Supplement of Hydrol. Earth Syst. Sci., 29, 427–445, 2025
https://doi.org/10.5194/hess-29-427-2025-supplement

Hydrology and Earth System Sciences
Open Access

Supplement of

Combined impacts of climate change and human activities on blue and green water resources in a high-intensity development watershed

Xuejin Tan et al.

Correspondence to: Bingjun Liu (liubj@mail.sysu.edu.cn) and Xuezhi Tan (tanxuezhi@mail.sysu.edu.cn)

S1. Supplementary Figures

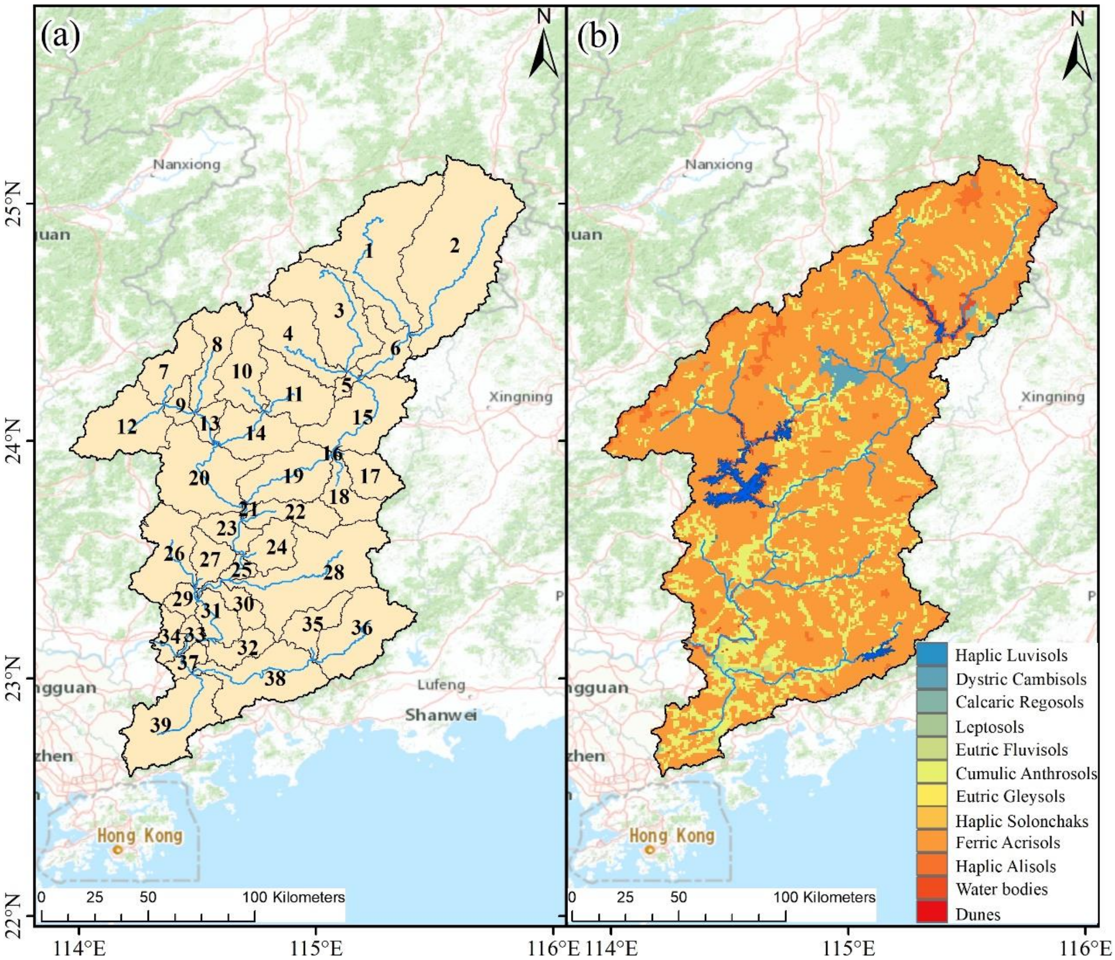

Figure S1. Spatial distribution of sub-basins and soil types in the Dongjiang River basin (Fischer et al., 2008).

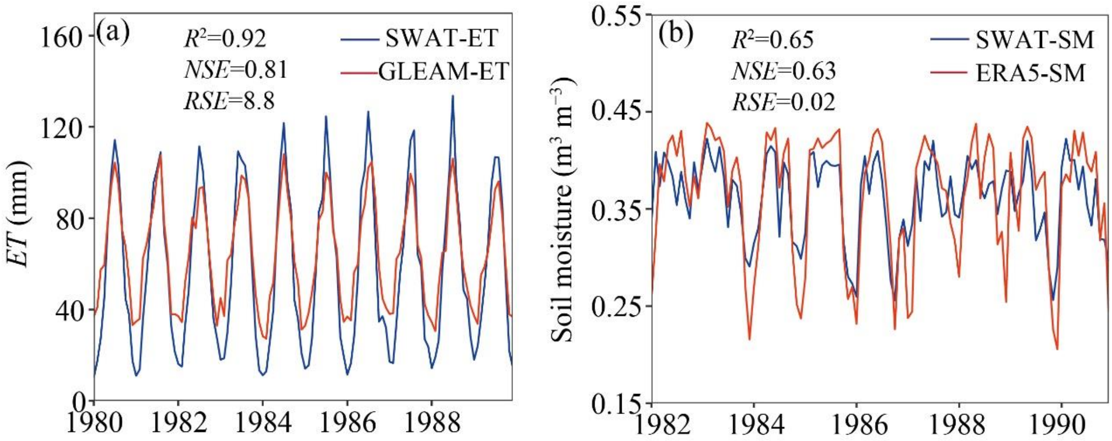

Figure S2. Verification of modeled actual evapotranspiration and soil moisture in the Dongjiang River basin.

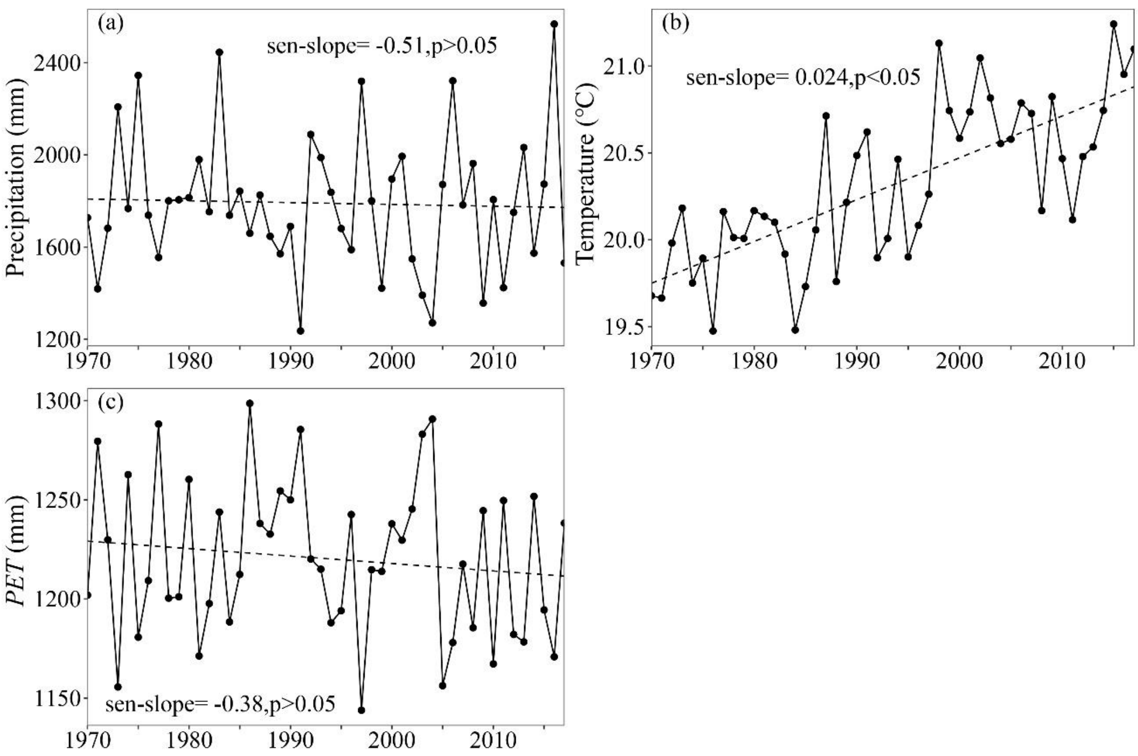

Figure S3. Interannual variation of (a) precipitation, (b) temperature, and (c) potential evapotranspiration in the Dongjiang River basin from 1970 to 2017.

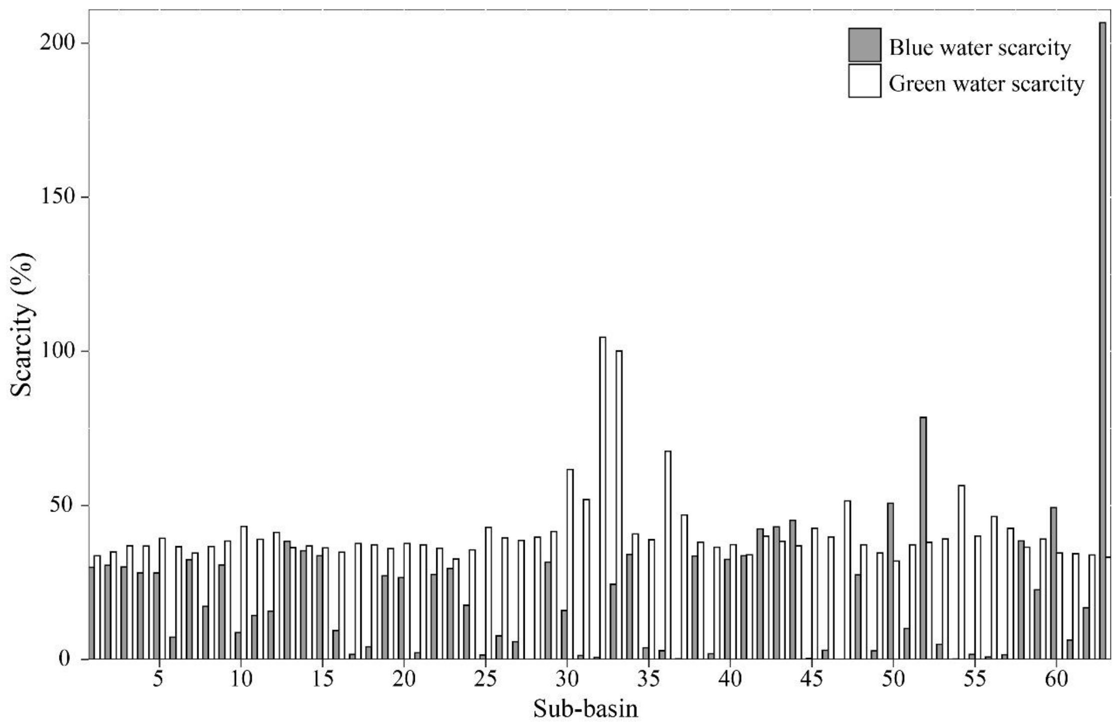

Figure S4 Annual average blue water scarcity and green water scarcity in each sub-basin of the Dongjiang River basin.

S2. Seasonality variation of blue and green water scarcity

The time of occurrence of blue and green water scarcity in the basin during the year is different, with the peak of blue water scarcity occurring from October to March, while green water scarcity mainly occurs from May to September (Figure S5). The climate of the Dongjiang River Basin belongs to the subtropical monsoon climate, and precipitation is mostly concentrated in the flood season (April to September), resulting in larger river streamflow from April to September and larger blue water resources available in the basin; The available blue water resource is low in the dry season (October to March), so moderate, severe, and extreme blue water scarcity occurs in the downstream sub-basins with a large population during the dry season. The population in the upstream sub-basins is smaller, so the risk of blue water scarcity is smaller. It is worth noting that this study only distributes the annual blue water demand evenly to each month and does not consider the intra-year change in blue water demand, which may cause certain errors in the results. Green water demand tends to be smaller from October to April, while vegetation growth is strong from May to September, and therefore evapotranspiration from the watershed is larger, based on the results in the previous section green water storage (soil moisture) fluctuates within the year much less than evapotranspiration (green water streamflow), resulting in moderate green water scarcity in May to September in the four sub-watersheds of the middle reaches of the watershed.

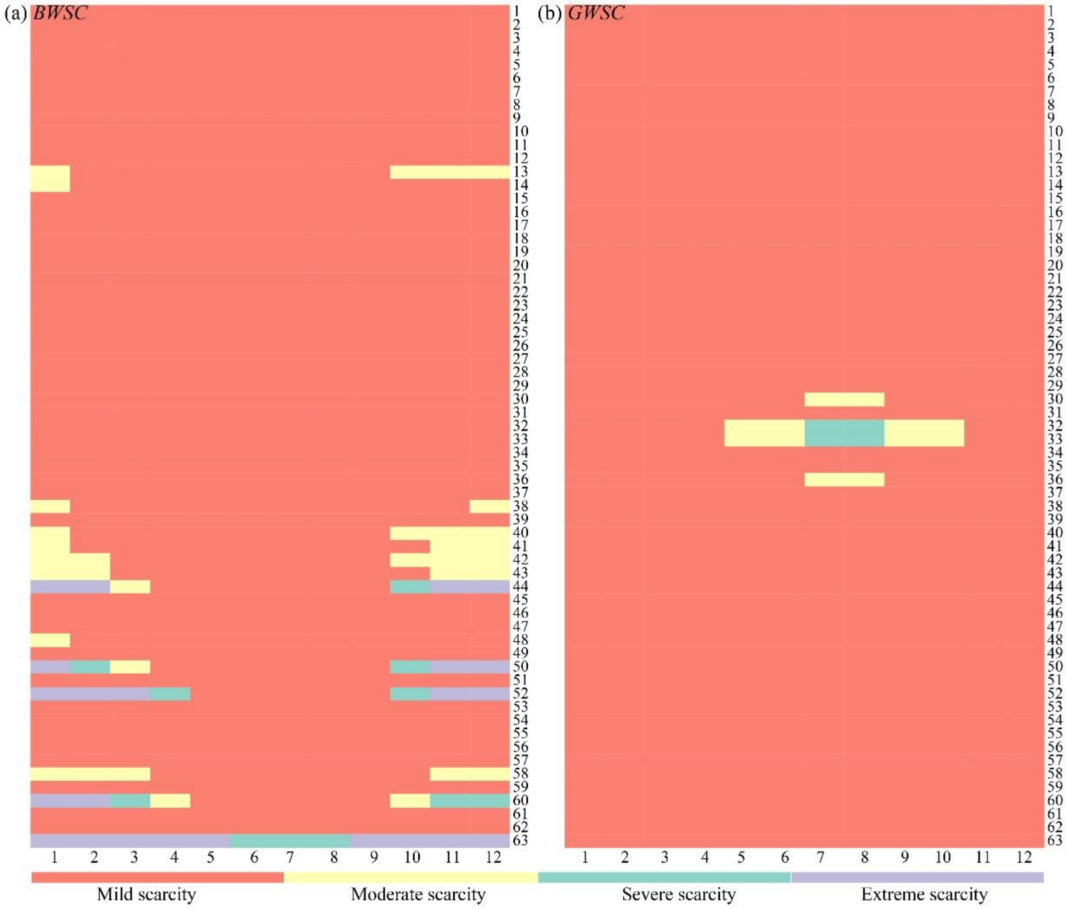

Figure S5 Intra-annual variation of blue and green water scarcity in each sub-basin of the Dongjiang River basin

S3. Impacts of climate and LULC changes on blue water for sub-basins

The Figure S6 shows the relative contributions of climate change and land use change to blue water, green water flow, and green water storage variations in sub-basin scale. From 1970 to 2017, when looking at the sub-basins, in 79.0% (50) of the sub-basins, climate change contributed to more than 90.0% of the relative contribution to blue water. In 21.0% (13) of the sub-basins with significant land use changes, the relative contribution of land use change to blue water variation exceeded 10.0%. These were mainly distributed in the middle and lower reaches, such as sub-basins 36 and 39, where land use changes resulted in a decrease in blue water, with relative contributions of 32.8% and 25.5%, respectively. In sub-basin 36, a decrease in cultivated land by 129.6 km^2, an increase in forest land by 115.0 km^2, and an increase in urban land by 14.0 km^2 were observed. In sub-basin 39, a decrease in cultivated land by 118.9 km^2, an increase in forest land by 104.0 km^2, and an increase in urban land by 17.7 km^2 were observed. An increase in built-up area led to a larger impermeable area in the basin, resulting in reduced soil infiltration and increased surface runoff, thereby increasing blue water. An increase in forest land can promote soil infiltration, increase evapotranspiration retention, reduce surface runoff, increase green water flow and green water storage, and decrease blue water. The decrease in blue water in sub-basin 36 indicates that the reduction effect of forest land increase on blue water is stronger than the increase effect of built-up area. Sub-basins 61, 62, and 63 downstream resulted in an increase in blue water with relative contributions of 24.0%, 24.9%, and 11.6%, respectively. The built-up area increased by 16.1 km^2, 59.5 km^2, and 241.0 km^2 in these sub-basins, leading to an increase in basin impermeable area and consequently an increase in blue water in the basin.

In 75.0% (47) of the sub-basins, climate change had a relative contribution of over 90.0% to changes in green water flow. From 1970 to 2017, climate change dominated the impact on green water flow in 61 sub-basins (with relative contributions exceeding 50.0%). In 2 sub-basins, namely, sub-basins 36 and 39, land use change played a dominant role in green water flow changes, with relative contributions of 77.1% and 72.9%, respectively. The likely reason for this is that in sub-basin 36, there was a decrease in cultivated land by 129.6 km^2, an increase in forest land by 115.0 km^2, and an increase in built-up area by 14.0 km^2. In sub-basin 39, cultivated land decreased by 118.9 km^2, forest land increased by 104.0 km^2, and built-up area increased by 17.7 km^2. Vegetation transpiration is the main source of green water flow, and an increase in forest land leads to an increase in vegetation transpiration, thereby increasing basin green water flow. In the northeastern and southwestern parts of the basin, a decrease in forest land led to a decrease in green water flow, with land use contributing over 10.0% to the change. Additionally, in the sub-basin where the Xinfengjiang Reservoir is located, an increase in water body area led to increased water surface evaporation, resulting in an increase in green water flow in the sub-basin. Land use also contributed over 10.0% to the change in green water flow in this sub-basin.

The change in green water storage is relatively smaller compared to blue water and green water flow. In over half of the sub-basins, land use had a relative contribution of over 10.0% to changes in green water storage. In 24.0% (15) of the basins, land use changes had a relative contribution of over 30.0% to changes in green water storage, primarily concentrated in the middle and lower reaches of the basin. There were 4 sub-basins where land use changes contributed over 90.0% to changes in green water storage. From 1970 to 2017, in sub-basins like 36 and 39 in the middle of the basin, cultivated land was converted into forest land, resulting in an increase in green water storage. Land use had a relative contribution of over 90%, which was much larger than the impact of climate change. In the southwestern part of the basin, sub-basins 61, 62, and 63 saw an increase in built-up area, leading to a decrease in green water storage. Their relative contributions to changes in green water storage reached 46.7%, 79.8%, and 48.4%, respectively.

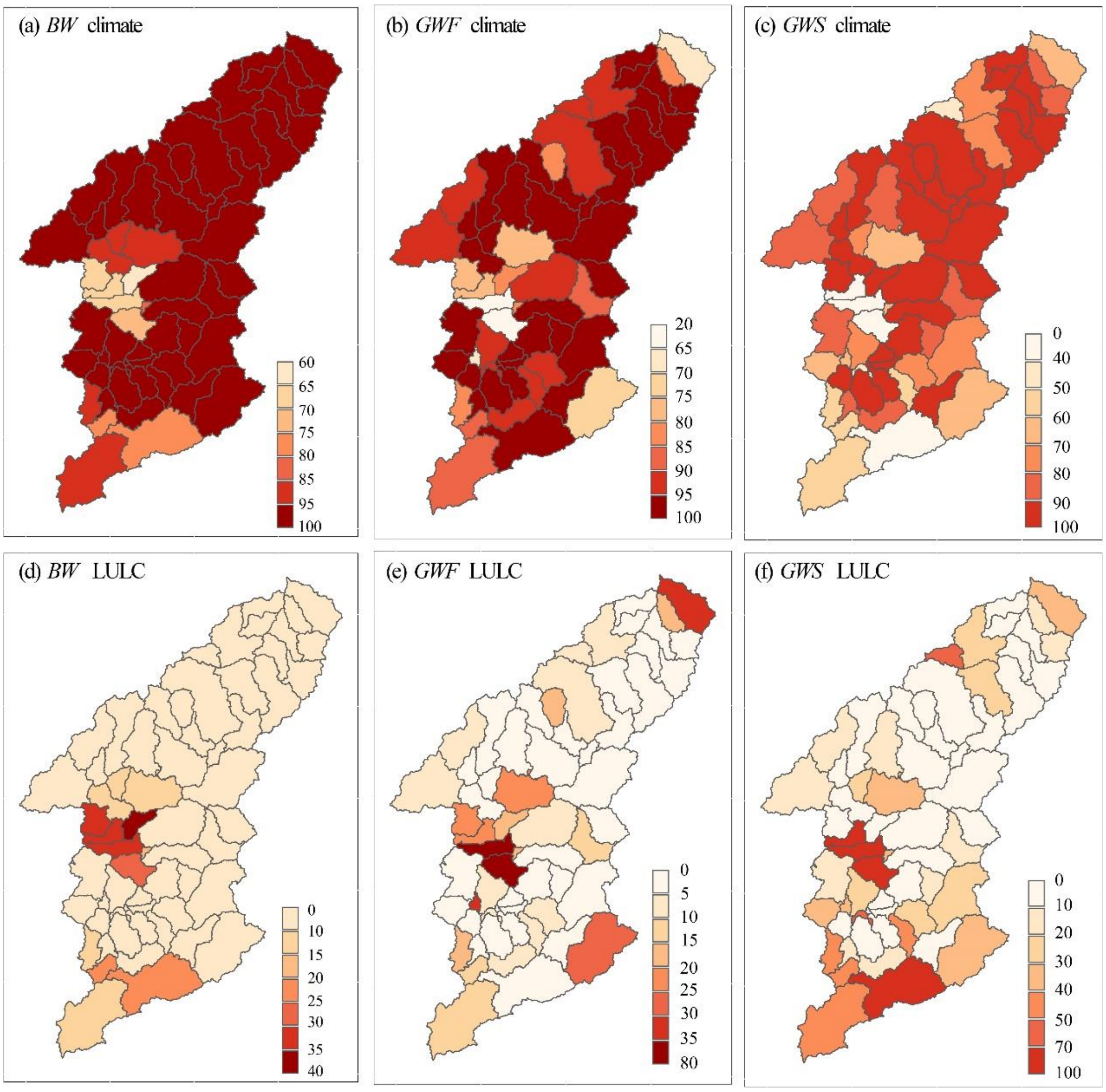

Figure S6. Relative contribution of climate change and land use change to changes in (a) *BW*, (b) *GWF*, and (c) *GWS* in sub-basin.

References

Fischer, G., Nachtergaele, F., Prieler, S., Van Velthuizen, H. T., Verelst, L., and Wiberg, D.: Global agro-ecological zones assessment for agriculture (GAEZ 2008), IIASA, Laxenburg, Austria and FAO, Rome, Italy, 10, 2008.