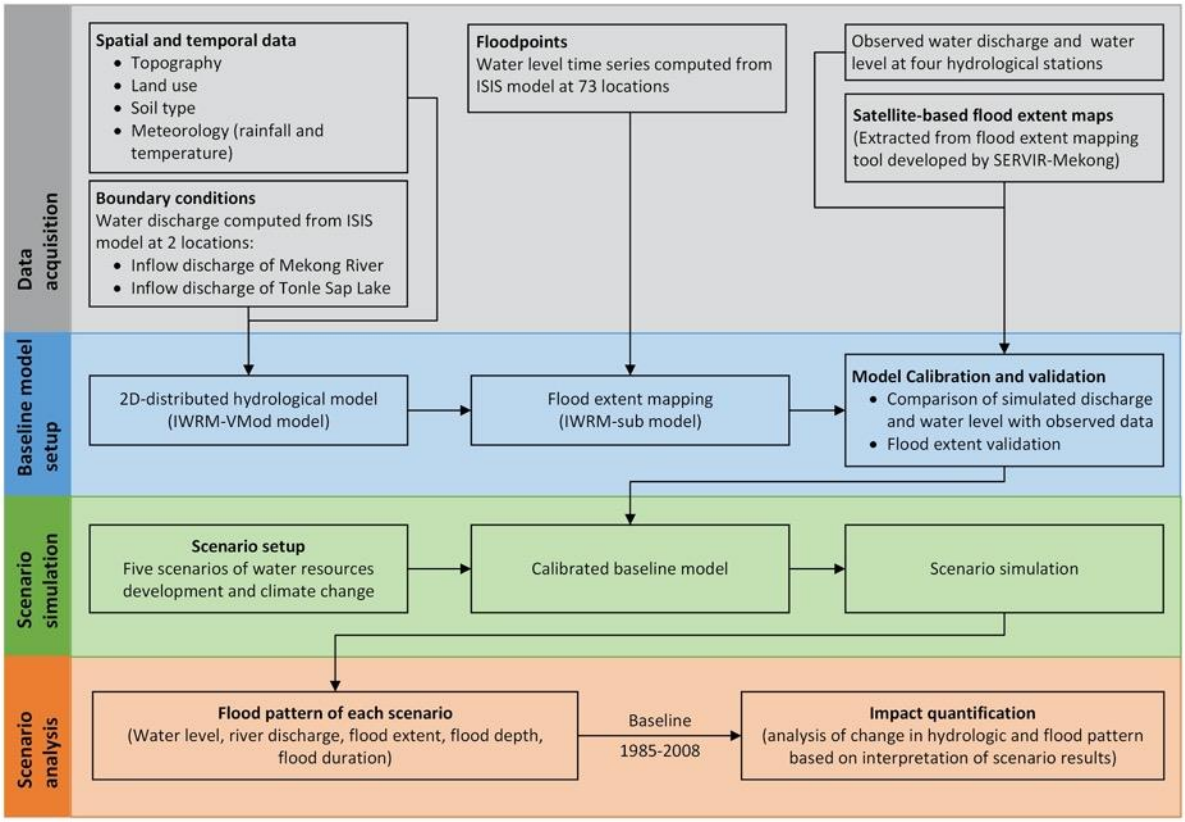

Figure S1. Overall framework of methodology.

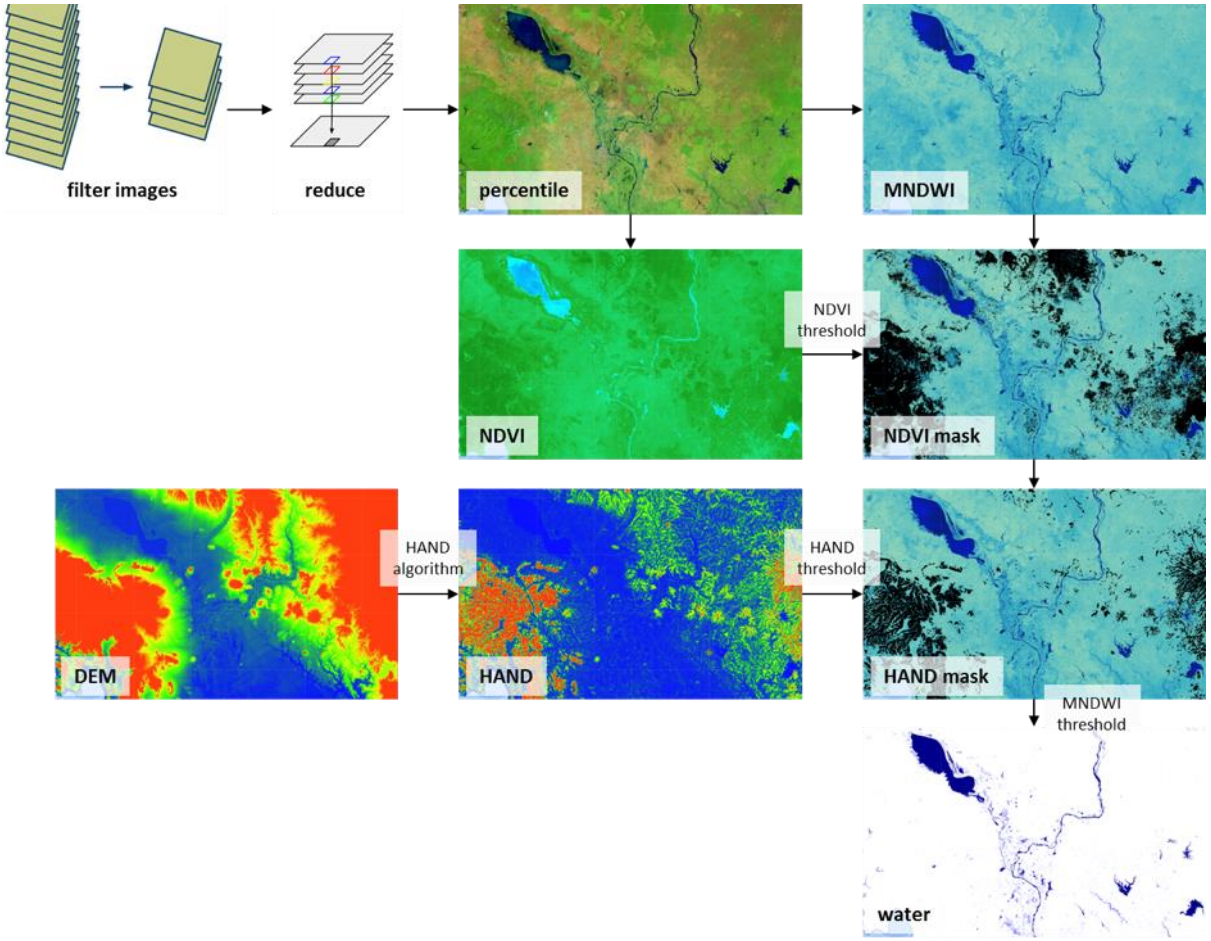

Figure S2. Schematic processes in generating floodwater coverage from satellite images of the SERVIR-Mekong project using Surface Water Mapping Tool.

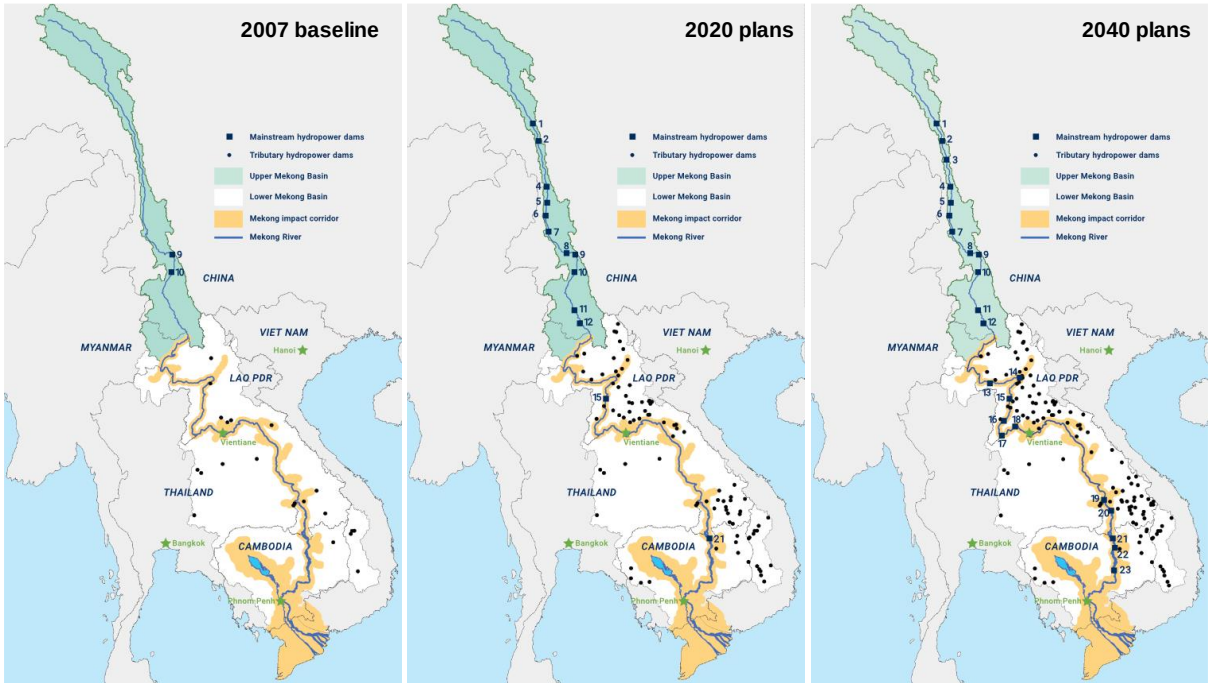

Figure S3. Location map of hydropower dams considered in this study (MRC, 2019). The mainstream dams are (1) Wunonglong, (2) Lidi, (3) Tuoba, (4) Huangdeng, (5) Dahuaqiao, (6) Miaowei, (7) Gongguoqiao, (8) Xiaowan, (9) Manwan, (10) Sachaoshan, (11) Nuozhadu, (12) Jinghong and Lower Mekong's mainstream dams are (13) Pak Beng, (14) Luang Prabang, (15) Xayaburi, (16) Pak Lay, (17) Sanakham, (18) Pak Chom, (19) Ban Koum, (20) Lat Sua/Phou Ngoy, (21) Don Sahong, (22) Stung Treng, (23) Sambo.

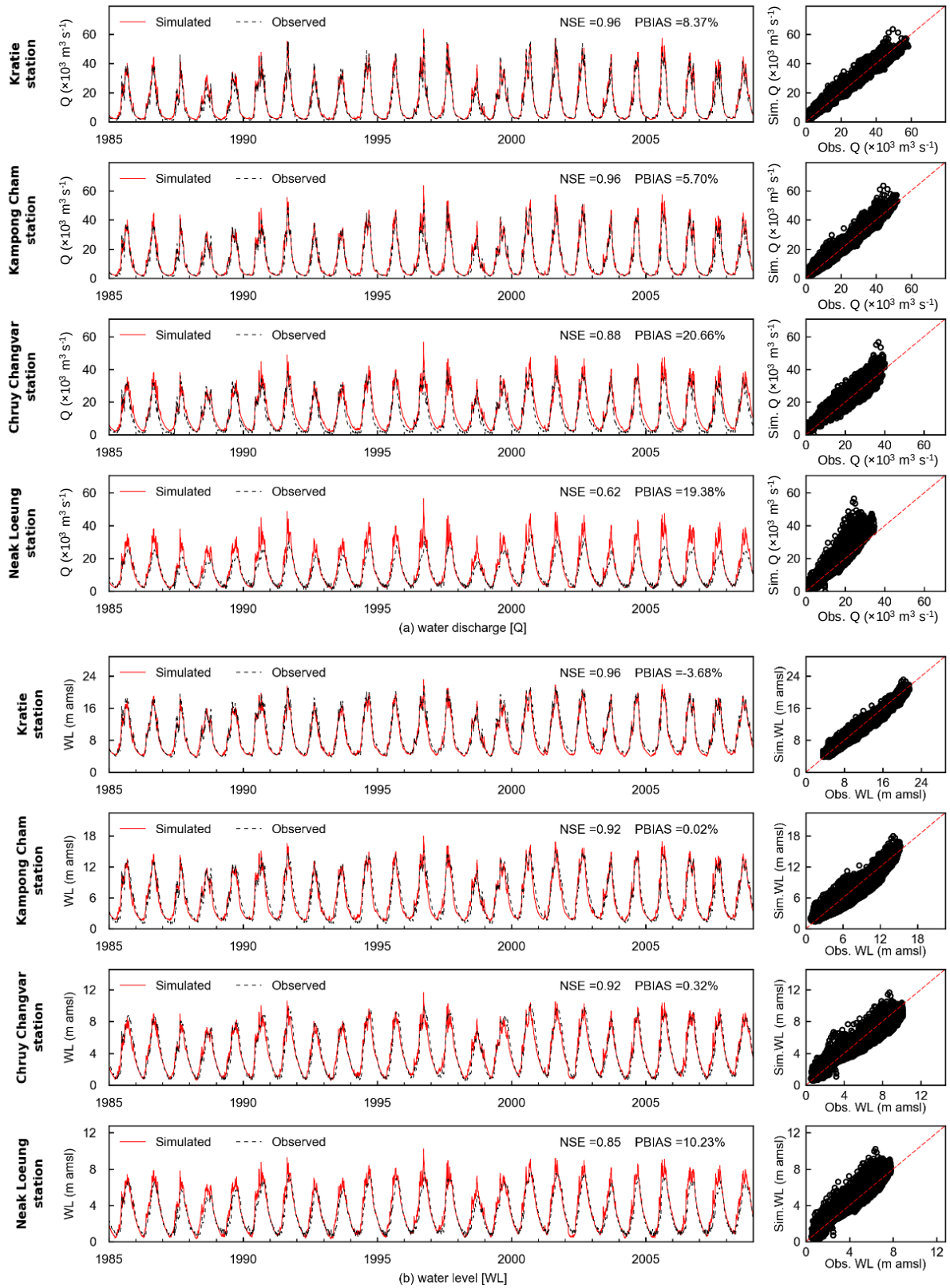

Figure S4. Time series comparison and scatter plot between the observed and simulated water discharge [Q] and water level [WL].

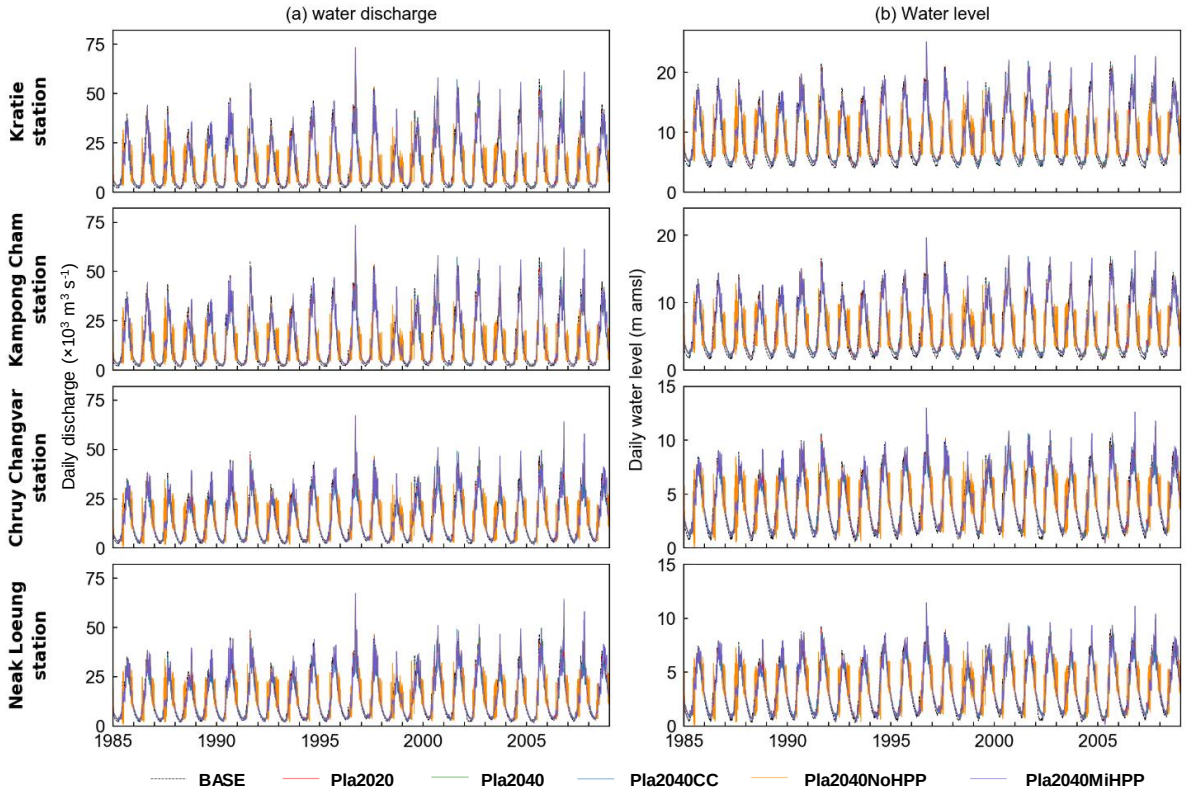

Figure S5. Time series comparison of water discharge and water level under different scenarios.

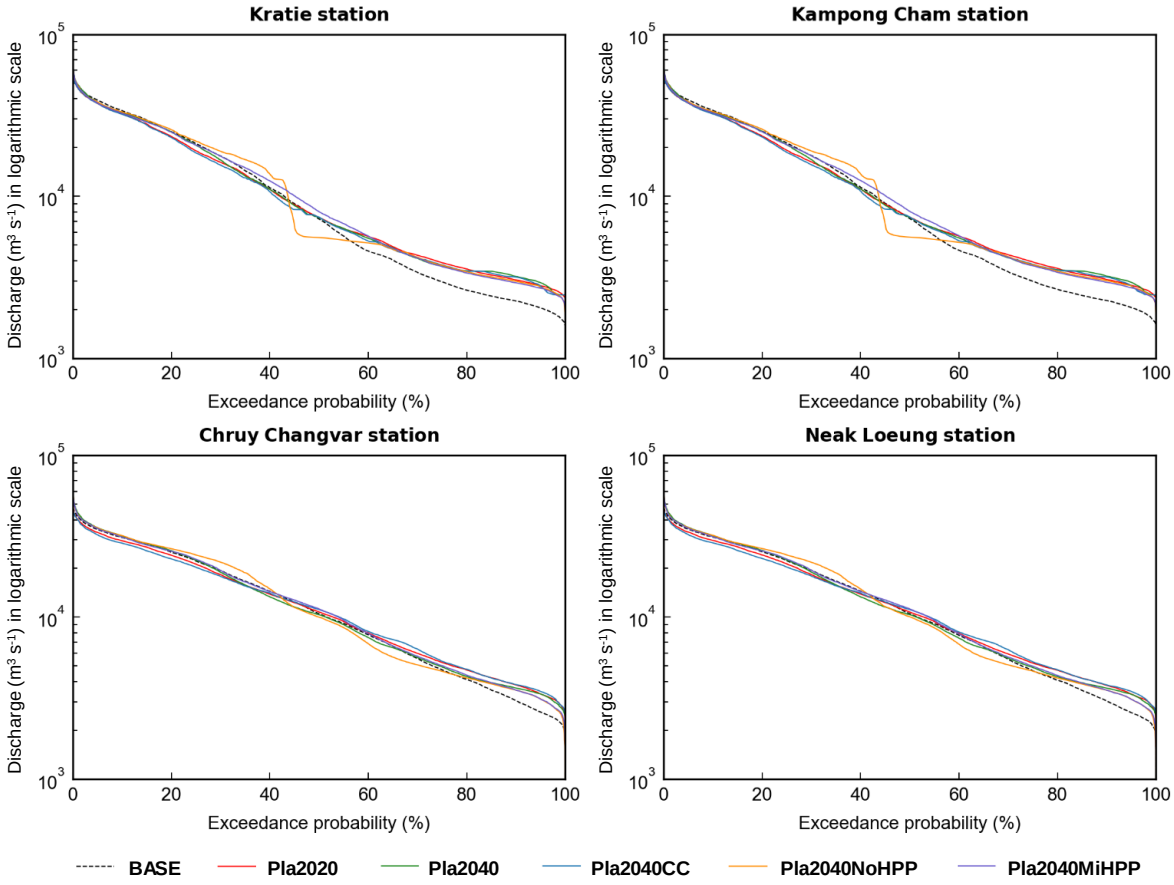

Figure S6. Comparison of flow duration curves under different scenarios. Vertical axis is log-scale.

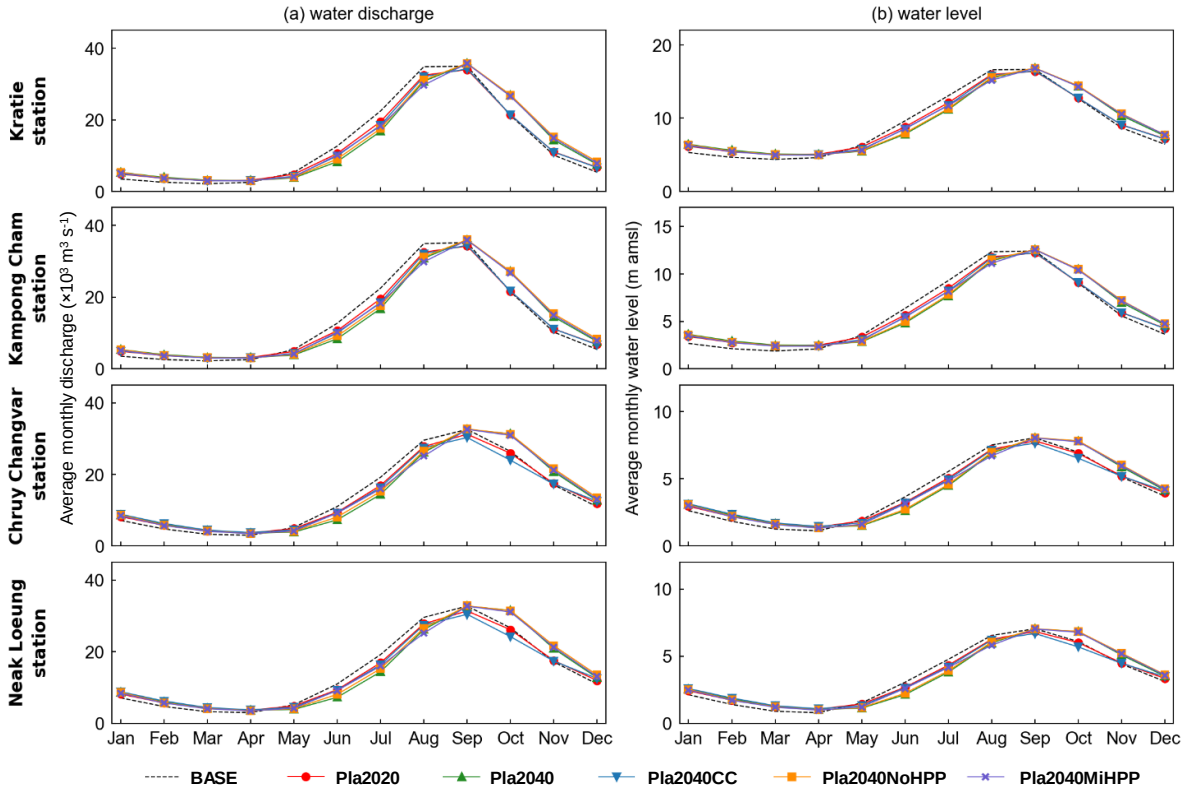

Figure S7. Comparison of monthly water discharge and water level under different scenarios.

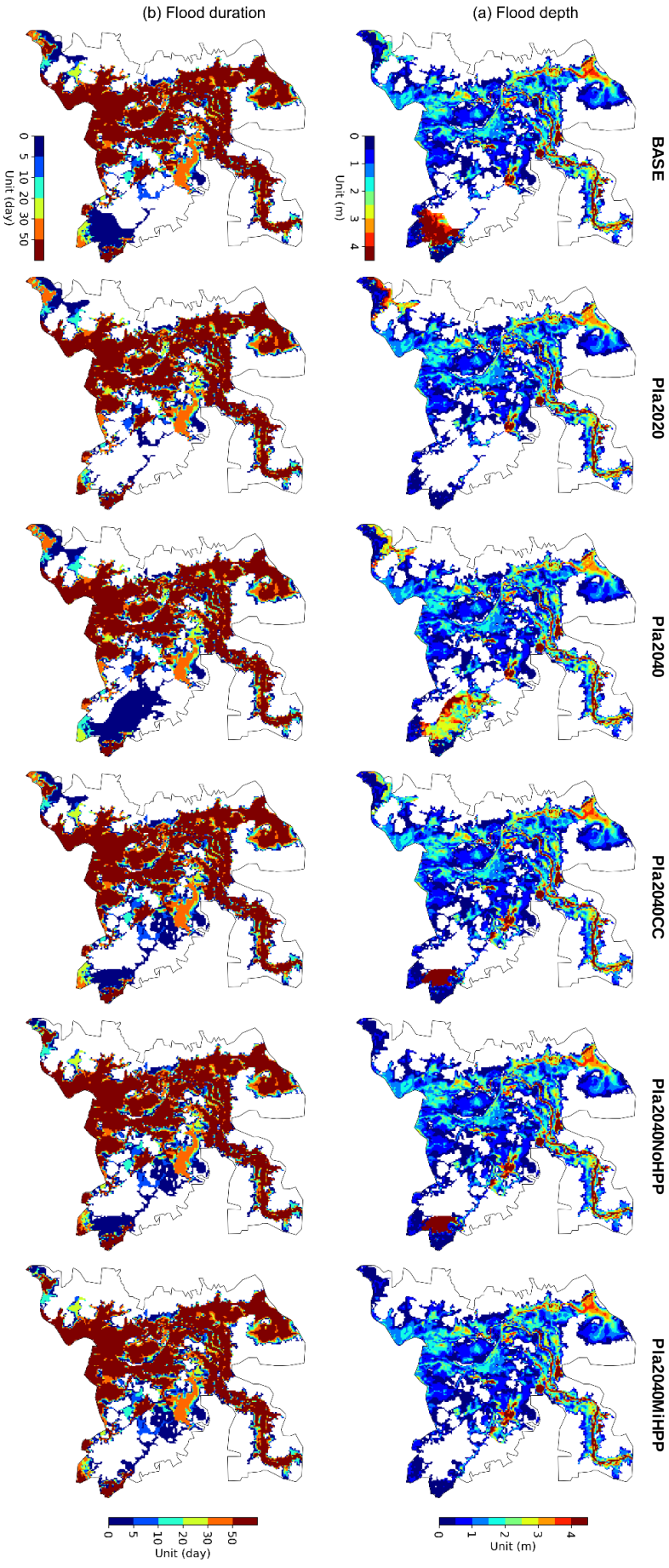

Figure S8. Spatial distribution of mean annual flood depth and flood duration.

Table S1. Changes in flooded area, flood depth, and flood duration over the baseline period 1985–2008 at provincial level.

Province	Change in flooded area (%)				
	Pla2020	Pla2040	Pla2040CC	Pla2040NoHPP	Pla2040MiHPP
Kampong Cham	-5.9	-6.3	-0.8	-0.8	0.0
Kampong Chhnang	-2.7	-3.1	-0.7	-0.5	-0.1
Kampong Thom	-9.3	-10.5	-2.9	-2.3	-0.5
Kandal	-5.2	-5.6	-0.7	-0.4	0.4
Kratie	-5.6	-6.2	-3.9	-4.3	-3.6
Phnom Penh	-6.3	-6.9	-1.0	-0.7	0.2
Prey Veng	-8.7	-9.2	-1.1	-0.7	0.7
Svay Rieng	-12.2	-23.4	18.5	28.2	32.3
Takeo	-6.3	-6.6	-0.6	0.3	1.2
Tboung Khmum	-4.7	-4.7	-1.8	-2.2	-1.4
Means of all 10 provinces	-6.7	-8.2	0.5	1.7	2.9
Province	Change in flood depth (%)				
	Pla2020	Pla2040	Pla2040CC	Pla2040NoHPP	Pla2040MiHPP
Kampong Cham	-2.6	-2.5	-0.7	-0.9	-0.4
Kampong Chhnang	-3.9	-4.3	-1.0	-0.7	0.0
Kampong Thom	-5.4	-6.0	-0.6	-0.4	0.5
Kandal	-3.8	-4.1	-0.1	0.1	0.8
Kratie	-3.3	-3.0	-2.0	-2.2	-1.7
Phnom Penh	-3.6	-3.9	-0.4	-0.3	0.5
Prey Veng	-3.6	-3.6	-0.4	-0.2	0.3
Svay Rieng	-4.2	-2.3	3.1	1.9	2.5
Takeo	-3.5	-3.9	-0.2	0.6	1.4
Tboung Khmum	-2.6	-2.4	-1.2	-1.3	-1.0
Means of all 10 provinces	-3.7	-3.6	-0.3	-0.3	0.3
Province	Change in flood duration (%)				
	Pla2020	Pla2040	Pla2040CC	Pla2040NoHPP	Pla2040MiHPP
Kampong Cham	-8.2	-10.4	-1.9	-1.0	0.5
Kampong Chhnang	-2.6	-4.3	-0.7	1.0	2.6
Kampong Thom	-11.6	-14.1	-3.5	-2.0	-0.2
Kandal	-6.9	-8.6	-2.1	-0.7	0.3
Kratie	-8.3	-10.9	-4.3	-3.2	-0.9
Phnom Penh	-9.2	-10.2	-4.0	-4.9	-3.5
Prey Veng	-11.2	-13.0	-3.8	-1.8	-1.2
Svay Rieng	-5.8	-22.7	0.5	18.5	21.5
Takeo	-8.3	-10.4	-2.3	1.7	2.9
Tboung Khmum	-8.8	-10.9	-2.4	-1.8	-0.3
Means of all 10 provinces	-8.1	-11.5	-2.5	0.6	2.2

Analysis of flood alterations at provincial level

As the Cambodian Mekong floodplain covers only a little part of Kampong Speu and Kampot province, and Tay Ninh province is in Vietnam, we did not present results for these regions. For the remaining 10 provinces, we examined the change in flooded area, flood depth and flood duration for each scenario compared to the baseline period at the provincial level (Fig. 6 and Table S1). Under the baseline scenario (BASE), the modelling results show that the average flooded area ranges from a minimum of 184 km^2 in Svay Rieng province to a maximum of 2,251 km^2 in Prey Veng province, which represents 43% of the provincial territory. Whilst the average flood depth ranges from 1.1 m in Svay Rieng province to 4.9 m in Kratie province, and the average flood duration ranges from 6 days in Svay Rieng province to 85 days in Kandal province.

Results from all scenarios predominantly show decreasing flood conditions in most provinces. The degree of alteration at provincial level is generally less than 10% in comparison with the baseline. Both scenarios Pla2020 and Pla2040 show reductions to flooded area, depth, and duration in all provinces, with the reductions for Pla2040 being slightly larger than for Pla2020. The largest reductions displayed by Pla2040 are located in Svay Rieng province in terms of area (–23.4%), Kampong Thom province in terms of depth (–6.0%), and Kampong Thom province for duration (–22.7%). This signifies the benefit to flood prevention efforts afforded by the planned developments in 2020 and 2040.

In comparison with Pla2040, the incorporation of climate change into the Pla2040CC scenario reverses the magnitude of these developmental impacts, as the warmer dry season months and wetter wet season months compensate for the anthropogenic flow alterations. As a result, the Pla2040CC scenario is in a much closer alignment with the baseline, so that reductions to the flood extent, depth, and duration are much smaller than for the Pla2040 scenario, whilst one province displayed increases in flood extent and depth. The largest reductions displayed by Pla2040CC are all located in Kratie province (area –3.9%, depth –2.0%, duration –4.3%). However, the province of Svay Rieng, which displayed the largest reductions under scenario Pla2040, displays overall increases in flooded area (+18.5%), depth (+3.1%) and duration (+0.5%) under scenario Pla2040CC. This illustrates that the impact of climate change works in opposition to the impact of planned developments, diminishing both the negative environmental implications of the dams, and the negative flood implications of climate change.

Under the Pla2040NoHPP scenario, a reduction in flood conditions is observed in most provinces, except Svay Rieng and Takeo province which are characterized by increases to all three measurements of flooding. Moreover, in Kampong Chhnang and Kandal provinces, at least one of the three measurements increase whilst the others reduce ever so slightly. The magnitude of the reductions is again much smaller than for Pla2040 and more in line with the Pla2040CC results. This reflects the reduction in anthropogenic flow alternations introduced by mainstream dam operations. The largest reductions of flood extent and depth are found in Kratie province (–4.3% and –2.2%), and Phnom Penh city in terms of duration (–4.9%). The largest increases for all measurements are again found in Svay Rieng province (area +28.2%, depth +1.9%, duration +18.5%).

The Pla2040MiHPP scenario is more varied still, displaying reductions smaller than Pla2040NoHPP and more increases across the measurements and provinces. The change in flooded area ranges from –3.6% in Kratie province to +32.3% in

Svay Rieng province, the change in flood depth ranges from –1.7% in Kratie province to +2.5% in Svay Rieng province, and the change in flood duration ranges from –3.5% in Phnom Penh city to +21.5% in Svay Rieng province. In comparison with Pla2040, the mitigation measures and joint operation of key dams (Pla2040MiHPP scenario) not only significantly lessen the reducing impact of dams on flood conditions, but also transform some provinces from a reducing impact to an increasing impact on flood measures. Such mitigation investments are introduced generally to optimize the dam benefits while maintaining the natural flow in rivers and thus benefiting ecosystem productivity. However, installing run-of-the-river style dams along the mainstream reduces the active storage capacity and seriously compromises the dam's ability to act as flood prevention, forsaking the opportunity to counteract the increasing flood potential of climate change.

The majority of provinces are characterized by a reduction in flood conditions under all scenarios. The provincial flood conditions show a decreasing rate of flooded area between –23.4% and –0.1%, between –6.0% and –0.03% for flood depth, and between –22.7% and –0.2% for flood duration. Although a few provinces did exhibit an increasing pattern under the Pla2040CC, Pla2040NoHPP and Pla2040MiHPP scenario (up to +32.3% for flooded area, +3.1% for flood depth and +21.5% for flood duration). Under Pla2040CC, Svay Rieng was the sole province characterized by an increase in flood conditions, and it also displayed the largest increasing trends under Pla2040NoHPP, and Pla2040MiHPP, suggesting that Svay Rieng province is the most sensitive and vulnerable to the effect of climate change and LMB mainstream dam operations. Svay Rieng province is located in the lowland area and far from the mainstream (poor flood drainage system), indicating a significant impact of the widespread and prolonged flood condition.

Overall Prey Veng is the province most vulnerable to the largest flooded area of about 2,056 km^2 under Pla2020 and 2,045 km^2 under Pla2040, or respectively 47% and 43% of the provincial territory. Kampong Thom province receives the largest flood protection benefit from the planned developments between 2020 and 2040, with reductions under the Pla2040 scenario of –10.5% for flooded area, –6.0% for flood depth, and –14.1% for flood duration. Kampong Chhnang province receives the least benefit from such developments in terms of flooded area (only –3.1% under Pla2040) and flood duration (only –4.3% under Pla2040), while Kampong Cham province receives the least benefit in terms of flood depths, only –2.5% under Pla2040.