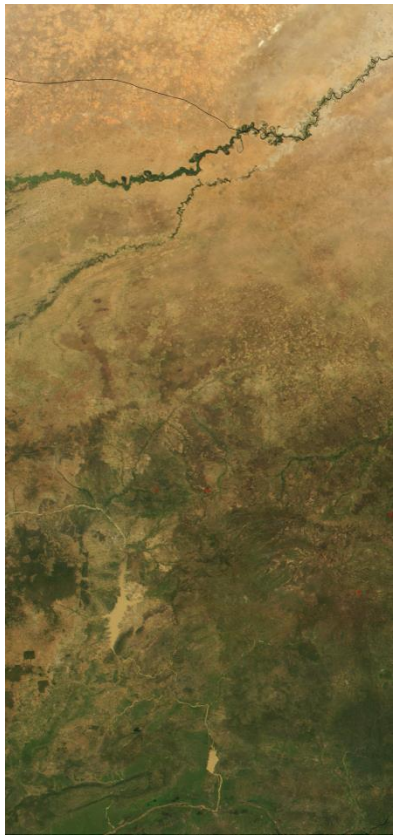
U-TURN

Understanding turning points in dryland ecosystem functioning



Paulo Bernardino *et al.*
November 13th 2018, Belgium

belspo

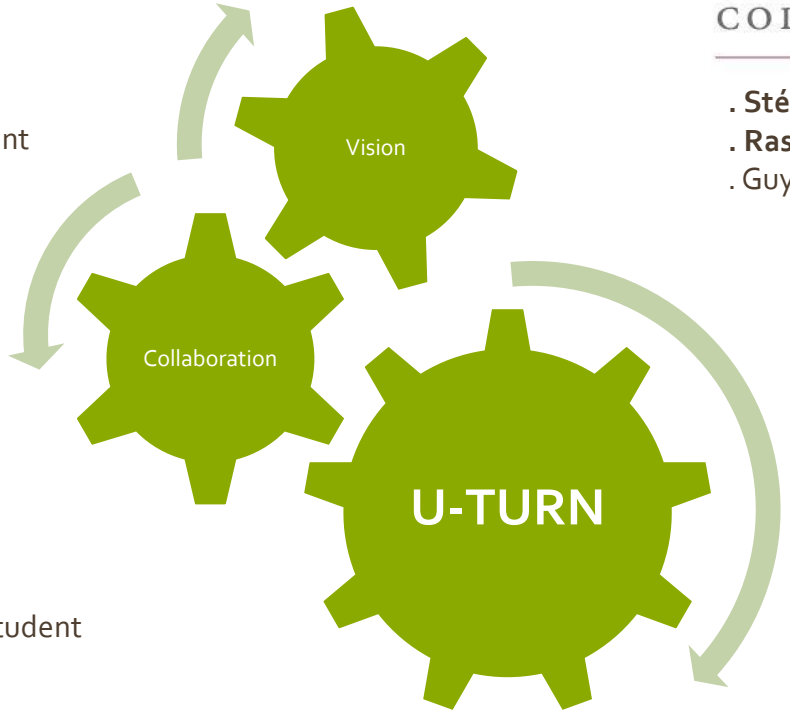
Our consortium

KU LEUVEN

. **Ben Somers (coordinator)**
. Wanda de Keersmaecker
. Paulo Bernardino, PhD student

UNIVERSITY OF COPENHAGEN

. **Stéphanie Horion**
. **Rasmus Fensholt**
. Guy Schurgers



UNIVERSITEIT GENT

. **Hans Verbeeck**
. Marie Combe
. Wim Verbruggen, PhD student

WAGENINGEN UR
For quality of life

. **Jan Verbesselt**

vito
vision on technology

. **Ruben Van De Kerchove**

TU Delft

. **Stef Lhermitte**

Outline

PROJECT OVERVIEW

1st PHASE

RESULTS

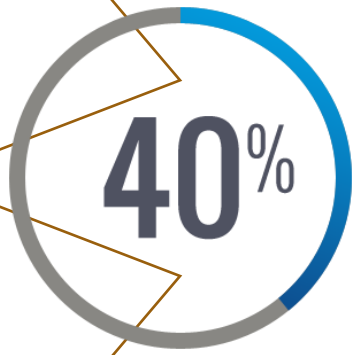
WHY?

- Earth's surface
- Global NPP

- Population

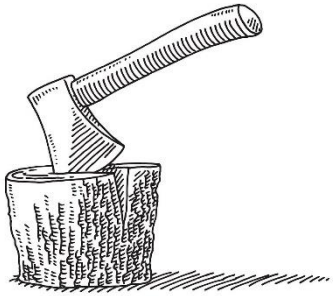
Project Overview

WHY?



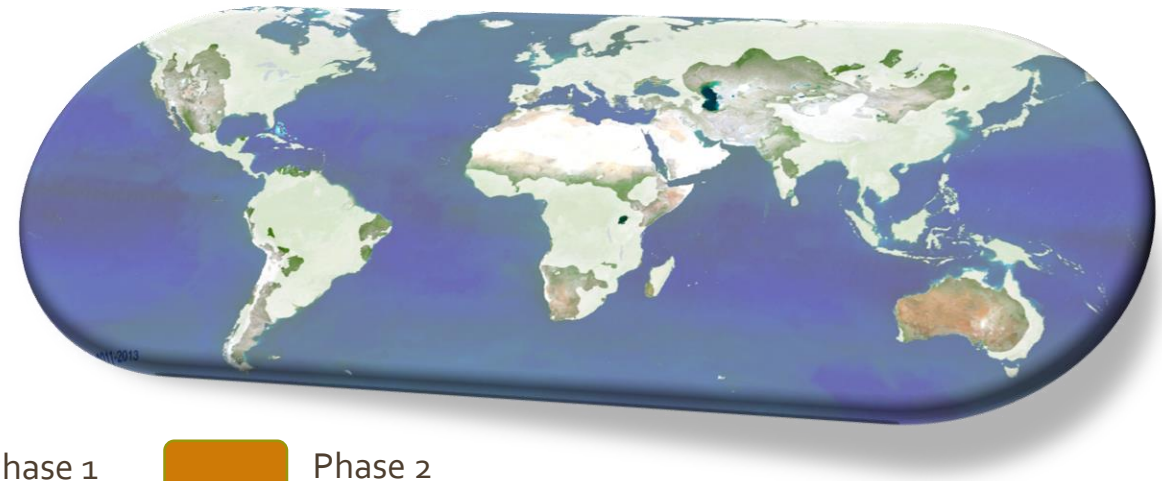
- Earth's surface
- Global NPP

- Population



Project Overview

RQ 1: What is the overall importance of turning points in ecosystem functioning?



Phase 1 Phase 2

Project Overview

RQ 1: What is the overall importance of turning points in ecosystem functioning?

RQ 2: Which are the driving forces of turning points?

Phase 1

Phase 2

Project Overview

RQ 1: What is the overall importance of turning points in ecosystem functioning?

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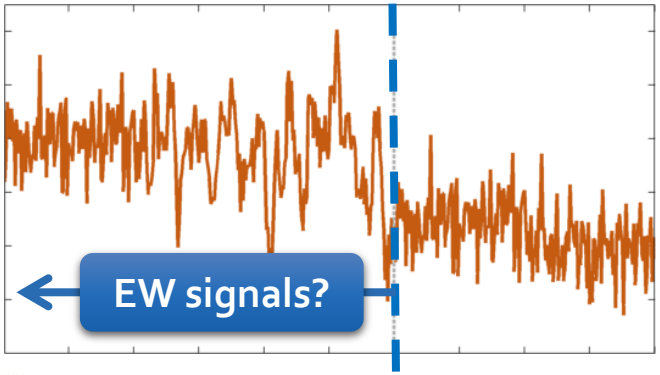
RQ 3: Can combined EO-DVMs analysis provide relevant information for **early warnings** of TPs?



Phase 1 Phase 2

Project Overview

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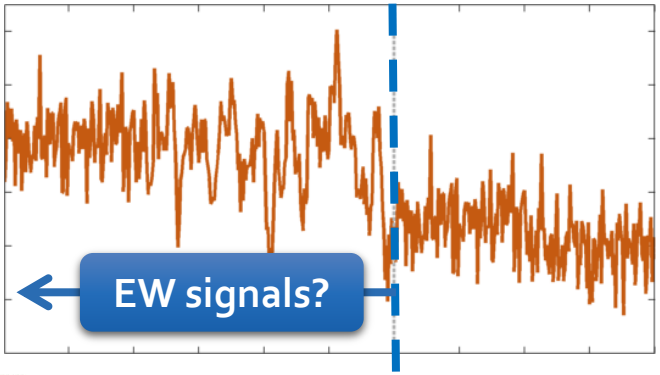


Phase 1

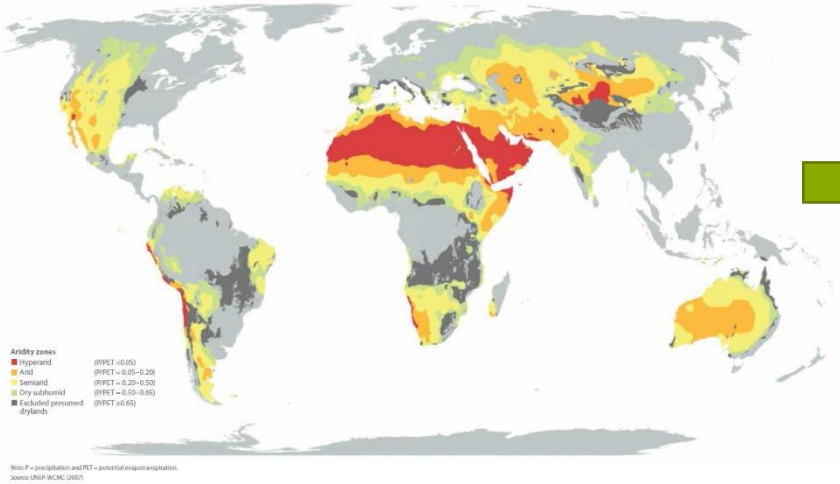
Phase 2

Outline

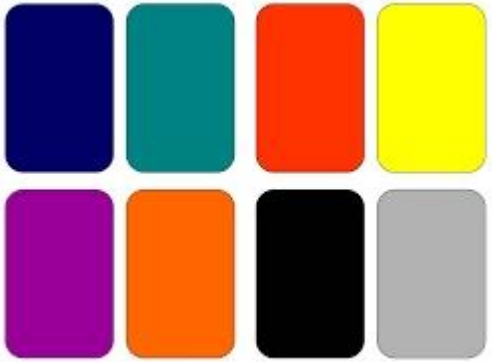
PROJECT OVERVIEW

1st PHASE

WHAT?



Turning Points



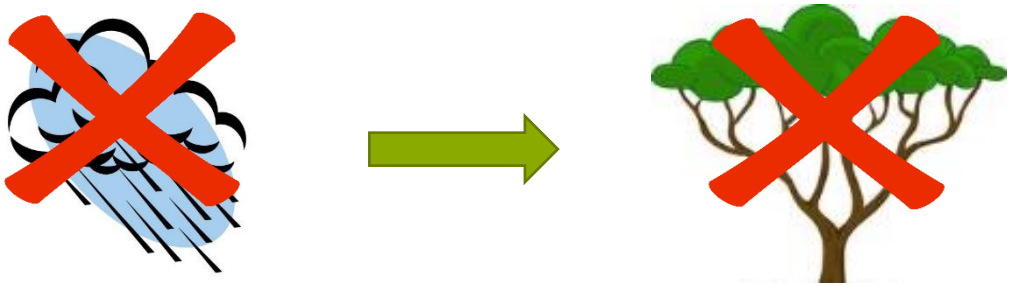
HOW?

- Temporal changes in Rain-Use Efficiency (RUE)

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

HOW?

- Temporal changes in Rain-Use Efficiency (RUE)



NDVI in drylands ≠ ecosystem functioning

HOW?

- Temporal changes in Rain-Use Efficiency (RUE)

- key EO proxy for studying:

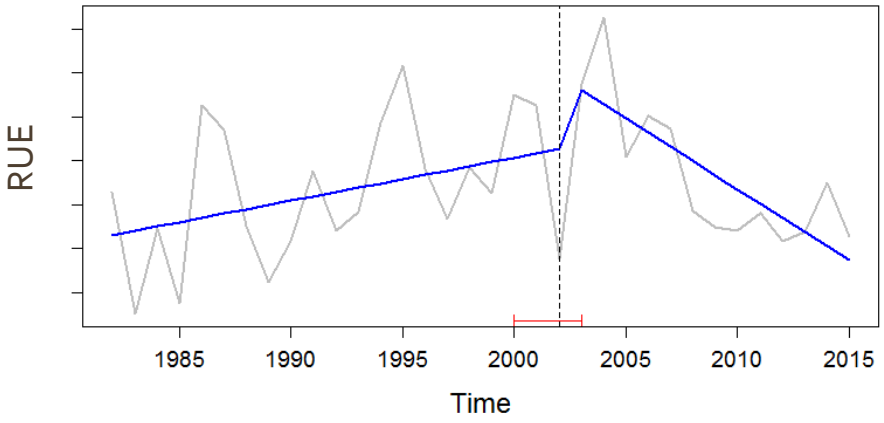
  (1) ecosystem functioning

  (2) resilience

  (3) land degradation

HOW?

- Temporal changes in Rain-Use Efficiency (RUE)



Significant change in ecosystem response to precipitation

=

Hotspots of altered ecosystem functioning (EF)

=

Turning points in EF

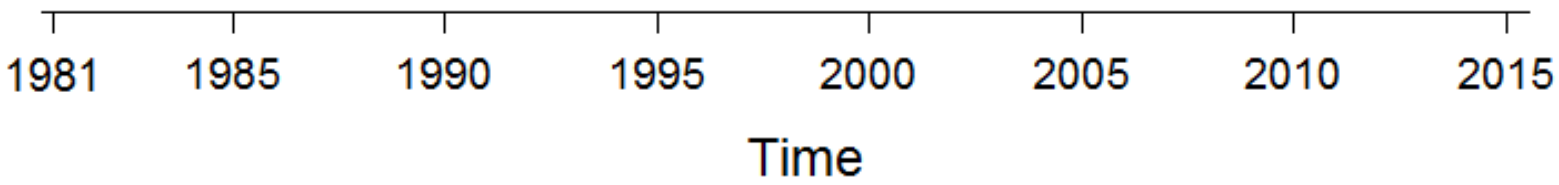
DATA?

Long-term time series → Accurate assessment of turning points in EF

GIMMS3g v1 NDVI

~ 8 km

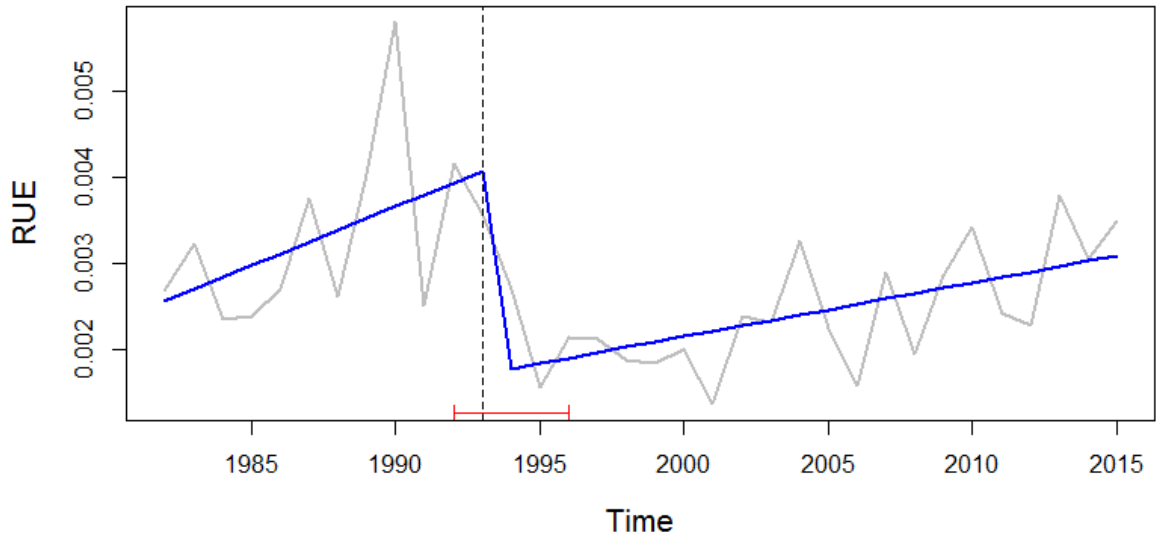
CHIRPS



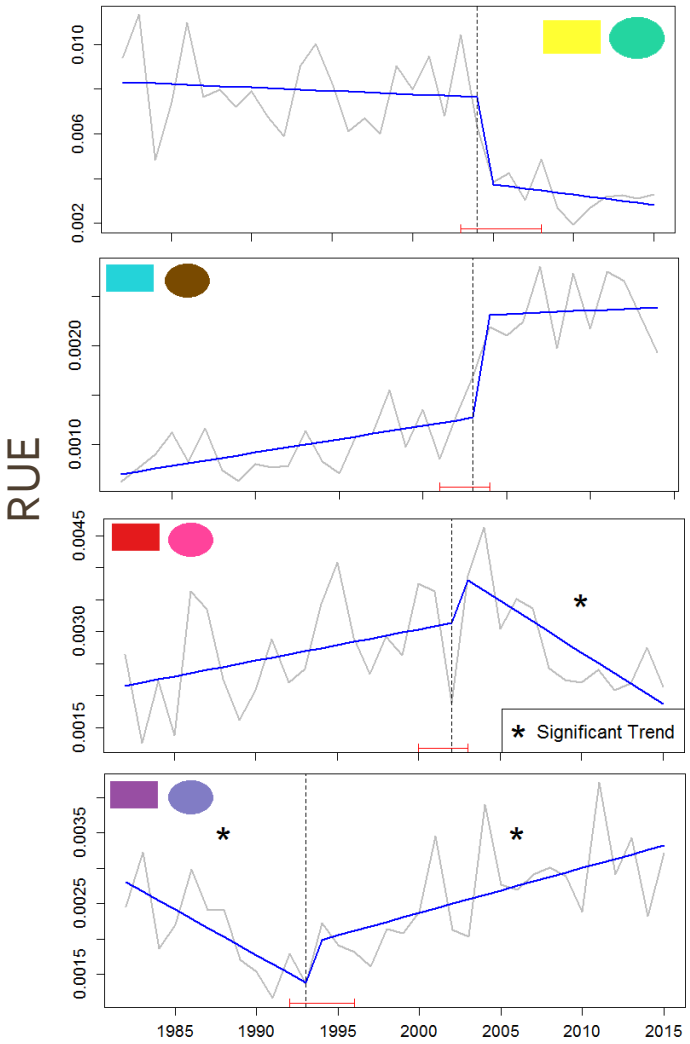
METHOD

- Time series segmentation technique (BFAST)
  - gradual and abrupt changes in RUE

- BFAST01 -> major break + classification of changes



METHOD



New Typology

Type	Subtype
Non-monotonic decrease	Accelerating
Non-monotonic increase	Slowing down
Reversal: increase to decrease	Transition
Reversal: decrease to increase	Complete

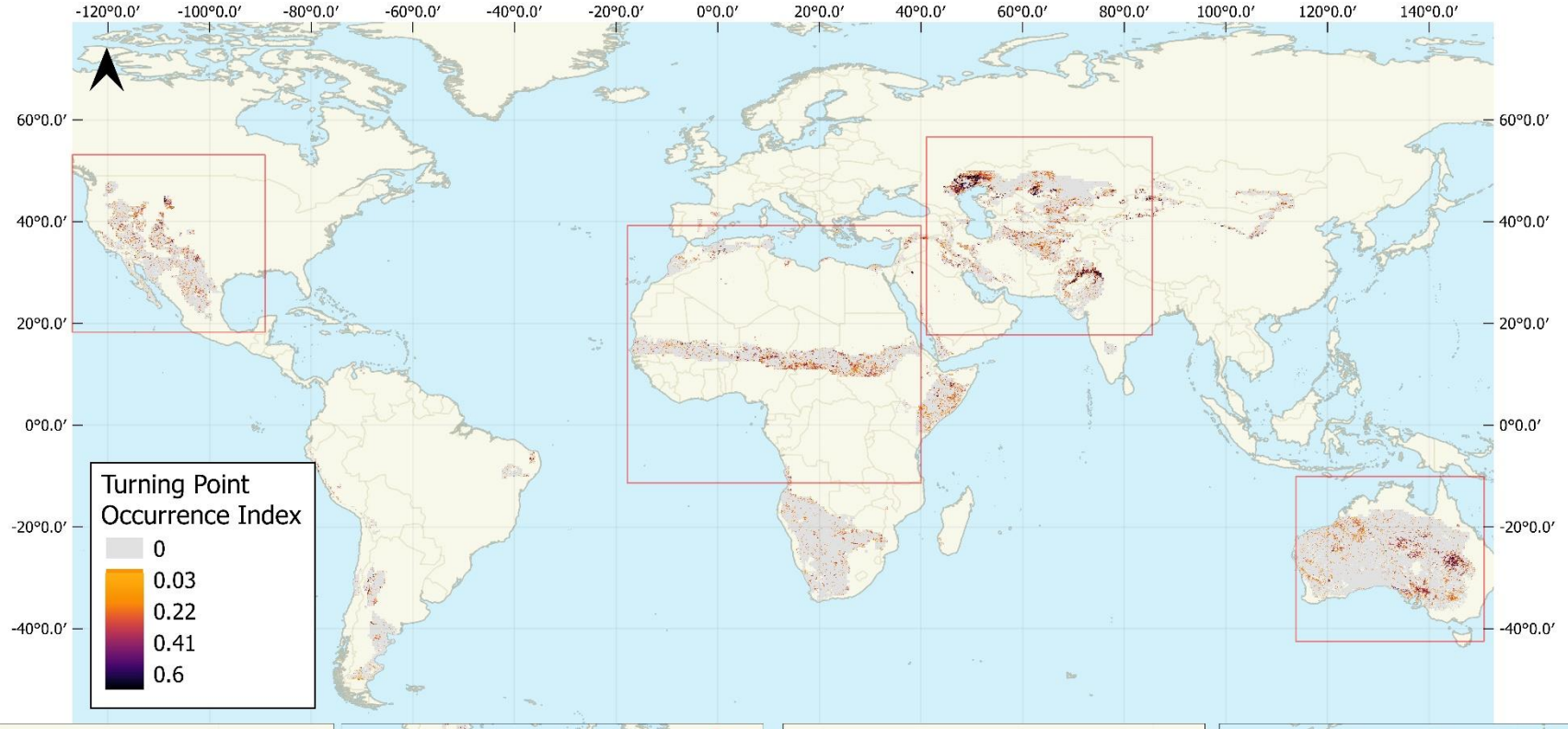
Outline

PROJECT OVERVIEW

1st PHASE

RESULTS

Results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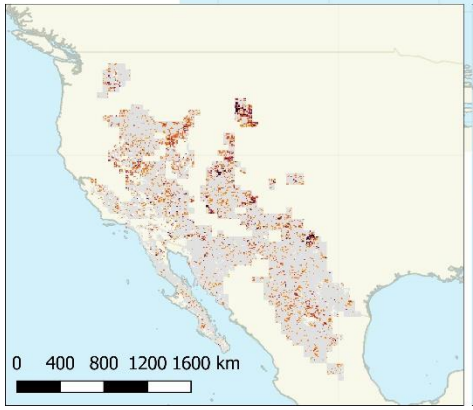
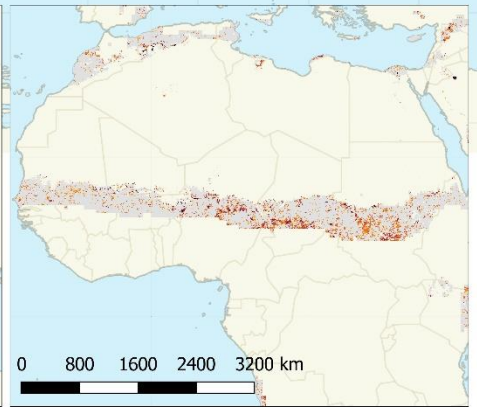
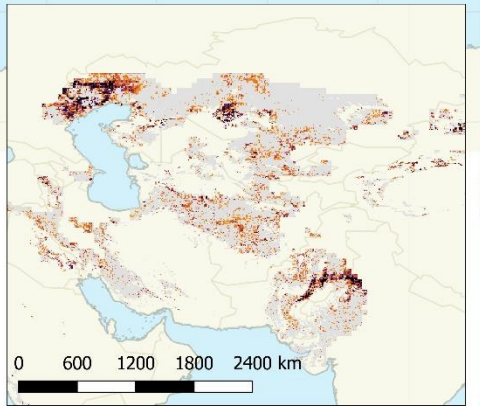
Turning Point Occurrence Index
0
0.03
0.22
0.41
0.6


0 400 800 1200 1600 km


0 800 1600 2400 3200 km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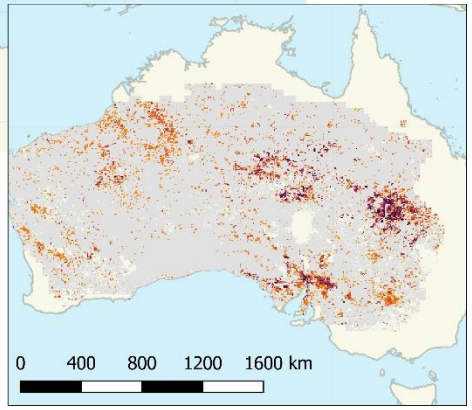
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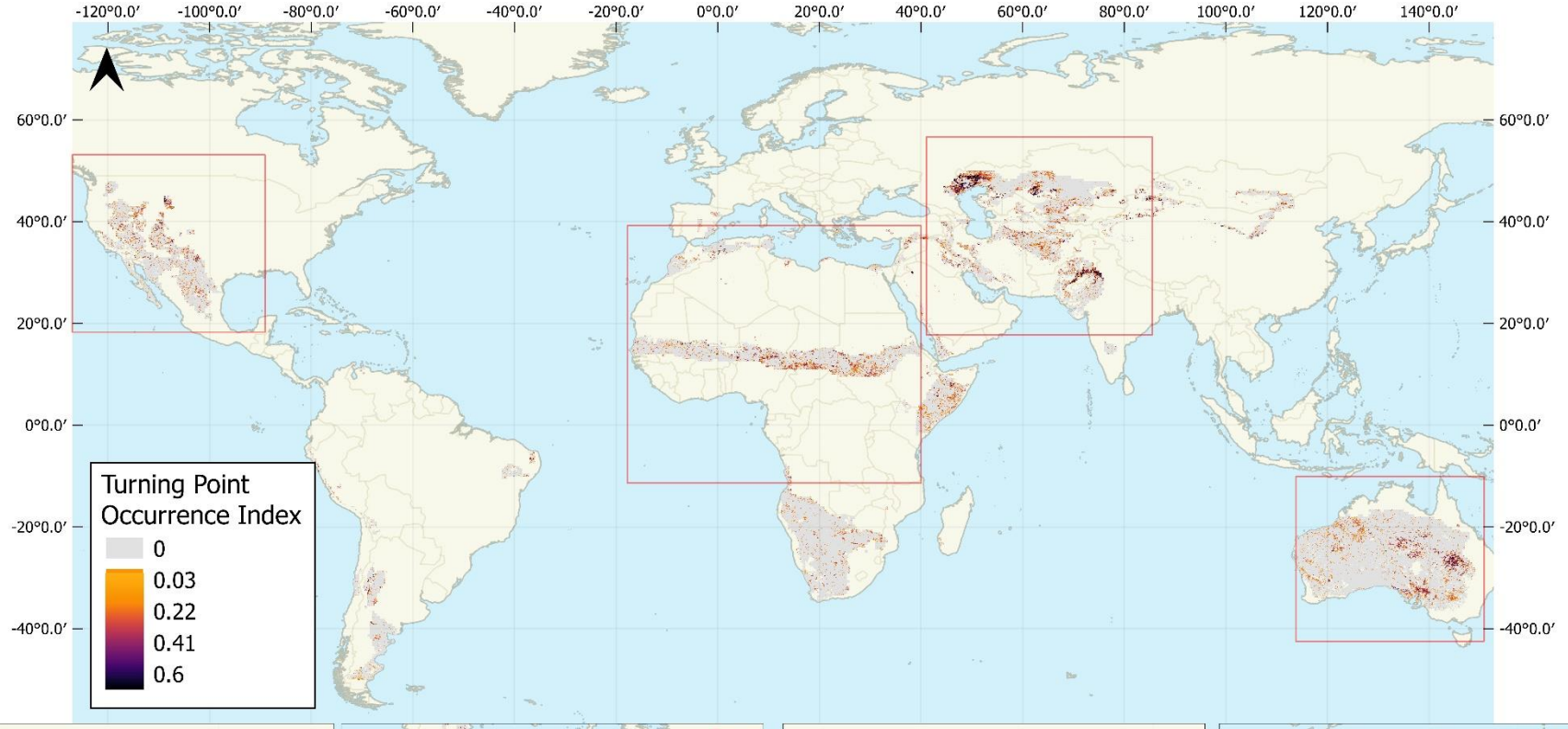
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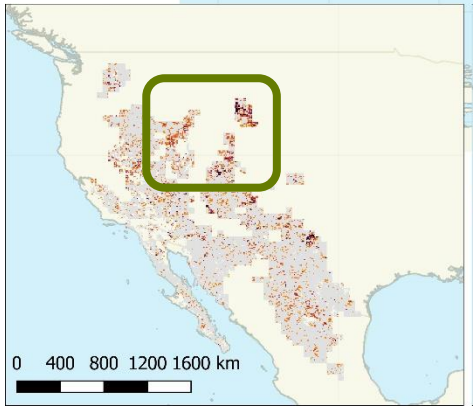
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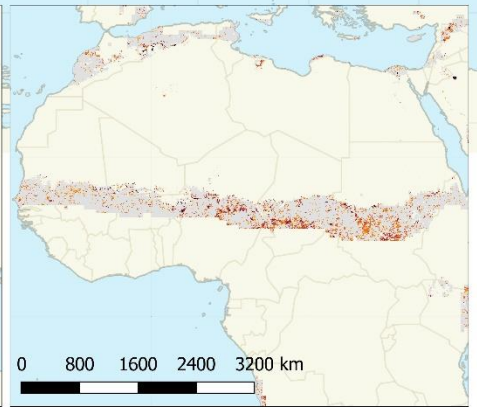
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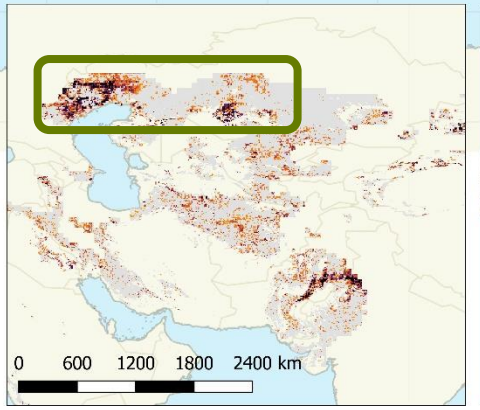
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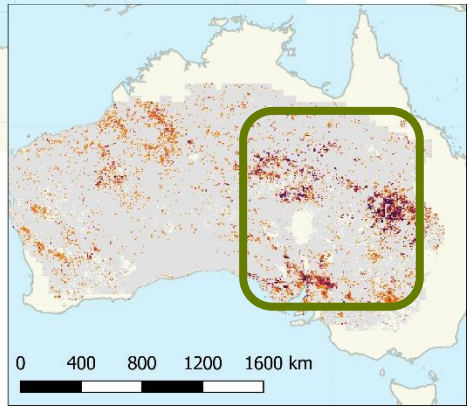
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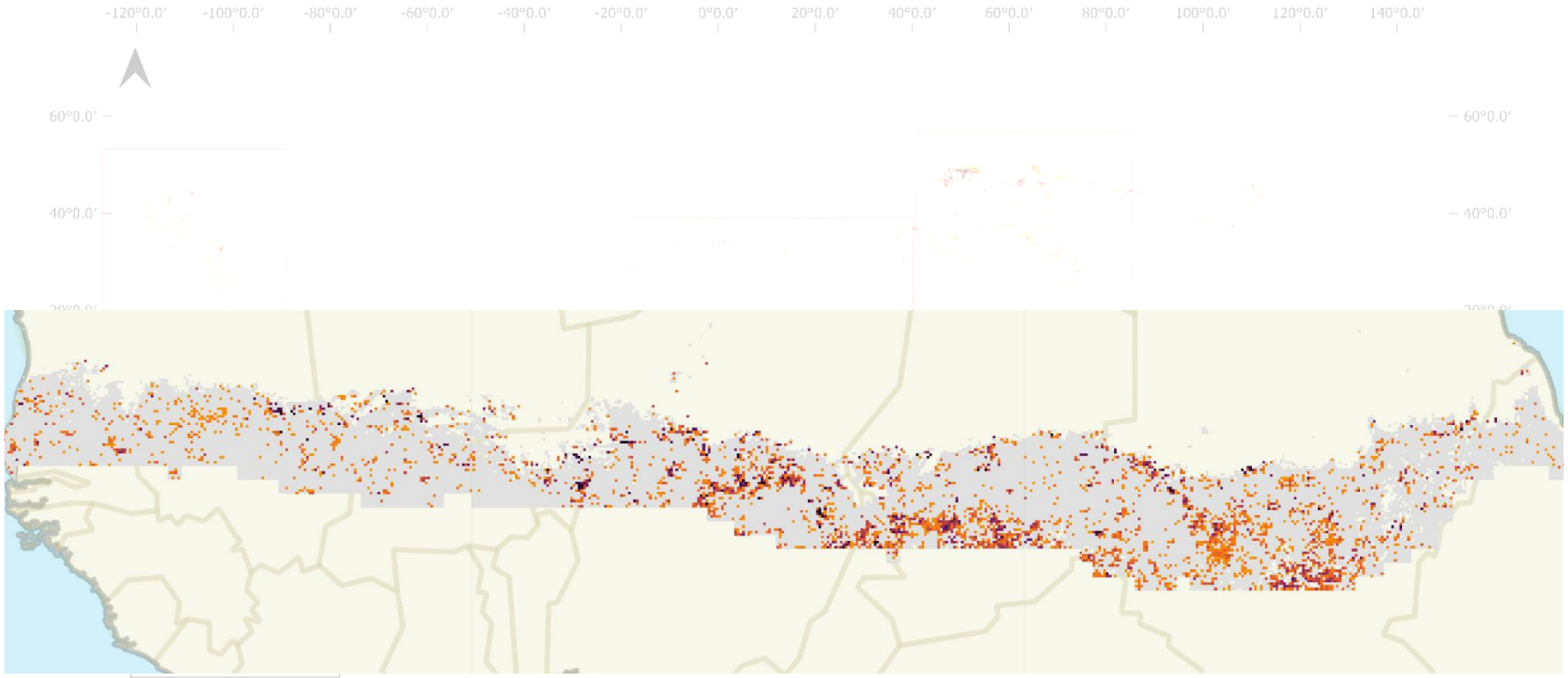
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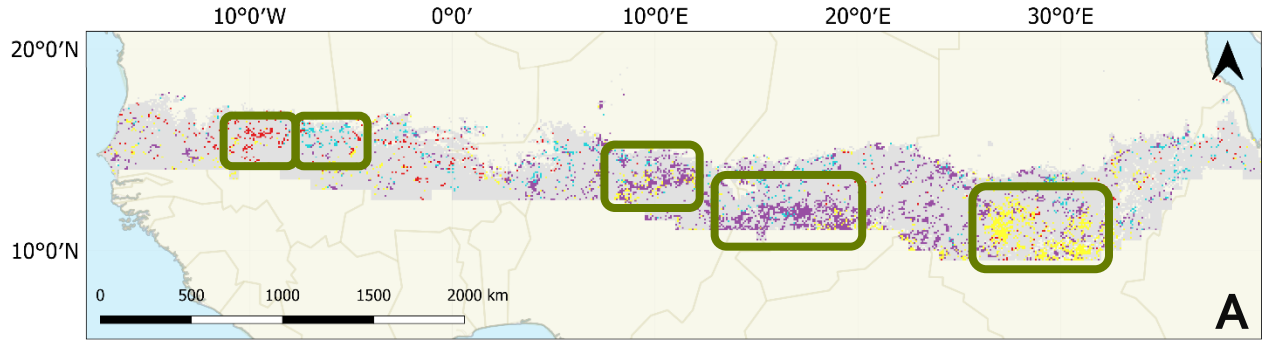
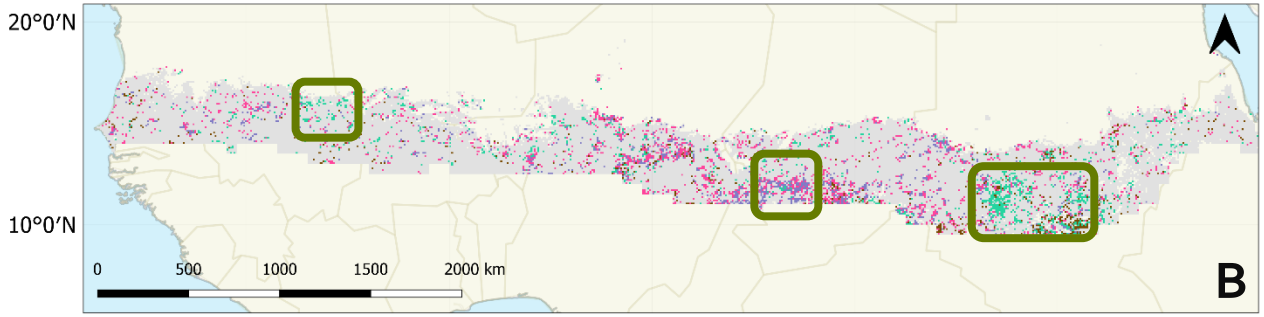
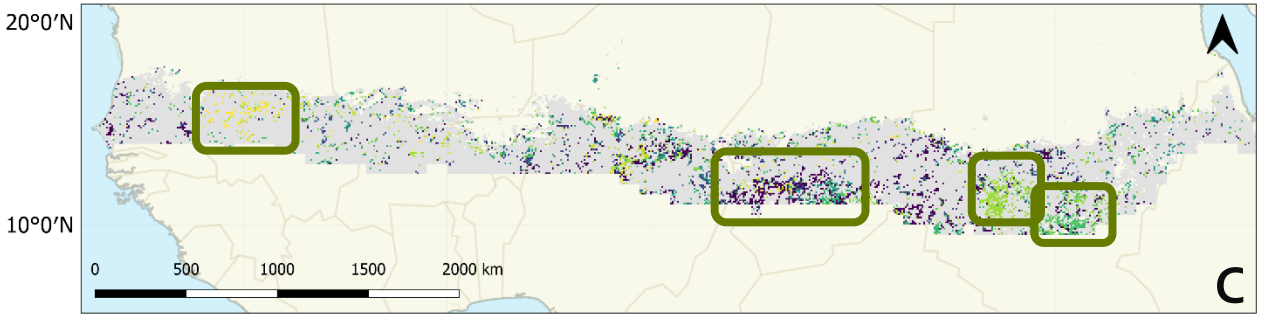






Map A:
Type

- Non-mon. increase
- Non-mon. decrease
- Reversal: inc-dec
- Reversal: dec-inc

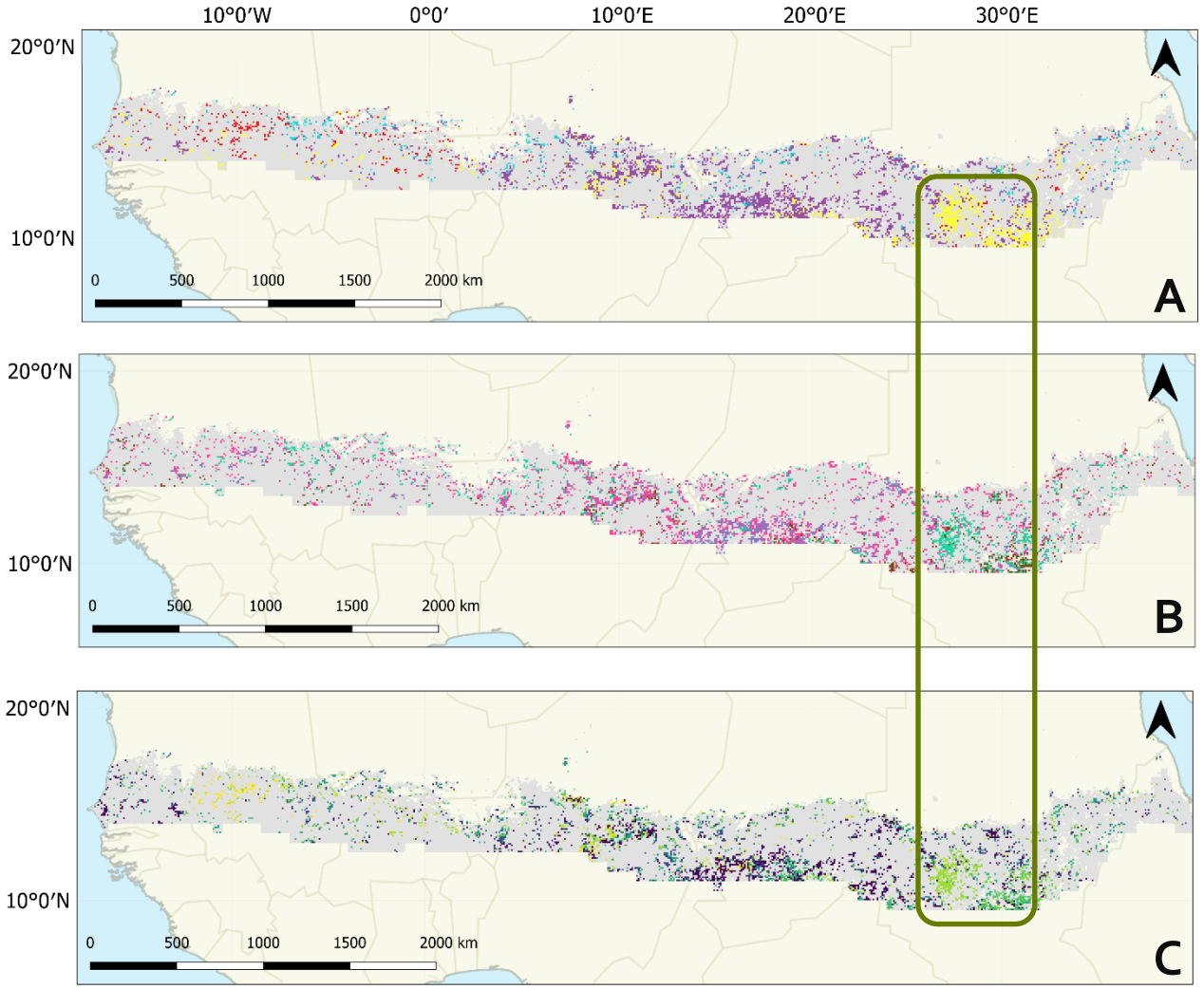
Map B:
Subtype

- Slowing down
- Accelerating
- Transition
- Complete

Map C:
Time of break

- 1992
- 1994
- 1996
- 1998
- 2000
- 2002
- 2004
- 2006

Results



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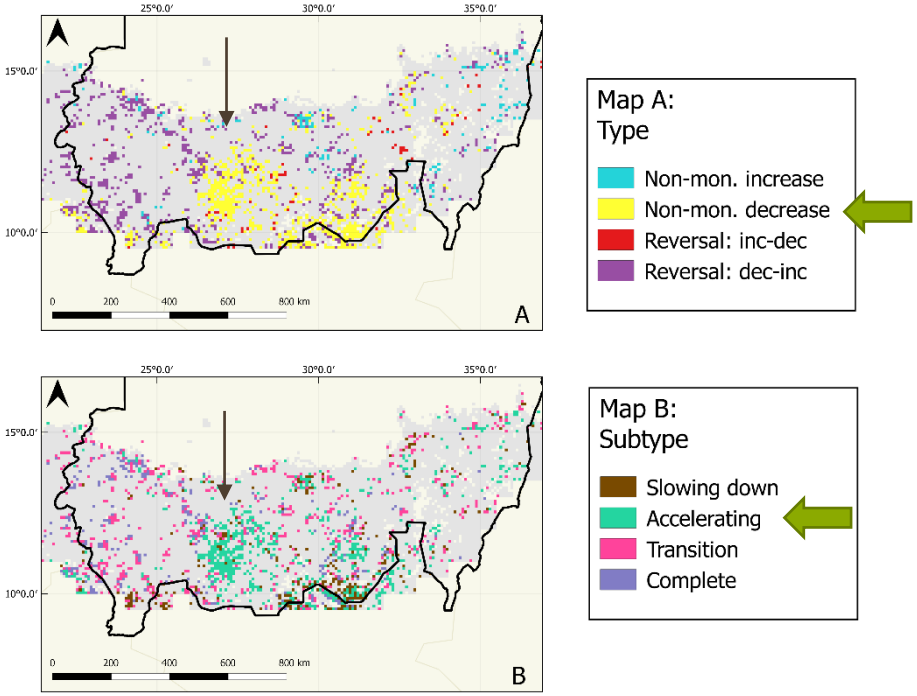
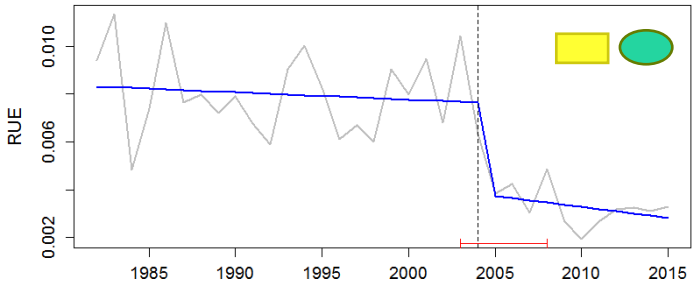
❖ Large scale turning point events

Case study:

- Sudan (south)

- Accelerated degradation





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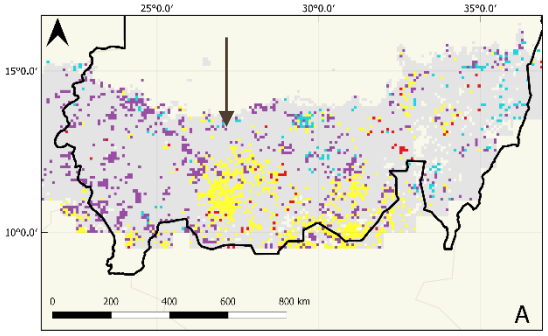

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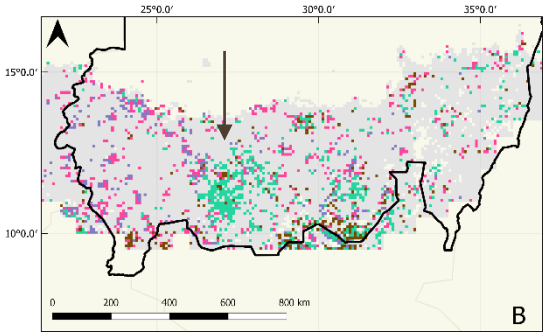

Map B:
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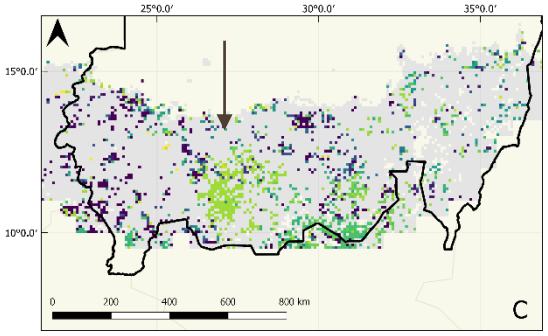

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Time of break

- 1992
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- 2006

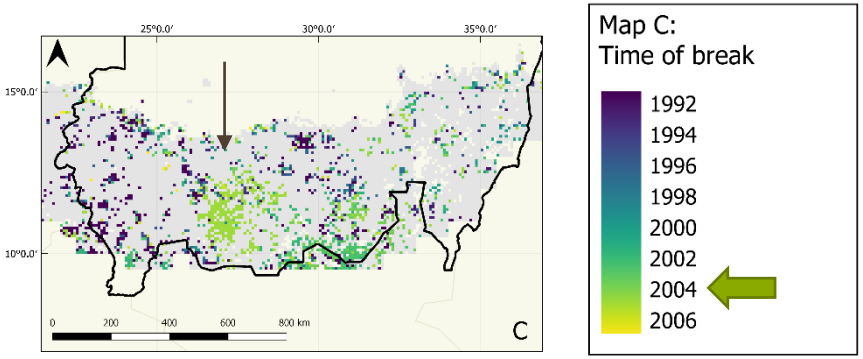
Case study:

- Sudan (south)

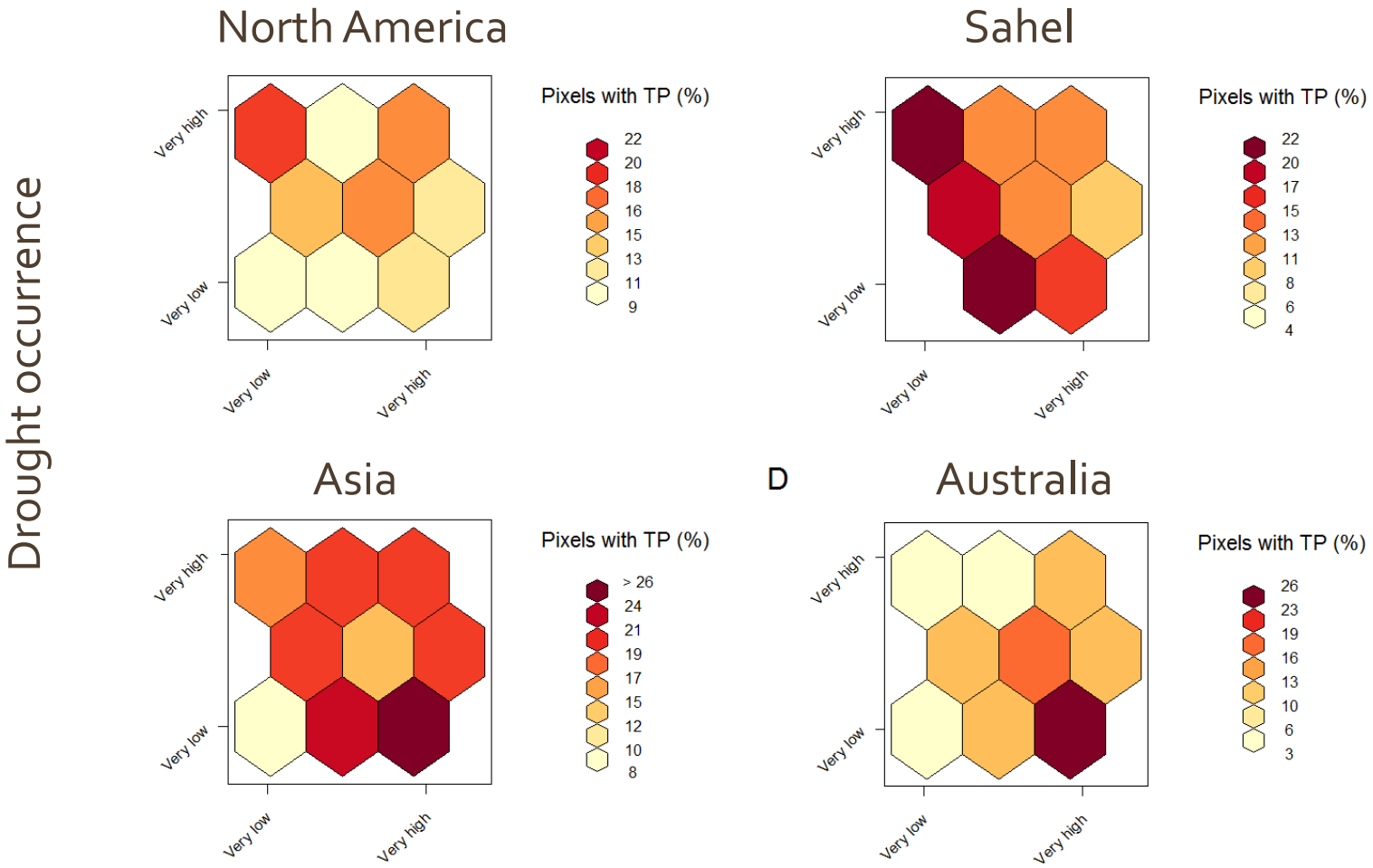
- Accelerated degradation

- 2004

- Driest year of the decade

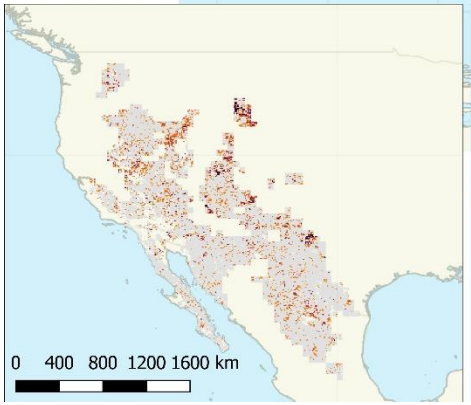


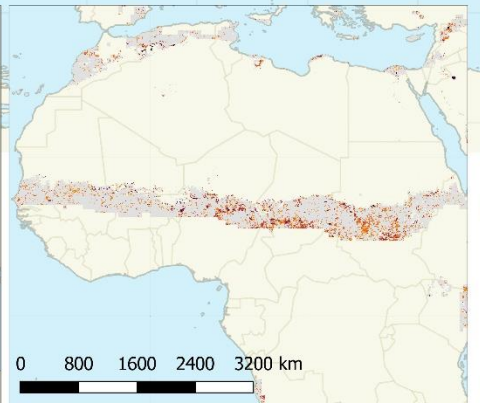
First insight on drivers:

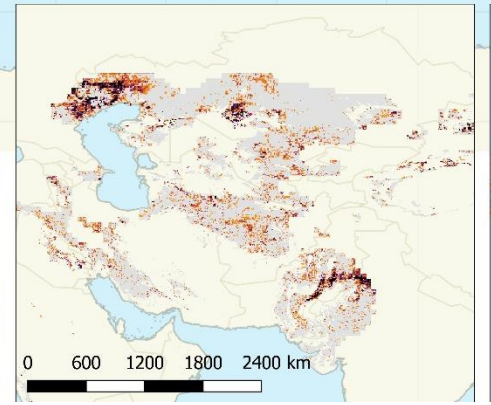


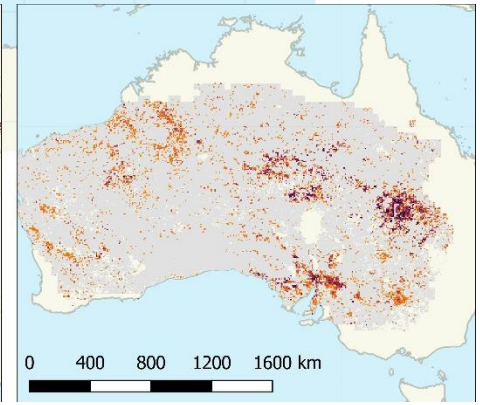
Final remarks:

- Hotspots: central-western North America, eastern Sahel, north-western Central Asia and eastern Australia.





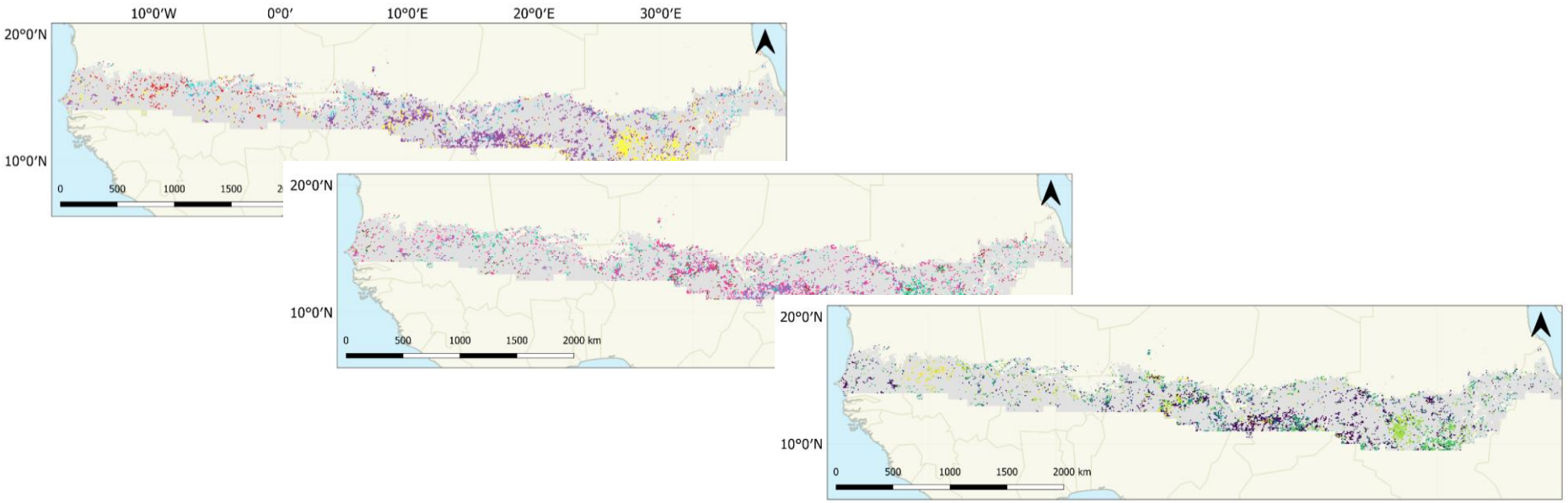




Final remarks:

- Hotspots: central-western North America, eastern Sahel, north-western Central Asia and eastern Australia.

- New typology: detailed characterization of detected changes in ecosystem functioning + year of TP occurrence.



Final remarks:

- Hotspots: central-western North America, eastern Sahel, north-western Central Asia and eastern Australia.
- New typology: detailed characterization of detected changes in ecosystem functioning + year of TP occurrence.
- Large-scale mapping: high interest for decision making; help to set priorities for ecosystem conservation measures.

Final remarks:

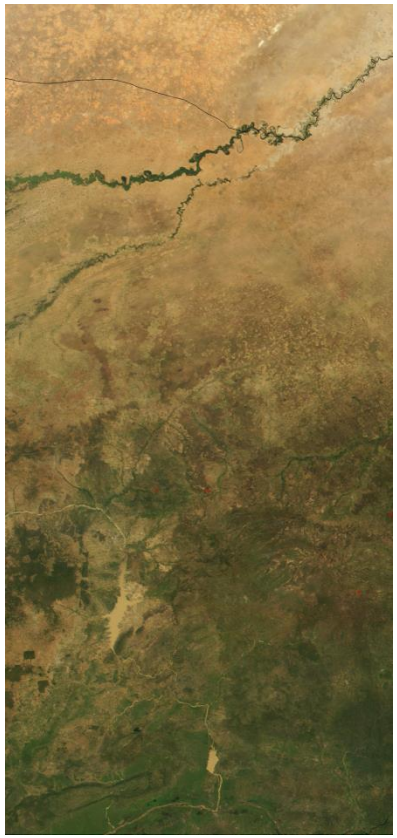
- Phase 2: already up and running!

  - drivers of turning points

  - early warning indicators

U-TURN

THANK YOU

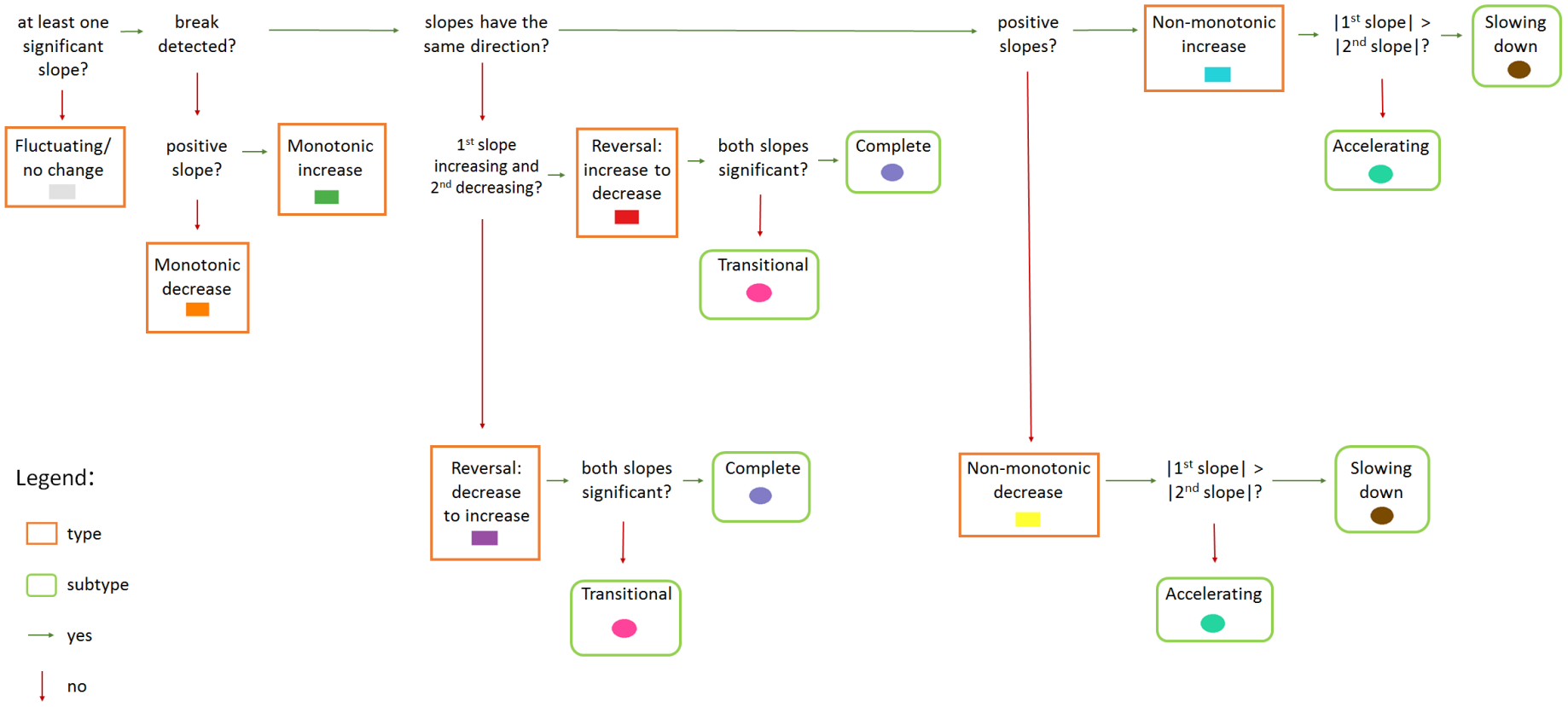


More info: **http://uturndryland.wixsite.com/uturn**

belspo

New Typology Decision Tree

New typology decision tree:



New Typology Decision Tree

New typology decision tree:

at least one significant slope? →

↓

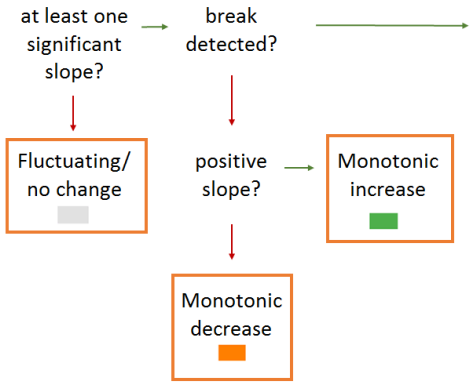
Fluctuating/ no change

Legend:

- type
- subtype
- → yes
- ↓ no

New Typology Decision Tree

New typology decision tree:

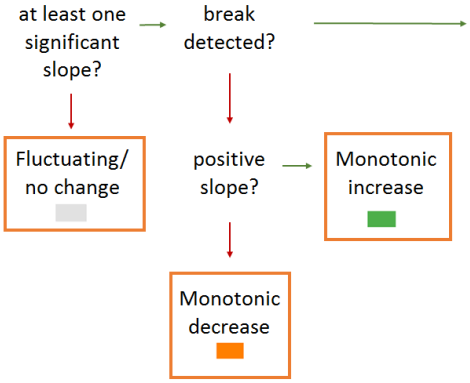


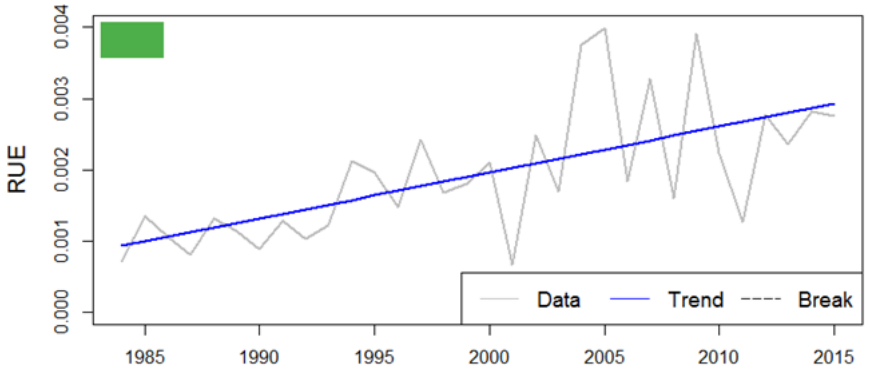
Legend:

- type
- subtype
- yes
- no

New Typology Decision Tree

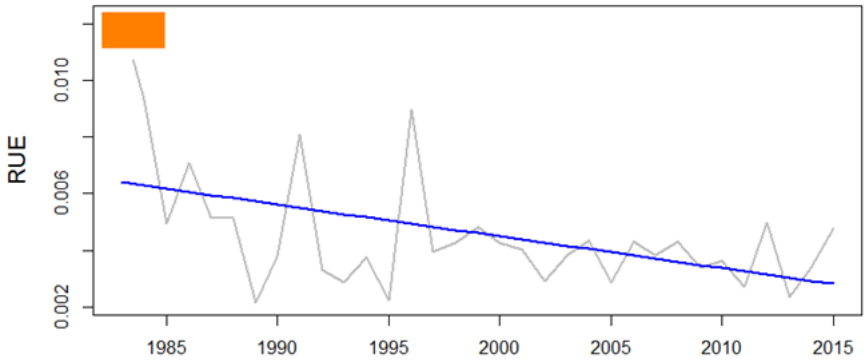
New typology decision tree:





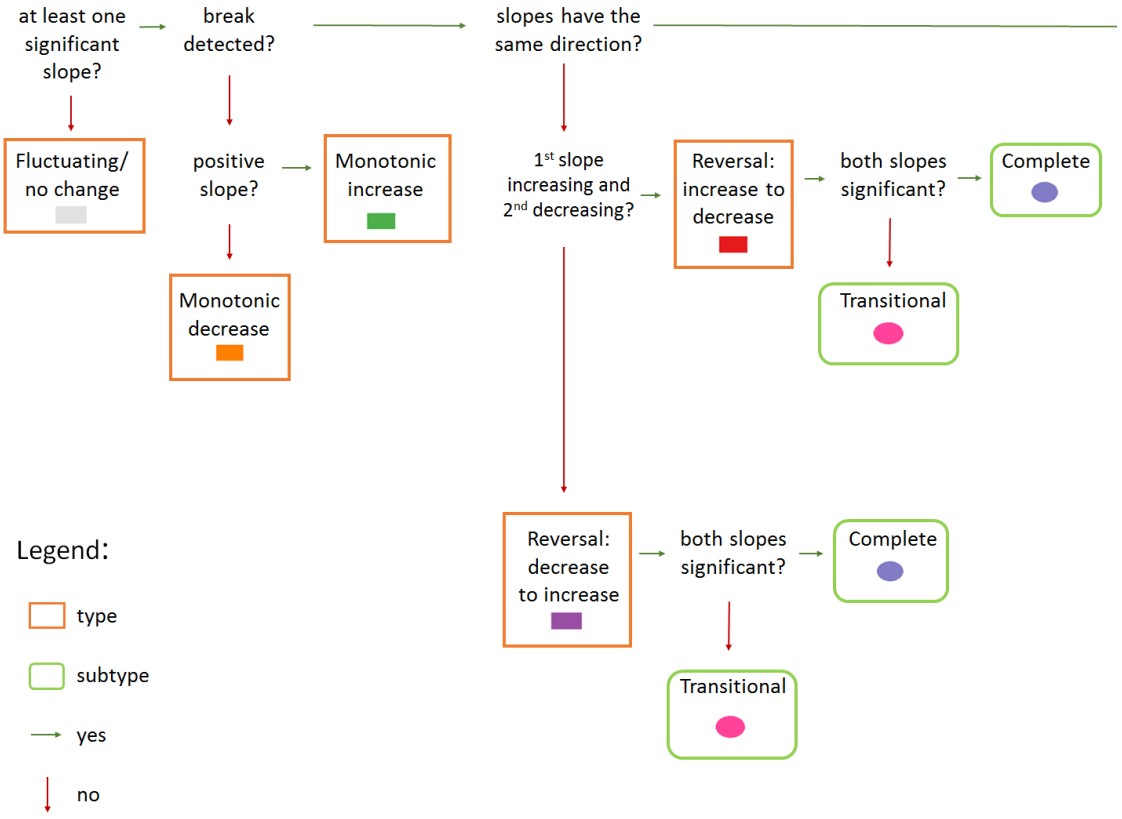
Legend:

- type
- subtype
- yes
- no



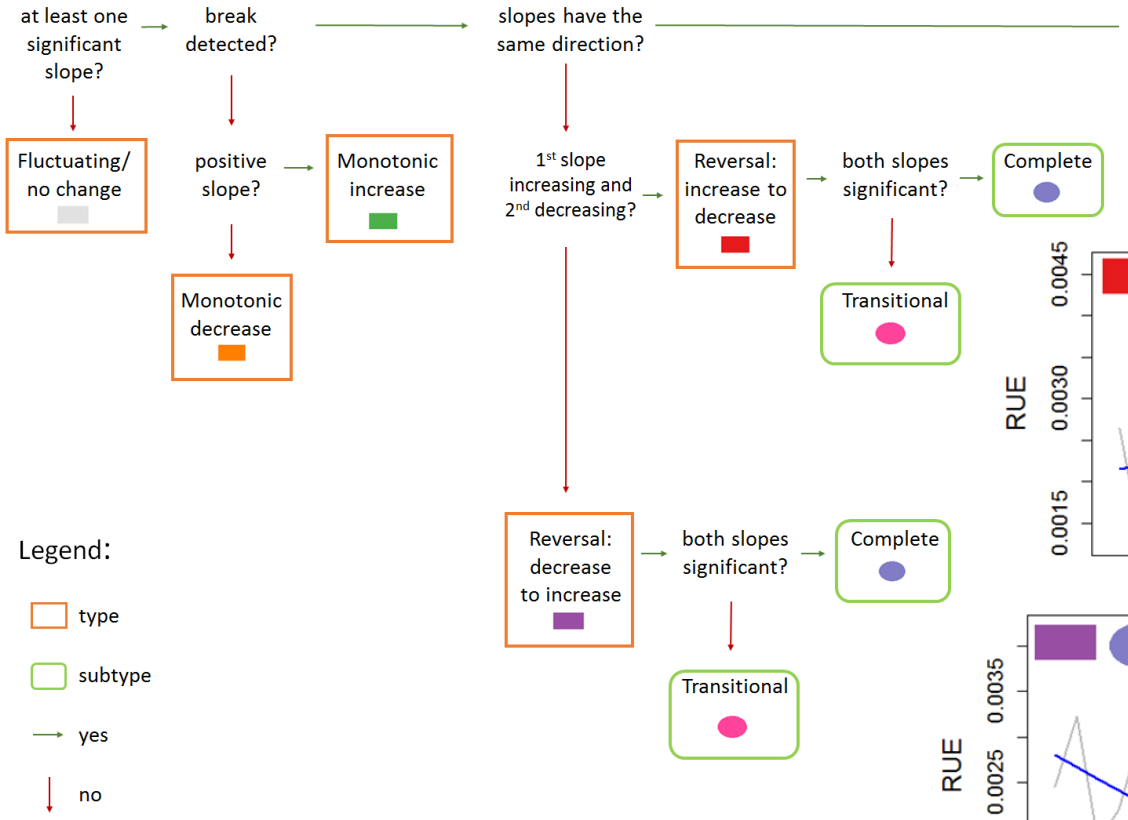
New Typology Decision Tree

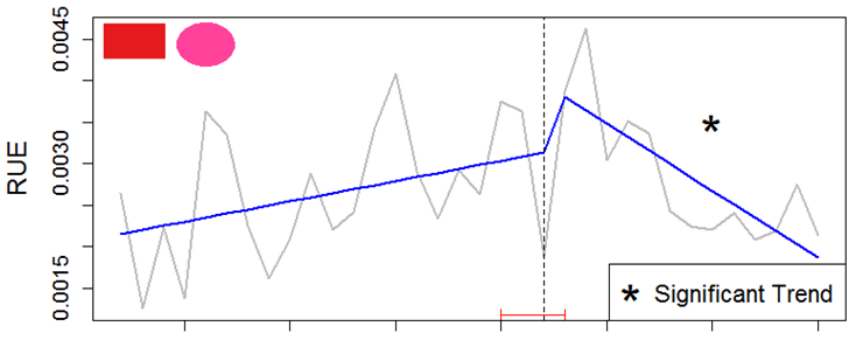
New typology decision tree:

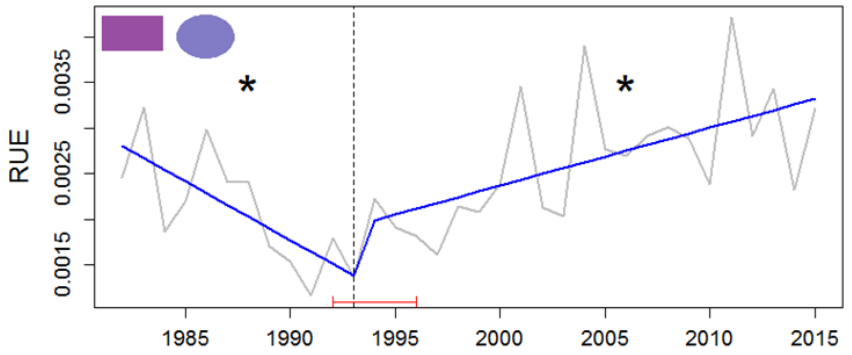


New Typology Decision Tree

New typology decision tree:

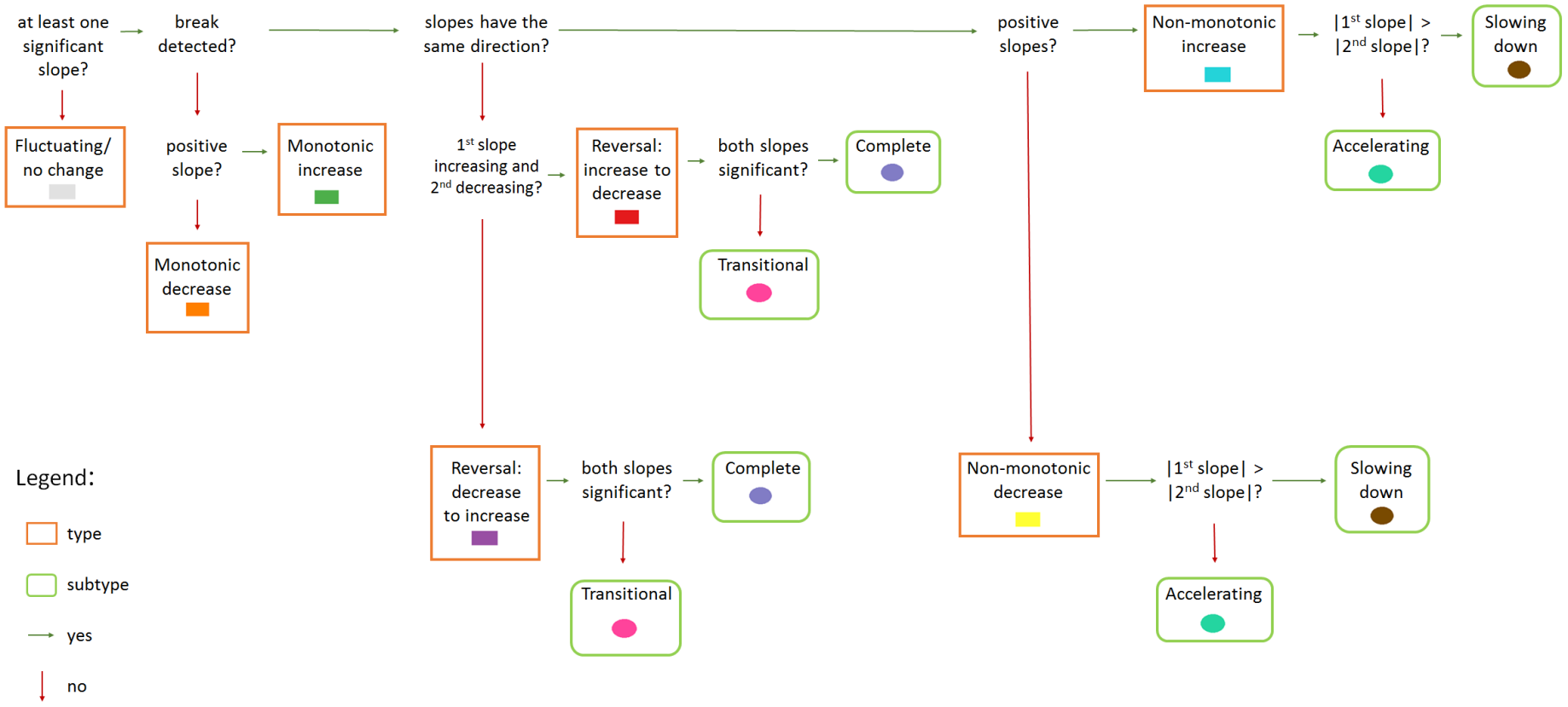






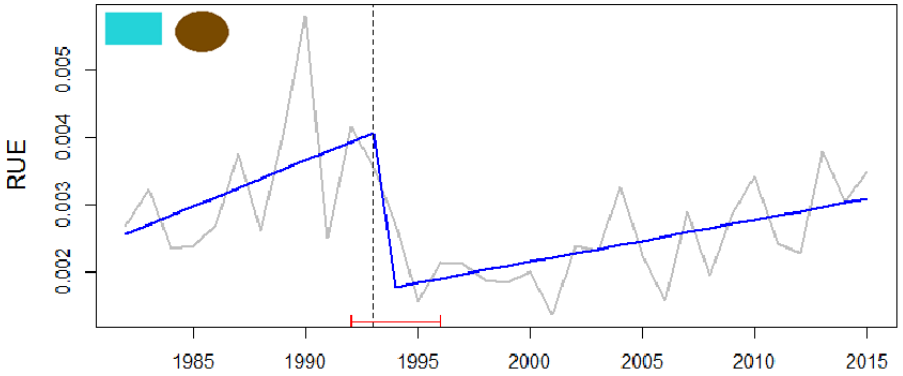
New Typology Decision Tree

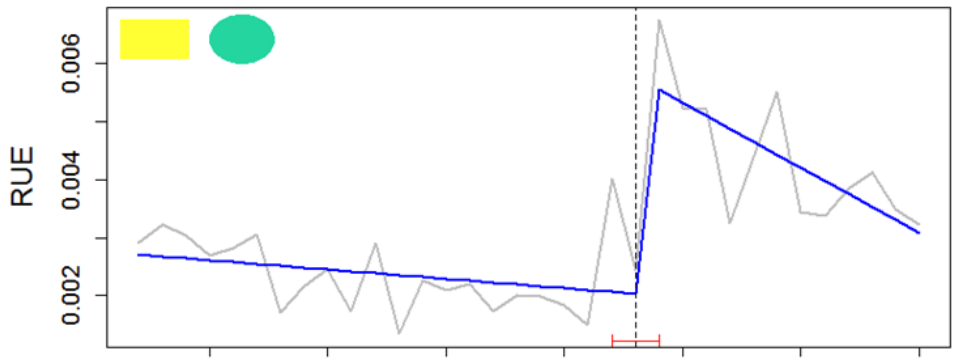
New typology decision tree:

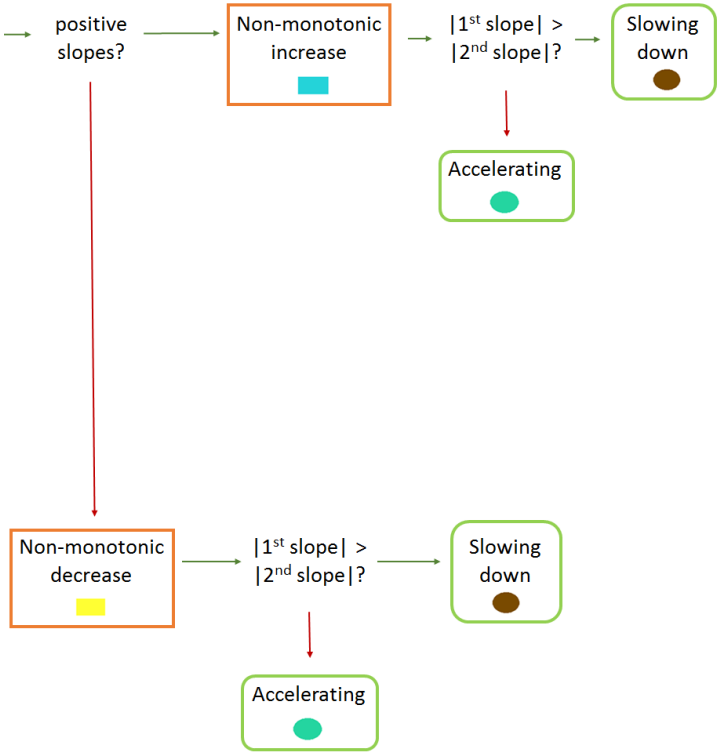
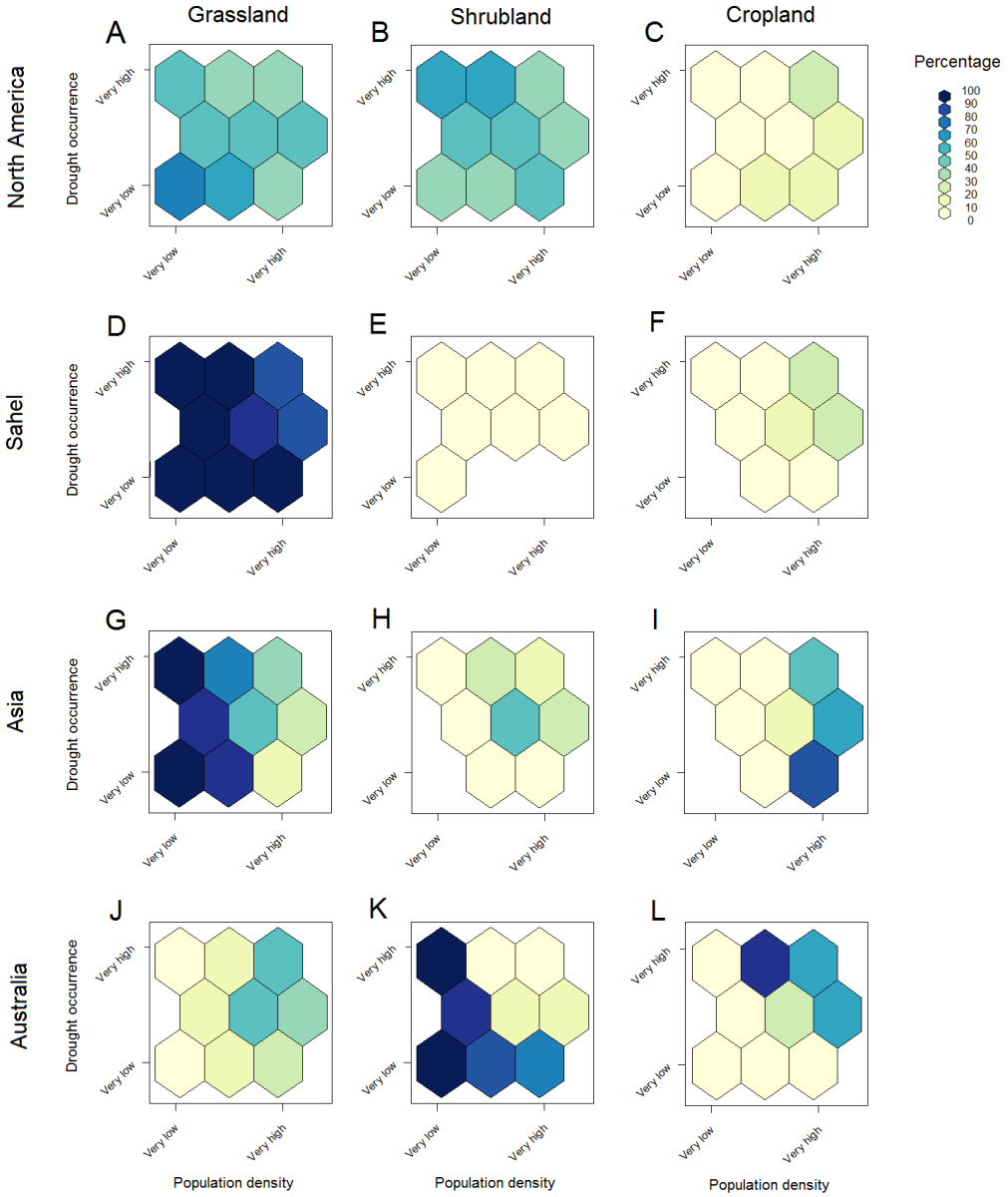


New Typology Decision Tree

New typology decision tree:







Land cover types