Changes in Flood Dynamics in the Lower Mekong River Basin Due to Upstream Flow Regulation

Yadu Pokhrel[1], Sanghoon Shin[1], Zihan Lin[2], Dai Yamazaki[3], and Jiaguo Qi[2]

[1]*Department of Civil and Environmental Engineering, Michigan State University, East Lansing, MI 48824, USA*

[2]*Center for Global Change and Earth Observations, Michigan State University, East Lansing, MI 48823, USA*

[3]*Institute of Industrial Science, The University of Tokyo, Komaba, Tokyo, Japan*

H21H-1723

AGU100 ADVANCING EARTH AND SPACE SCIENCE FALL MEETING Washington, D.C. | 10–14 Dec 2018

Correspondence: ypokhrel@egr.msu.edu

1. Introduction

- The Mekong river has been relatively unaltered by humans compared to other river basins of comparable size, but it is now undergoing unprecedented changes due to the construction of large-scale hydroelectric dams across the basin; a series of dams have already been built in recent years and 16 in the mainstream and over 100 in the tributaries are planned to be completed by 2030 (**Fig. 1**).
- In this study, we address the following two questions:
  1. *What is the role of seasonal flood pulse and TSR flow reversal in modulating the TWS variations in the MRB?*
  2. *What are the potential impacts of changes in flood pulse due to upstream flow regulation on river-lake flood inundation dynamics in the LMRB?*
- The modeling framework used comprises of a global hydrological model (**HiGW-MAT**[1]) and a river-floodplain routing model (**CaMa-Flood**[2]). GRACE data are also used.

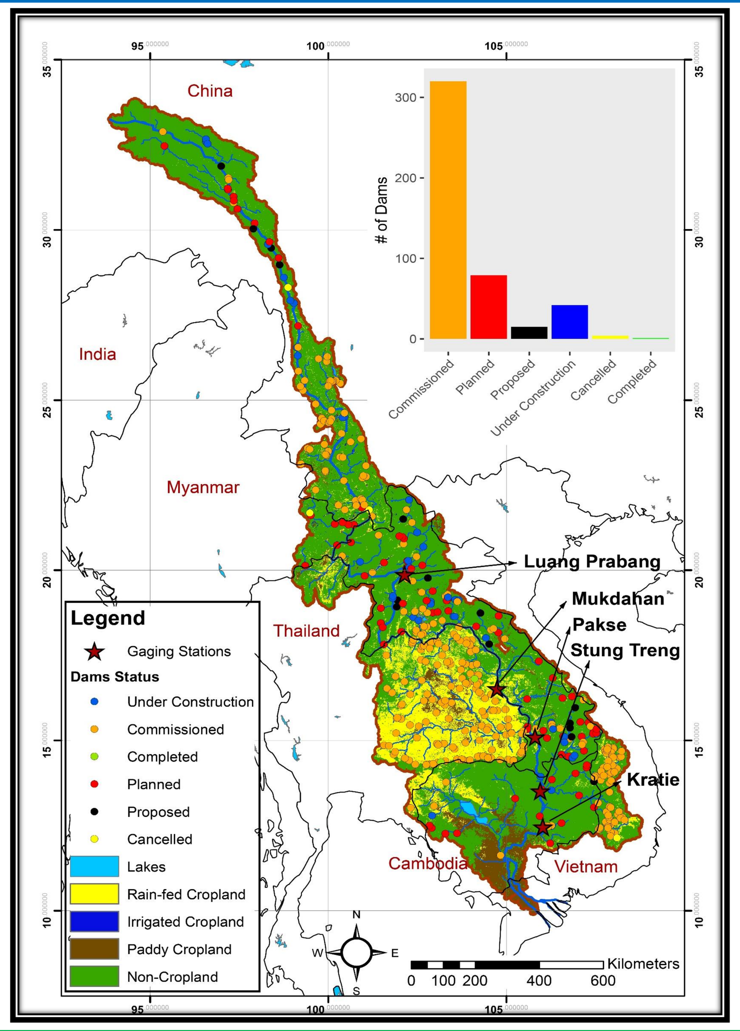

Fig. 1: *The Mekong River basin.*

2. Models: HiGW-MAT[1] (1°) and CaMa-Flood[2] (10km)

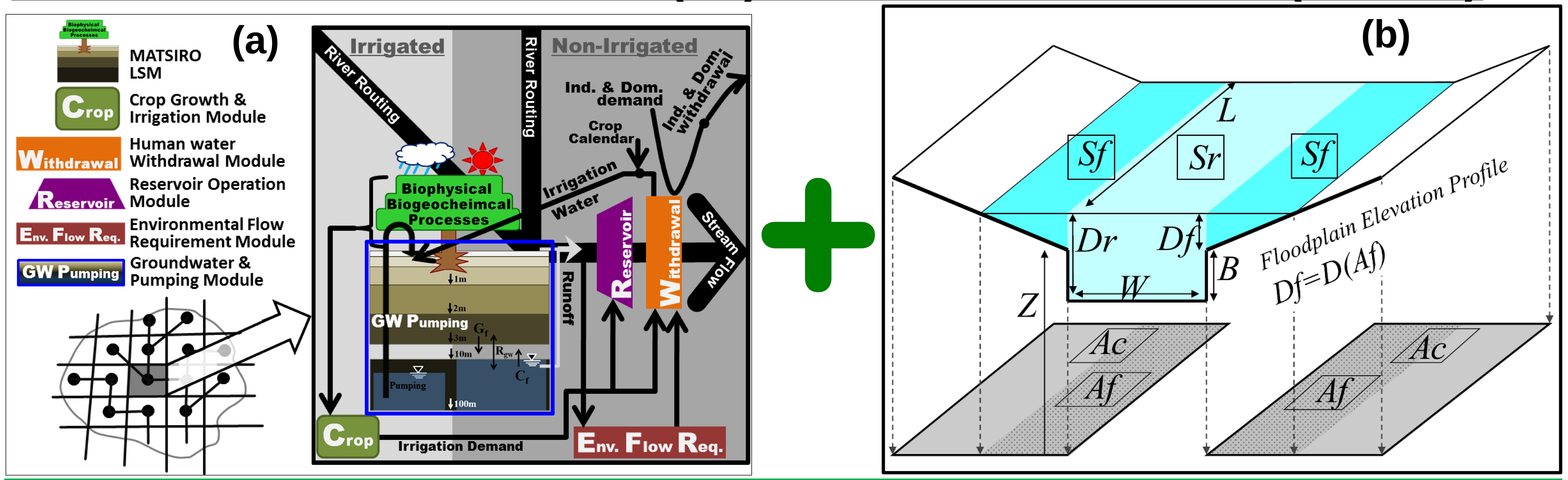

Fig 2: *A schematic depiction of various hydrological processes (soil moisture movement, crop, and groundwater dynamics) simulated by HiGW-MAT[1] model (a) and the schematic of the treatment of river-floodplain geometry in CaMa-Flood[2] model.*

3. Results

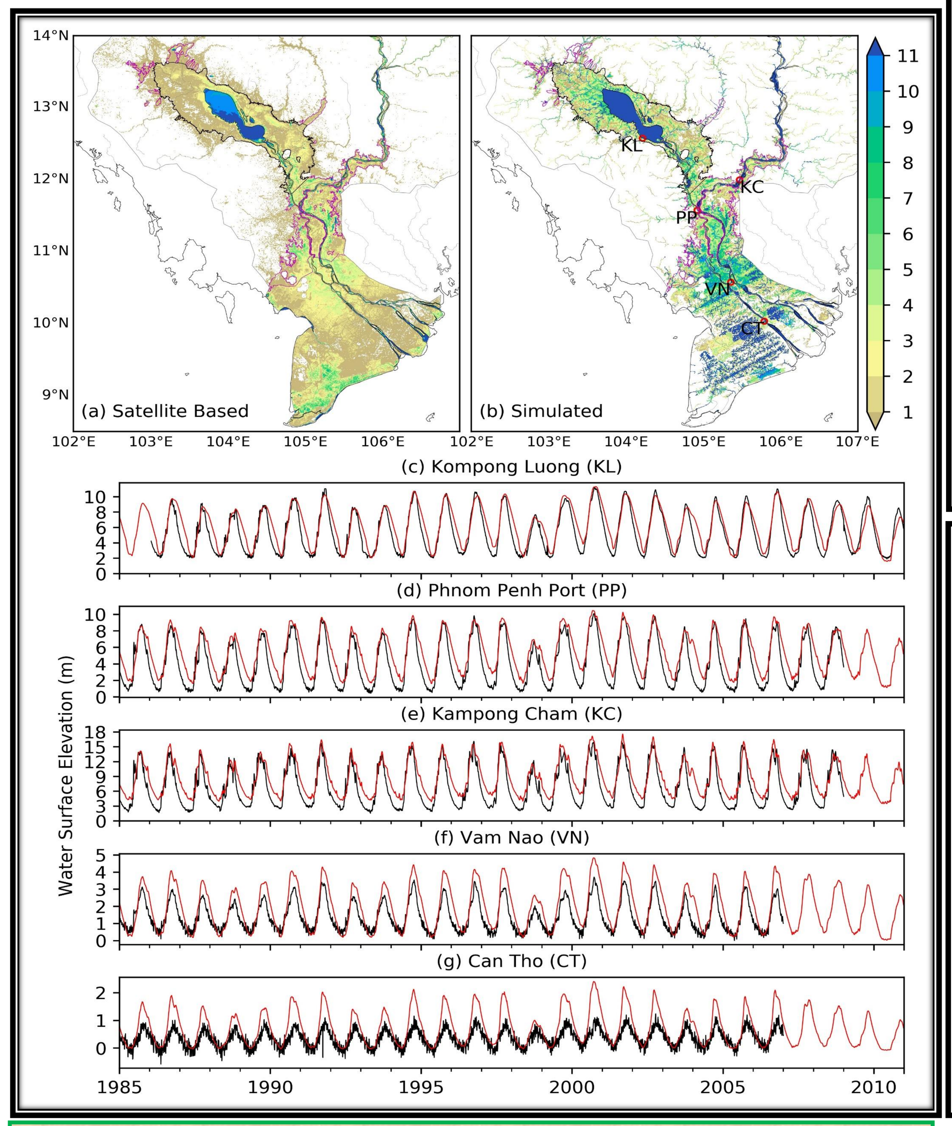

Fig. 3: *(a, b) Comparison of simulated flood occurrence (number of months) with satellite-based data; (c-g) simulated and observed water levels.*

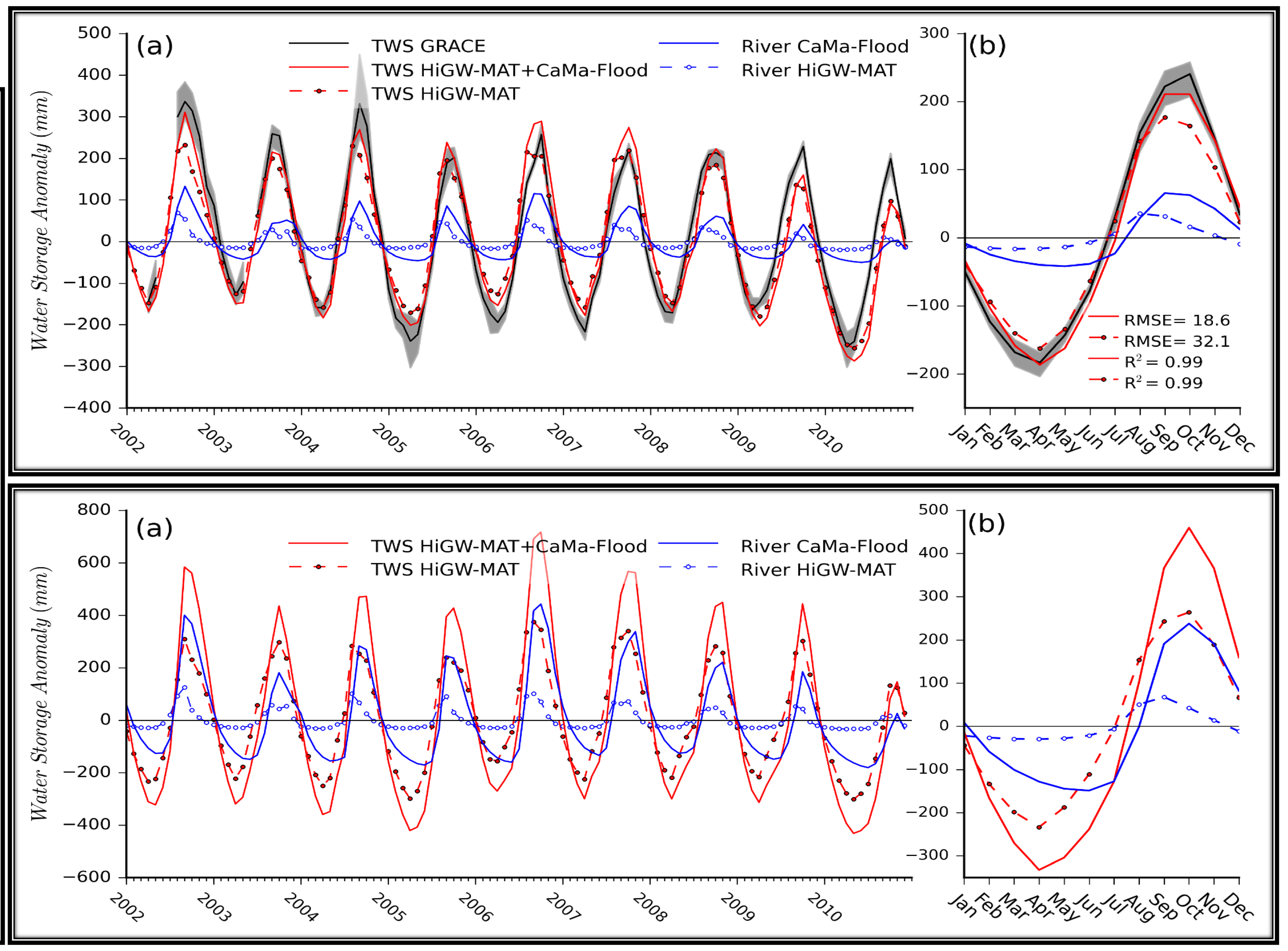

Fig. 4: *Comparison of simulated terrestrial water storage (TWS) variations with GRACE-based TWS, and role of river-floodplain storage on TWS dynamics over the entire MRB (top) and only for the lower portion of the basin shown in Fig. 3 (bottom).*

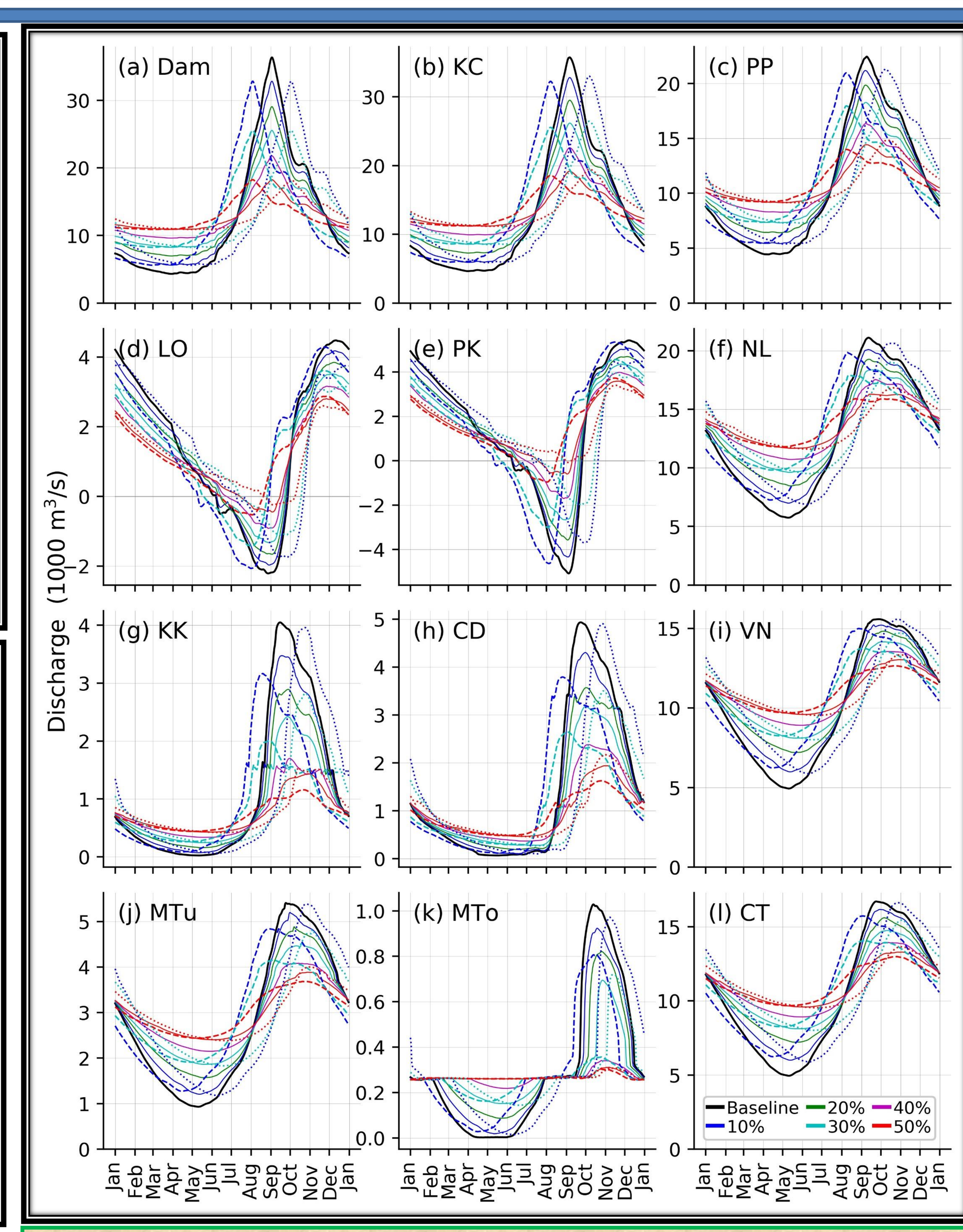

Fig. 5: *Effects of potential flow regulation by different degree at the dam location shown in Fig. 6 on streamflow dynamics at selected locations in the LMRB.*

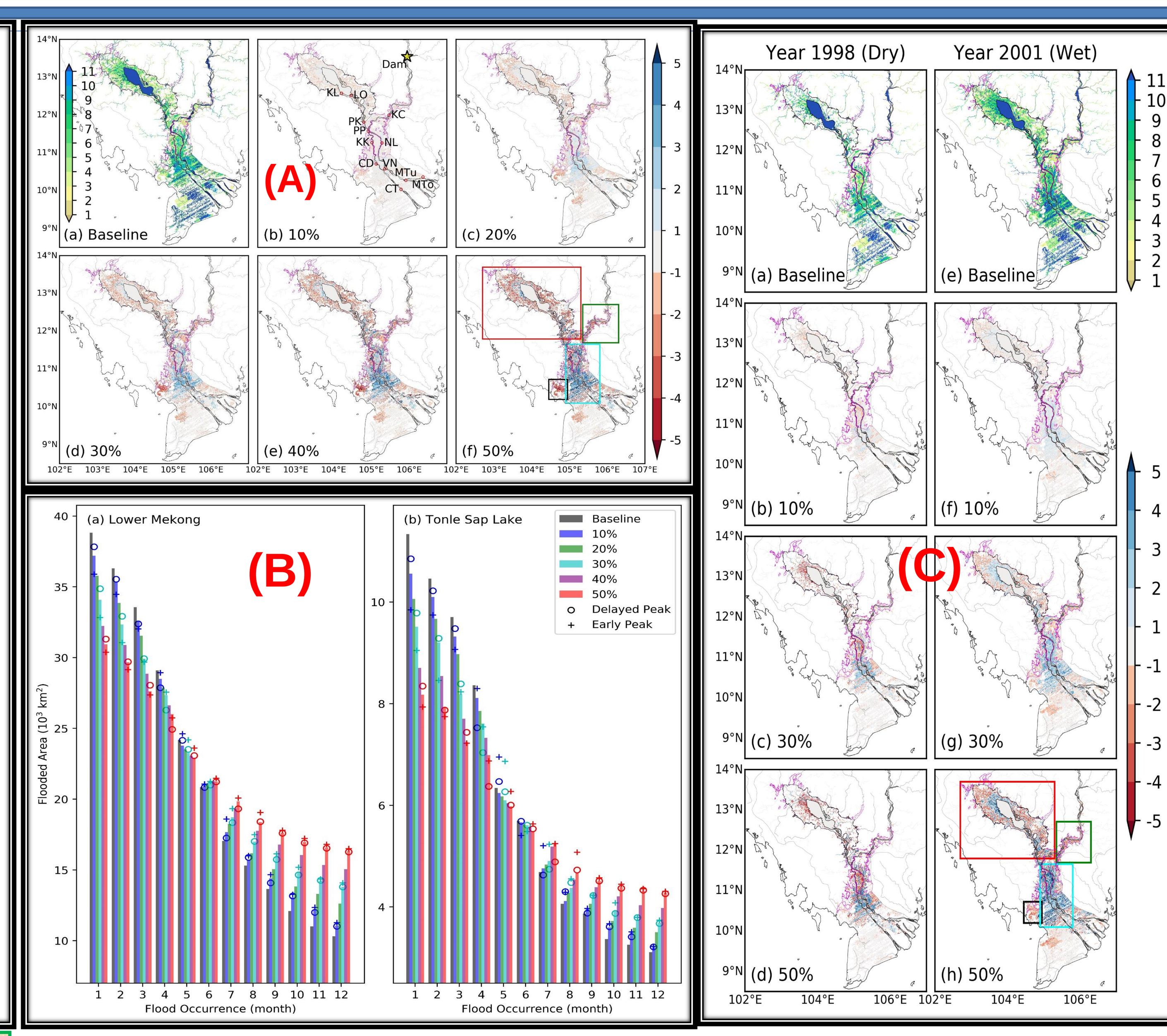

Fig. 6: *(A) Changes in flood occurrence during an average year; (B) changes in flooded areas under different degrees of flow regulation and altered peak timing (one month early and delayed); (C) same as in (A) but for dry and wet years.*

4. Summary and Conclusions

- River-floodplain water storage explains ~26% of the total terrestrial water storage dynamics in the MRB and ~49% in the LMRB (Fig. 4).
- Reduction in the peak of flood pulse by more than 20% near Stung Treng gauging station could cause a significant alteration in the water balance of the TSL, potentially ceasing the flow reversal in the TSR, if the flood peak at the same location is dampened by 50% and delayed by one-month
- During average and wet years, flood occurrence could increase at the outer fringe of the TSL and post-flooding agricultural regions in the middle reach of the Delta; during dry years flood occurrence could reduce by up to 5 months around the outer edge of the flooded areas in the TSL.
- While areas flooded for less than five months and over six months are likely to be impacted significantly by flow regulations, areas flooded for 5-6 months could be impacted the least.

References:

1. Pokhrel, Y. N., S. Koirala, P. J.-F. Yeh, N. Hanasaki, L. Longuevergne, S. Kanae, and T. Oki (2015), Incorporation of groundwater pumping in a global Land Surface Model with the representation of human impacts, *Water Resour. Res.*,51,78–96.
2. Yamazaki, D., S. Kanae, H. Kim, and T. Oki, 2011: A physically based description of floodplain inundation dynamics in a global river routing model. *Water Resources Research*, 47, W04501.

Acknowledgements: This work is supported by the National Science Foundation (NSF) (Award#: 1752729) and NASA (Award#: 80NSSC17K0259).