Understanding Turning Points in Dryland Ecosystem Functioning
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Research topic & Project relevance

40% Earth’s land surface - 40% Global Net Primary productivity - 30% population
Research topic & Project relevance

Turning points in ecosystem functioning

- Traditional assumptions about linear changes in vegetation dynamic
- No method for large-scale assessment
- Low understanding of drivers and processes leading to turning point
- Needs for monitoring, modelling and early warning of turning point

Large scale drought-induced tree dying (Senegal, 2015)

Reforestation (Niger)
Research questions

1. What is the **overall importance** of turning points in ecosystem functioning in global dryland?

2. How sensitive is dryland vegetation response to anthropogenic and climatic **drivers**?

3. Can combined EO-DVMs analysis provide relevant information for **early warning** of TP?
[1] Mapping and characterizing turning points in EF in global drylands

[2] Reconstructing the history of land use/cover change (Focus areas)

[3] Parametrizing Dynamical Vegetation Models (DVMs) to dryland specific conditions (Focus areas)

[4] Disentangling climatic and anthropogenic drivers of turning points (Focus areas)

[5] Assessing proxies for early warning of turning points in EF (Focus areas)
Mapping and characterizing turning points in ecosystem functioning in global drylands:

- Use of segmented trend analysis (BFAST) on time series of Rain-Use Efficiency (based on AVHRR derived NDVI and rainfall)

- Key research steps:
  - Improvement of the breakpoint detection and categorization techniques

- First global assessment of turning points in ecosystem functioning
Concept and Method

Rationale

- Gain insights in the contribution of LULCC to dryland vegetation dynamics (WP 3 and 4)
- Establish a LULC mapping methodology designed for the Sahel
- Construct approx. 5 year epochs products using dense HR images stack (Landsat/SPOT)
- VHR data for training and validating (NASA)

Challenges of LU/LC mapping in the Sahel

- Small agricultural plot size and fragmentation of agricultural landscape
- Mosaic of cropland, fallow and natural grassland
- Dry versus wet season
Available data - HR

Launch LE 7
Launch LT 5
Launch LC8 / end LT 5
Launch S2
Concept and Method

Dynamic global vegetation models
- Simulate vegetation ecology and its associated biogeochemical and hydrological cycles
- Two state-of-the-art 2nd generation models: *ED2* and *LPJ-GUESS*

**Parametrizing Dynamical Vegetation Models (DVMs) to dryland specific conditions** through EO data assimilation to enable accurate simulation of drylands vegetation dynamics
Preliminary results

Flux tower sites across the Sahel
- drivers (meteorology)
- validation (carbon flux)

PFT
- Drought-deciduous tropical trees
- C4 grasses

Seasonal NEE cycle – Dahra, Senegal

LPJ-GUESS
- fair representation of carbon exchange captures seasonal cycle relatively well

ED2
- underestimates carbon exchange significantly
- possible reason: trees die off in model
- originally developed for tropical forests: further parameter tuning necessary
Concept and Method

WP4
Human vs. climatic drivers

Turning point

Climatic or anthropogenic turning point?

Vegetation state

Plant Functional Type

PFT 1
PFT 2
WP5
Early-warning proxies for turning points

- Proxy type 1: Short-term vegetation stability indicators
- Proxy type 2: Critical eco-climatic thresholds
U-TURN

Understanding Turning Points in Dryland Ecosystem Functioning

Research programme for earth observation "STEREO III"
(Support to the exploitation and Research in Earth Observation)
Research questions

Global turning points in ecosystem functioning?

What is the overall importance of turning points in ecosystem functioning in global dryland?
Research questions

What are the driving forces for these abrupt changes in ecosystem functioning?

How sensitive is dryland vegetation response to each of the anthropogenic and climatic drivers?

How important is the anthropogenic footprint on the drylands?
Ground truth data

• Use of existing datasets as much as possible
  • Open data: GOFC-GOLD (+400 training points available)
  • (Copernicus Global Land Cover Mapping: >1500 training points available and counting)
  • KU datasets

• Gather new training validation data based on VHR imagery
Turning point detection

Time of Break
- No break
- 1992
- 1994
- 1996
- 1998
- 2000
- 2002
- 2004
- 2006
Turning point detection

Map showing various classes of changes.
Turning point detection
Flux tower sites across the Sahel
- drivers (meteorology)
- validation (carbon flux)

Savannah biome

Plant Functional Types