

# Global-scale characterization of turning points in arid and semi-arid ecosystem functioning

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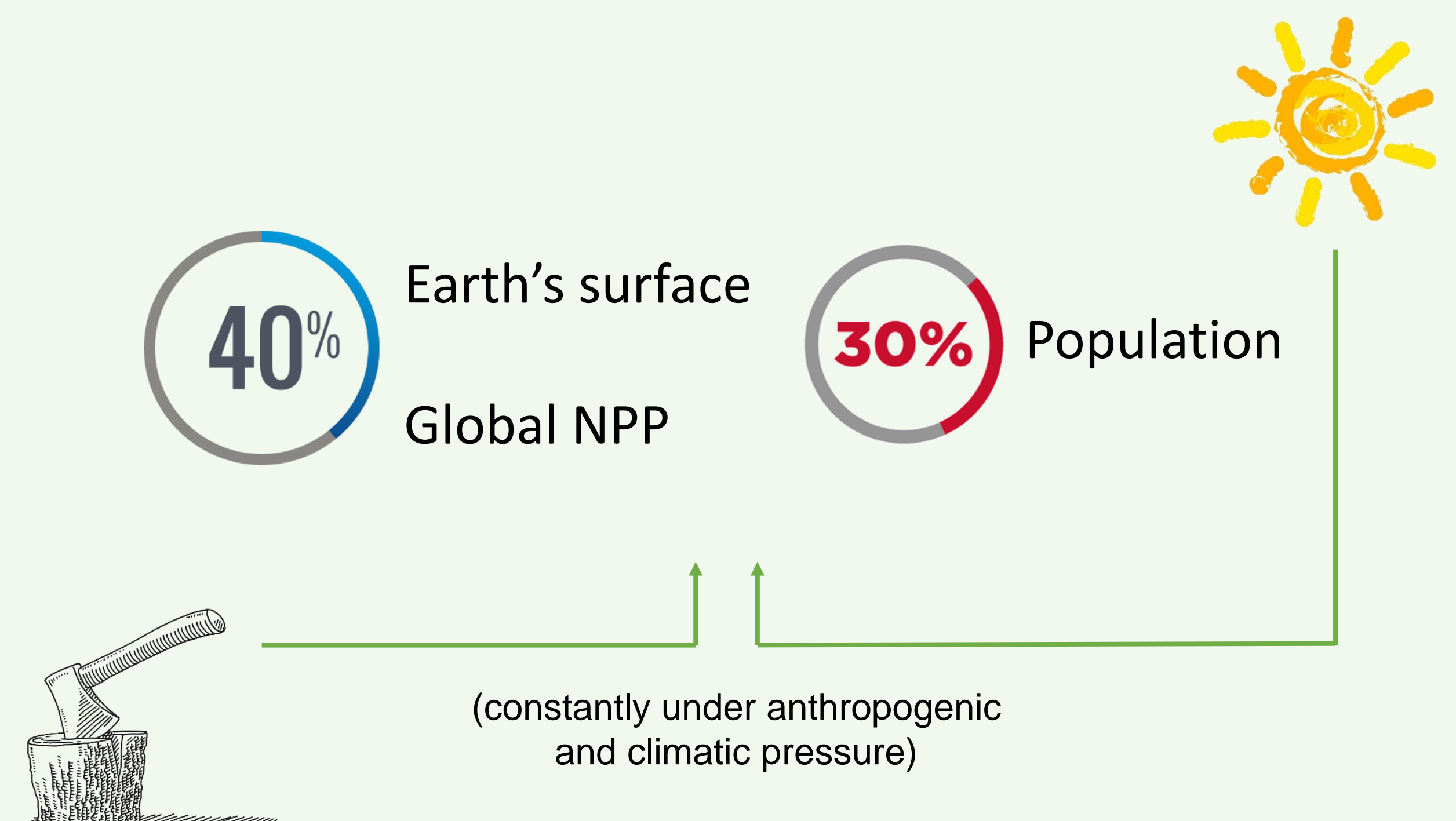
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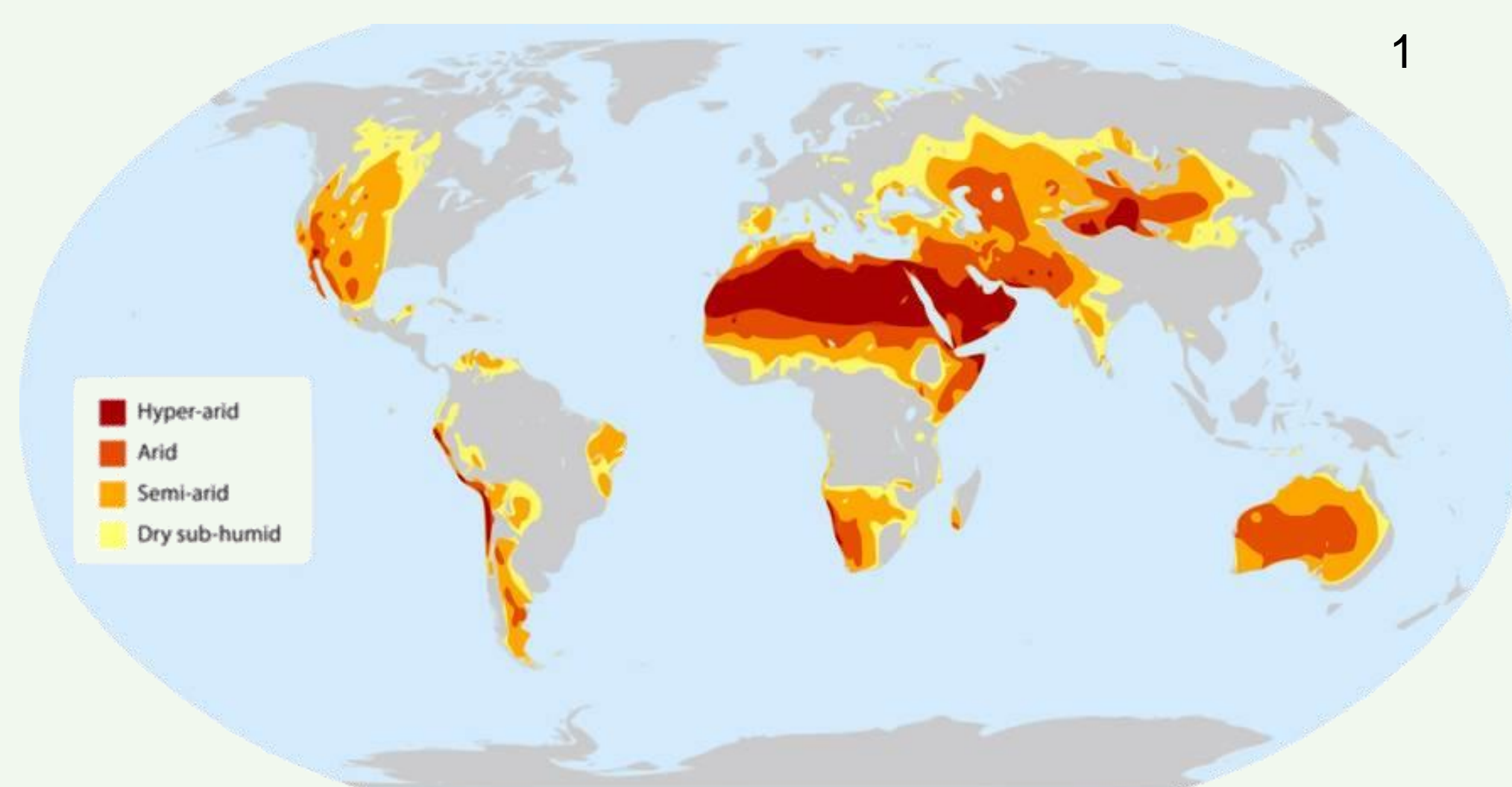
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## Background

- Drylands cover around 40% of Earth's land surface and support one-third of the global human population.
- Changes in dryland ecosystem functioning are threatening ecosystems stability and the well-being of populations worldwide.
- Turning points (TPs) happen when ecosystems change abruptly from a way of functioning to an alternative one.



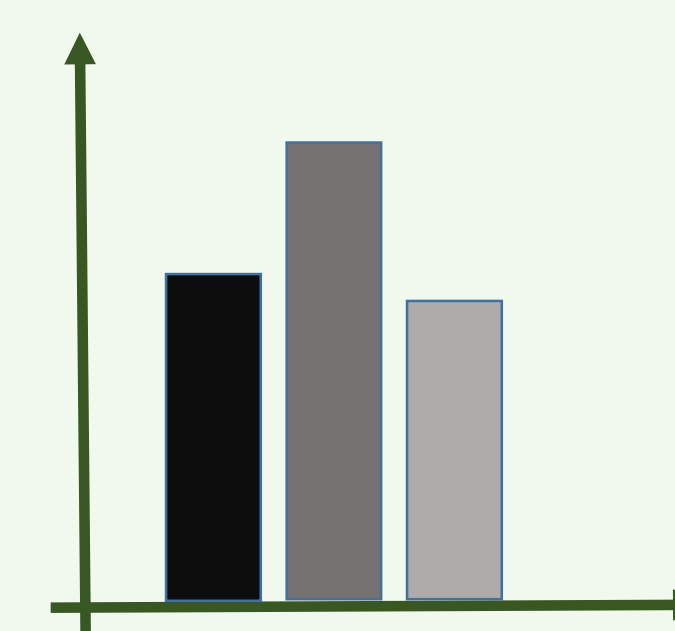
## Objectives



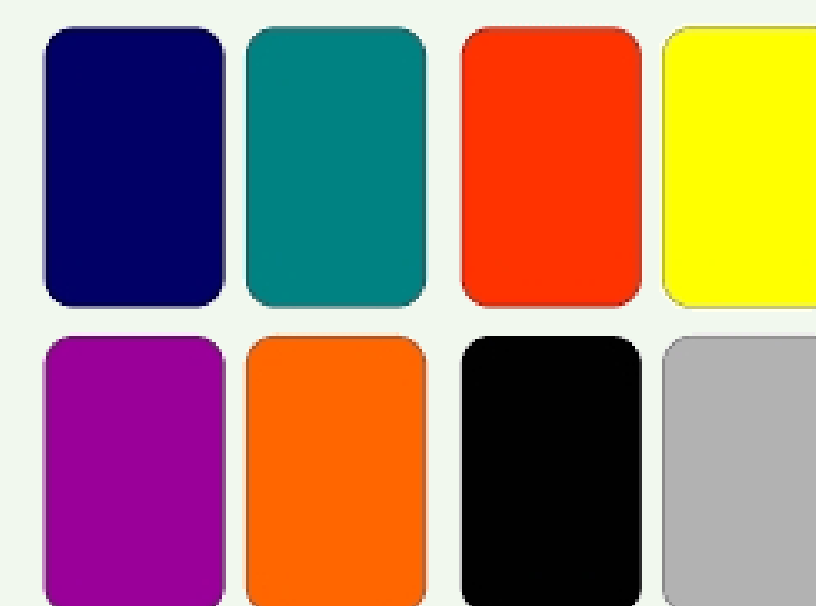
(only arid and semi-arid regions were considered)

Detect

TP



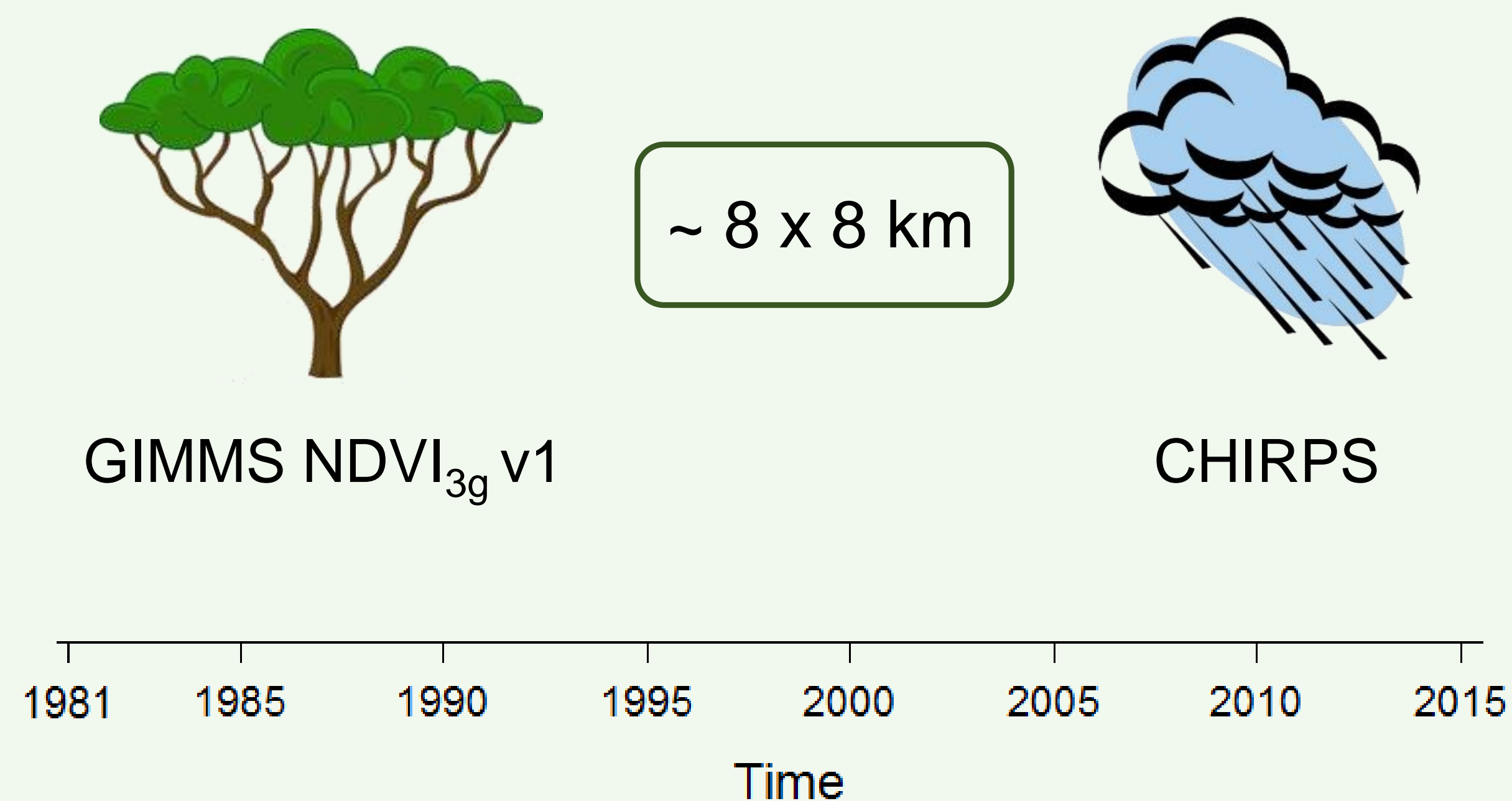
Quantify



Characterize

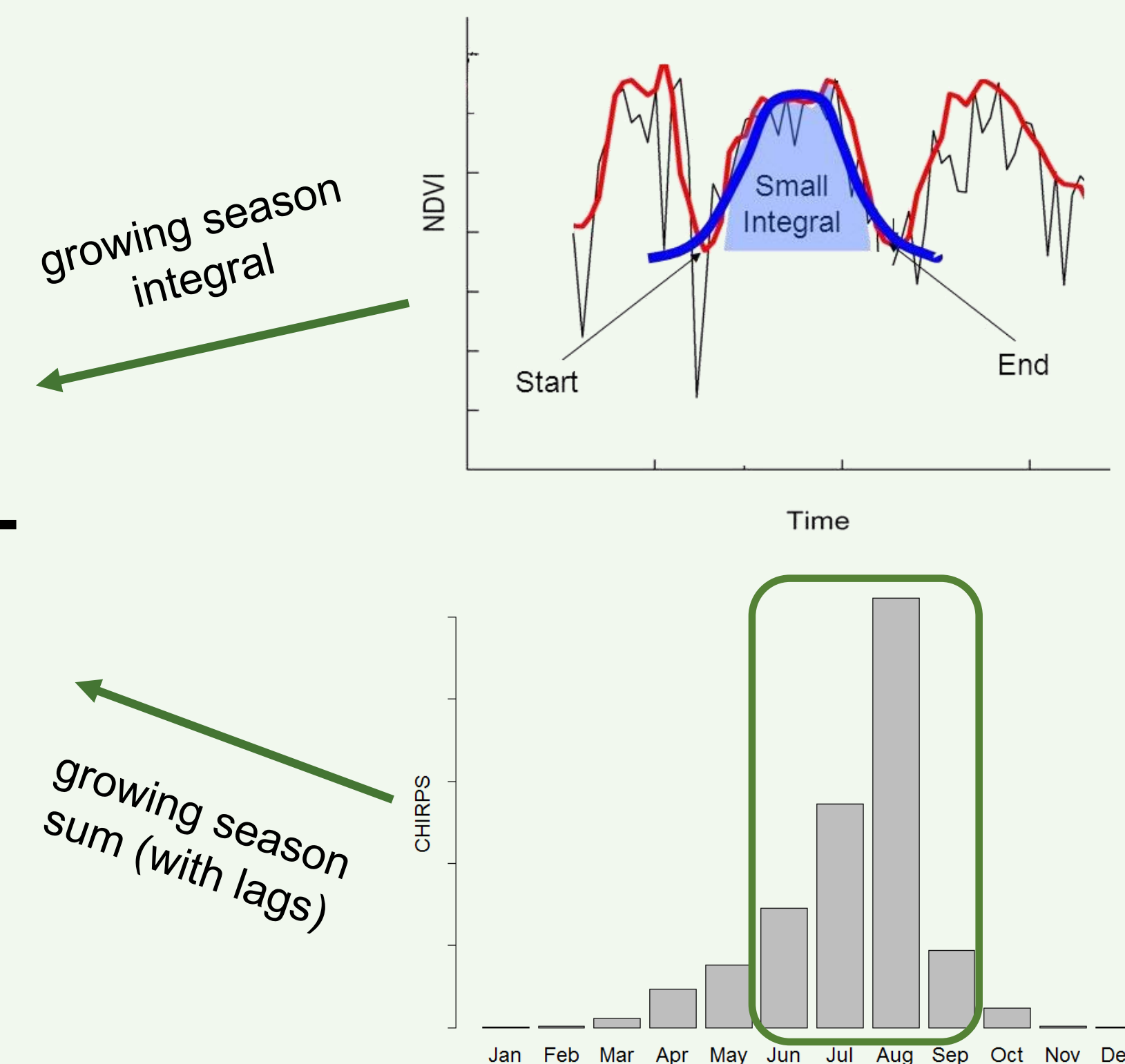


## Vegetation and rainfall time series

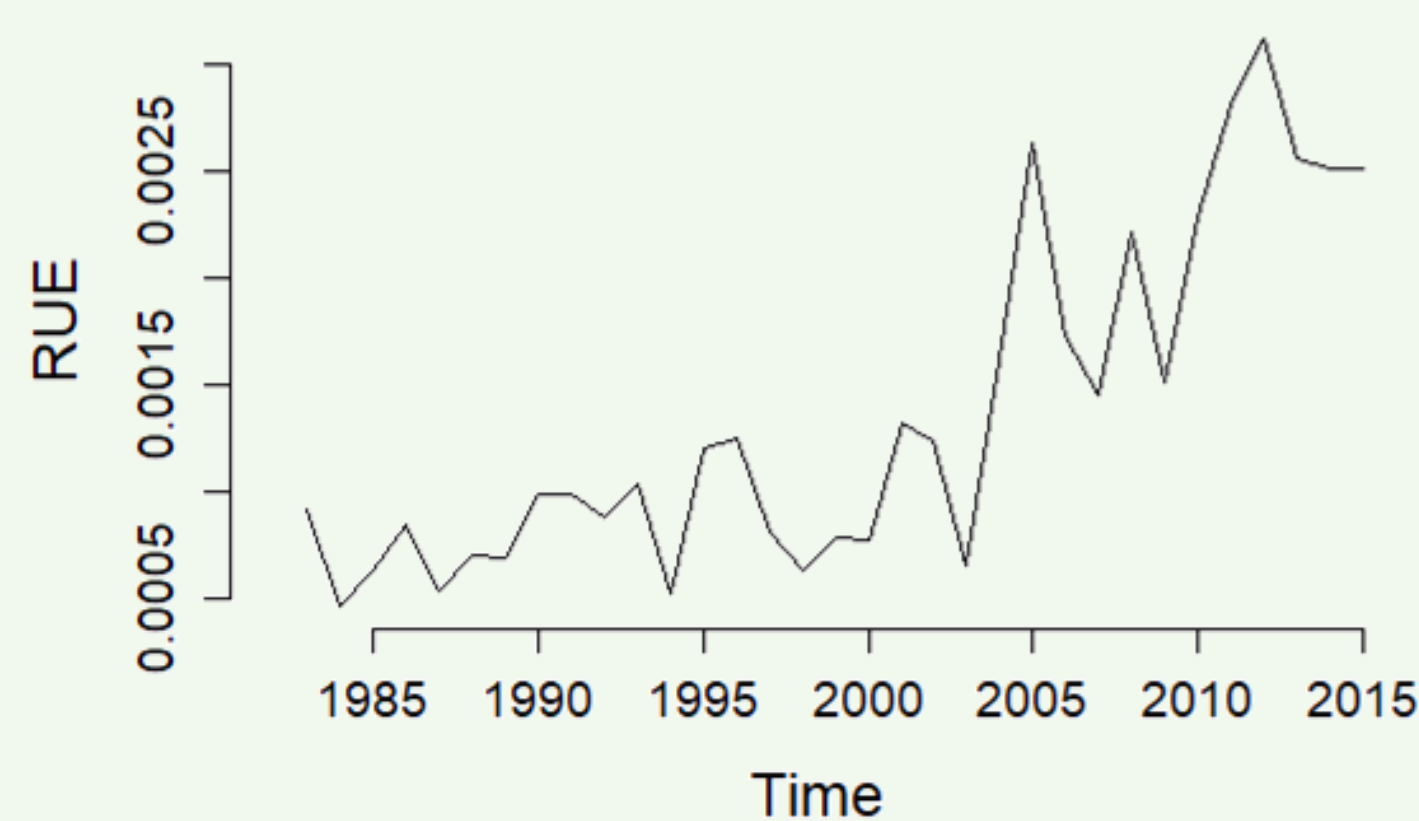


## Rain-use efficiency (RUE)

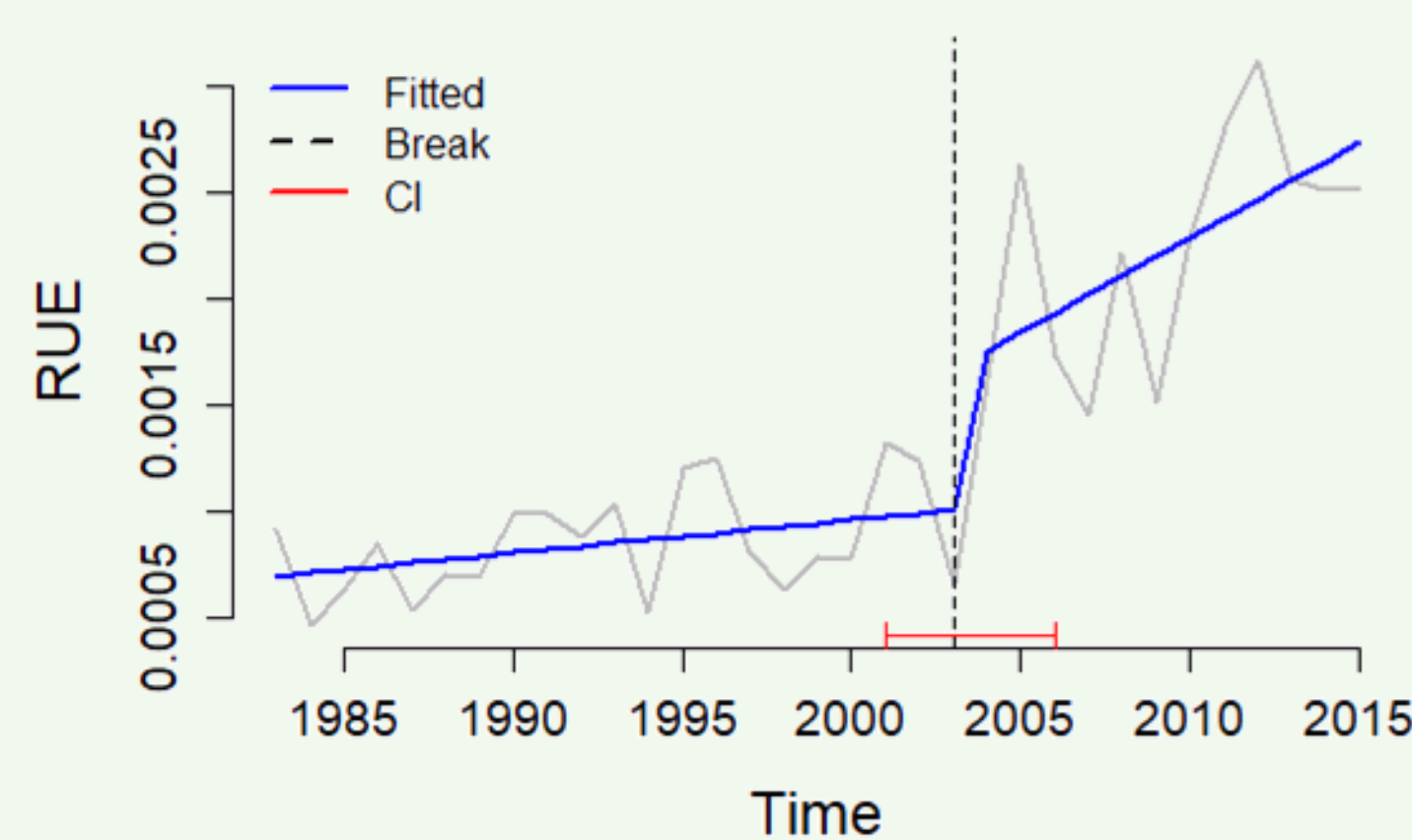
$$RUE = \frac{NPP}{\text{rainfall}}$$



## Temporal changes in RUE



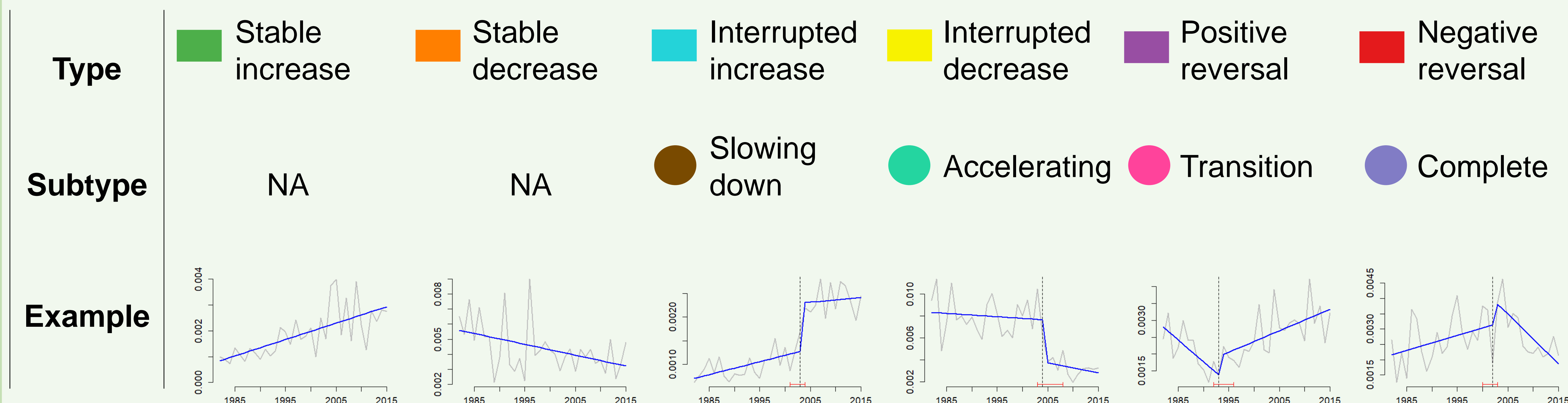
## Breakpoint detection algorithm (BFAST01)<sup>2,3</sup>



## Characterization

- Interrupted increase (direction of change)
- Accelerating (rate of change)

## Typology to characterize the detected changes:

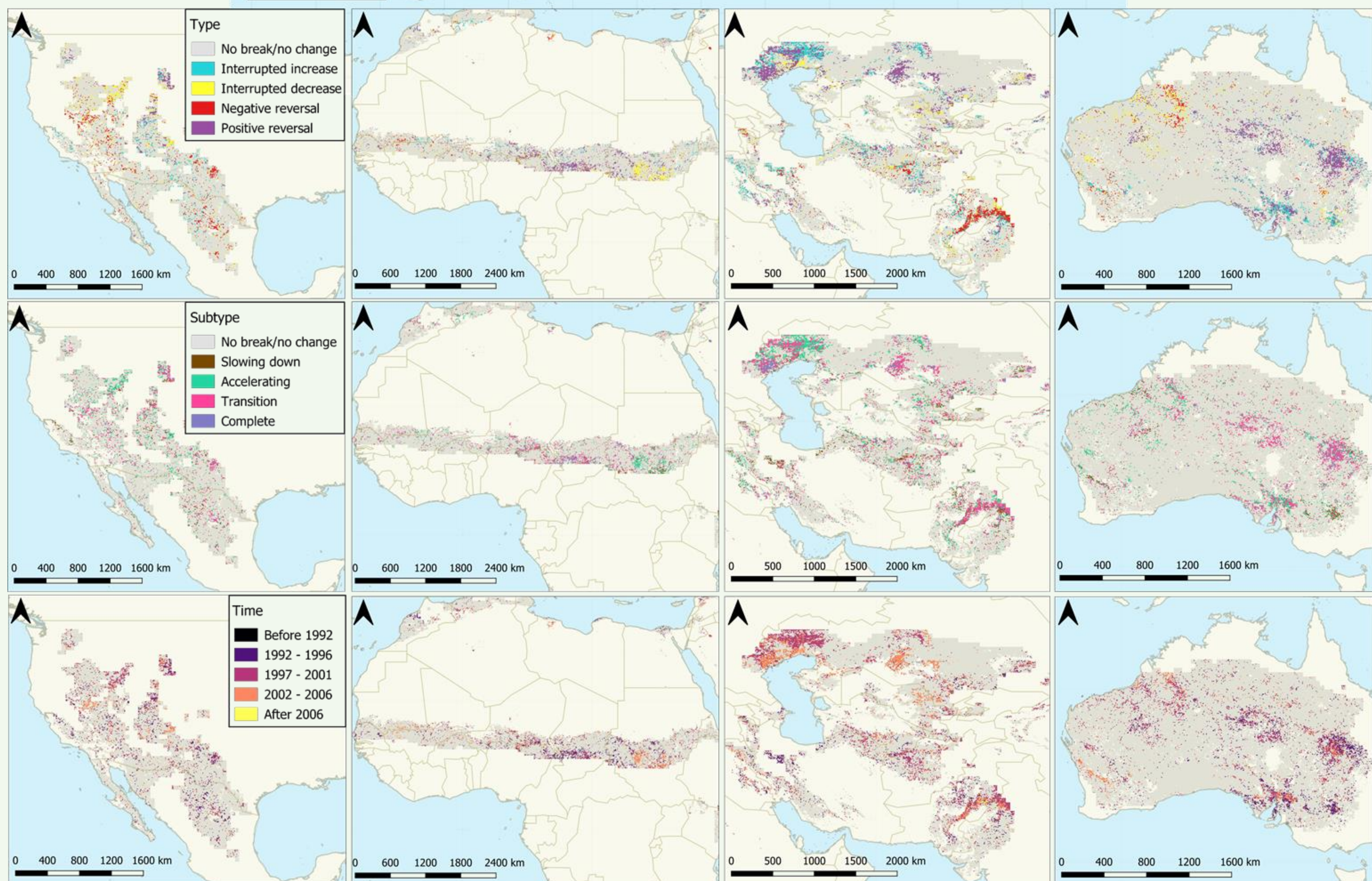


<sup>2</sup> Verbesselt, J., Hyndman, R., Newnham, G., & Culvenor, D. (2010). Detecting trend and seasonal changes in satellite image time series. *Remote Sensing of Environment*, 114, 106–115

<sup>3</sup> de Jong, R., Verbesselt, J., Zeileis, A., & Schaepman, M. E. (2013). Shifts in global vegetation activity trends. *Remote Sensing*, 5, 1117–1133

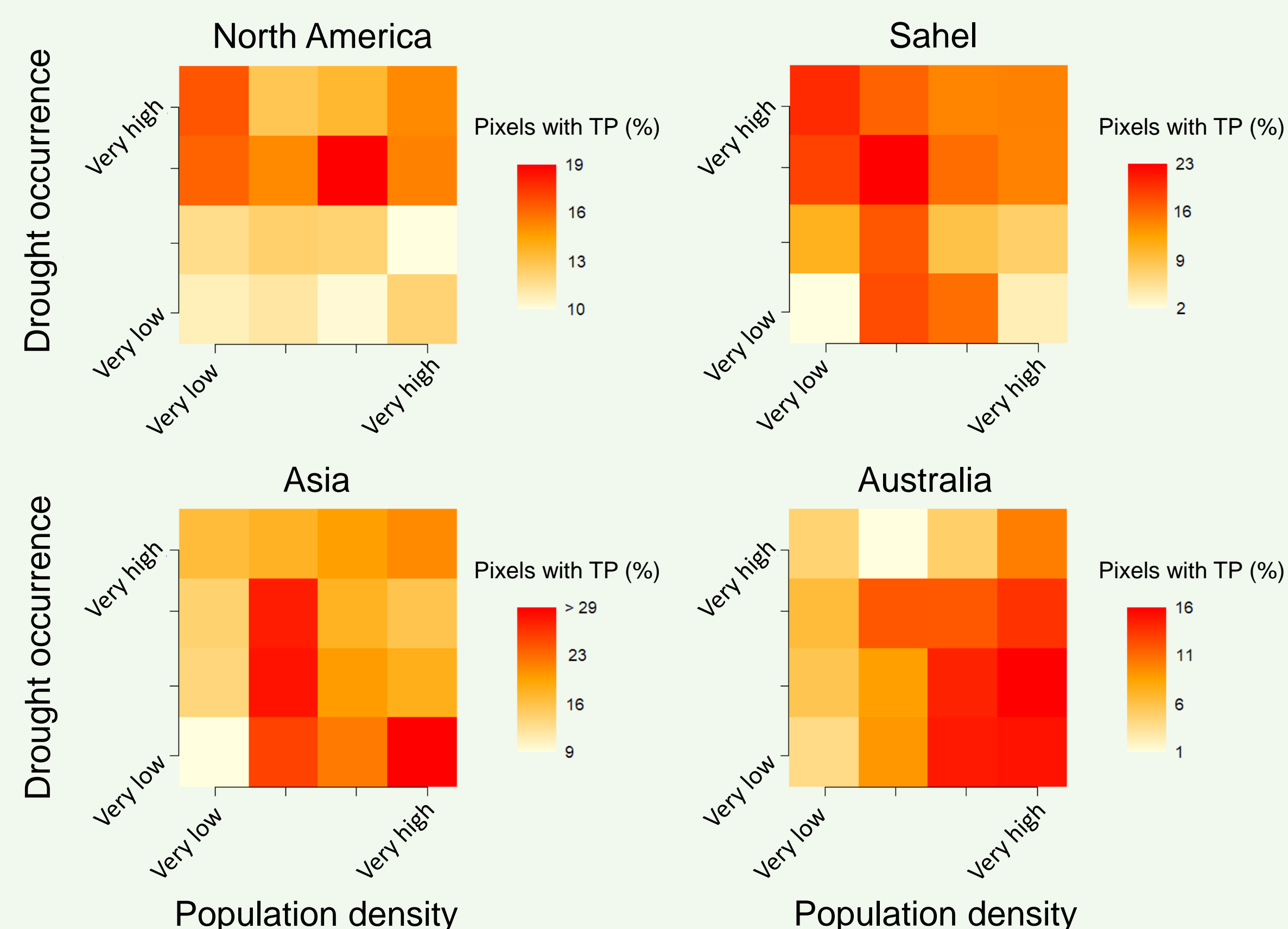
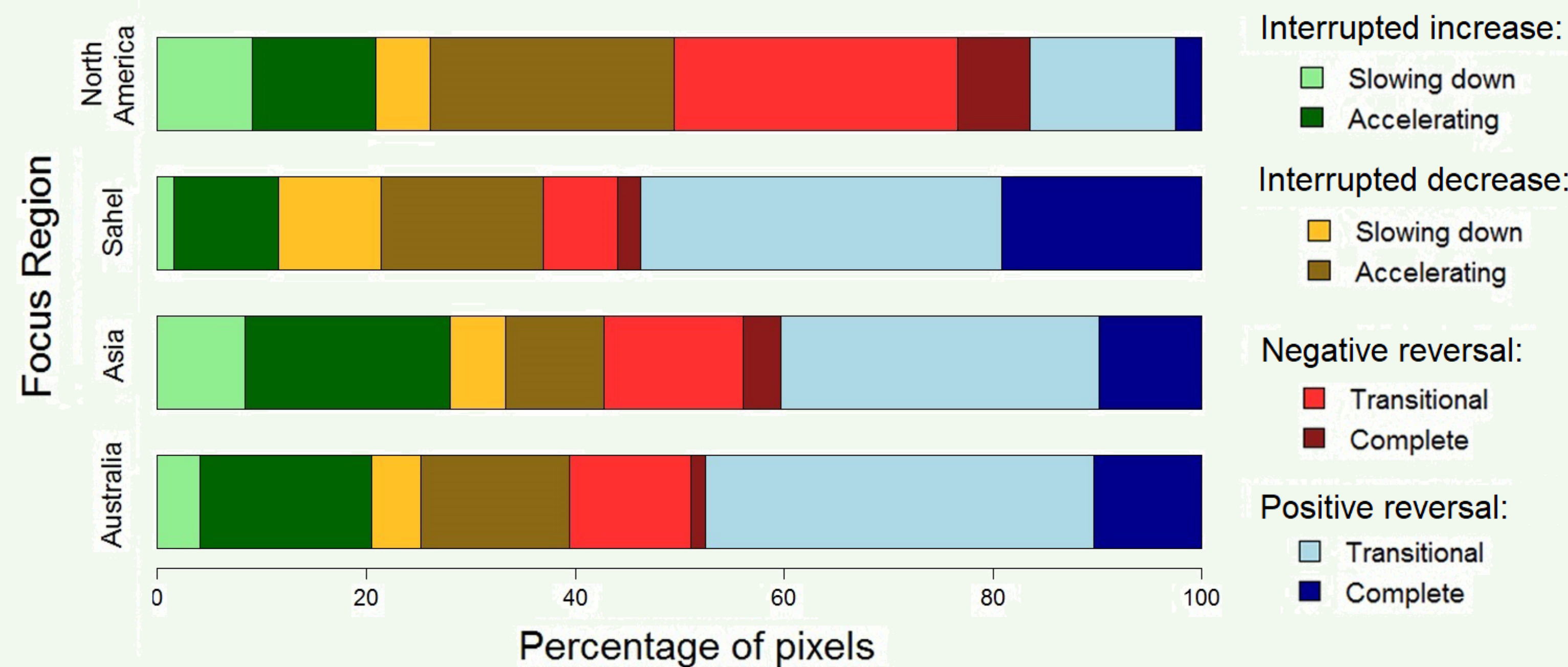


- Hotspots of turning point occurrence in central-western North America, the Sahel, central Asia, and eastern Australia:





## Results



- Summary of type/subtype of turning points in ecosystem functioning for each region.

- Percentage of pixels showing a turning point for different classes of population density and drought occurrence.

## Conclusion

- The new BFAST01 typology allowed for an integrated analysis of gradual and abrupt changes in ecosystem functioning in drylands. We successfully (i) detected hotspots of altered functioning in recent decades, (ii) determined when the alteration occurred, and (iii) characterized the changes.
- By using climate and population density data, we obtained overall insights on the drivers of functioning changes at the regional scale.
- Hotspot regions with high turning point occurrence deserve special attention, in particular when the ecosystem functioning presents an accelerated decreasing trend or a shift towards a decreasing trend, as such changes may imply a decrease in productivity, species diversity, and/or resilience.
- With this new approach, we made an important step towards large-scale assessment and characterization of abrupt changes in dryland ecosystem functioning.
- For more information: Bernardino PN, De Keersmaecker W, Fensholt R, Verbesselt J, Somers B, Horion S (2020). *Global-scale characterization of turning points in arid and semi-arid ecosystem functioning*. Global Ecol Biogeogr. <https://doi.org/10.1111/geb.13099>