

Supplementary material for

# Projecting Response of Ecological Vulnerability to Future Climate Change and Human Policies in the Yellow River Basin, China

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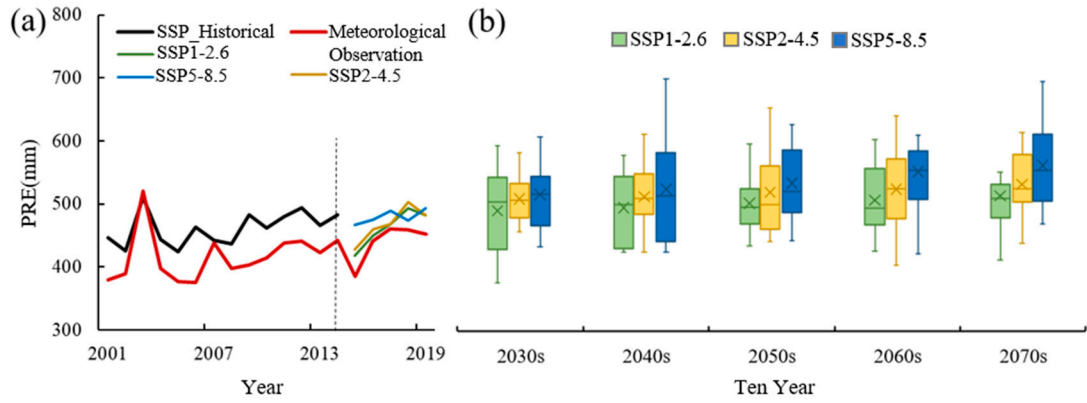
## Corrections of the NPP-VIIRS data

### (1) Background noise reduction.

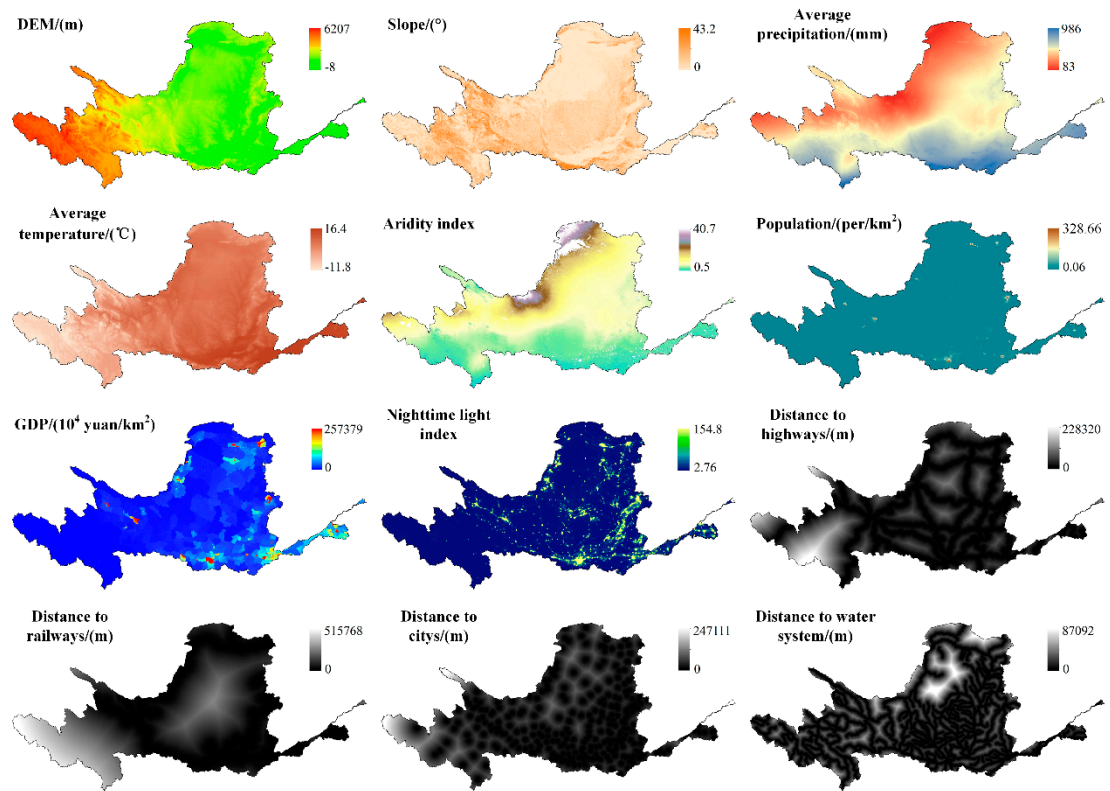
National Oceanic and Atmospheric Administration (NOAA) website provides NPP-VIIRS annual products for 2016, and the background noise such as fire and aurora in the images has been filtered out. This study assumes that the lighting areas of NPP-VIIRS nighttime light images after 2016 are the same as those in 2016 [1,2]. Thus, we generate a mask with 1 in the light area and 0 in the non-light area from the 2016 NPP-VIIRS annual product data, and multiply the 2020 NPP-VIIRS image by the mask to achieve the purpose of extracting effective lights and removing noise.

### (2) Outlier correction.

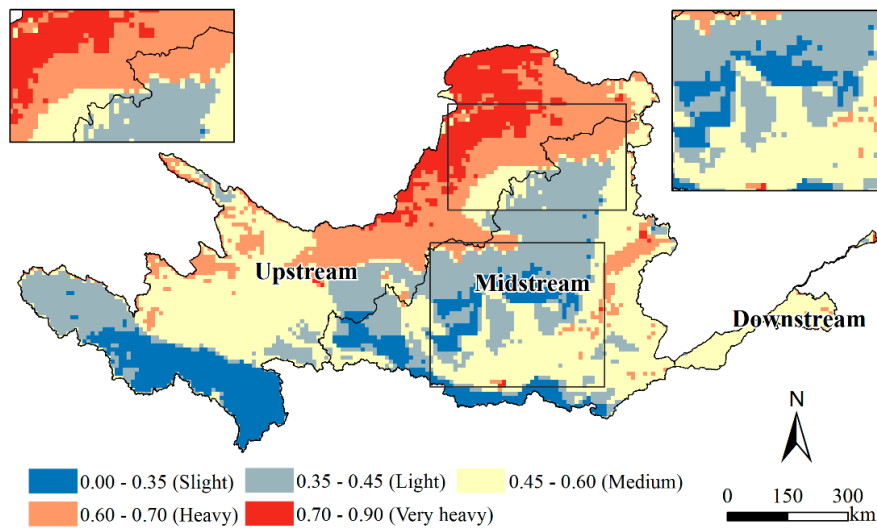
Usually, megacities within a region have the highest stable nighttime light values. Based on this premise, we select Beijing, Shanghai, and Guangzhou as reference areas. When the radiation values in other areas are higher than the maximum radiation values of these three megacities, they are considered to be outliers caused by short-lived light sources such as oil or gas fires [3]. These outliers are reassigned to the average value of the grid in the 3×3 neighborhood, and iterated until all outliers do not exceed the maximum radiation values of the three megacities.



**Figure S1.** Precipitation changes in the Yellow River Basin. (a) The average annual precipitation of CMIP6 multi-model data and meteorological observation data in the Yellow River Basin from 2001 to 2020; (b) The CMIP6 multi-model (CESM2, CNRM-CM6-1, CNRM-ESM2-1, TaiESM1, BCC-CSM2-MR) 10-year average precipitation in the Yellow River Basin from 2030 to 2070.



**Figure S2.** Spatial distribution of the primary factors affecting land use. Natural factors (DEM, Slope, Precipitation, Temperature and Aridity index), socioeconomic factors (Population, GDP and Nighttime light), distance factors (Distance to highways, Distance to railways, Distance to cities and Distance to water system). Note: Average precipitation, temperature and aridity index are the annual average values from 2010 to 2020 in the YRB.



**Figure S3.** Spatial distribution of ecological vulnerability in the Yellow River Basin in 2020.

### References

1. Zhao, M.; Zhou, Y.; Li, X.; Zhou, C.; Cheng, W.; Li, M.; Huang, K. Building a Series of Consistent Night-Time Light Data (1992-2018) in Southeast Asia by Integrating DMSP-OLS and NPP-VIIRS. *Itgrs* **2020**, *58*, 1843-1856, doi:10.1109/TGRS.2019.2949797.
2. Jing, X.; Shao, X.; Cao, C.; Fu, X.; Yan, L. Comparison between the Suomi-NPP Day-Night Band and DMSP-OLS for Correlating Socio-Economic Variables at the Provincial Level in China. *Remote Sens.* **2016**, *8*, doi:10.3390/rs8010017.
3. Sun, Y.; Zheng, S.; Wu, Y.; Schlink, U.; Singh, R.P. Spatiotemporal Variations of City-Level Carbon Emissions in China during 2000 - 2017 Using Nighttime Light Data. *Remote Sens.* **2020**, *12*, doi:10.3390/rs12182916.