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Supply and Demand of Net Primary Production in the Semiarid Sahel

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Introduction

- NPP represents the rate of formation of new plant biomass and is an important component in the global carbon cycle.
- Fluctuations in the supply and demand of NPP drives ecosystem processes and directly impacts human livelihood in terms of providing food, feed, fuel and fiber.
- Semiarid regions in Africa are particularly vulnerable to fluctuations in the supply of, and demand for, NPP due to recurring food crises.

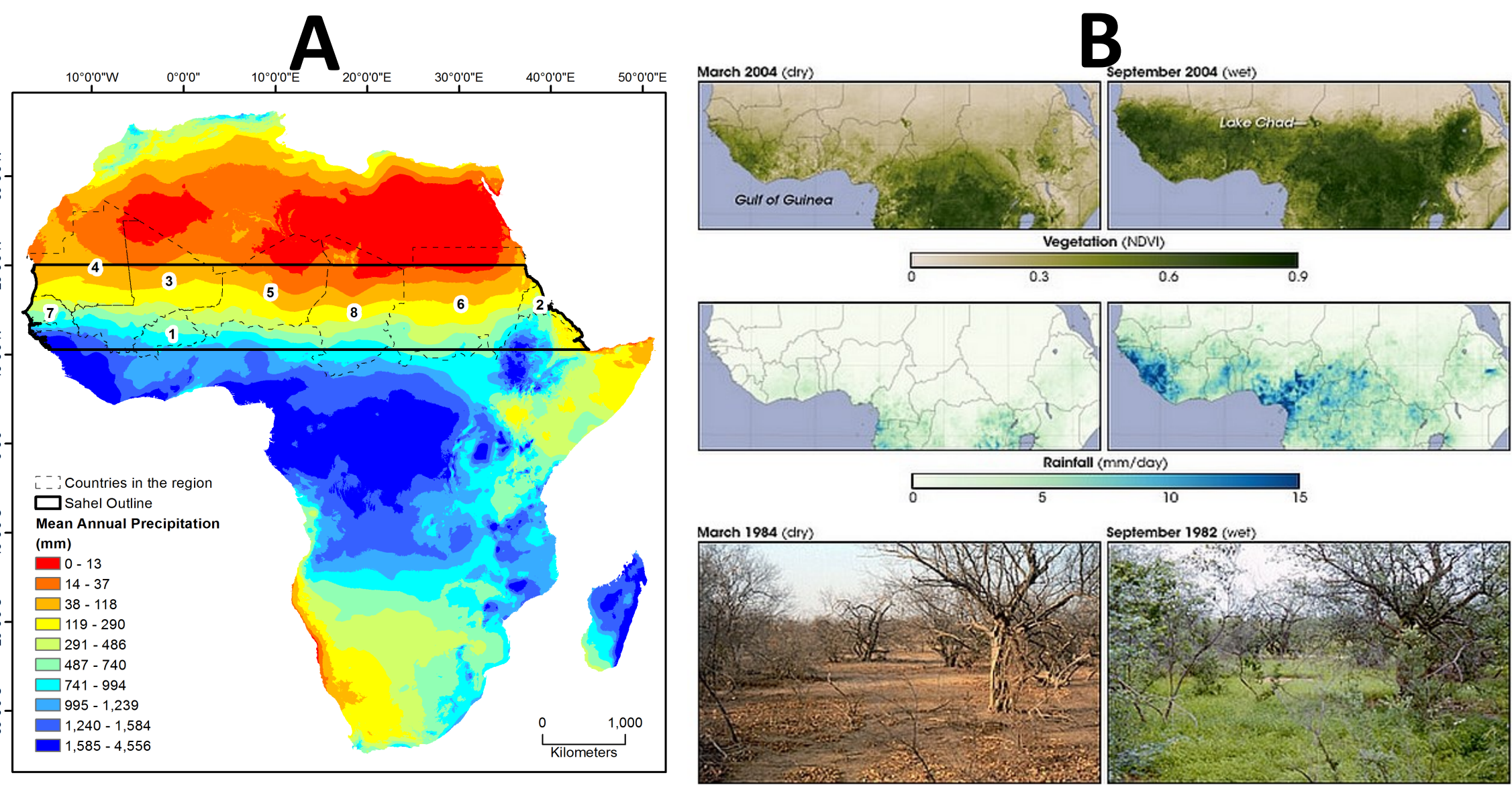


Figure 1: **A**) Mean annual precipitation in continental Africa from 1950-2000. Countries in the region include (1) Burkina Faso (2) Eritrea (3) Mali (4) Mauritania (5) Niger (6) Sudan (7) Senegal, and (8) Chad. **B**) Contrast between the dry and rain season in West Africa. Photos: NASA

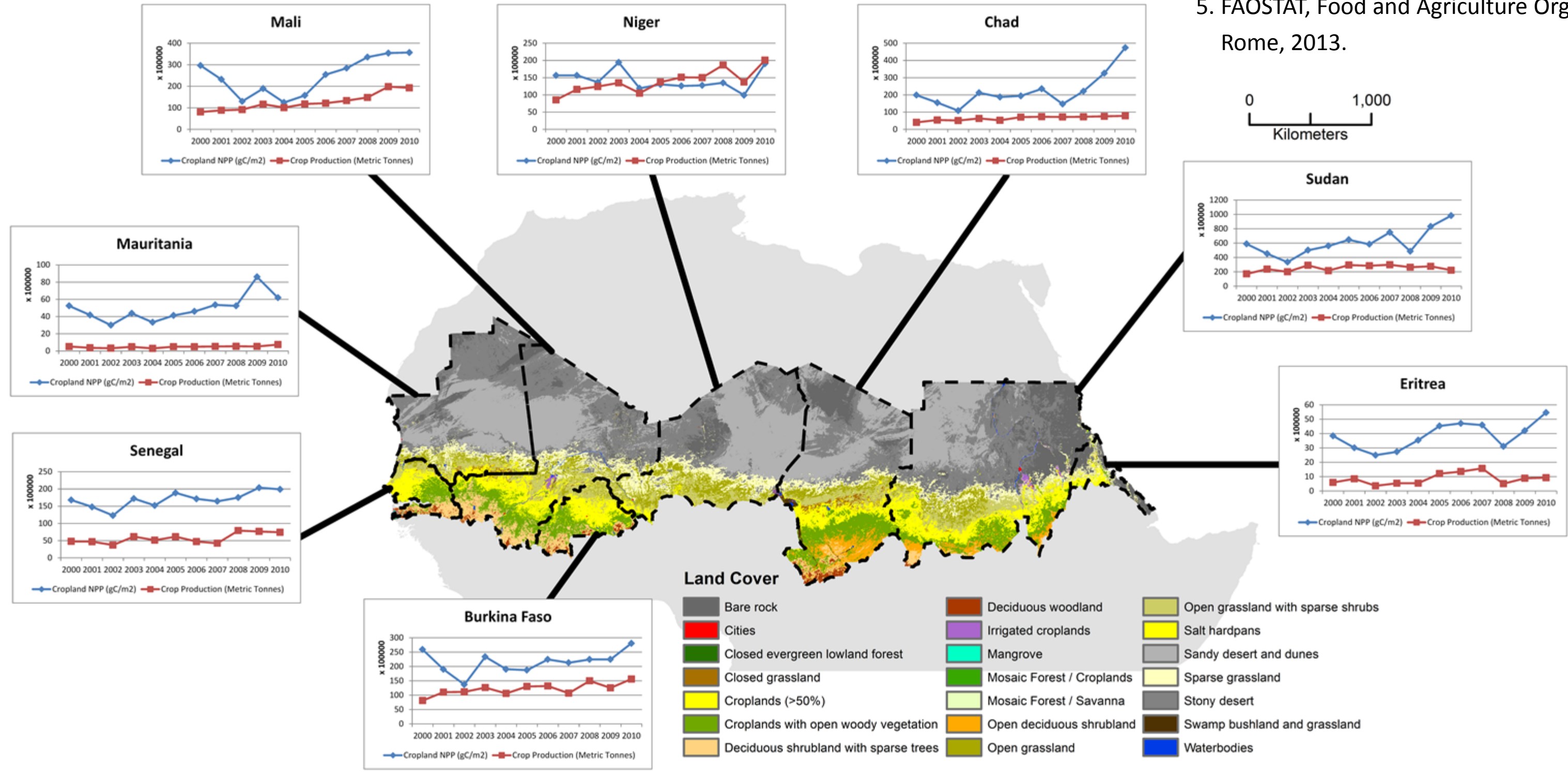


Figure 3: Relationship between primary crop production and MODIS NPP between 2000 and 2010 for the eight Sahelian countries that are the focus of this study. Data: FAOSTAT⁵

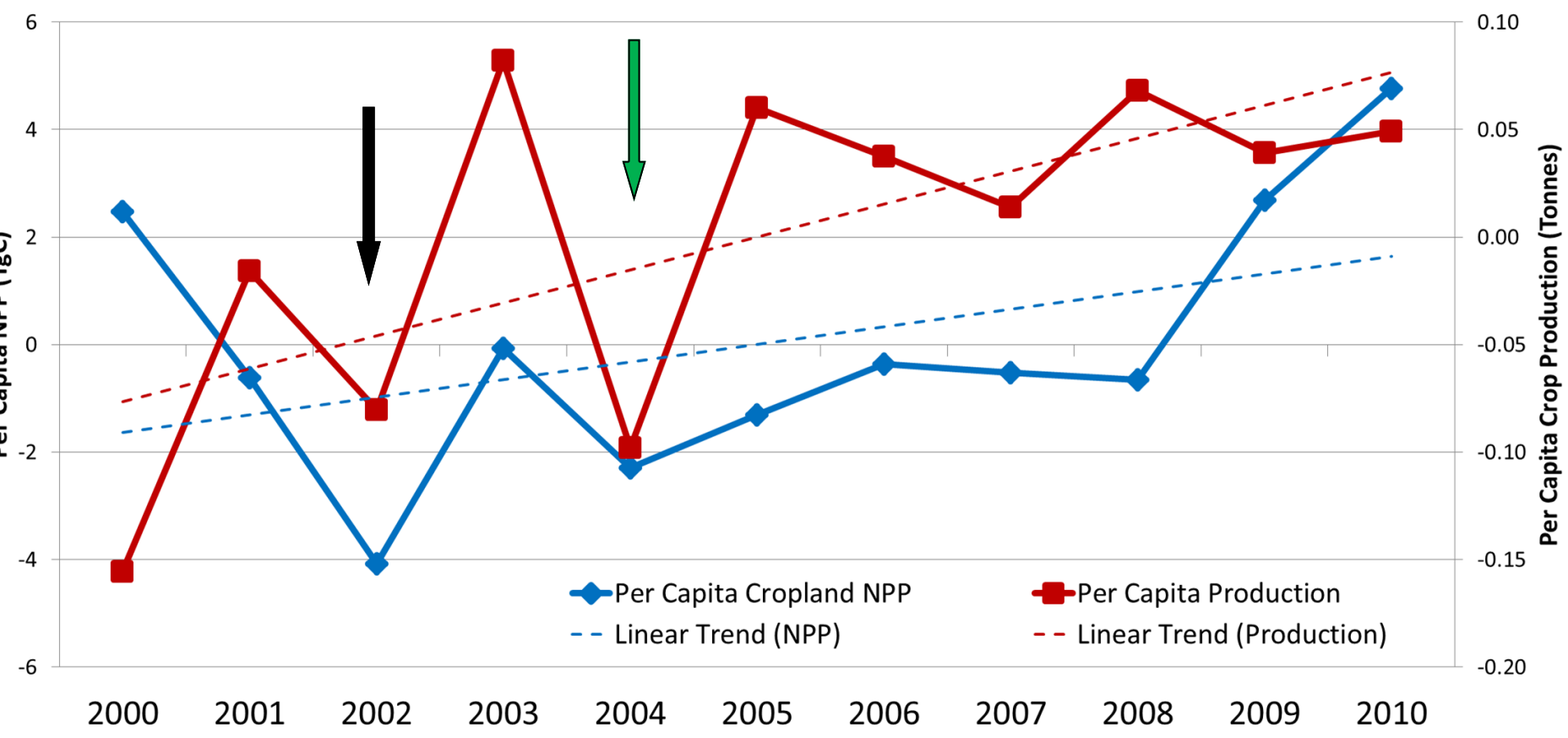


Figure 5: Trends in per capita NPP from MODIS and primary crop production from FAO between 2000-2010 for the eight Sahelian countries. The arrows show shortage in per capita NPP and primary crop production in connection to food crises that are visible in precipitation anomalies (see Figure 2A).

Research Questions

- What is the present condition of per capita NPP availability in the Sahel?
- What drives the trend of per capita NPP in the Sahel?
- Are trends in annual food production visible in annual cropland NPP?

Methodology

Cropland NPP was extracted from MODIS¹ and GLO-PEM² using the recent MARS-JRC³ cropland mask. Then, per capita NPP was derived using decadal population data (1980-2010) from UNEP/GRID⁴ and divided by GLO-PEM (1981-2000) and MODIS NPP (2000-2010) data. Primary crop production data was downloaded from FAOSTAT⁵.

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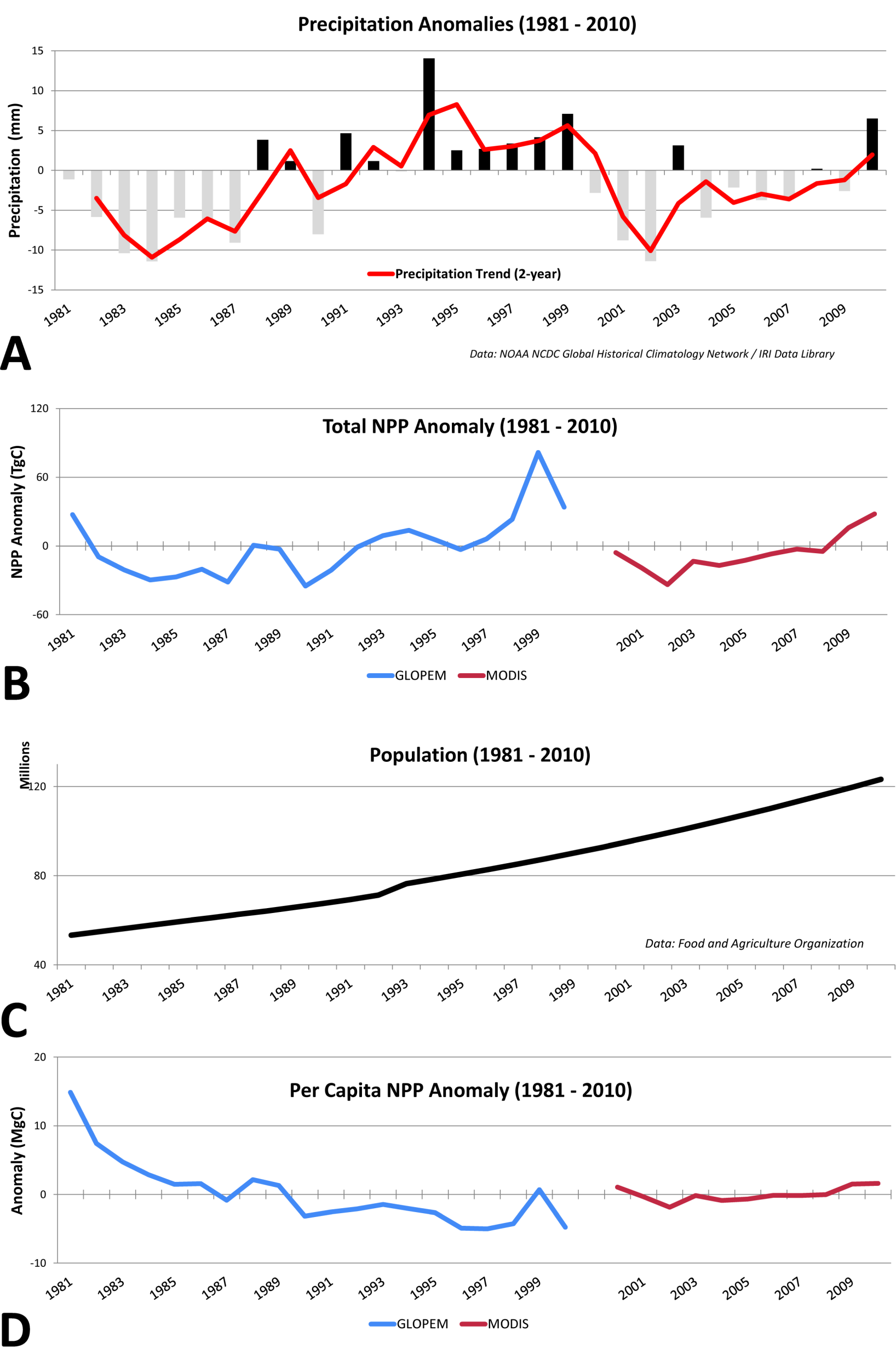


Figure 2: (A) Sahelian precipitation anomalies showing an increase in rainfall in the 1990s, which led to (B) increase in the total NPP anomaly highlighting the dependence on rainfall (C) The Sahelian population increased at an average annual rate of 4.5% a year between 1981 and 2010 and is reflected in (D) the general decreasing trend of the per capita NPP that could indicate the inability of NPP to keep up with the population increase.

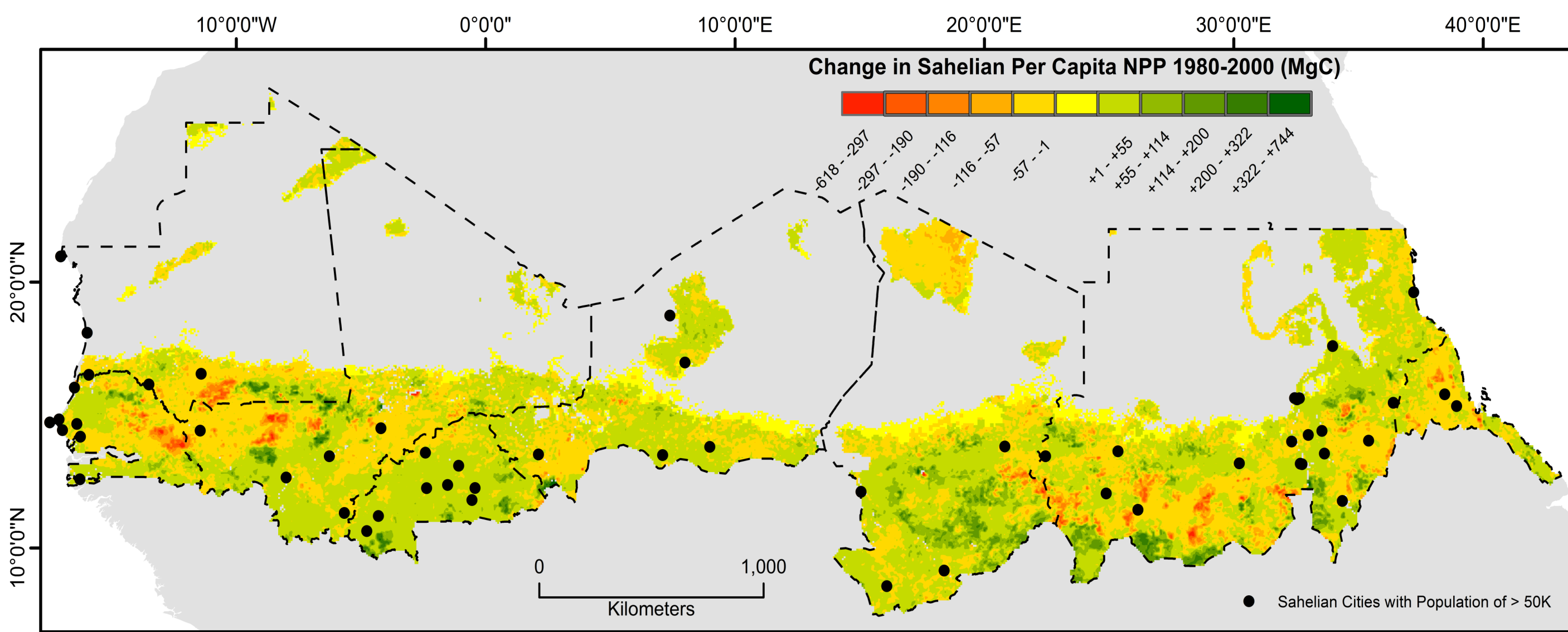


Figure 4: An overview of the change in per capita NPP in the Sahel between 1980 and 2000 from GLOPEM data. Some areas have increased per capita NPP, for example Burkina Faso, could be attributed to a combination of land rehabilitation efforts and increased rainfall. Other areas, such as Darfur and South Kordofan in Sudan and south-central Mauritania, exhibit decreases in per capita NPP that could be caused by overgrazing and deforestation for fuelwood.

Early Results

- There is moderate correlation between MODIS cropland NPP and primary crop production for the eight Sahelian countries (Figures 3 and 5).
- Per capita trends in MODIS cropland NPP and primary crop production seem to be coupled to the extent that both datasets were able to detect the 2002 Sahelian food crisis (Figures 2, 5, and 6).
- Change in per capita NPP between 1980 and 2000 has not been constant across the region (Figure 4) and is speculated to be a function of land use and climate.

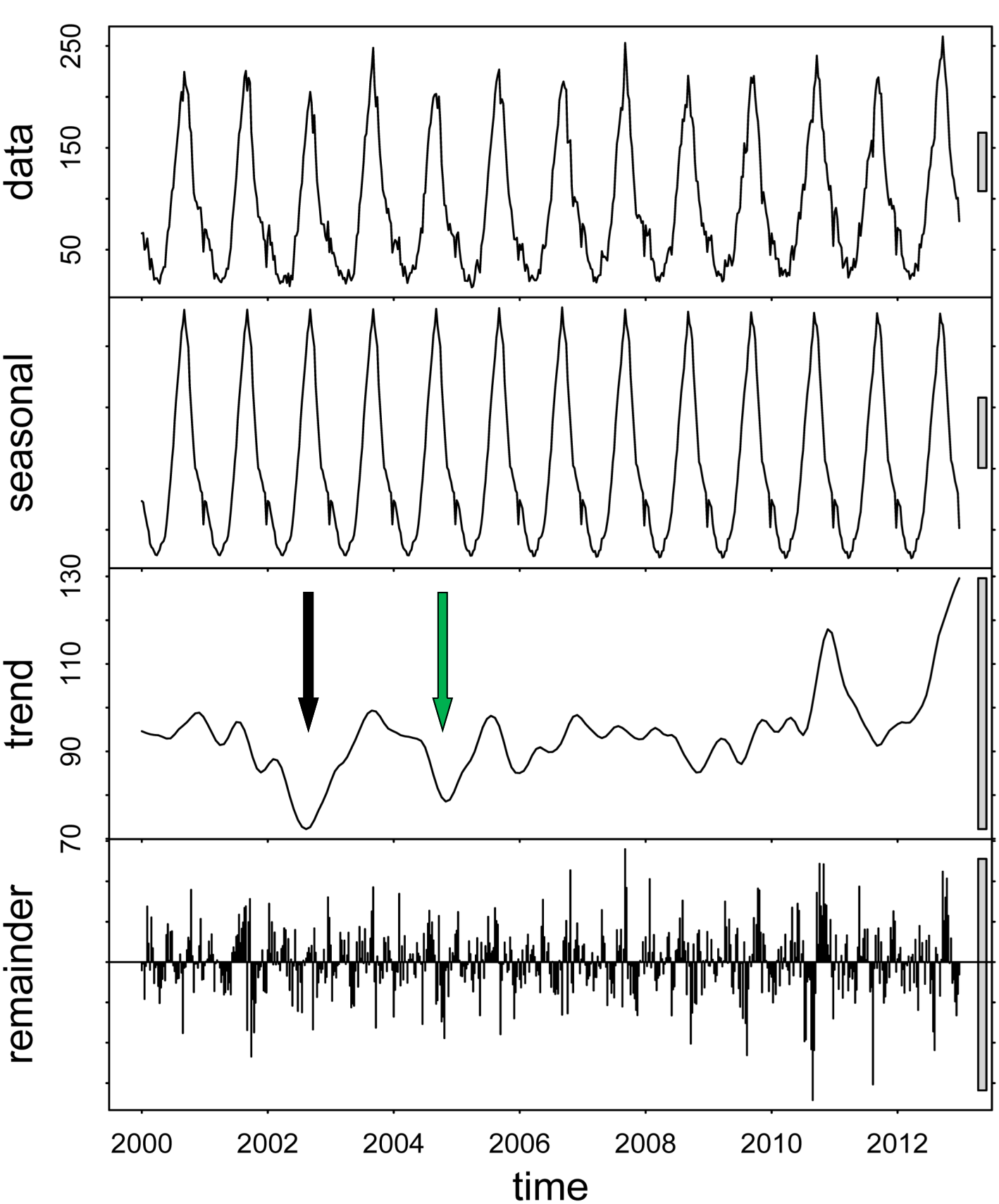


Figure 6: Time series of cropland GPP over the Sahel using MODIS data and the MARS-JRC cropland mask. The black and green arrows correspond with the ones in Figure 5 and signify drops in food production.

