultural Experiment Station, Temple, 2007.