

# **Quantifying the response of water and carbon balances to land cover and climate extremes across Germany.**

Karim Pyarali<sup>1,2\*</sup>, Lulu Zhang<sup>2\*</sup>, Ning Liu<sup>4</sup>, Abdulhakeem Al-Qubati<sup>1,2</sup> and Ge Sun<sup>3\*</sup>

<sup>1</sup>Technische Universität Dresden, Helmholtzstr. 10, 01069, Dresden, Germany.

<sup>2</sup>United Nations University, Institute for Integrated Management of Material Fluxes and of Resources, Ammonstrasse 74, 01067, Dresden, Germany.

<sup>3</sup>Eastern Forest Environmental Threat Assessment Center, Southern Research Station, USDA Forest Service, Research Triangle Park, NC 27709, USA.

<sup>4</sup>CSIRO Environment, Canberra ACT 2601.

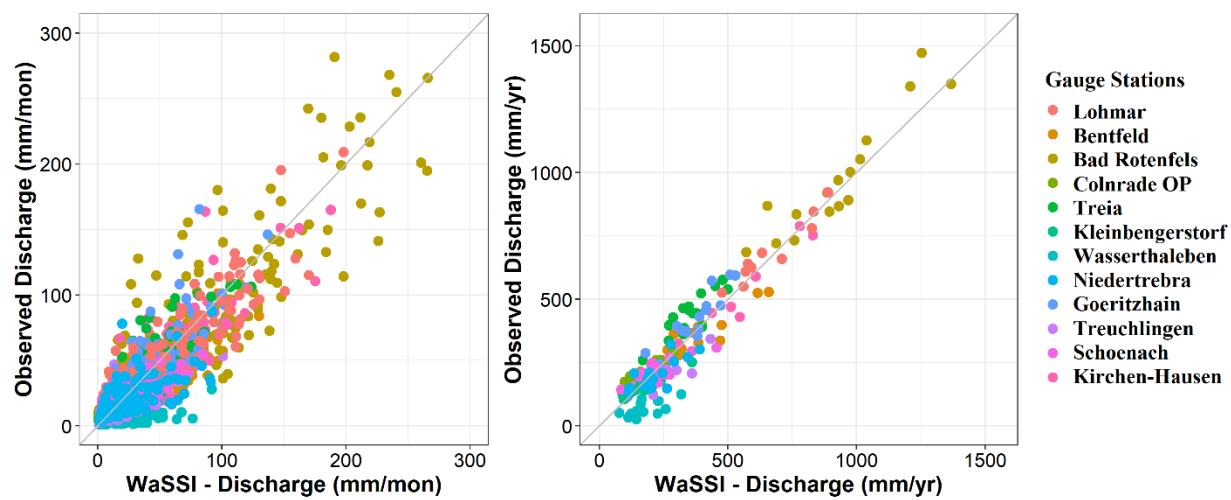
\*Corresponding authors: Karim Pyarali ([karim.pyarali@tu-dresden.de](mailto:karim.pyarali@tu-dresden.de)); Lulu Zhang ([lzhang@unu.edu](mailto:lzhang@unu.edu)); Ge Sun ([Ge.Sun@usda.gov](mailto:Ge.Sun@usda.gov))

## **Contents of this file**

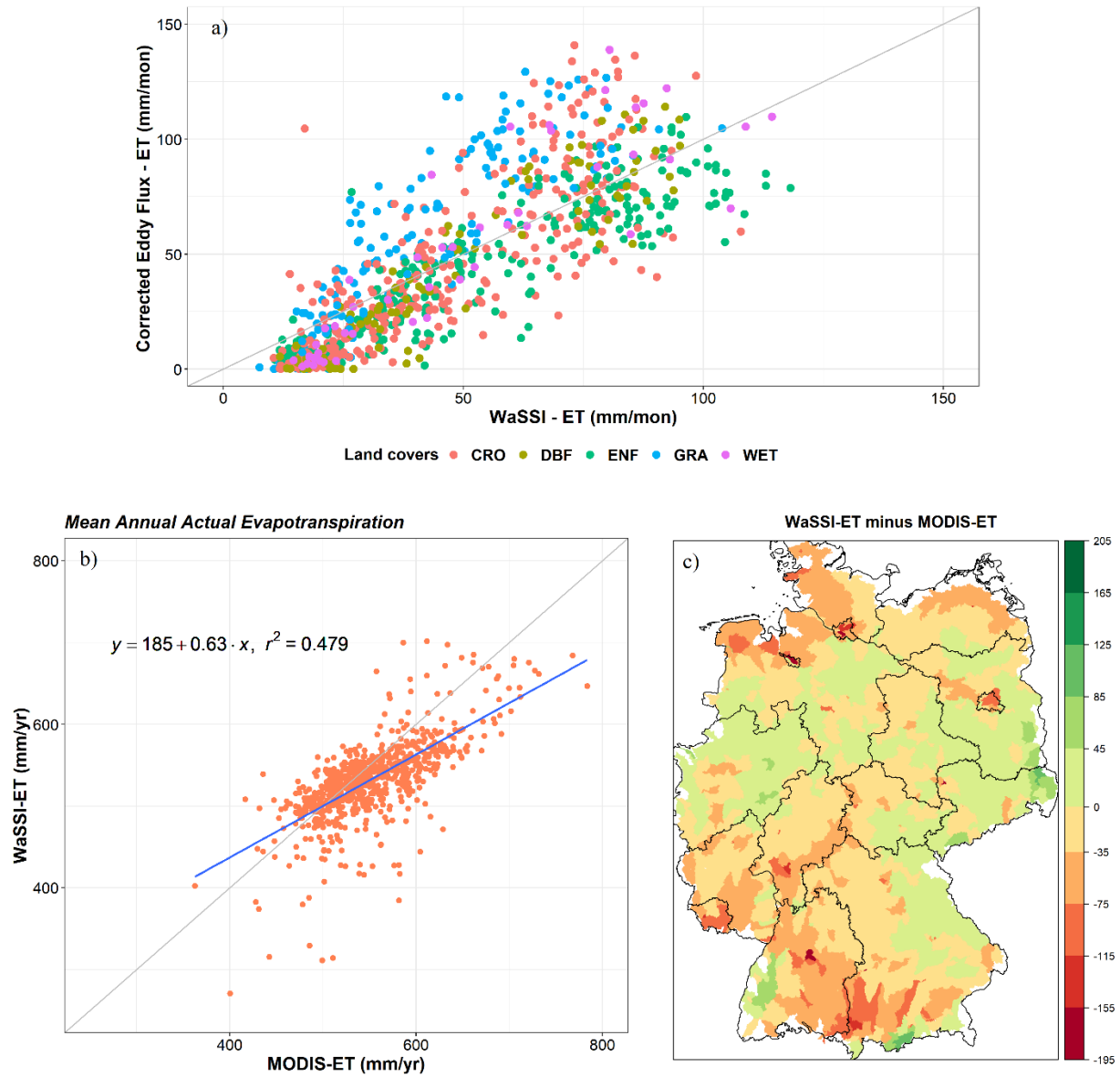
Figures S1 to S3

## **Introduction**

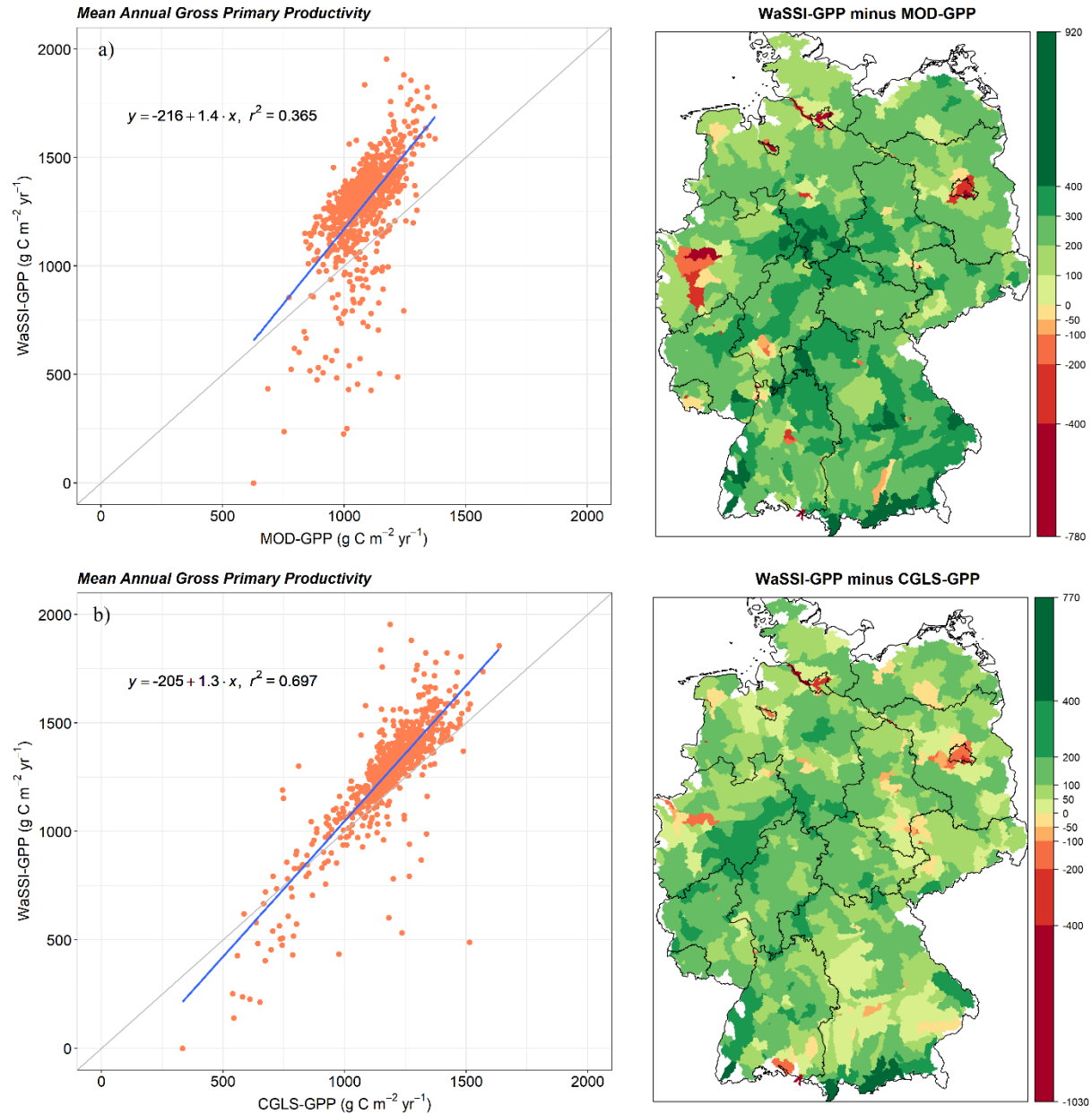
This supporting information provides the figures that supplements the main scientific conclusions of the paper.



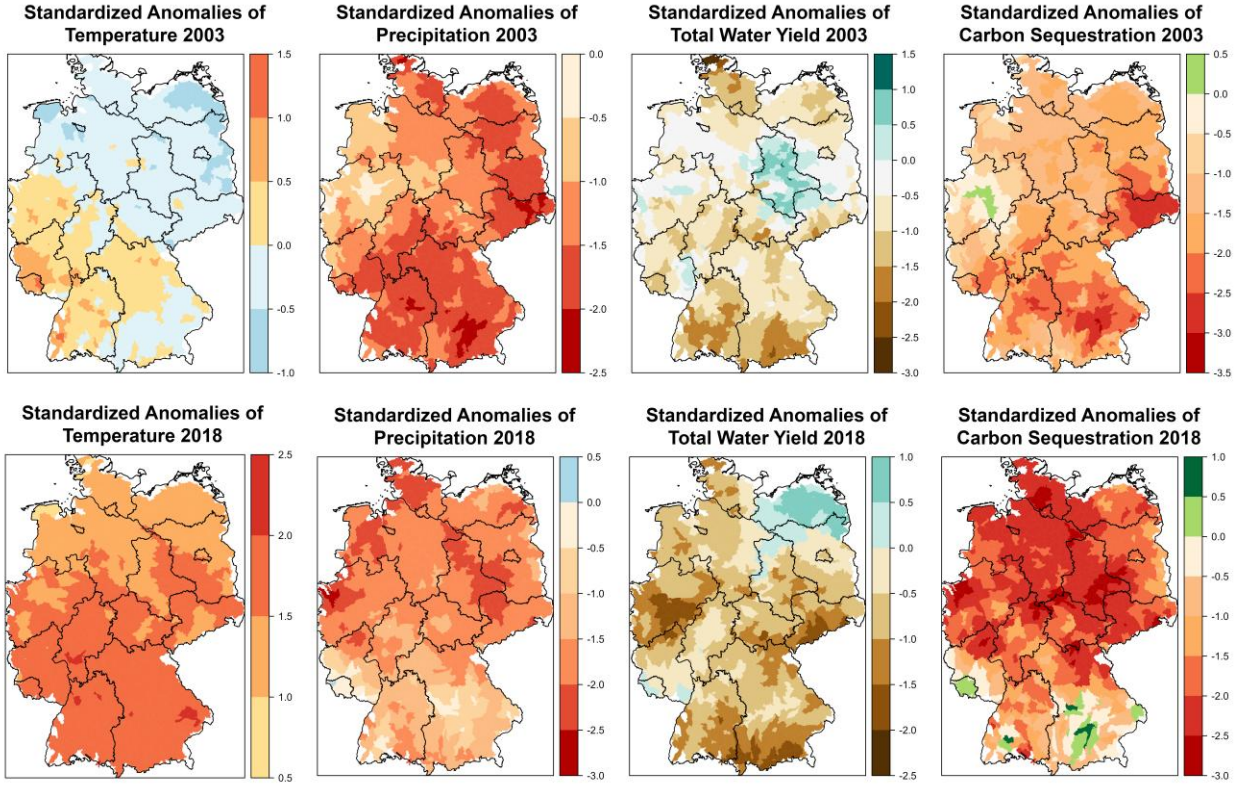
**Figure S1:** Monthly and Annual scatter plot between simulation and observed discharge for twelve different watersheds (2001-2019). The line running diagonally through the plot is a 1:1 line. Legends represent gaging station names.



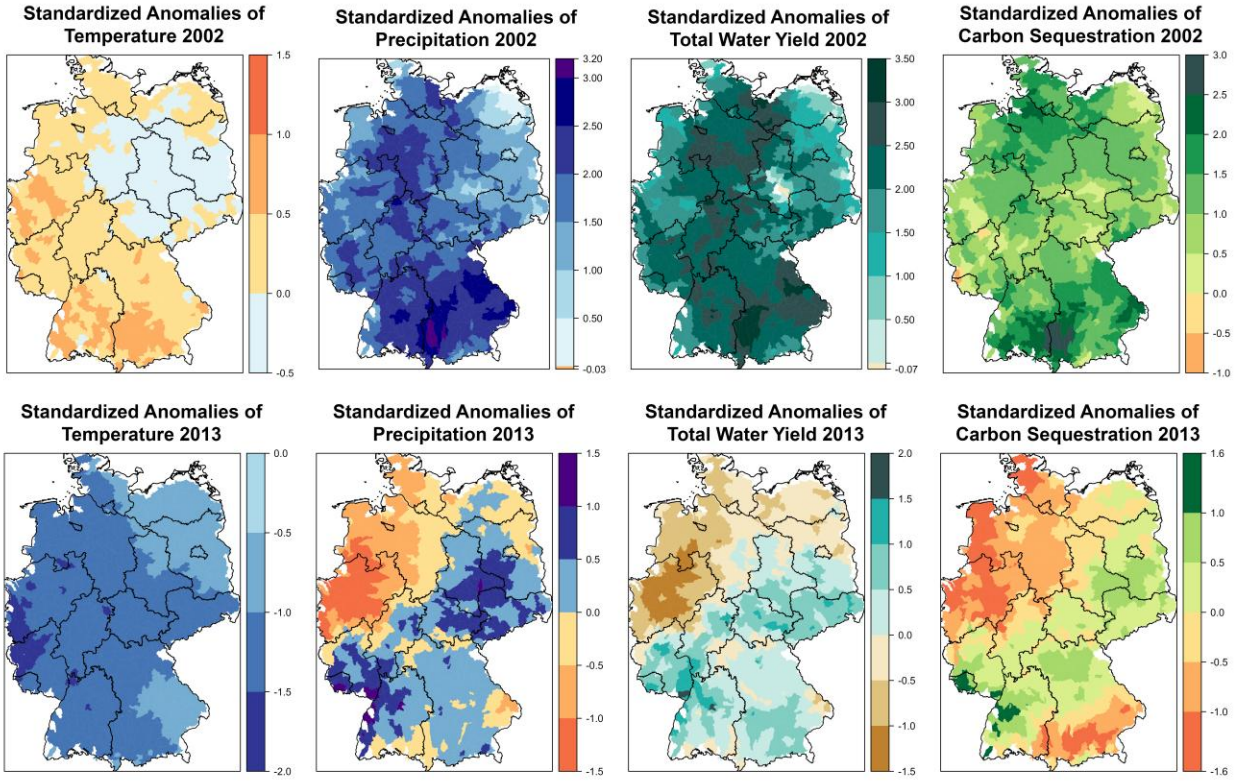
**Figure S2:** a) Monthly scatter plot between corrected ET from eddy flux towers and WaSSI-ET. The plot covers eleven different sites representing five different land covers. The line running diagonally through the plot is a 1:1 line. b) Mean annual WaSSI-ET validation w.r.t to MODIS-ET from 2001 to 2019 is presented in a scatter plot and c) difference map in mm to illustrate the magnitude and distribution of spatial similarities between the datasets across Germany.



**Figure S3: a)** Mean annual WaSSI-GPP validation w.r.t to MODIS-GPP from 2001 to 2019 is presented in a scatter plot and difference map (in mm) to illustrate the magnitude and distribution of spatial similarities between the datasets across Germany. **b)** Mean annual WaSSI-GPP validation w.r.t to CGLS-ET from 2001 to 2019 is presented in a scatter plot and difference map (in mm) to illustrate the magnitude and distribution of spatial similarities between the datasets across Germany.



**Figure S4:** The response of ecosystem services, water yield (mm) and carbon sequestration ( $\text{g C m}^{-2}$ ), during two drought events (2003 and 2018). Both drought events had different spatial patterns and intensities, thus the response from the ecosystem varied spatially. The standardised anomalies in the figure were estimated by subtracting the mean annual values for the period 2001 – 2019 from the estimates of the individual drought years 2003 and 2018 on a watershed scale and dividing the difference by the standard deviation.



**Figure S5:** The response of ecosystem services, water yield (mm) and carbon sequestration ( $\text{g C m}^{-2}$ ), during two extreme precipitation events (2002 and 2013). Both events had different spatial patterns and intensities, the response from the ecosystem varied spatially. The standardised anomalies in the figure were estimated by subtracting the mean annual values for the period 2001 – 2019 from the estimates of the individual years 2002 and 2013 on a watershed scale and dividing the difference by the standard deviation.