

# Exploring 20 Years of Eurasia NPP Changes Associated with Land-Cover/Land-Use Change

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## 1. Introduction

Changes in land use or land cover strongly influence ecosystem properties. One such property is net primary production (NPP), which may increase, as through human management of agricultural lands, or decrease, such as following deforestation or fire. In this study, we investigated changing NPP as computed from 21 years of 8-km satellite observations and a production efficiency model (CASA).

Advantages of this data set include

- Observationally based
- Wide spatial coverage
- Monthly time step continuously over 21 years

Disadvantages include

- Relatively short length of time
- Relatively coarse resolution
- Drivers of change must be inferred

Here we analyzed time series of satellite-derived NPP in conjunction with other data sets that describe land-use or land-cover change to evaluate the response of production.

## 2. Data and model

### Satellite observations:

- Normalized Difference Vegetation Index (NDVI) processed by NASA GSFC to minimize abiotic influences such as sensor degradation, intercalibration, changing solar zenith angle
- 8-km spatial resolution
- semi-monthly from 1982-2002

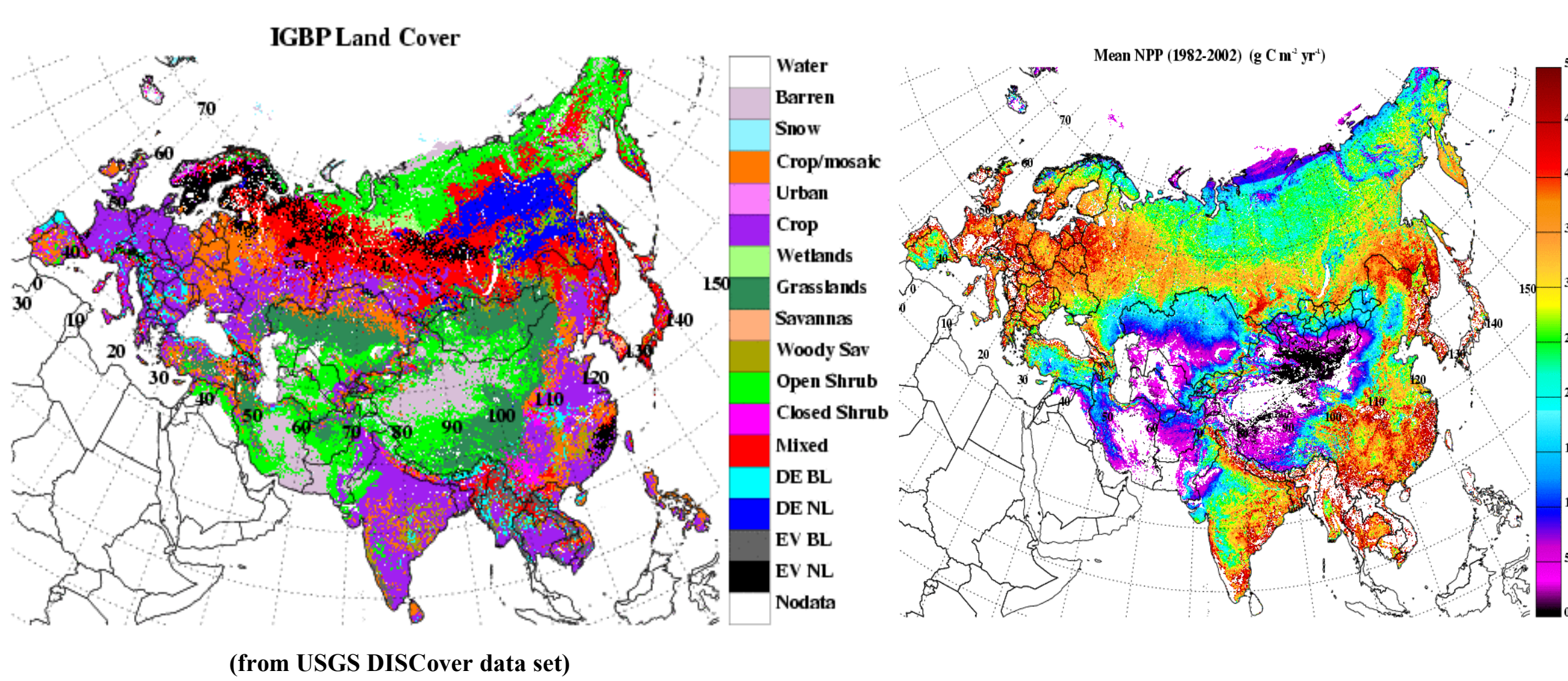
### Model:

Carnegie-Ames-Stanford Approach (CASA) production efficiency model:

$$NPP = fAPAR \times PAR \times \epsilon^* \times \delta$$

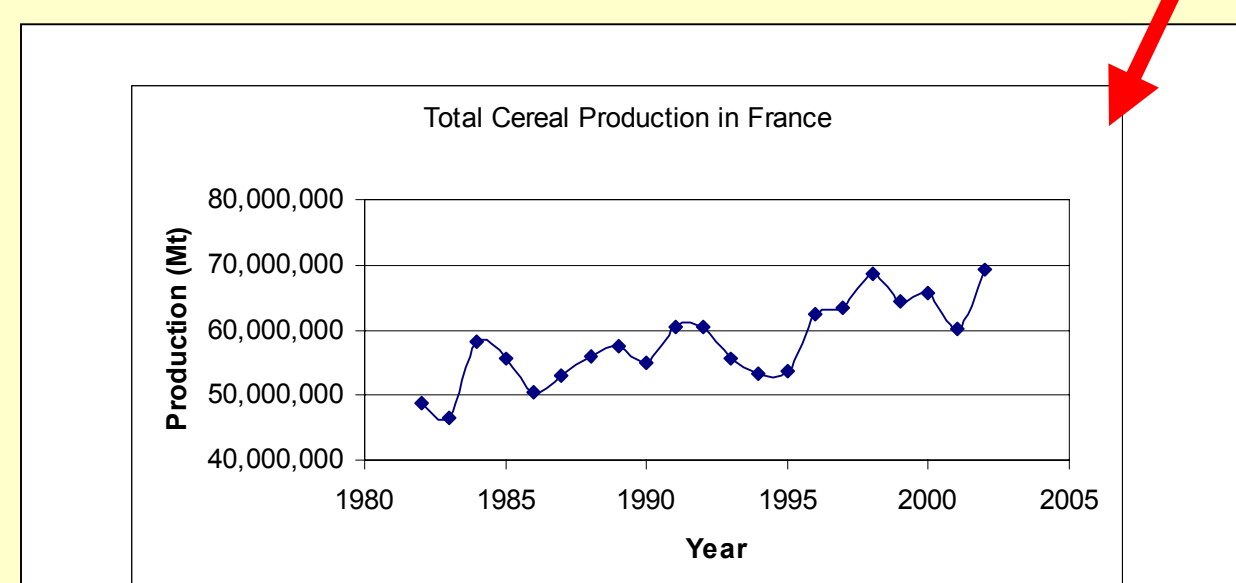
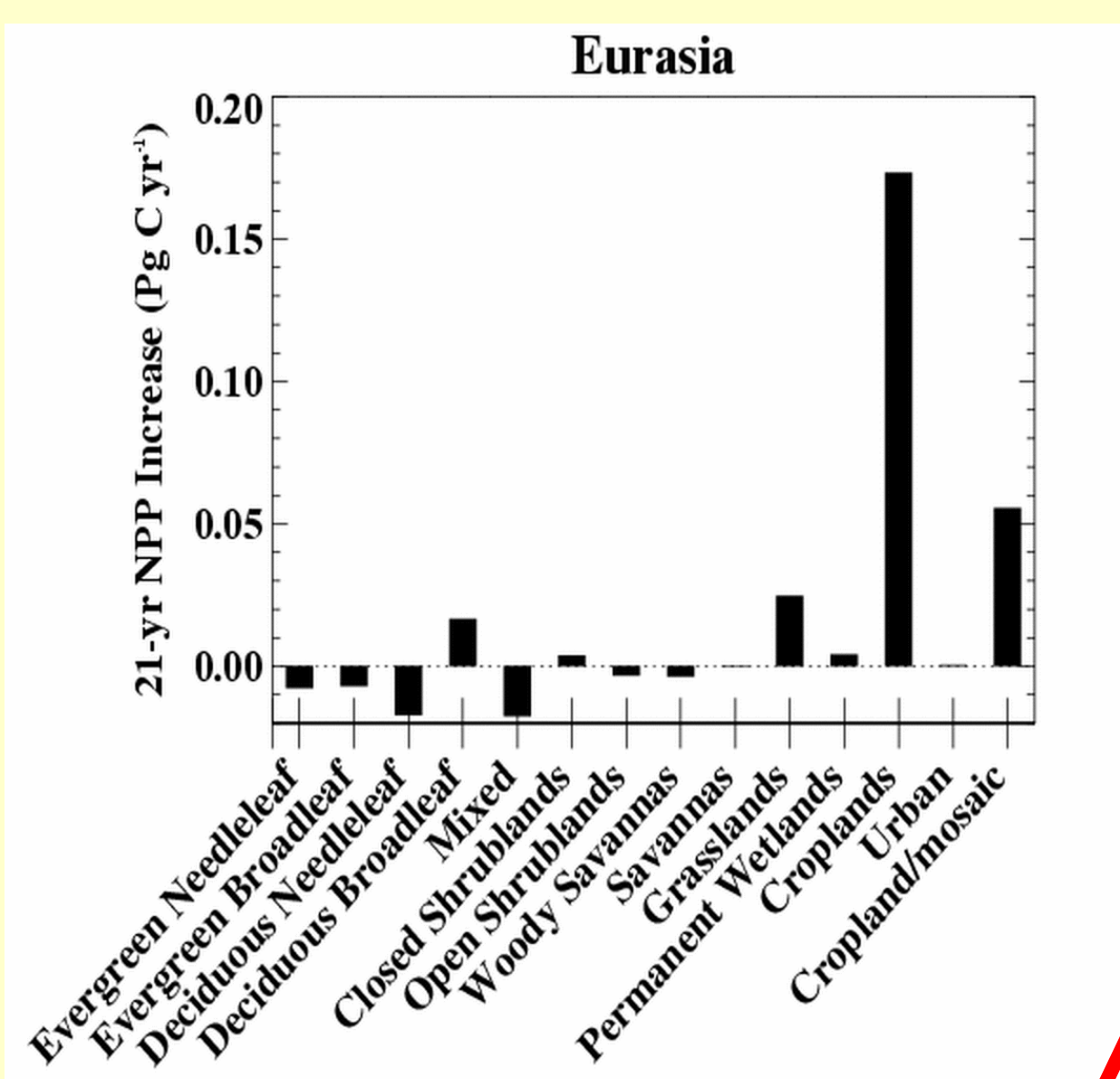
where NPP is net primary production ( $g C m^{-2} yr^{-1}$ ), PAR is the incident photosynthetically active radiation, fAPAR is the fraction of PAR absorbed by vegetation,  $\epsilon^*$  is the maximum light use efficiency that converts absorbed radiation into fixed carbon, and  $\delta$  down-regulates NPP in unfavorable climate conditions.

Additional inputs: Temperature and solar radiation from NCEP/NCAR Reanalysis (monthly, 2.5°); precipitation from Global Precipitation Climatology Project (monthly, 2.5°)

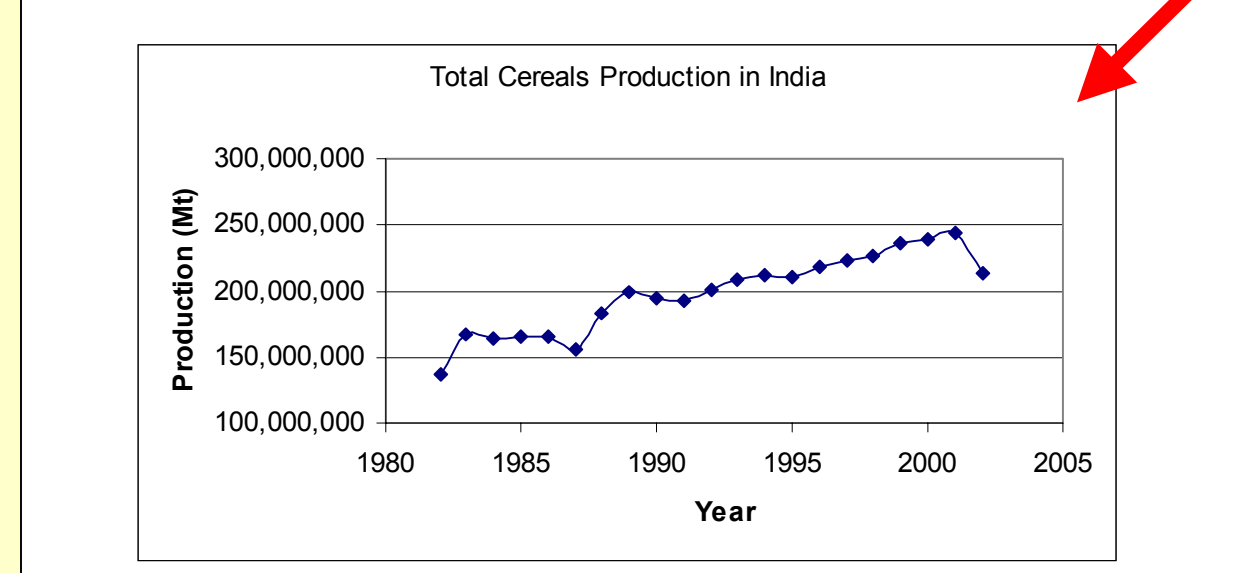


## 3. Changes in Agricultural NPP

- Croplands have contributed most to changes in Eurasian NPP, due both to their wide spatial extent as well as their large per area increase
- Land-use change probably played a role through management activities such as improved fertilization, pest management, and cultivars
- Other factors such as climate, economics may also have been important

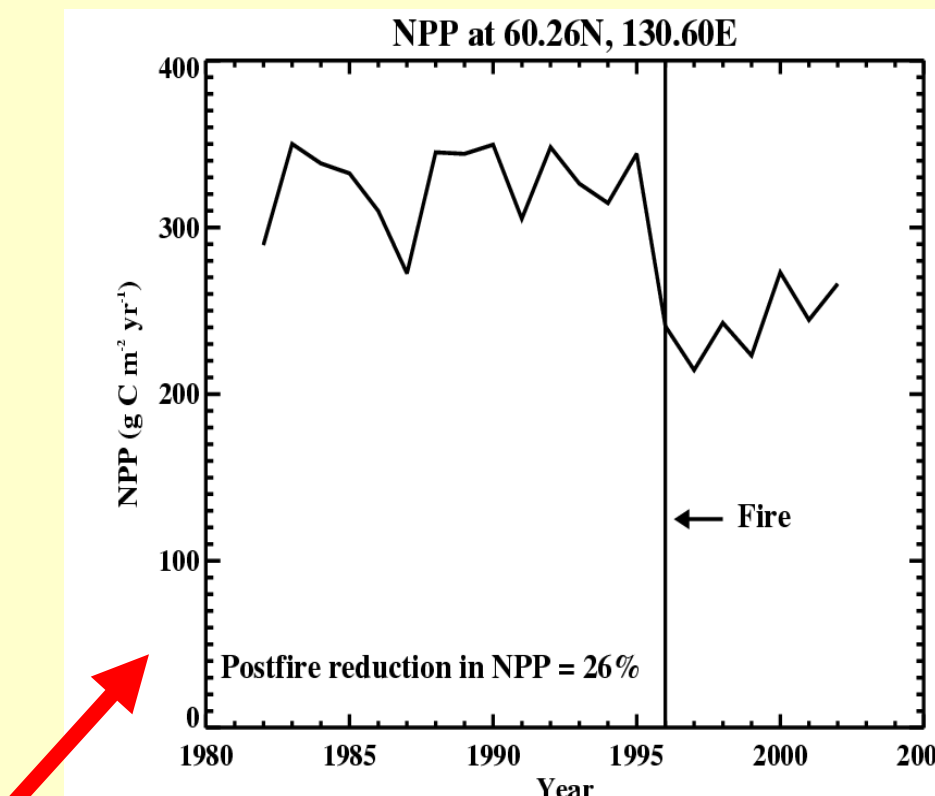


- Substantial increases in the satellite-derived production occurred in Europe and India
- Increasing production is also evident in FAO statistics

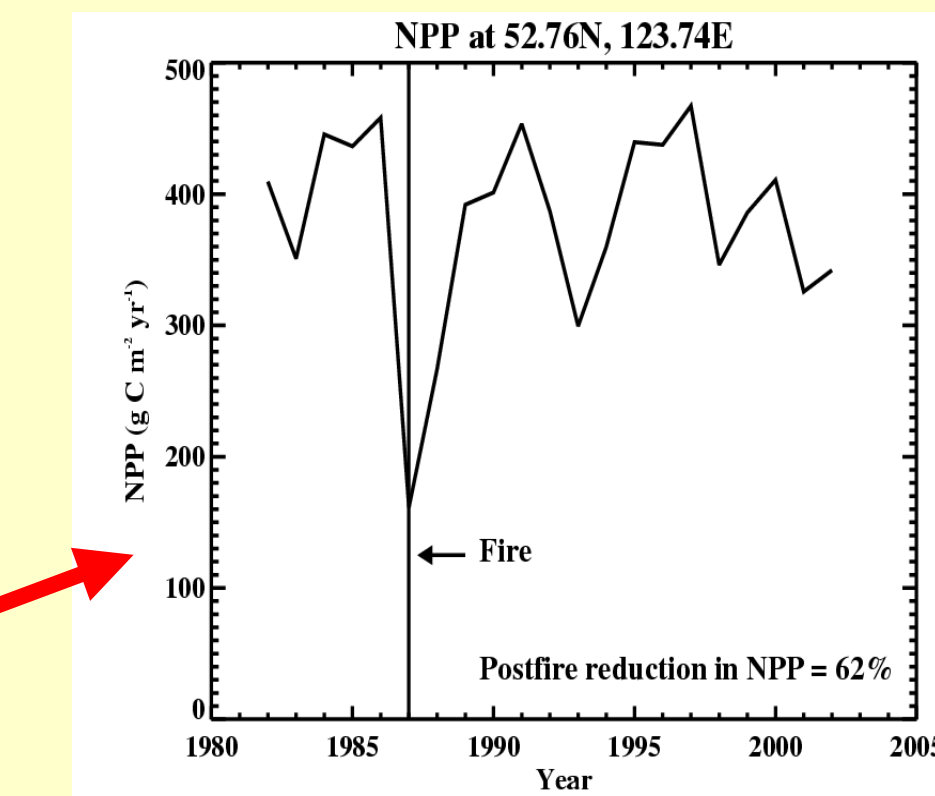


## 4. Fires

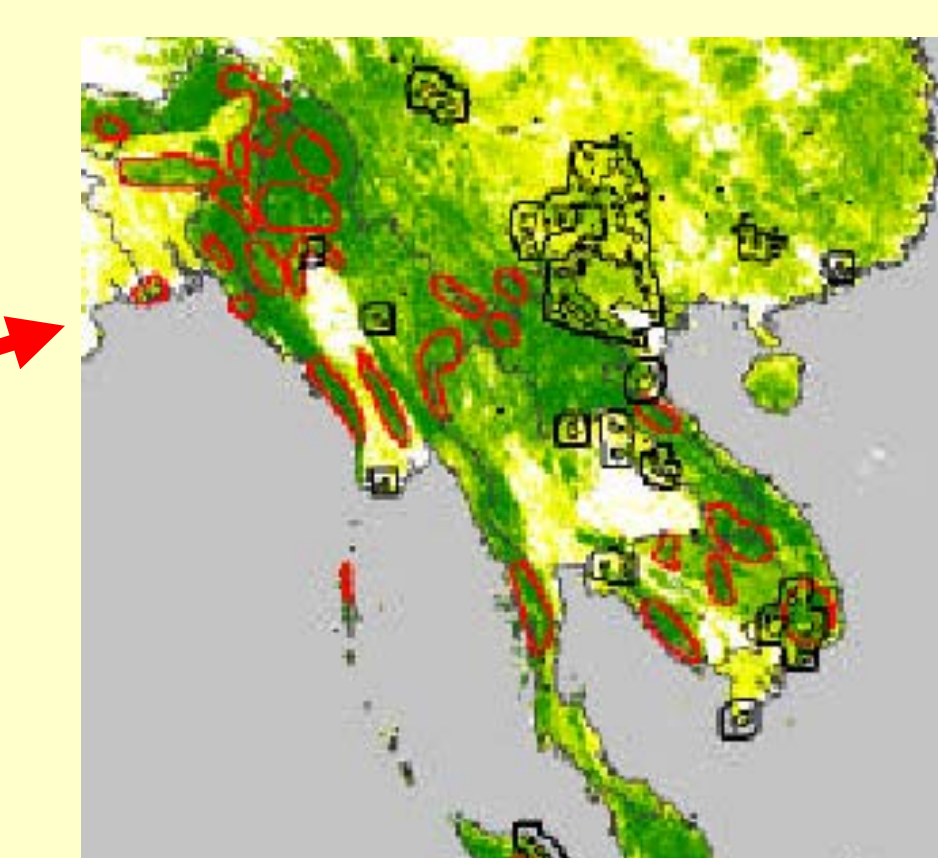
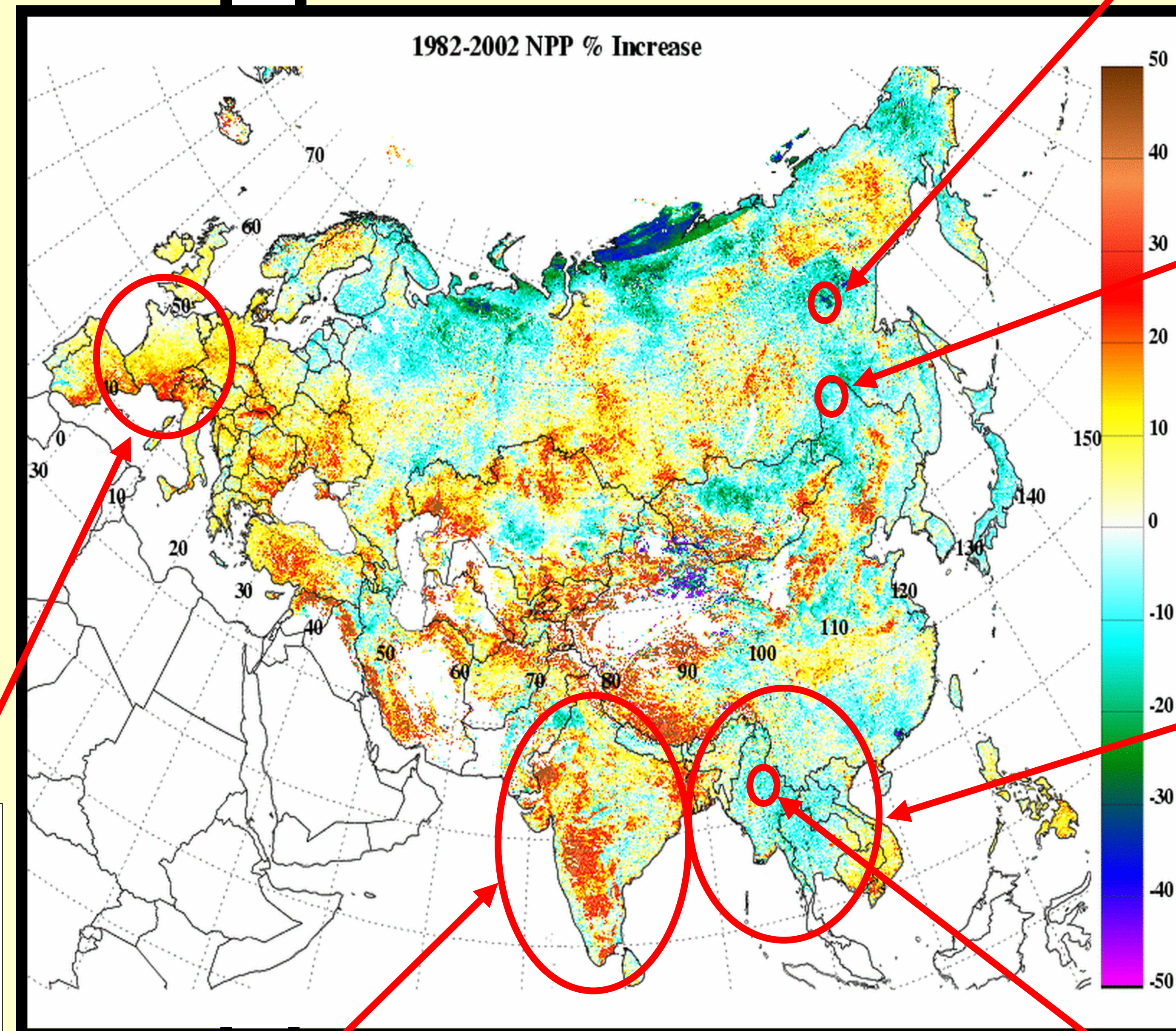
- Large fires frequently occur in boreal forests and grasslands
- Grassland fires are not detectable in the 8-km NPP due to the rapid recovery as well as the high background variability
- Large boreal forest fires are evident in this data set as substantial declines in NPP, although rapid recovery occurred as well



NPP for a location in Russia that experienced a forest fire in 1996 identified by Sukhinin et al. (in press).



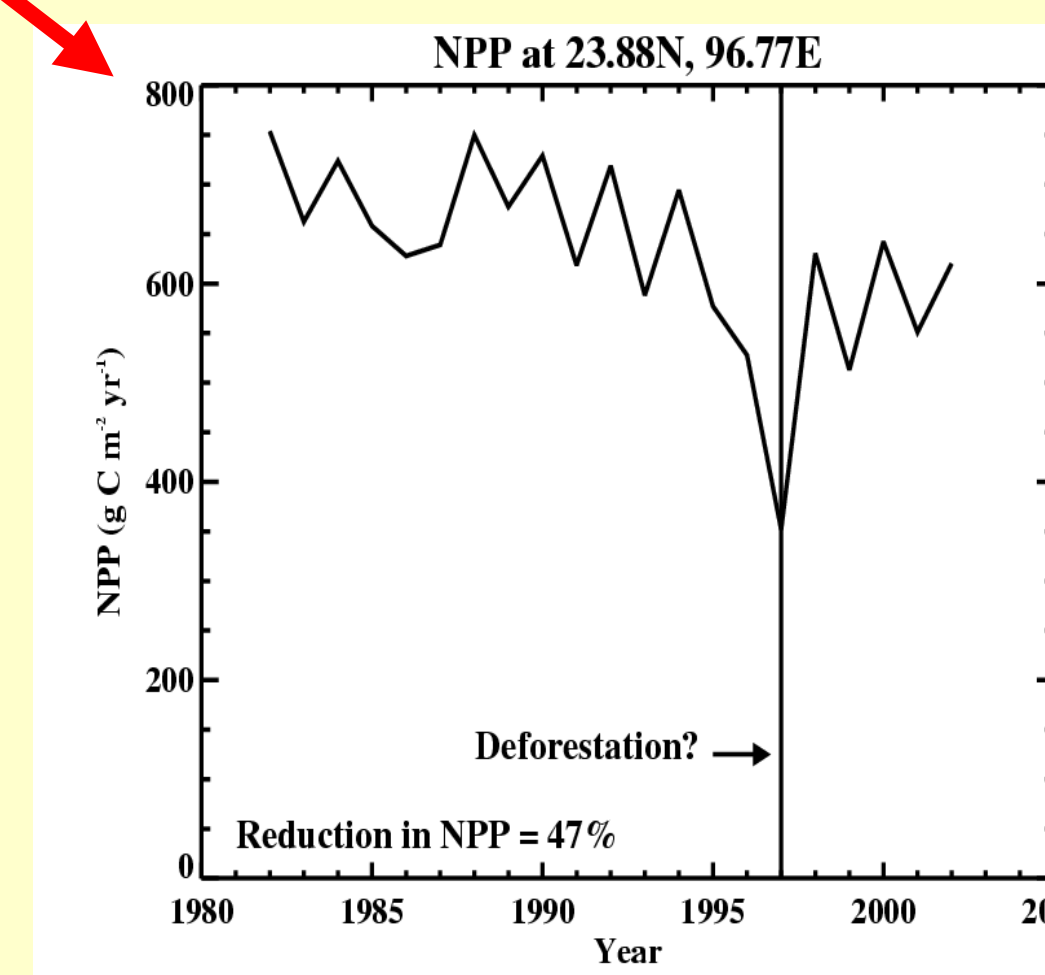
NPP for a Chinese location that experienced a forest fire in 1987 as identified by Cahoon et al. (1984).



Deforestation as detected by two satellite-based methods: TREES (red) (Achard et al., 1998); changes in % tree cover (black) (DeFries et al., 2002).

## 5. Deforestation

- Deforestation is occurring in Southeast Asia; evidence from two data sets is shown in upper right figure
- NPP in SE Asia decreased by 10-15% during 1982-2002
- NPP typically exhibited a gradual decline, although some pixels may have had detectable individual deforestation events (figure at right)
- Analysis with additional imagery is required to locate deforestation

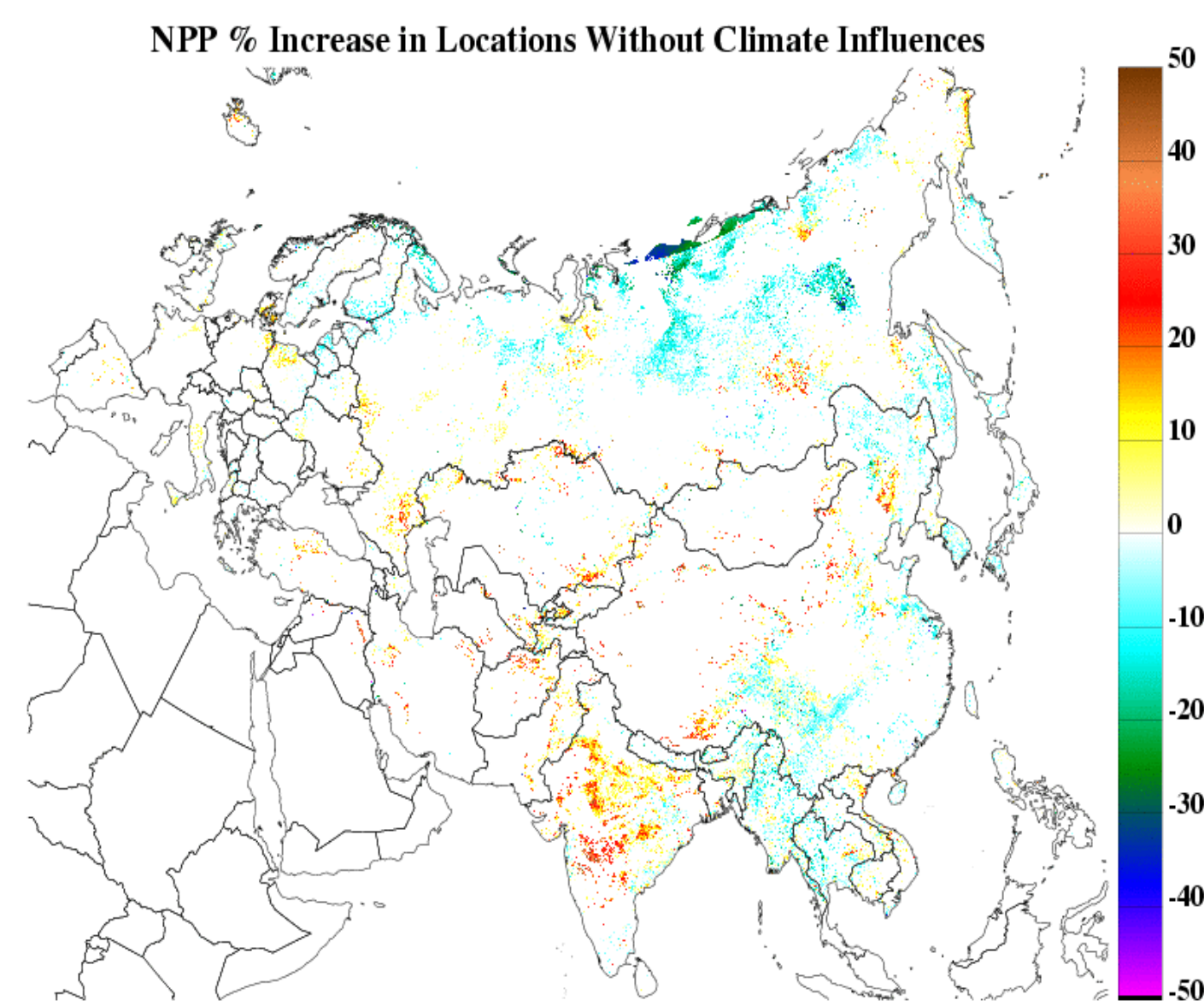


Response of NPP to possible deforestation.

## 6. Detecting Land-use/Land-Cover Change with Satellite-derived NPP

By identifying NDVI changes that occurred in spite of a lack of favorable climate change, we can highlight locations that may have undergone land-use or land-cover change.

This analysis suggests areas for further research to assess land-use/land-cover change; additional analyses in these locations with other data sources are required to identify land-use/land-cover change definitively.



## 7. Conclusions

- Time series of satellite-derived NPP are useful in estimating changes in production associated with land-use or land-cover change
- The 8-km, 21-year record is too coarse and too short to identify land-use or land-cover change for most events
- Ideally, ancillary data sets developed with other sources should be used to locate land-cover or land-use change
- In conjunction with climate data, the 21-year NPP data set can suggest locations undergoing land-use or land-cover change

## 8. Acknowledgements

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