

Changes in temperature extremes in Romania (1961-2013)

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INTRODUCTION

- Climate change is one of the most frequent topics in climatic literature over the last three decades. One of the major concerns with a potential change in climate is that an increase in extreme events will occur.
- In this paper, we focused on the spatial distribution and changes detected in air temperature extremes in Romania over a 53-yr period: 1961-2013.

Data used

- In this study, changes in extreme temperature and precipitation indices were calculated;
- Gridded daily temperature and precipitation time series derived from the national climatic database, ROCADA (Dumitrescu and Bîrsan, 2015) were used (1961-2013).
- The spatial resolution of the database is 0.1° latitude/longitude ($\sim 11 \times 11$ km).

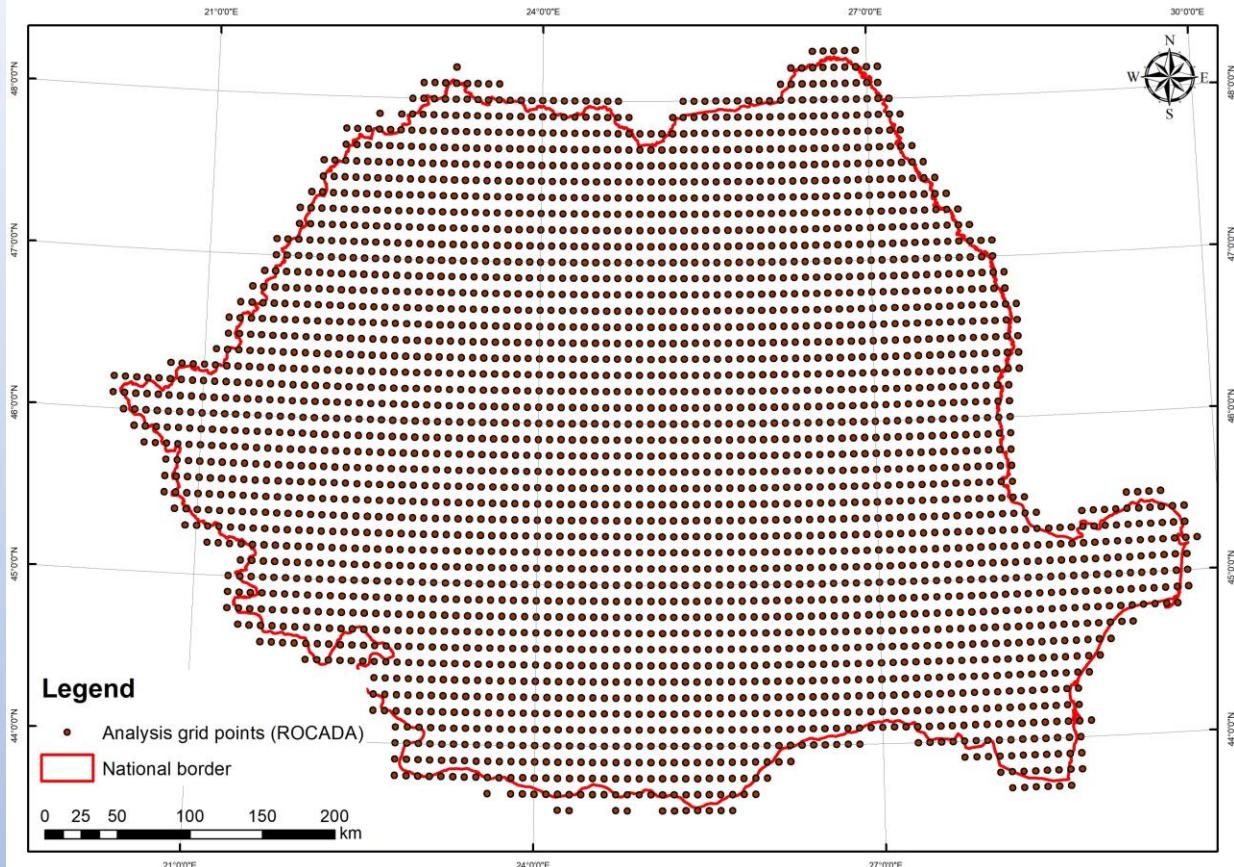


Figure 1. Grid network used for data analysis.

[Bîrsan, Marius-Victor; Dumitrescu, Alexandru \(2014\): ROCADA: Romanian daily gridded climatic dataset \(1961-2013\) V1.0. Administratia Nationala de Meteorologie, Bucuresti, Romania, PANGAEA, <https://doi.org/10.1594/PANGAEA.833627>,](#)

Methods

- Indices calculation;
- Trend detection;
- Mapping.

Methods

- We calculated the **extreme temperature indexes** established by the ET-SSI using ROCADA data for each grid and then **interpolated** the values.
- **Trend detection** was achieved based on two-fold approach:
 - Linear trend (calculated with ClimPACT, using the zyp package in R);
 - Change-point detection and slope calculation before and after change point.
 - Sen's slope;
 - Pettitt test.

Climpact

An R software package that calculates ET-SCI indices.

XLSTAT
by Addinsoft

Mapping

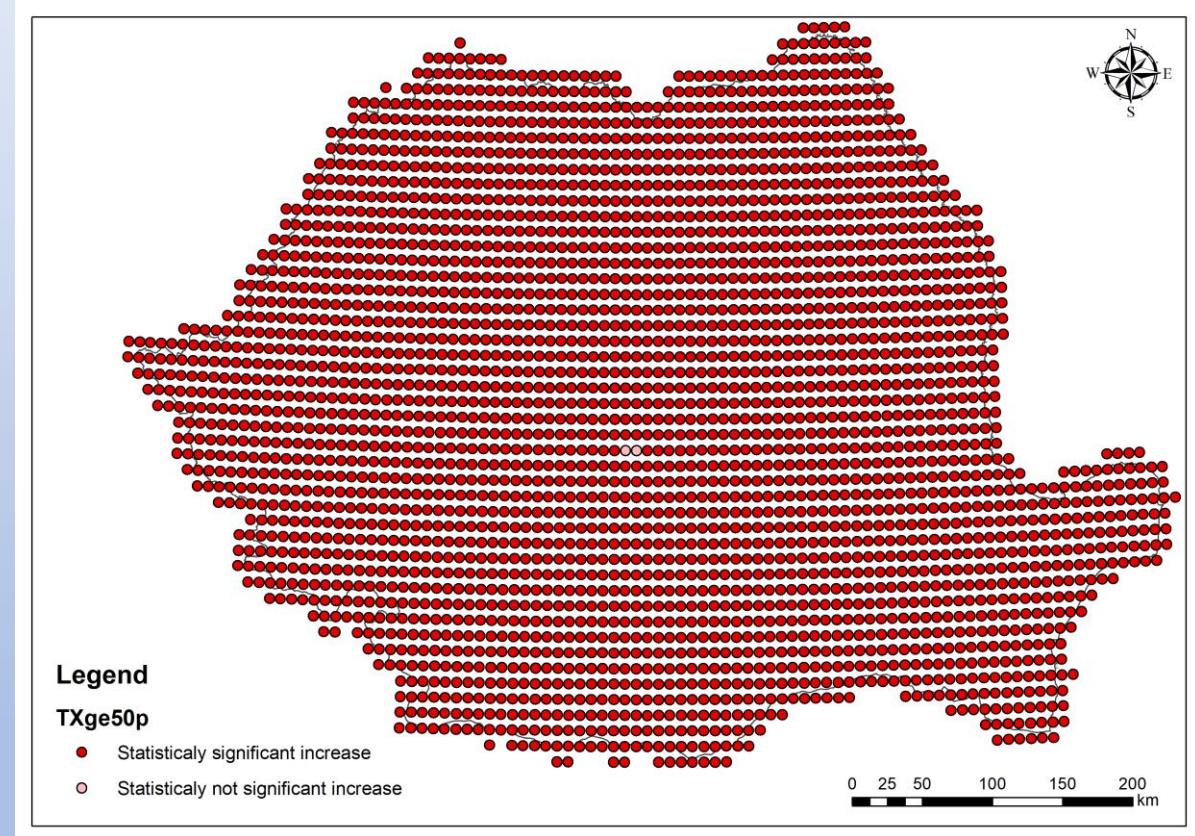
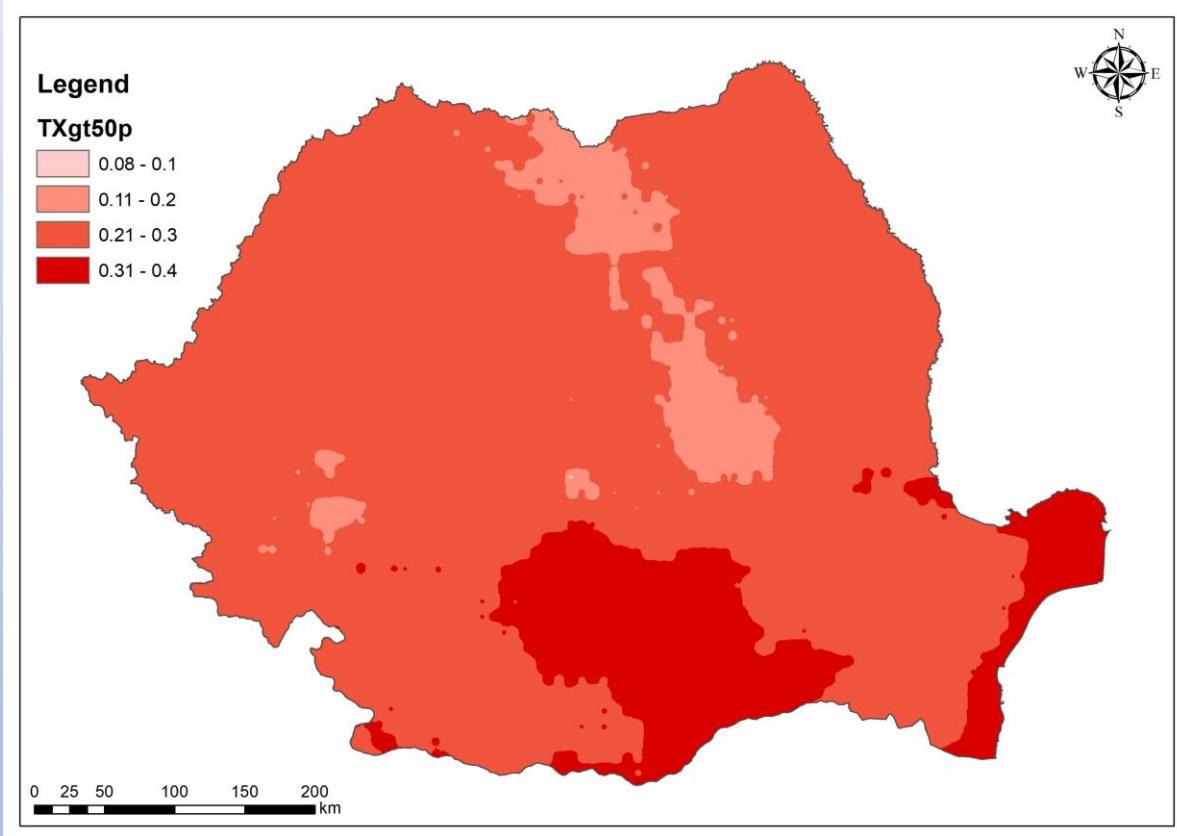
Inverse distance weighted (**IDW**)

- Interpolation determines cell values using a linearly weighted combination of a set of sample points.
- The weight is a function of inverse distance.
- The surface interpolated should be that of a locationally dependent variable.



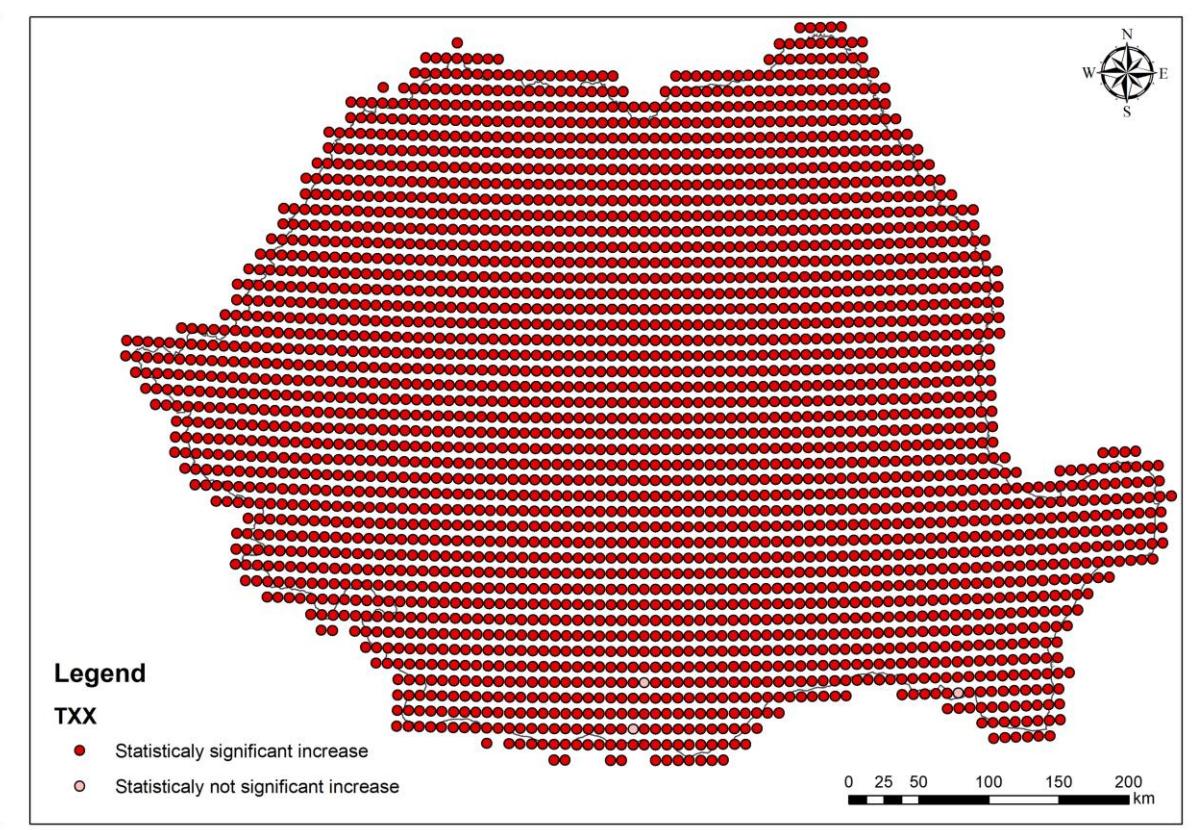
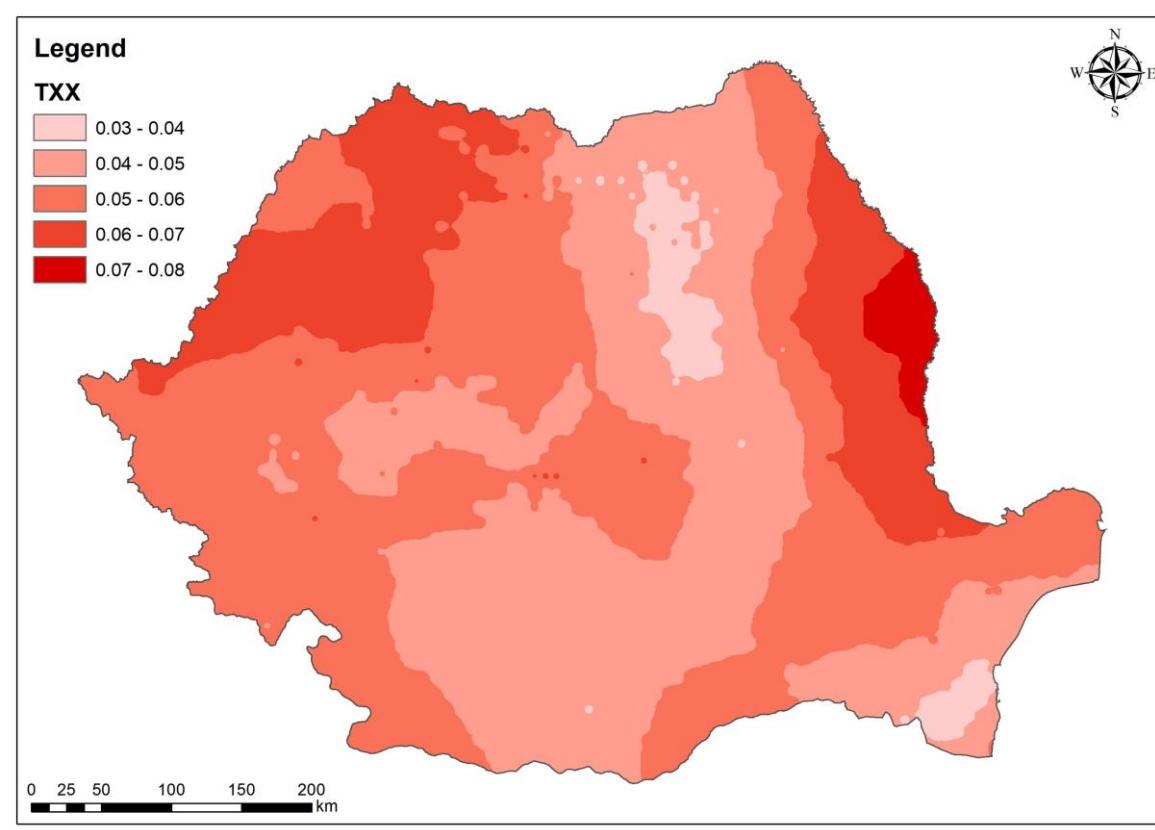
ArcGIS v10.8 (ESRI,
The Redlands, CA)

Results – linear trend



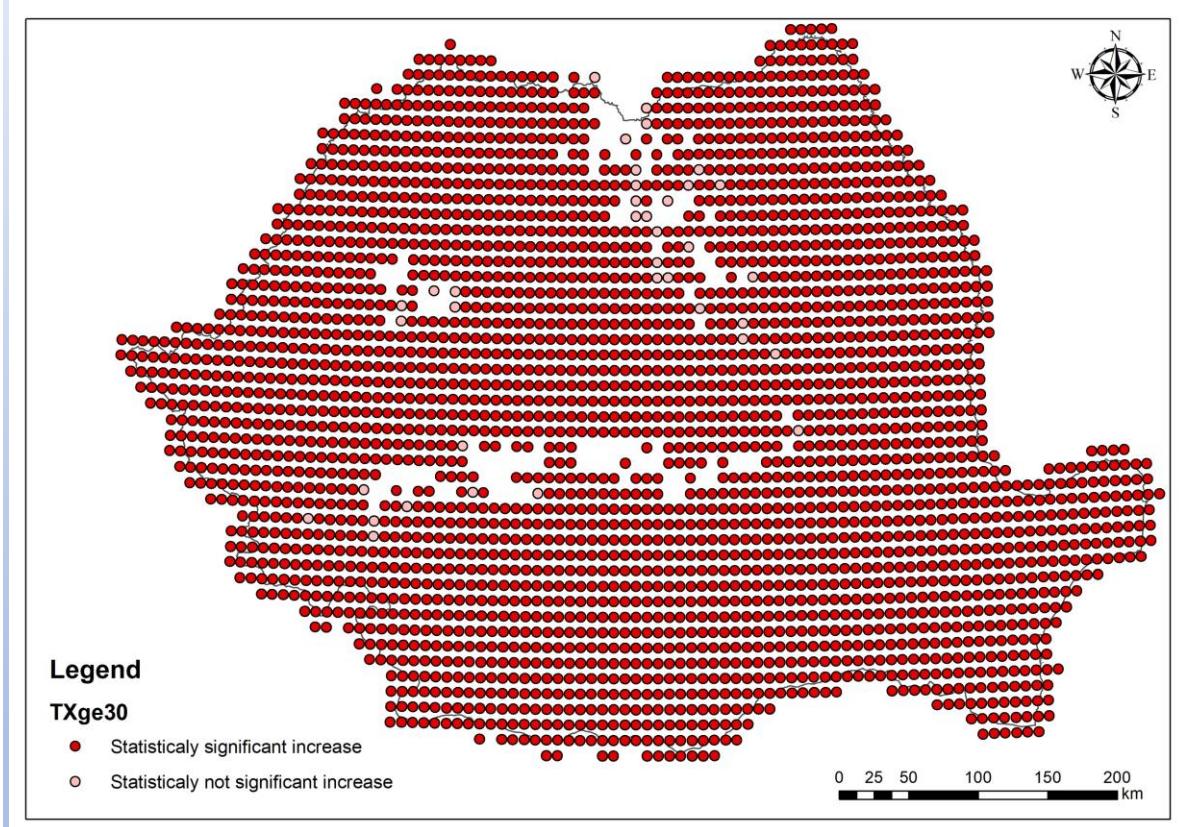
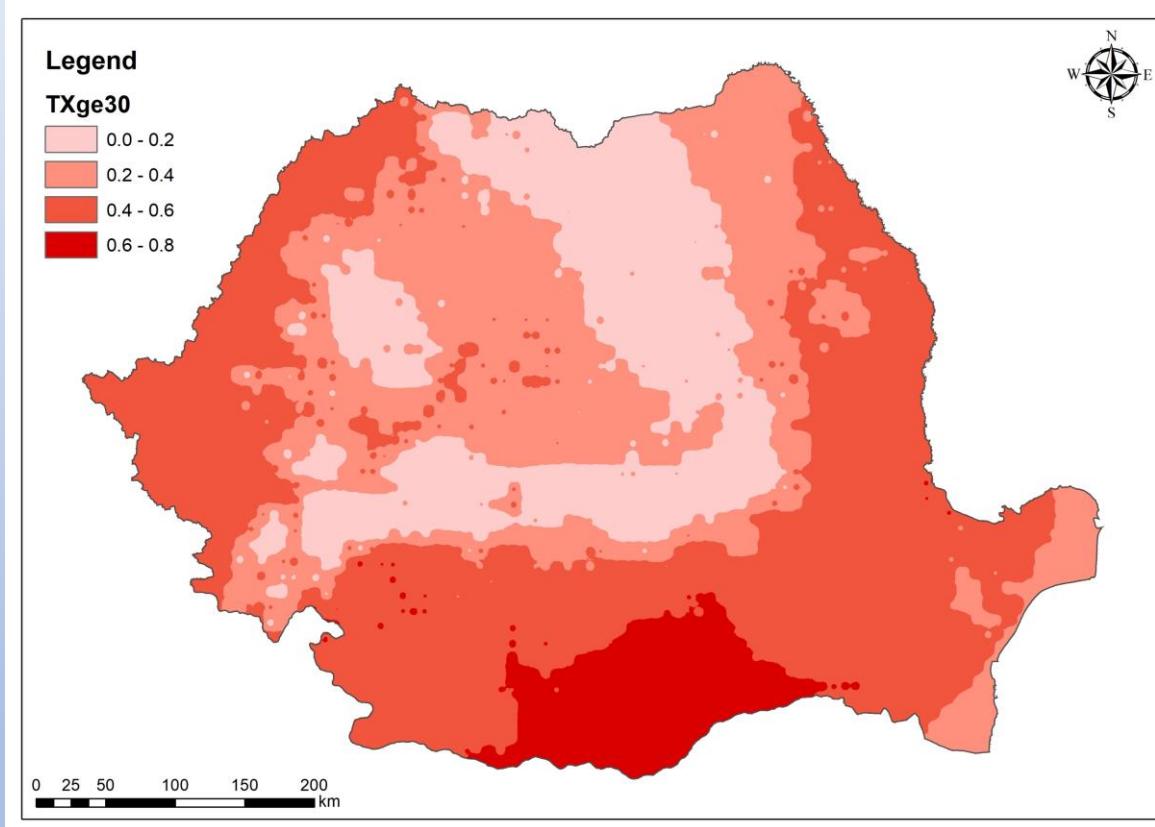
Changes and slopes detected in TXgt50p index

Results – linear trend



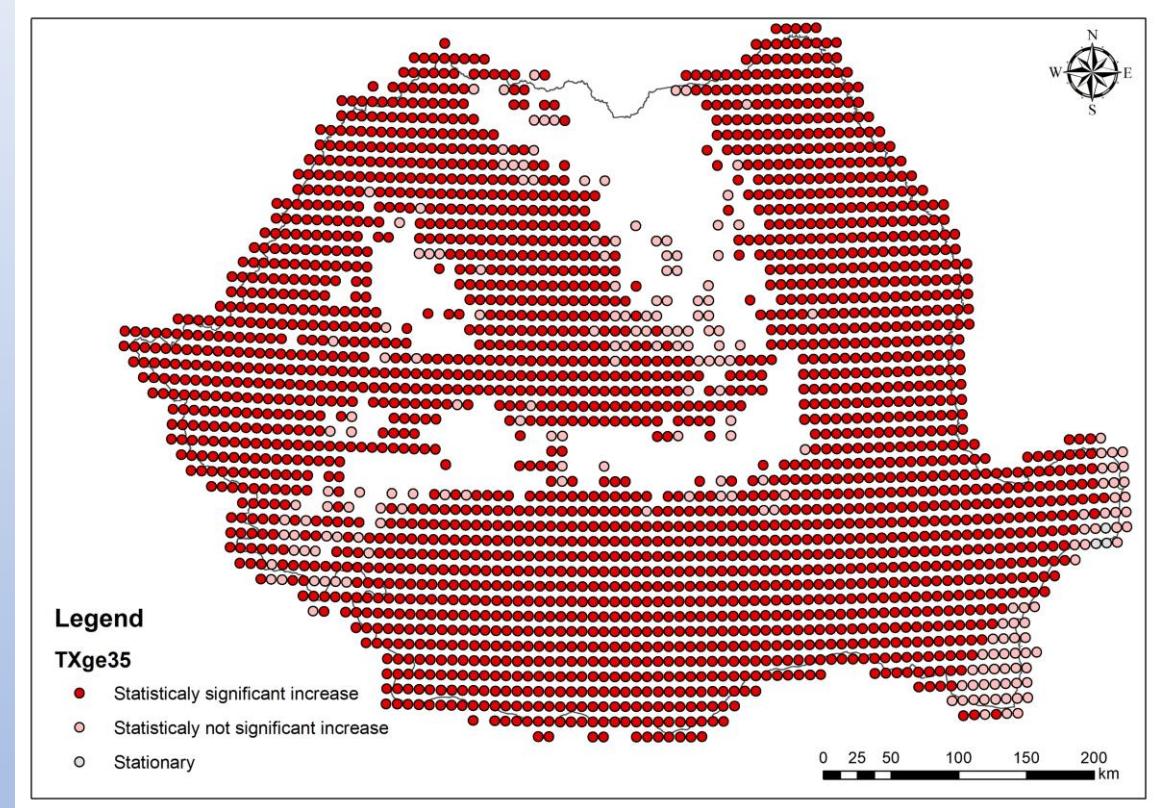
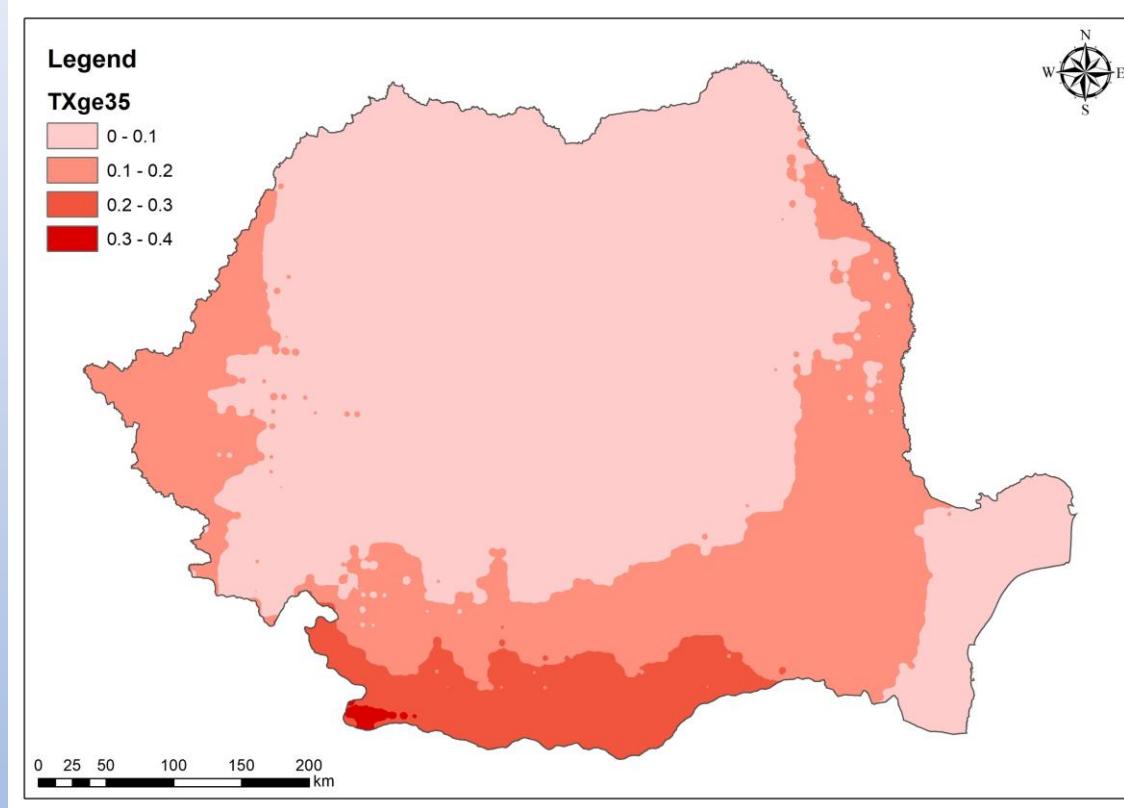
Changes and slopes detected in TXx index

Results – linear trend



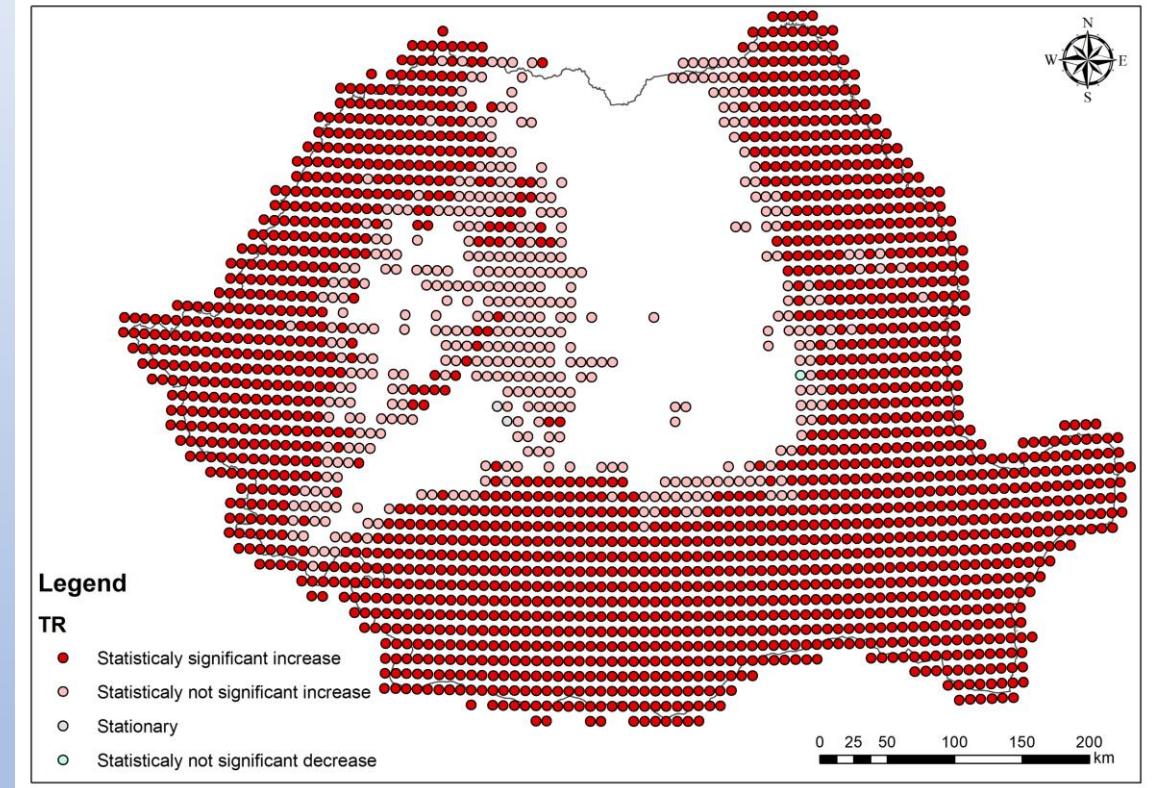
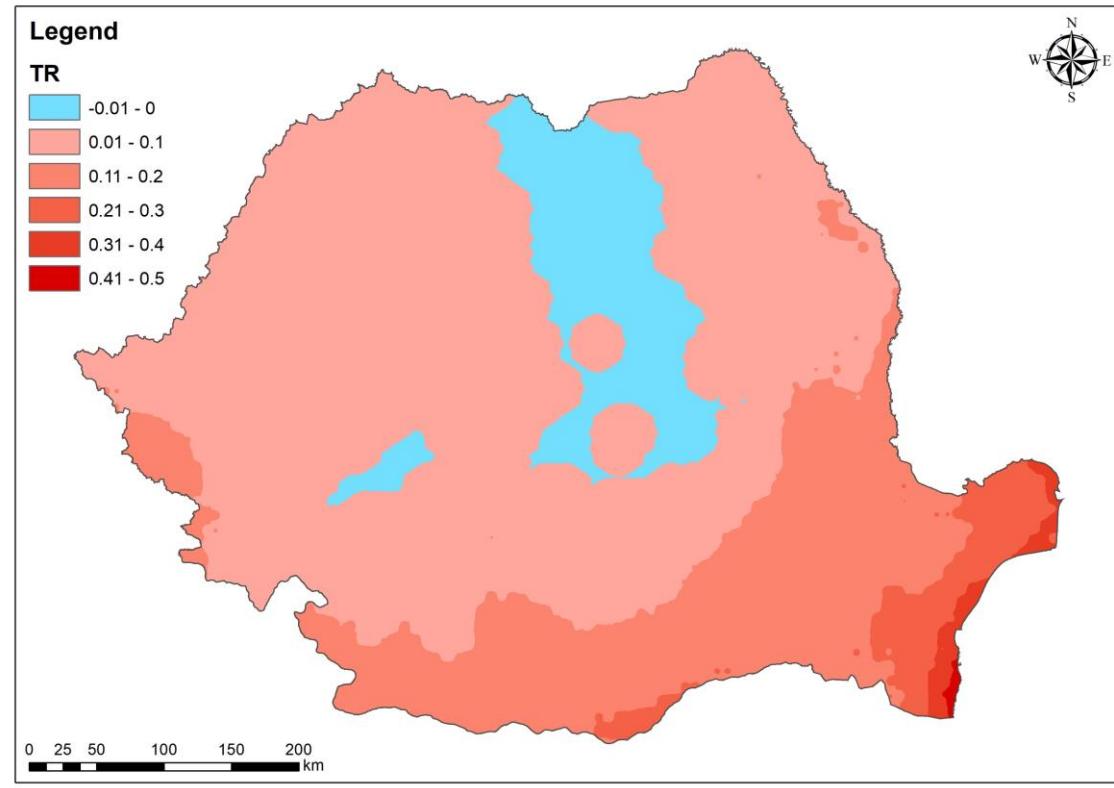
Changes and slopes detected in TXge30 index

Results – linear trend



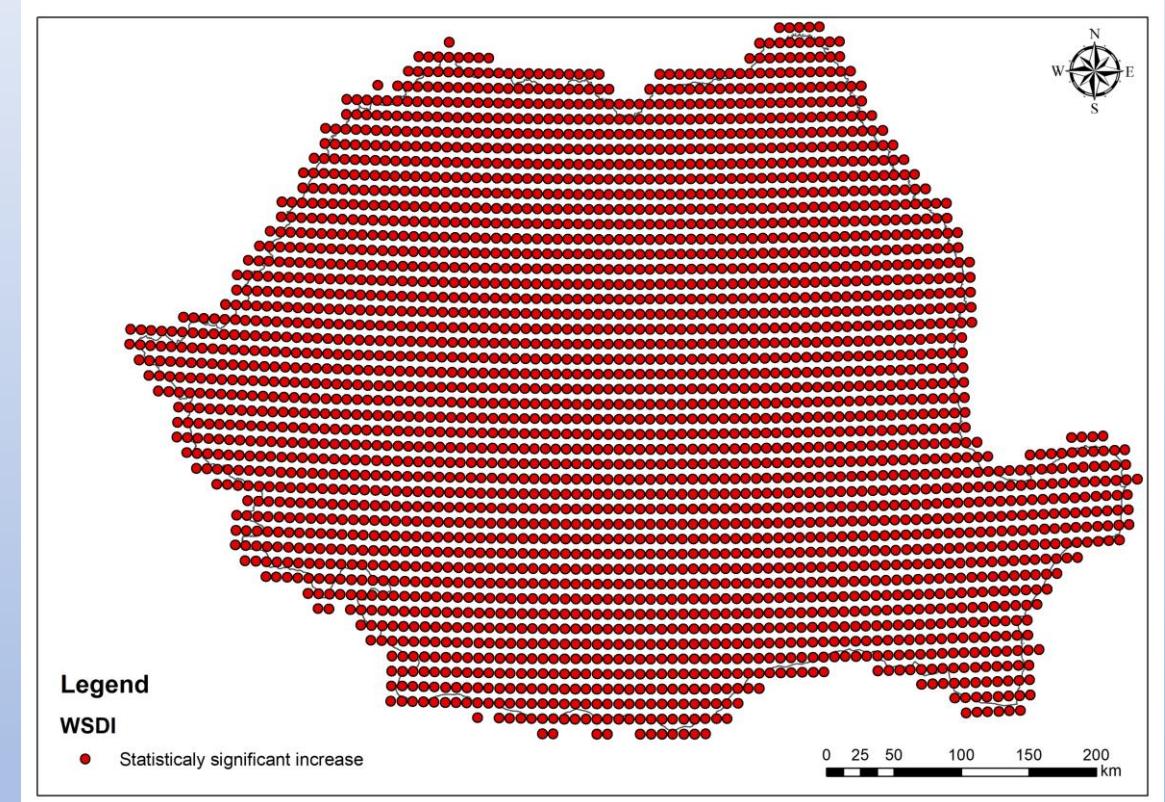
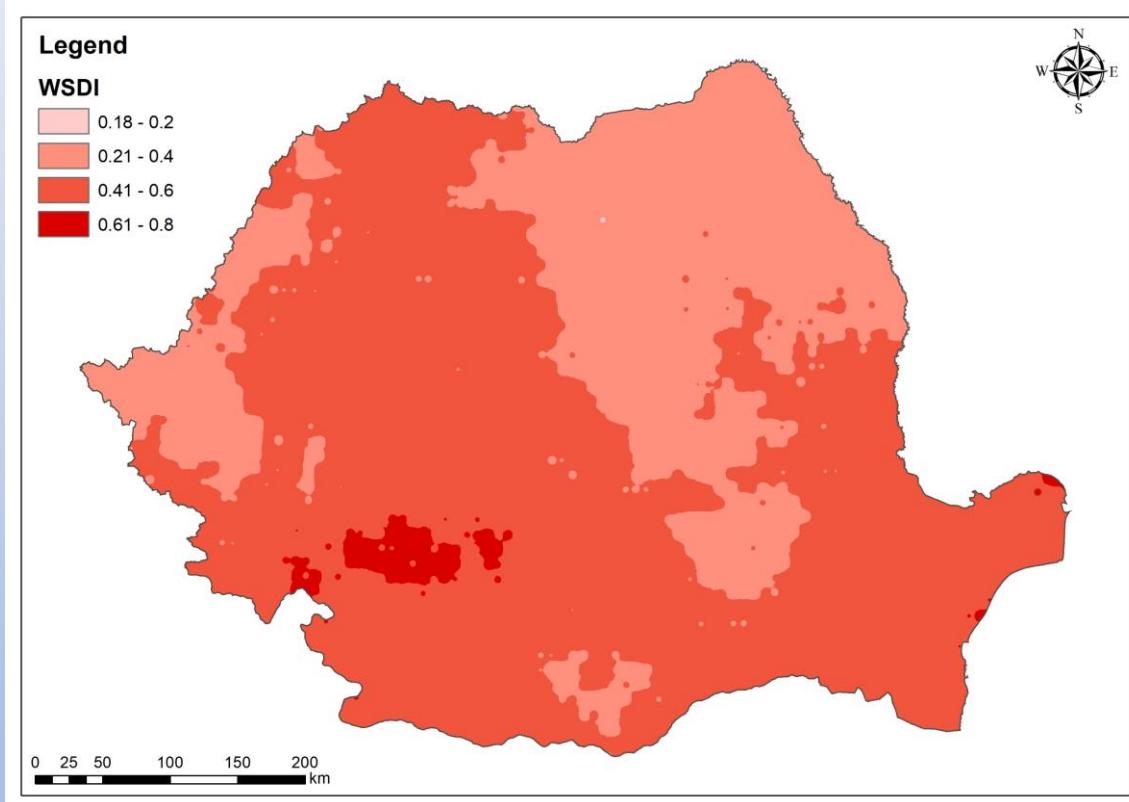
Changes and slopes detected in TXge35 index

Results – linear trend



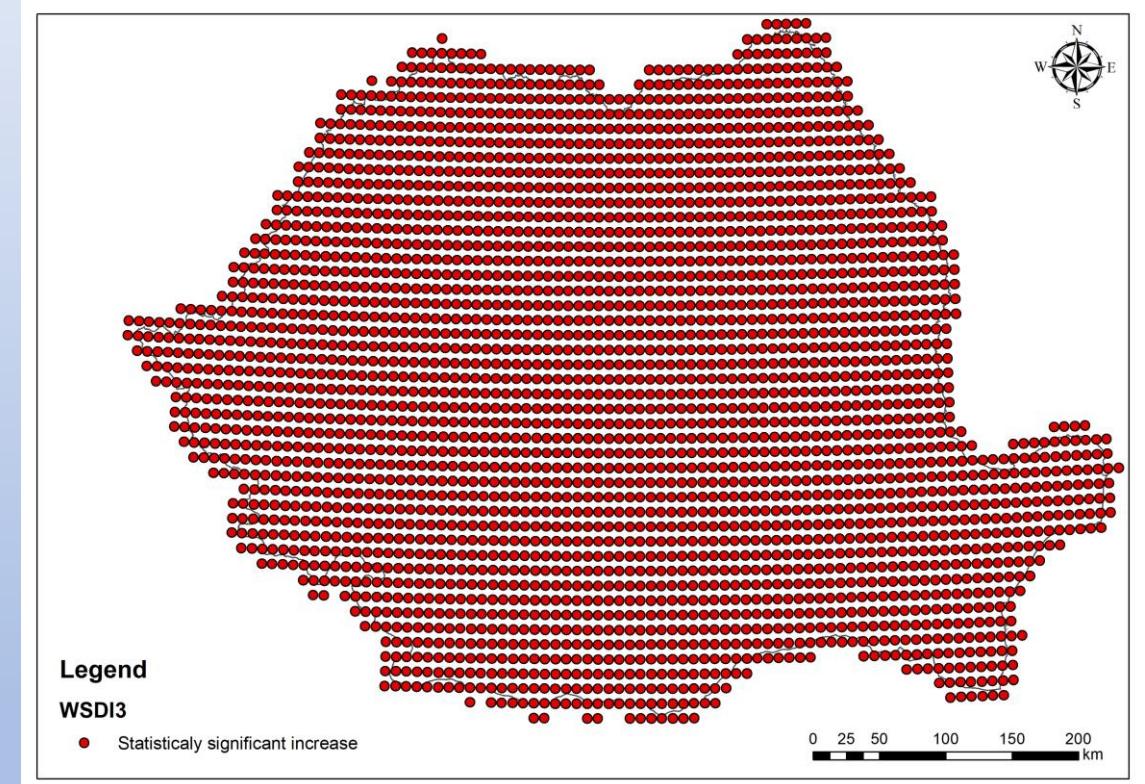
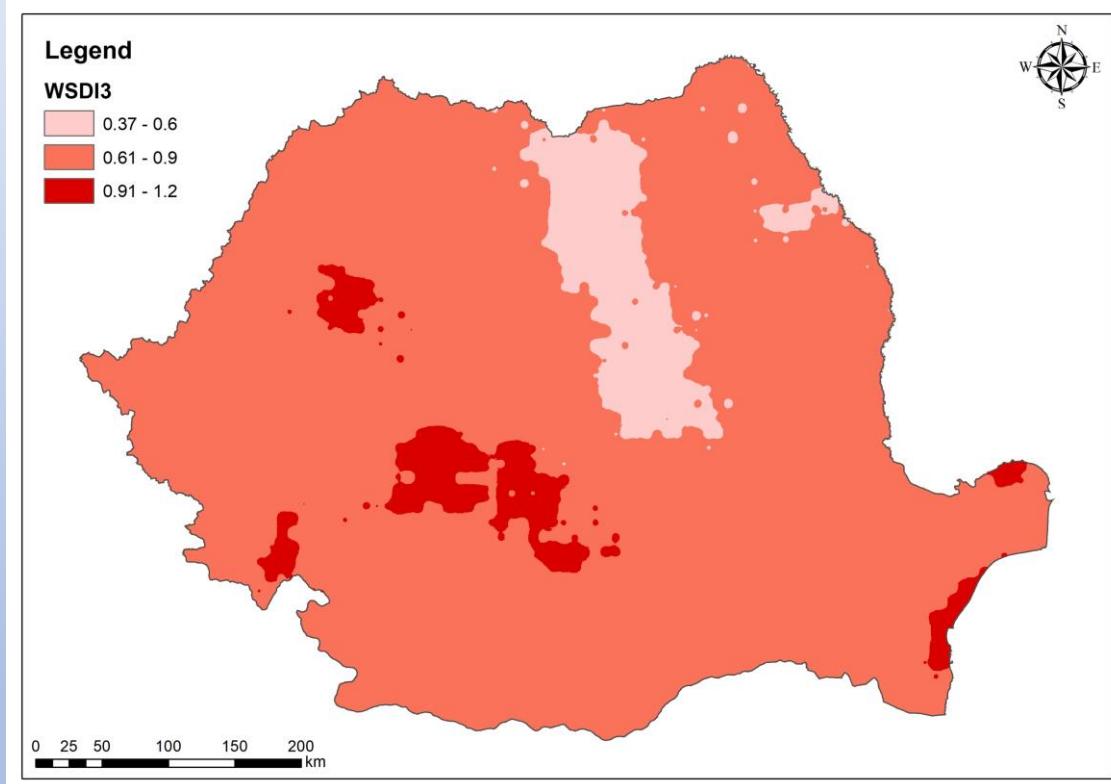
Changes and slopes detected in TR index

Results – linear trend



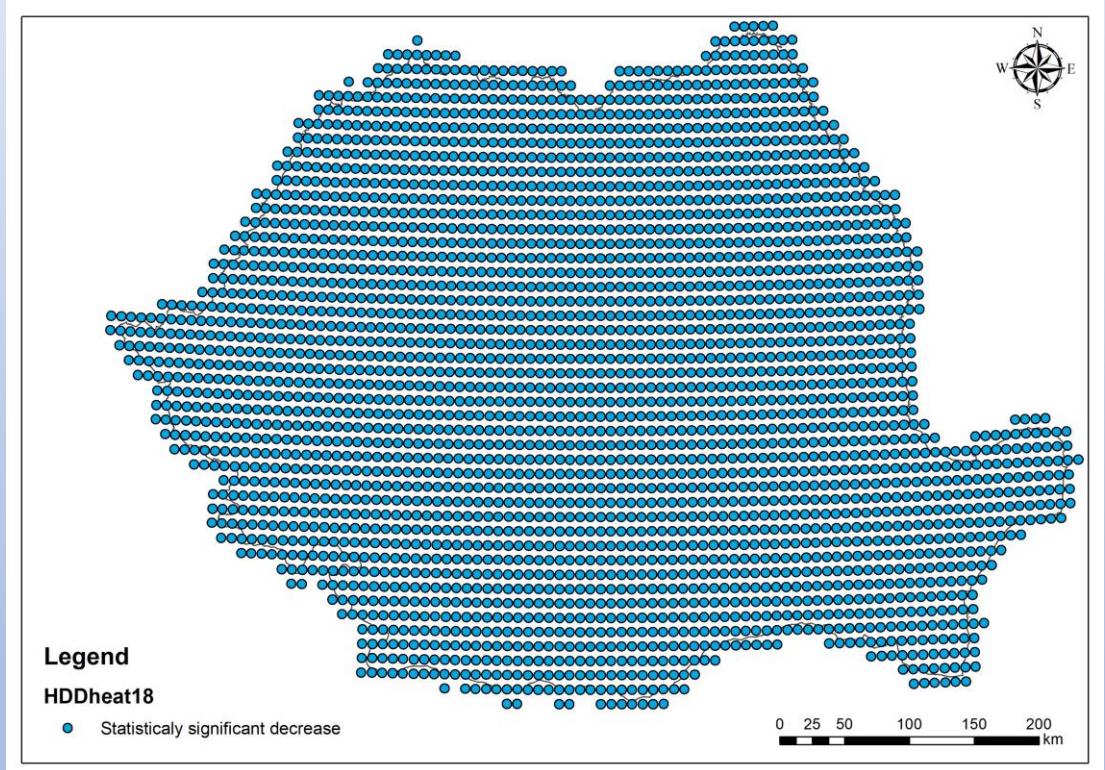
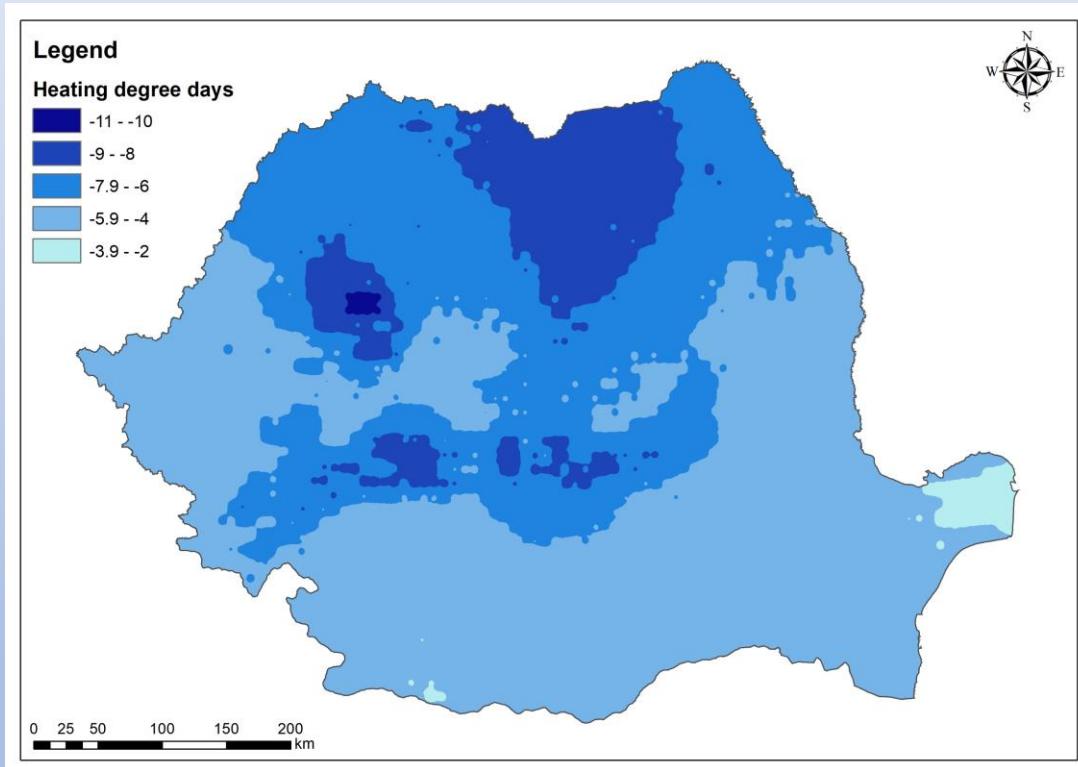
Changes and slopes detected in WSDI index

Results – linear trend



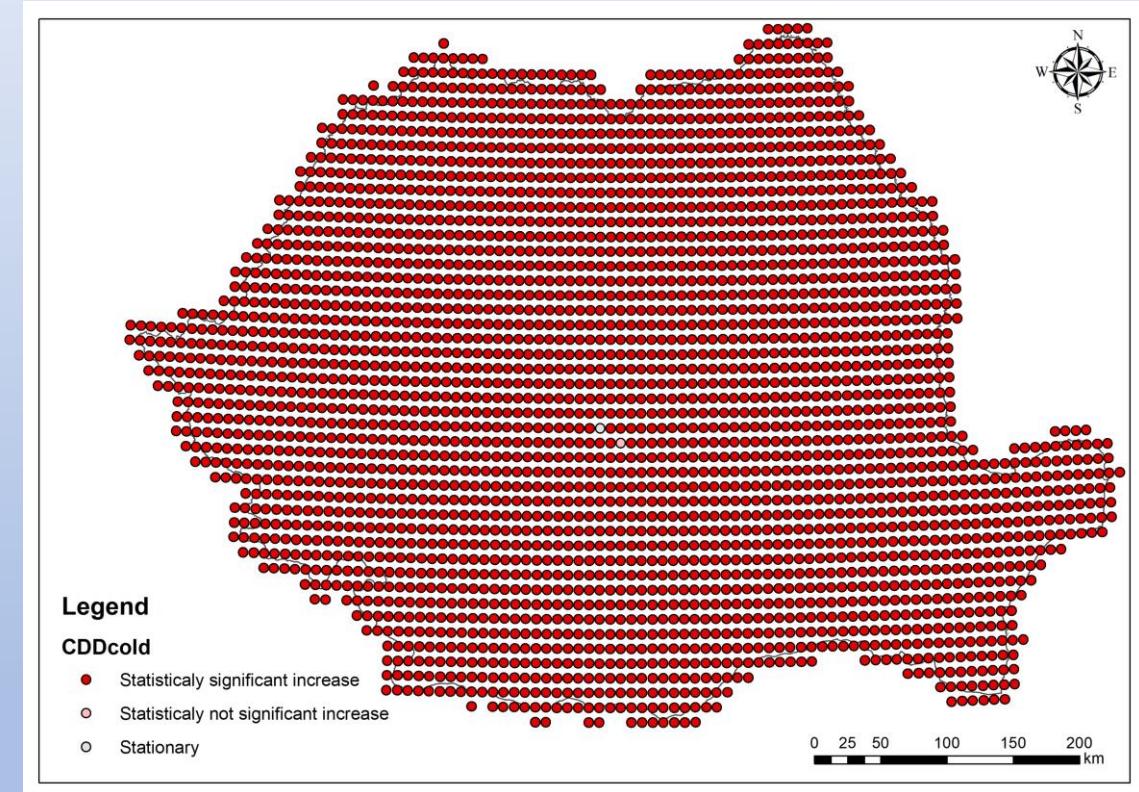
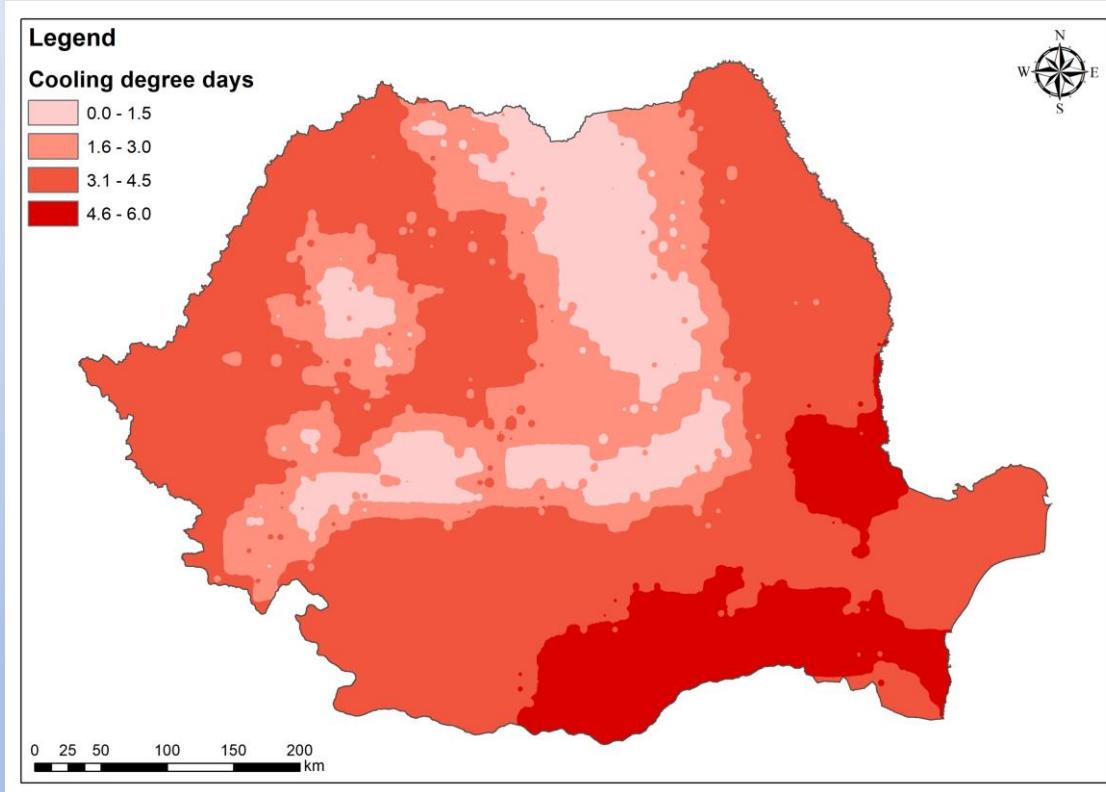
Changes and slopes detected in WSDI3 index

Results – linear trend



Changes and slopes detected in HDDheat index

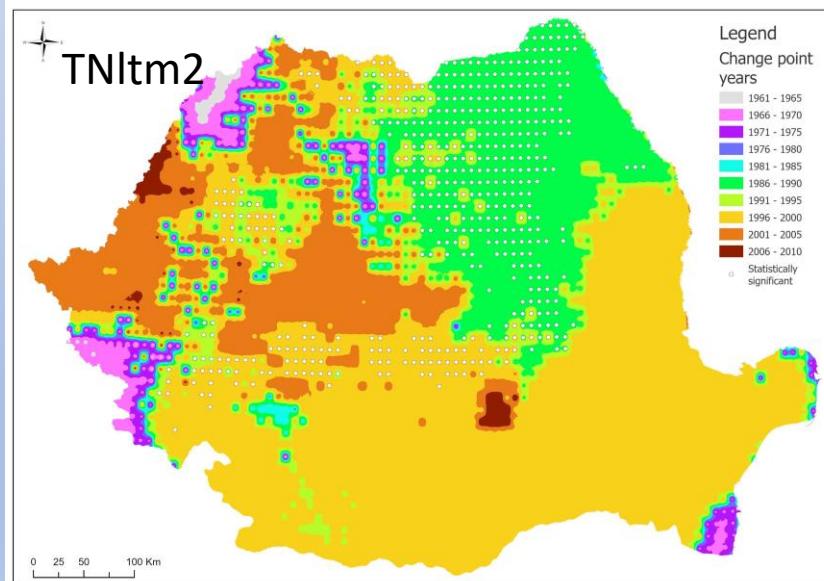
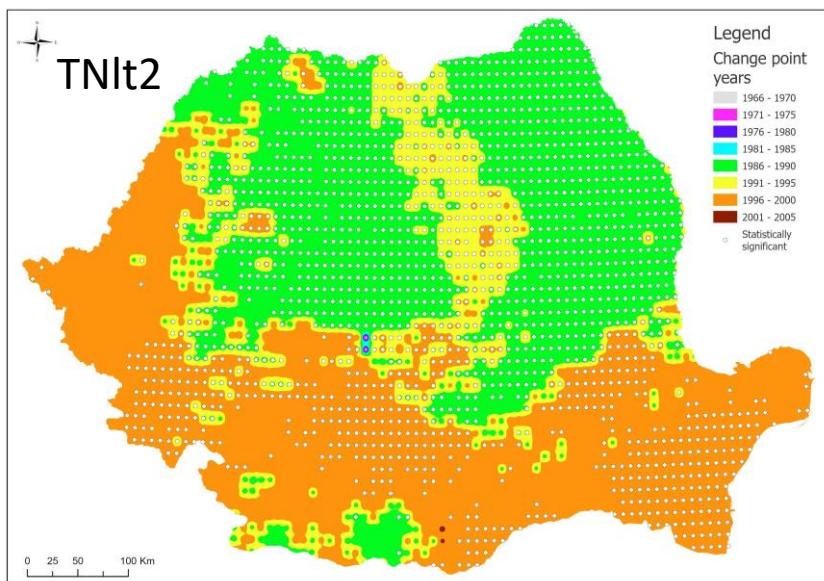
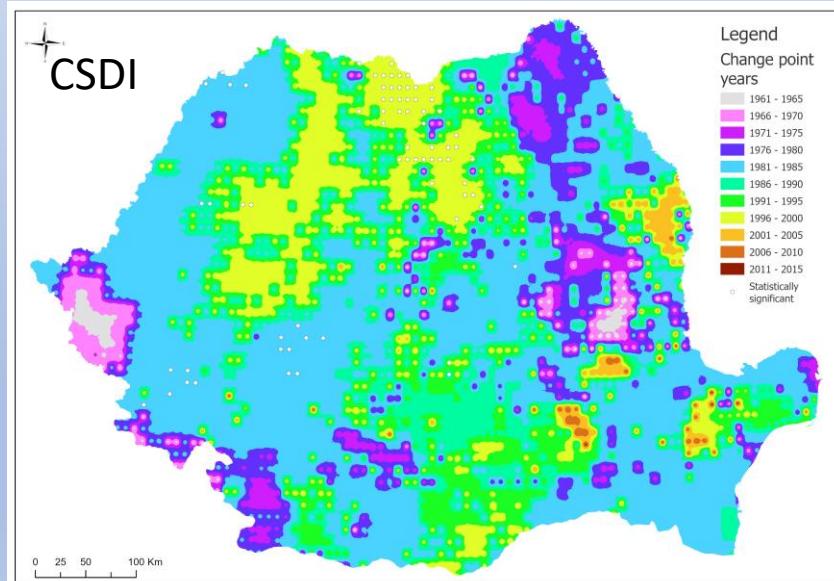
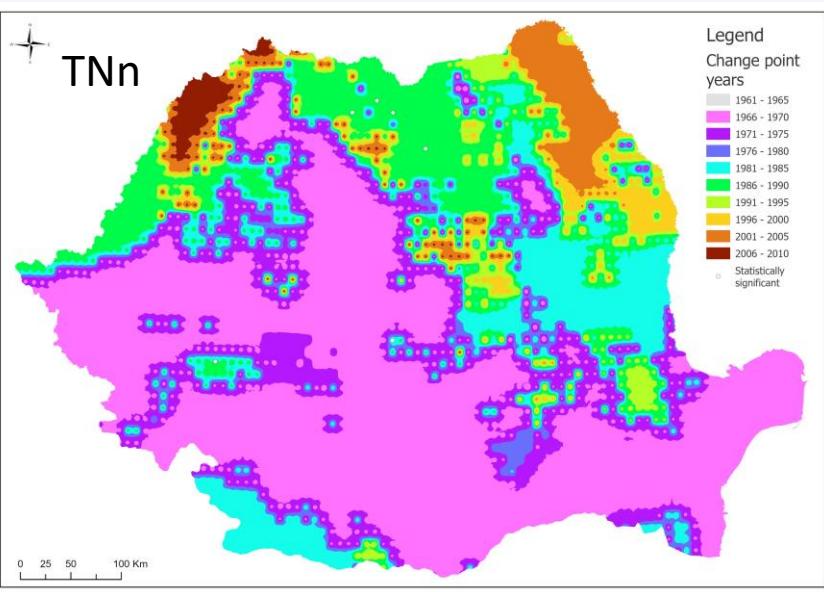
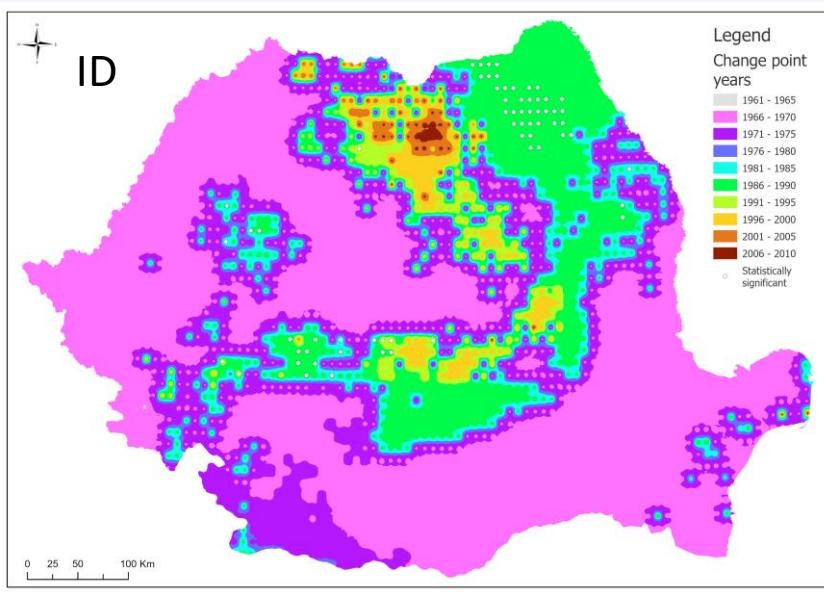
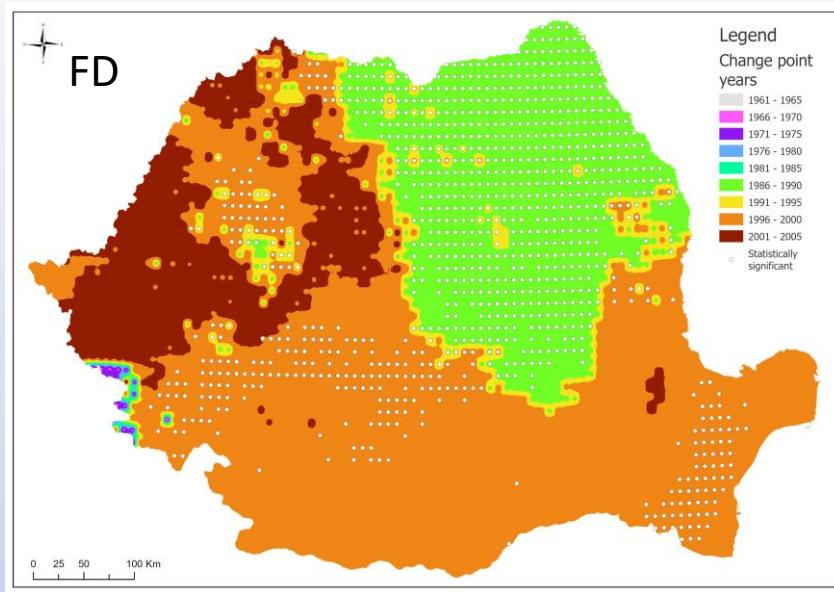
Results – linear trend



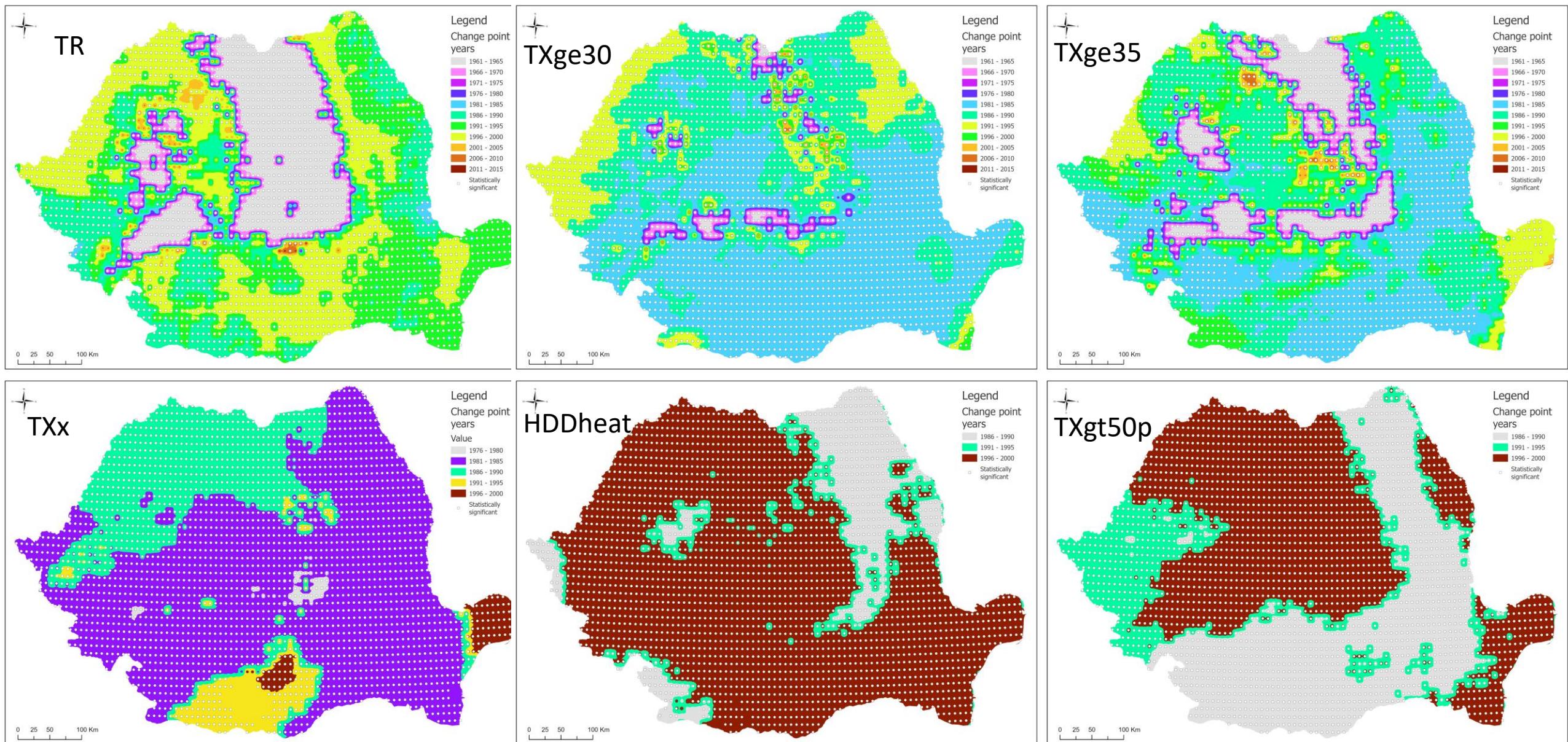
Changes and slopes detected in CDDcold index

Results- Change-point analysis

No	Type of index	Index	SS-CP (No of grids)	Frequency of SS-CP (%)	NSS-CP (No. of grids)	Frequency of NSS-CP (%)
1	Cold extreme	FD	1074	35.30	1972	64.70
2	Cold extreme	ID	70	2.30	2976	97.70
3	Cold extreme	TNn	6	0.20	3040	99.80
4	Cold extreme	CSDI	78	2.60	2968	97.40
5	Cold extreme	TNIlt2	1958	64.30	1088	35.70
6	Cold extreme	TNIltm2	562	18.50	2484	81.60
7	Cold extreme	TNIltm20	568	18.70	2478	8.40
8	Hot extreme	TR	2678	87.90	368	12.10
9	Hot extreme	TXge30	2938	96.50	108	3.50
10	Hot extreme	TXge35	2593	85.10	453	14.90
11	Hot extreme	TXx	2990	98.20	56	1.80
12	Hot extreme	HDDheat18	3019	99.10	27	0.90
13	Hot extreme	TXgt50p	3046	100.00	0	0.00
14	Hot extreme	WSDI	2998	98.40	48	1.60
15	Hot extreme	WSDI3	3046	100.00	0	0.00
16	Cold extreme	CDDcold	2171	100.00	0	0.00
17	Variability extreme	DTR	1456	47.80	1590	52.20
18	Variability extreme	GSL	1136	37.30	1910	62.70
19	Variability extreme	GDDgrow	3046	100.00	0	0.00
20	Variability extreme	TMge5	2344	76.95	702	23.05

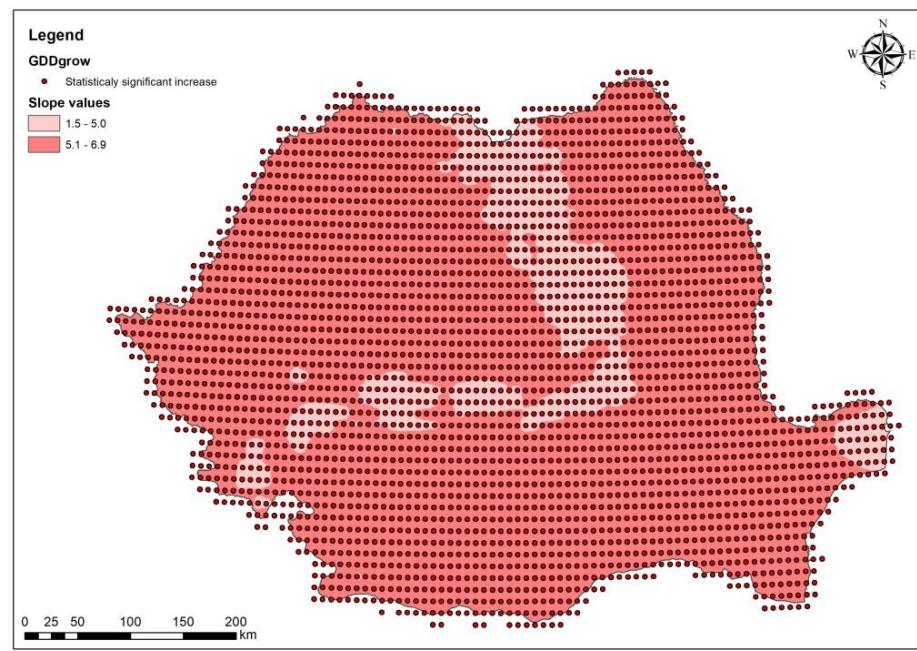


Change point year detected in cold extremes

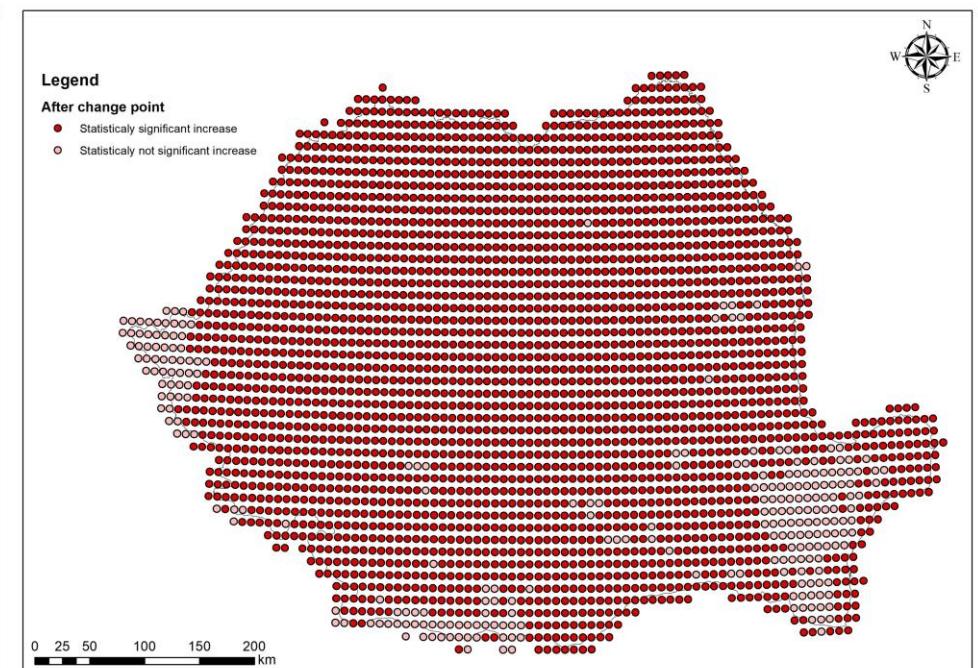
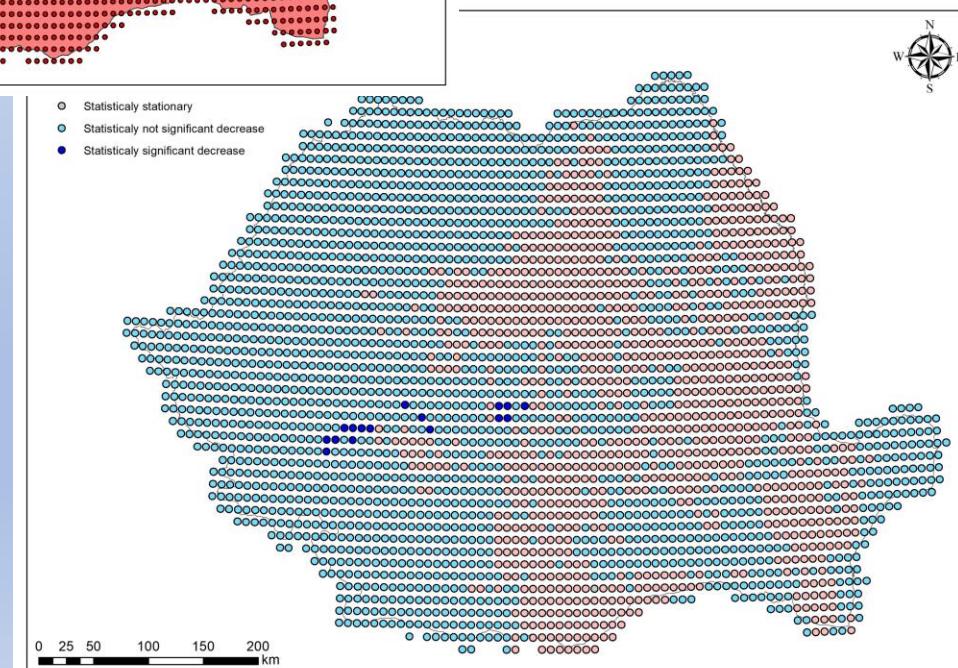
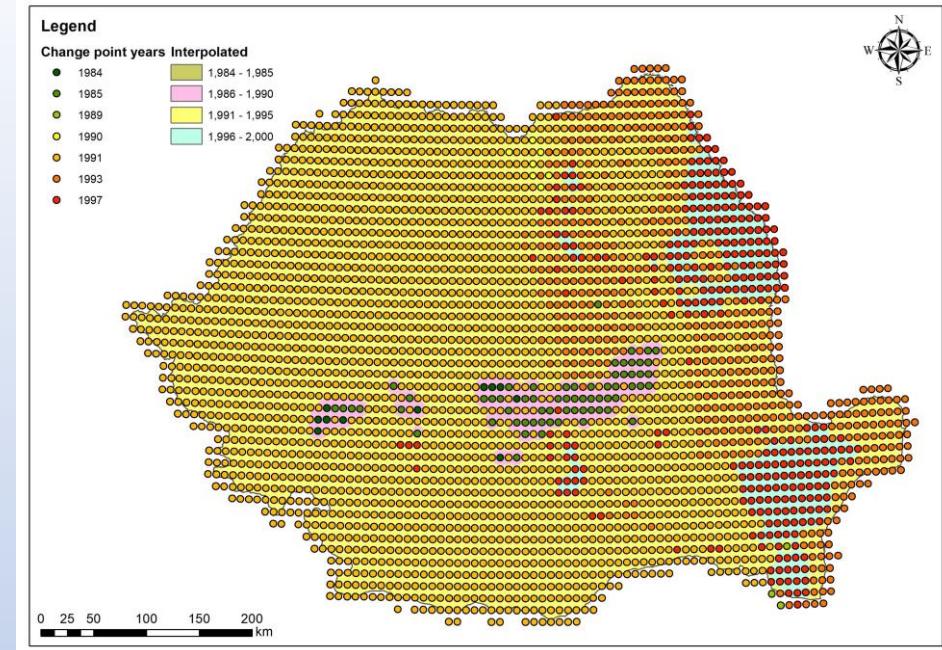


Change point year detected in hot extremes

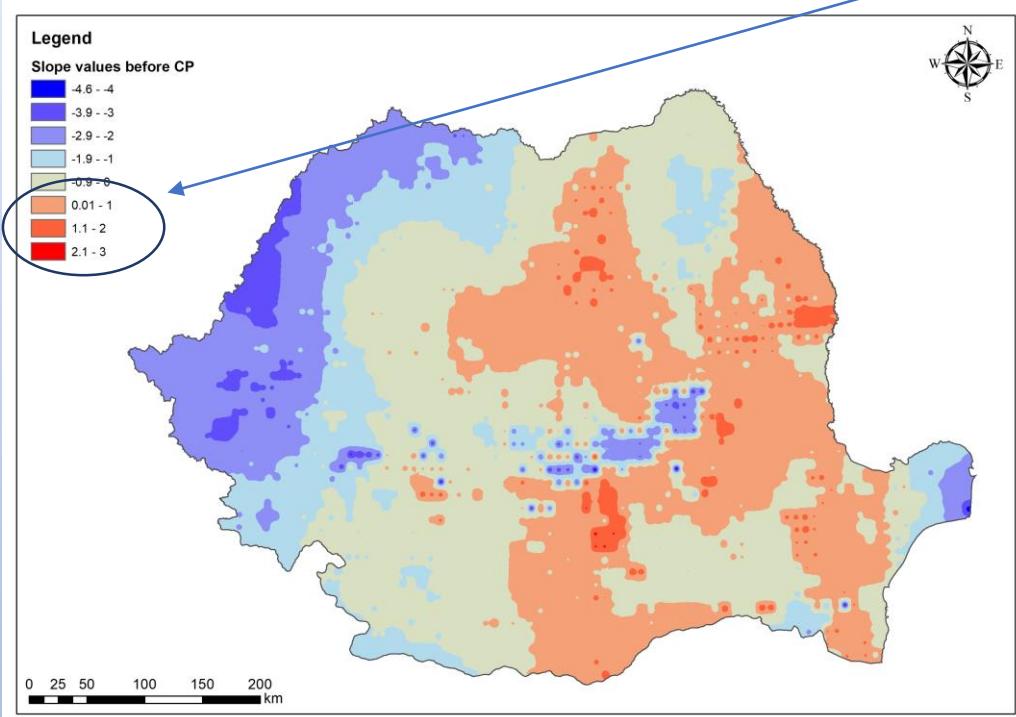
Results- Change-point analysis



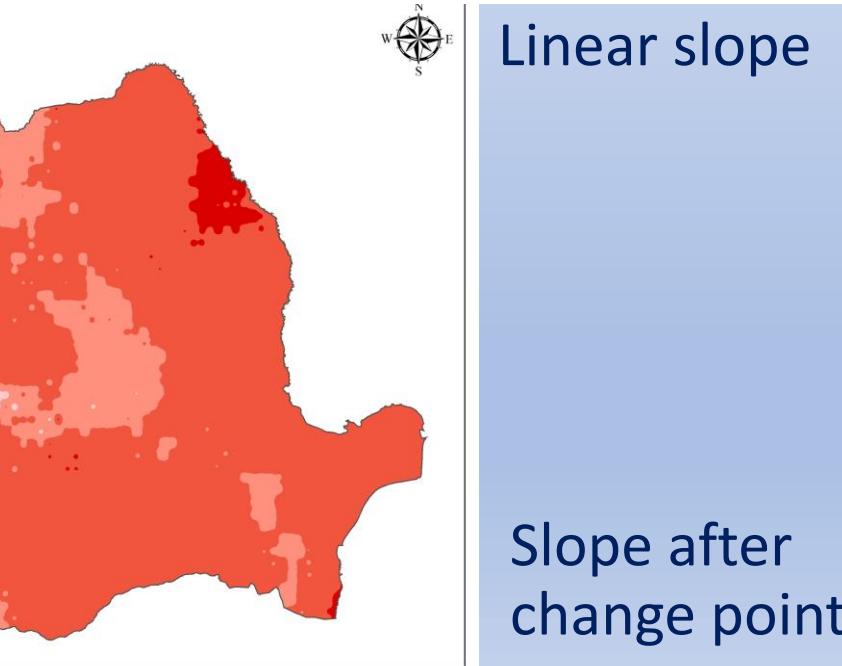
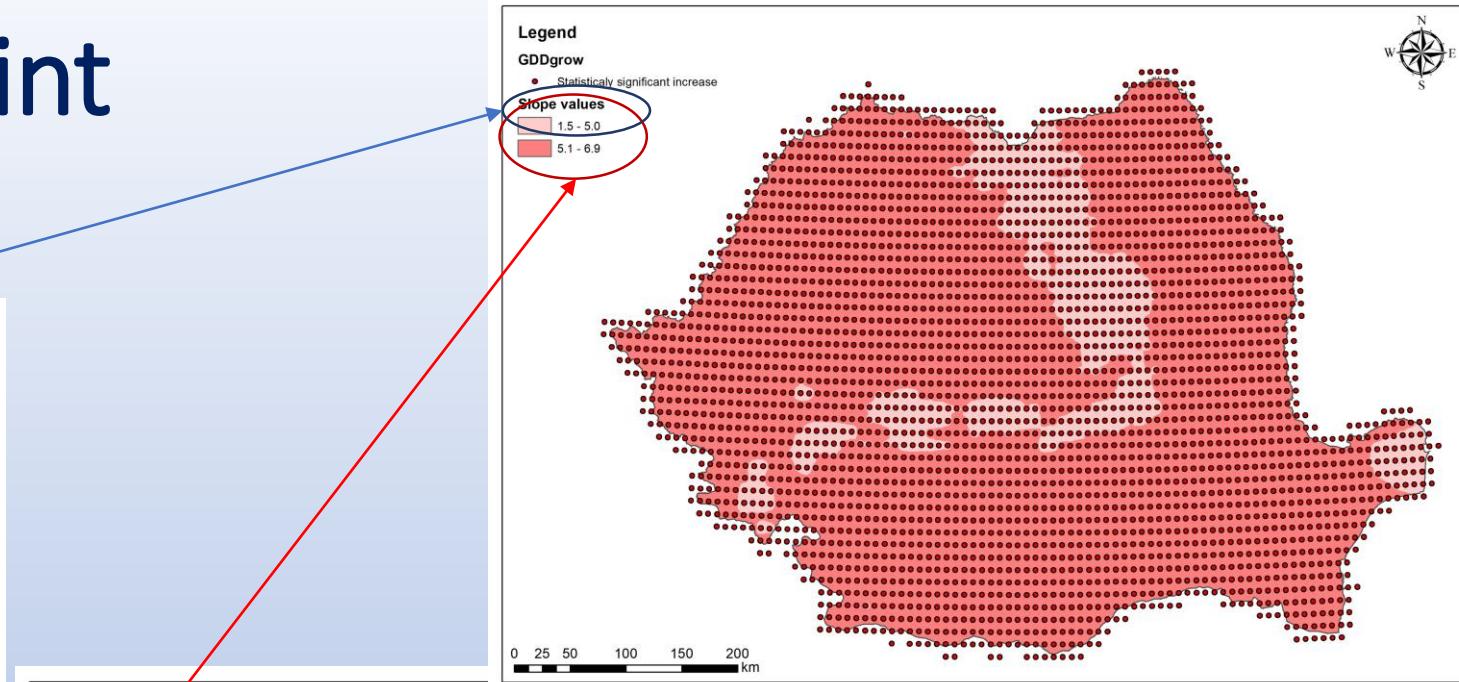
GDDgrow10 index



GDDgrow – change point analysis



Slope before change point



Linear slope

Slope after change point

Conclusions

- Almost all hot extreme indices indicated a significant increase over the entire period considered, but also a significant change point;
- In case of cold and variability extreme indices indicated mainly not significant change point year;
- In the case of hot extreme indices, before change point decreasing trends are dominant, whereas after the change point a significant increase was detected for most of the indices → **the slope after the change point was much higher compared to that given by the linear trend** (more than double in case of GDDgrow).

Conclusions

- The main conclusion of this study is that due to the non-linear trend detected in most of the extreme temperature indices, a change point analysis is more appropriate in terms of trend detection.

Thank you very much for your kind attention!

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