Combining tree ring analysis and remote sensing to assess the 2017 black pine dieback in Vinschgau/Val Venosta (Italy)

Nikolaus Obojes, Jennifer Klemm, Ruth Sonnenschein, Francesco Giammarchi, Giustino Tonon, Ulrike Tappeiner, Marc Zebisch

nikolaus.obojes@eurac.edu

unibz

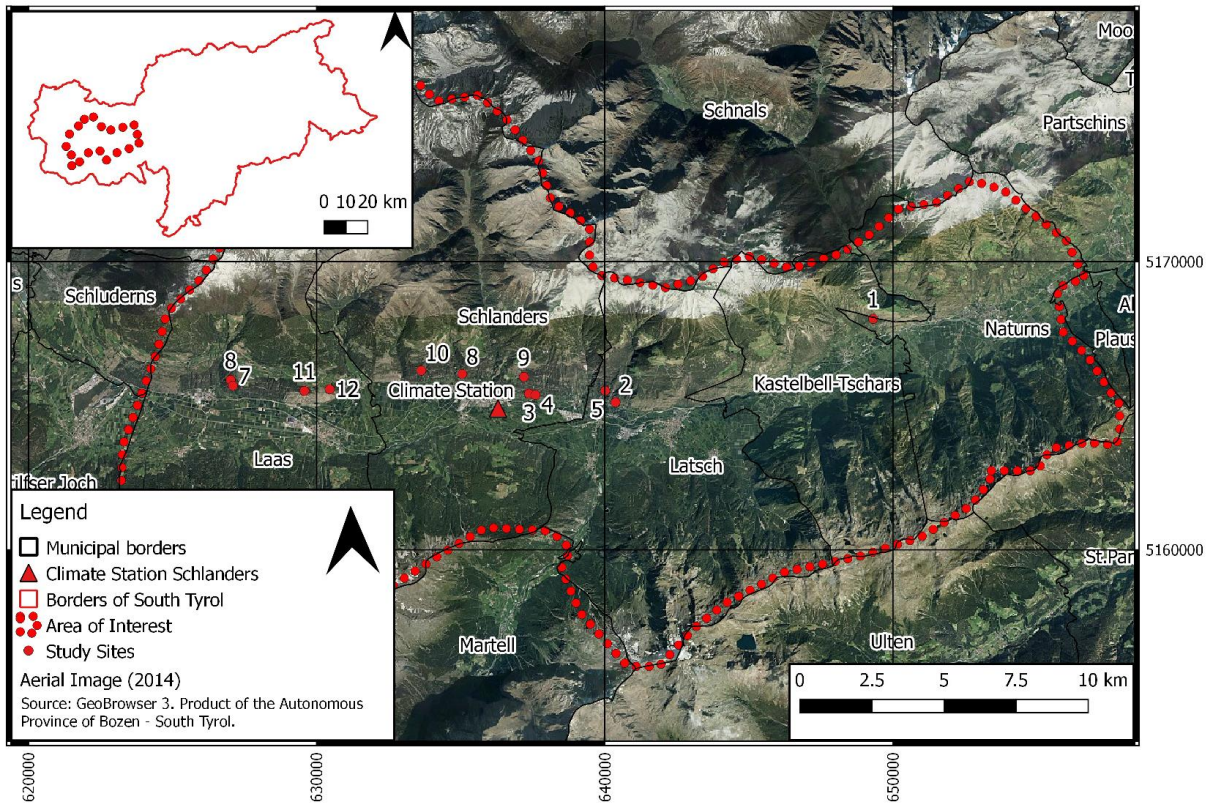
eurac research

Background

- 900 ha of non-nativeblack pine (Pinus nigra) afforestation at the south-exposed slopes (elevation 700-1400 m asl.) of Val Venosta (Province of Bozen/Bolzano, Italy) from 1890s to 1960s to prevent erosion.
- Mediterranean black pine was supposed to cope with dry inner-alpine climate conditions (Ø P 550mm, Ø T 10,6°C) and degraded soils.
- However repeated tree vitality decline and diebacks occurred in the occurred in the last 20-30 years, most recently in 2017 (see pictures).

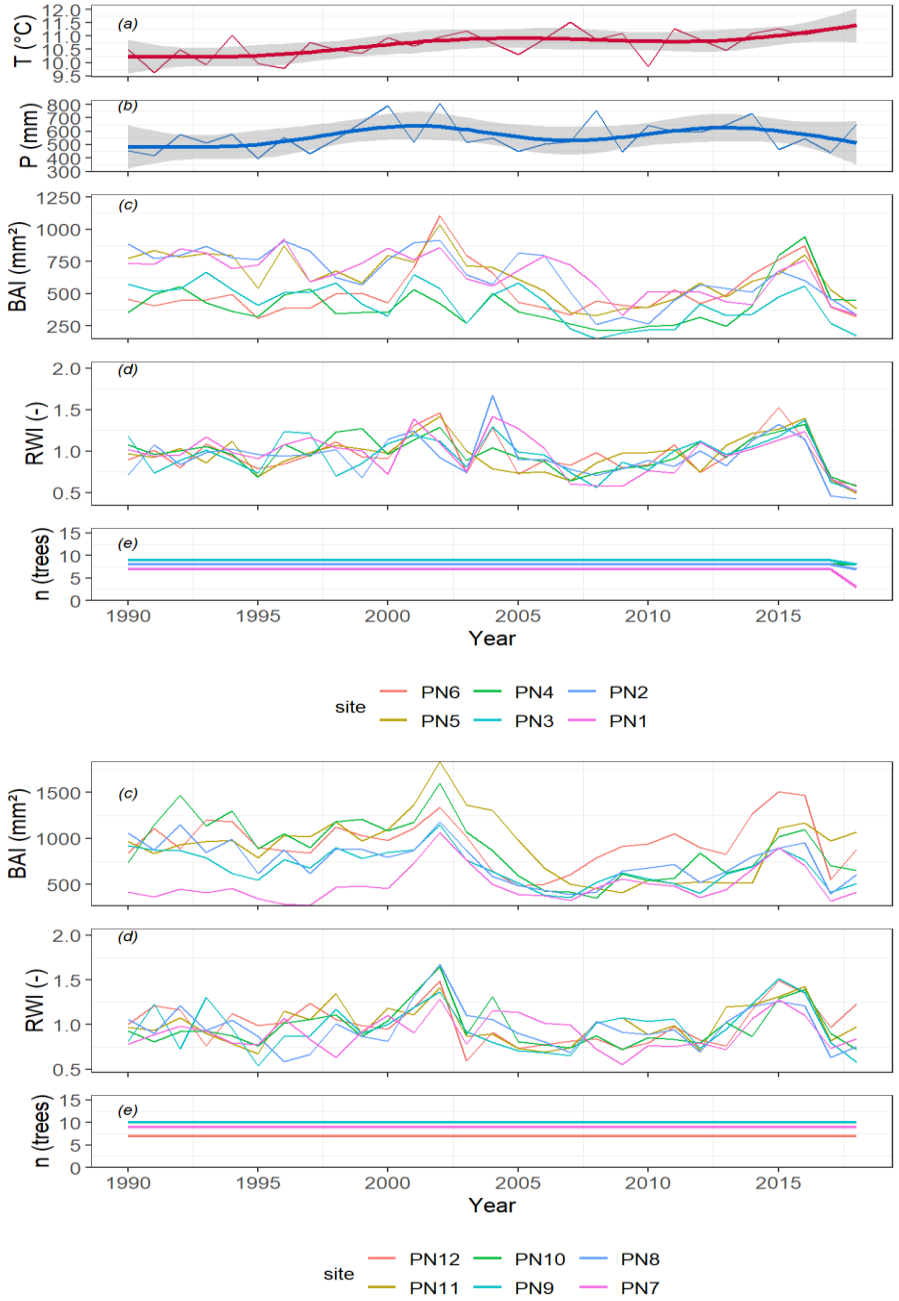
Methods

- Earth observation:
  - Sentinel 2A+B data (10 m spatial resolution, 5 days revisiting period).
  - Vegetation indices: Normalized Difference Vegetation Index NDVI, Green Normalized Difference Vegetation Index GNDVI, Normalized Difference Infrared Index NDII, Moisture Stress Index MSI.
- Dendrochronology:
  - 12 georeferenced sites (20x20 m) with decreasing vitality decline in 2017 from site 1 to site 12 sampled in autumn 2018.
  - 10 largest trees per site sampled, 2 cores per tree.
  - Tree ring analysis focused on last 30 years.
  - Temperature/precipitation data from climate station in Schlanders/Silandro run by the Province.



Results: Tree rings – BAI/RWI

- Climate: annual mean temperature (T) increase by 1°C in the last 30 years, no overall precipitation (P) trend, but dry periods starting in 2003 and 2015.
- BAI/RWI-peaks around 2000 and 2015/2016, strong decrease during dry periods around 2003 and in 2017/2018.
- Sites with less visual vitality decline in 2017 (PN8-12, lower figure) had slightly higher BAI values going back to the 1990s.



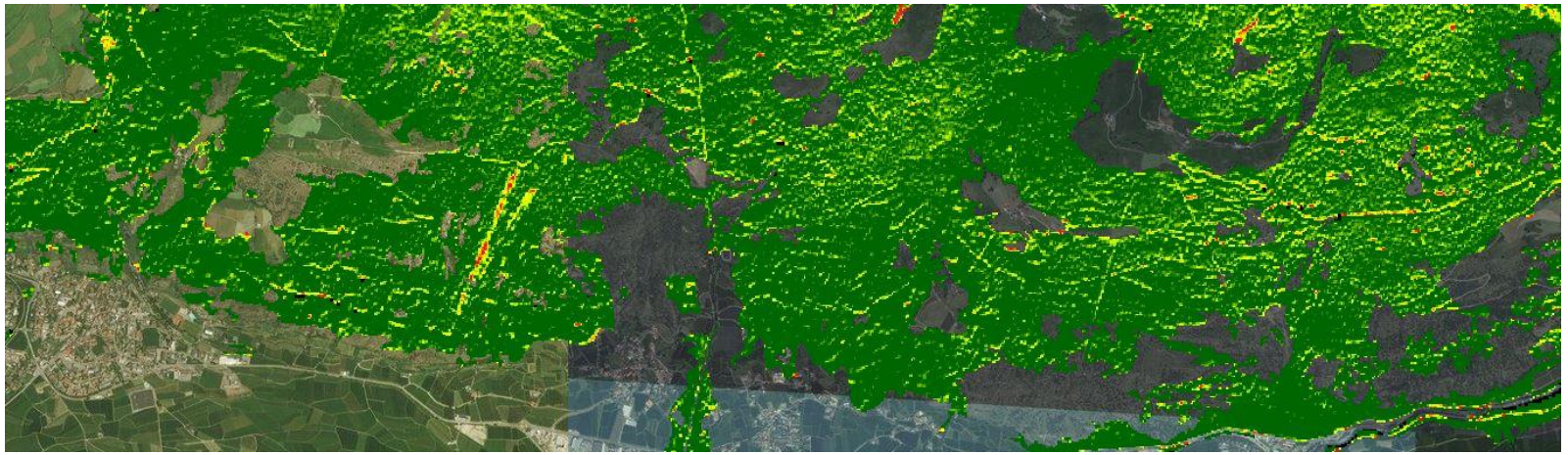
Results: Tree rings – Response functions

Site	a	m	j	j	a	s	o	n	d	J	F	M	A	M	J	J	A	S
S1													-T					
S2														-T				
S3											+P							
S4											+P			+P				
S5													+P	+P				
S6					+P	-T					+T			+P		+P		
S7								+T										
S8													+P	+P				
S9			-T			-T												
S10														+P				
S11											+T							
S12				+P											+P			

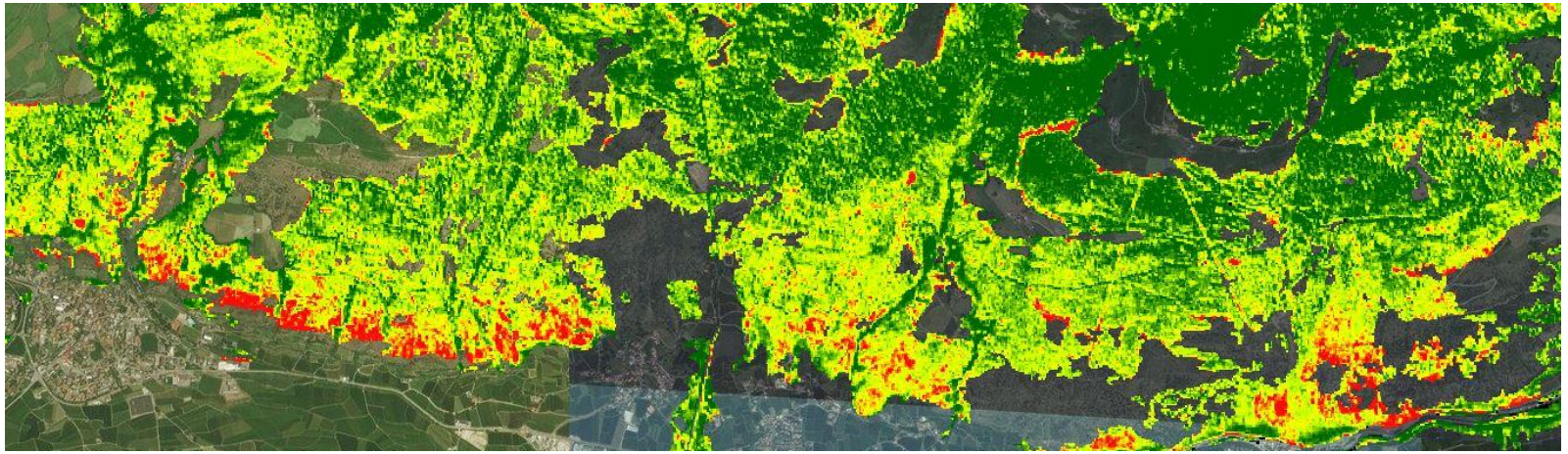
- Strong positive response to spring (April, May)-precipitation at most sites.
- Influence of previous years (lower case letters for months) rather rare

Results: Remote sensing

NDVI change early summmer 2016 – 2015 (Val Venosta south slope)



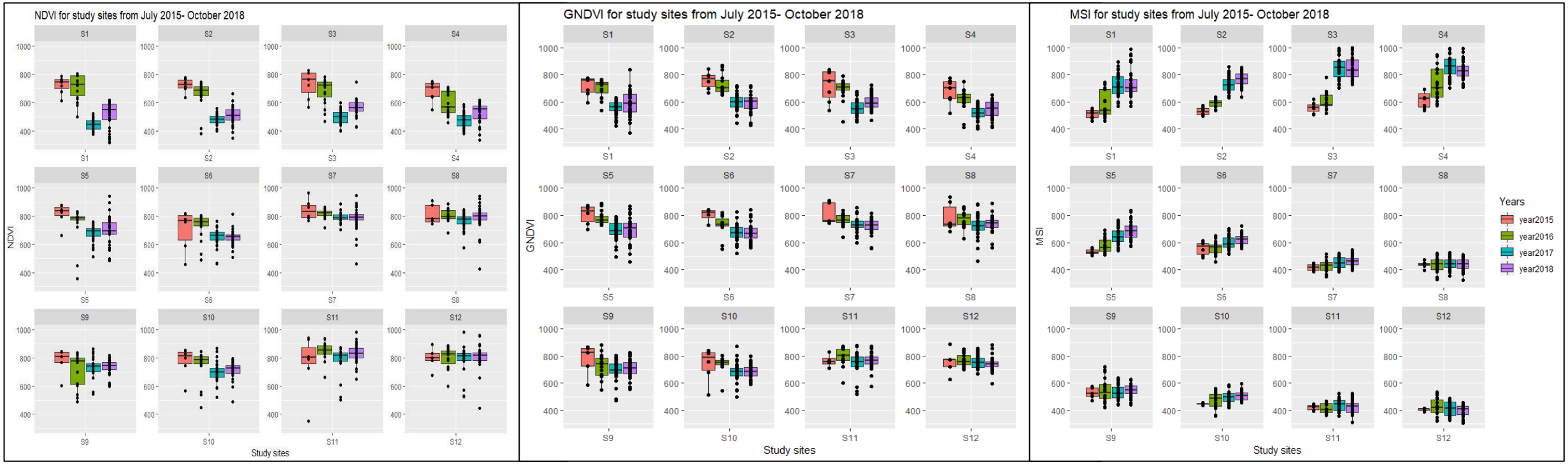
NDVI change early summmer 2017 – 2016 (Val Venosta south slope)



Strong decline (yellow/red pixel) in early summer NDVI in 2017 compared to precious years especially at lower elevations (bottom of the pictures).

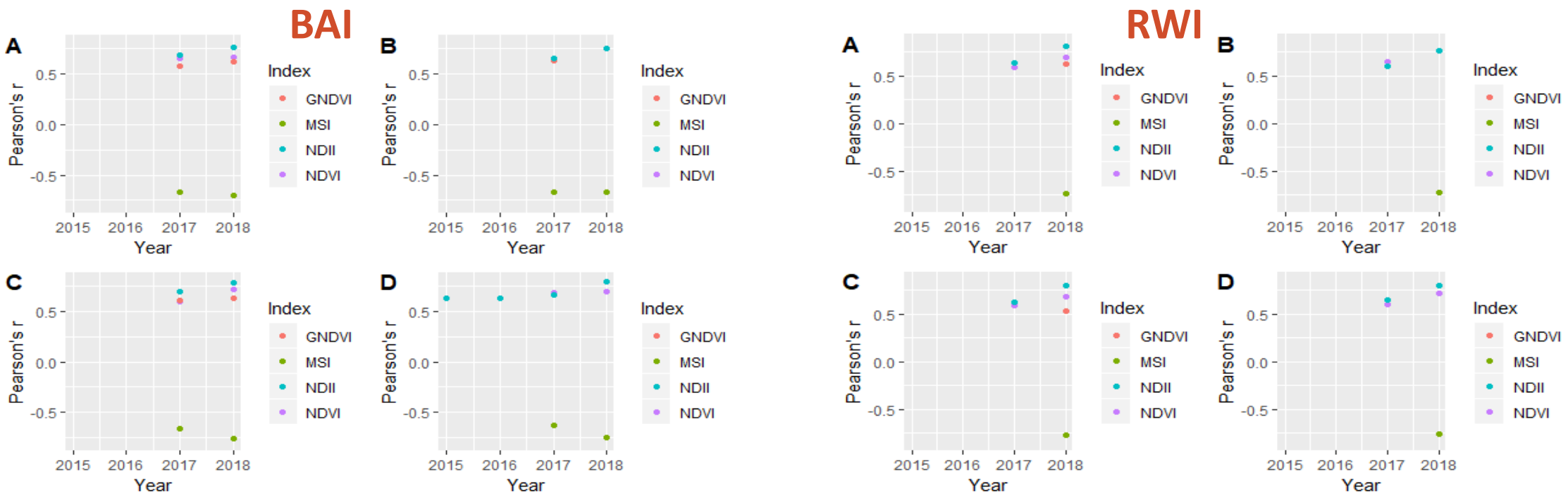
Results: Remote sensing

- NDVI + GNDVI (left + middle figure): values around 700-800 (green, vital vegetation) at all sites in 2015+2016, strong decrease in 2017+2018 at less vital sites (1-4), hardly any at sites 11+12.
- MSI (moisture stress index, right figure): low values indicating little water stress in 2015 at all sites, increase at less vital sites, no increase at sites 7-12.
- NDII (normalized difference infrared index, not shown): corresponds to water content of vegetation, similar pattern as NDVI/GNDVI.



Results: Correlations Tree rings – Vegetations indices

- Positive correlation between BAI/RWI and NDVI/GNDVI/NDII and negative correlation with MSI for the dry years 2017+2018 when strong differences in tree vitality between site where observed.
- Hardly any correlation in more humid 2015+2016.



A… average spring, **B**… maximum spring, **C**… average summer, **D**… maximum summer value of vegetation indices, critical value = 0.05.

Summary and conclusions

- Black pine shows vitality loss and reduction of tree ring width in dry periods also in the Alps, especially dry spring/early summer is critical.

- Vitality loss/dieback in 2017/2018 could be observed in vegetation indices calculated from satellite images and in tree ring data. High resolution of Sentinal data shows spatial distribution of vitality loss and allows use of satellite data in diverse landscapes such as mountain areas.

- Good correlation of vegetation indices and tree ring data (only) during dry years with clear vitality gradients.