Trends and variability of climate indices for the agricultural sector in the southern Peruvian highlands

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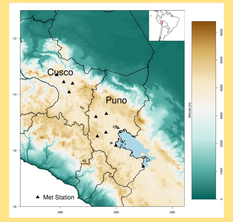
Motivation

The agricultural sector strongly depends on climatic conditions during the growing season. Unfavorable weather and climate events, such as droughts or frost can lead to crop losses and thereby to large economic damages or life-threatening conditions. In the southern highlands of Peru a large share of farmers lives of subsistence agriculture and are thus especially vulnerable. In this context, it is of high interest to know about the climatic variability and trends of indices relevant for the agricultural sector during the different growing phases.
This poster shows results of ongoing work within the Climandes project (Poster. 9 and 10).



Study area:
The regions of Puno and Cusco are located in the southern Andes of Peru at mean altitudes of around 3'800 m.a.sl.

Data & Methods

Station Data: Homogenized station data from SENAMHI for the Puno and Cusco regions [1,2]
Gridded Data: PISCOpd v.2.1 gridded dataset (5km resolution) [3]
Time period: 1981-2010
Trends: We use linear or logisitic regression for a trend estimate and a student's t test. Trends are shown only for a significance level of 0.95
All calculations and graphics have been prepared using the R-package **ClimIndVis,** an R-package for automatic generation of climate products:
www.github.com/Climandes/ClimIndVis

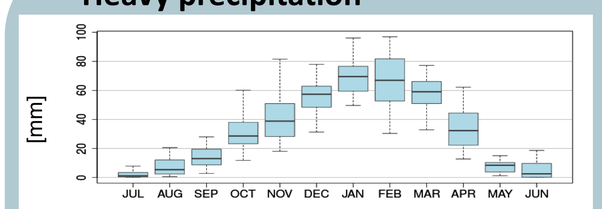
Indices

In user surveys, drought, frost and heavy precipitation have been identified as meteorological hazards with large adverse effects on harvests [4]. By expert opinion, well suited indices to represent these conditions have been selected. For results shown here, the following subset of indices was chosen.

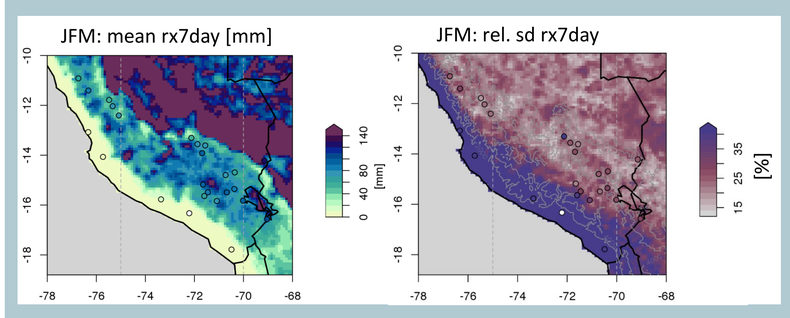
Index		Definition	Time period
Heavy precipitation	Rx7day SDII	Maximum 7day precipitation Simple daily intensity index	Jan-March
Drought	CDD SPI	Max. no. of consecutive dry days Standardized Precipitation Index	Nov-March
Frost	FD TNN	% of frost days (Tmin<0°C)* Min. of minimum temperature	Dez-Feb

*% frost days rather than days are used for a better comparison because of missing values in the data

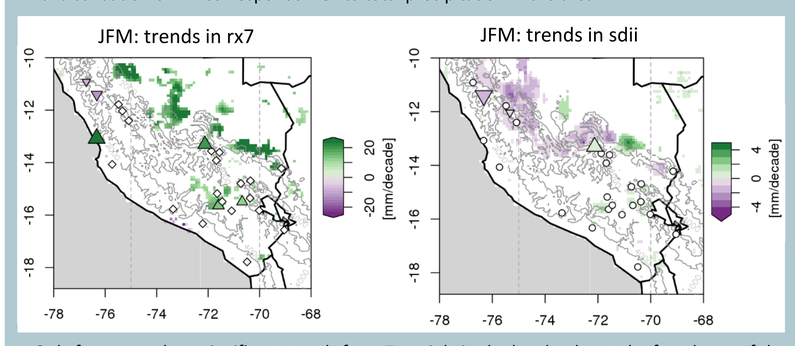
Heavy precipitation



The annual cycle for rx7 for the stations of Puno and Cusco shows the very dry austral winter with values of rx7 close to 0, whereas in summer values reach up to 80 mm.

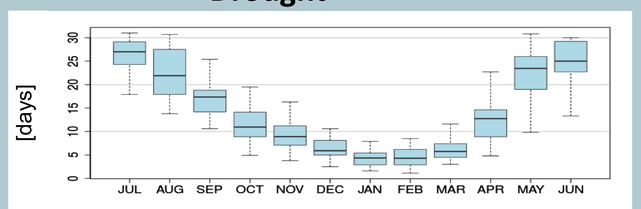


For JFM, the maximum 7-day precipitation lies between 0 -140 mm in the study area with highest relative standard deviations along the dry coast. The spatial variability is well visible, with the Andes separating the dry west from the moist Amazone. The picture spatial distribution of rx7 corresponds well to total precipitation in the area.

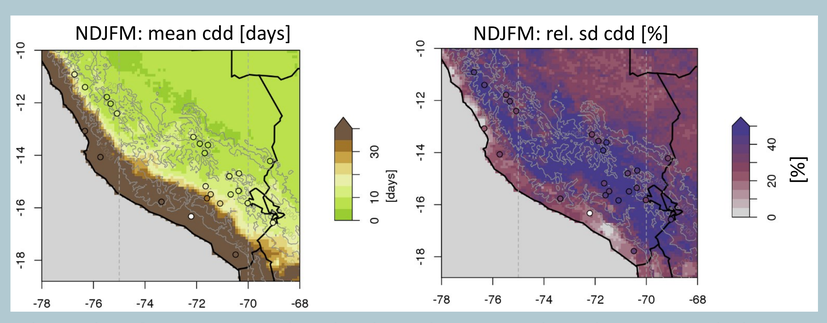


Only few areas show significant trends for rx7, mainly in the low lands , at the footslopes of the Andes and in some areas in the highlands. In the gridded data, trends in sdii show both areas of decreasing intensity and areas of increasing intensity along the footslopes of the Andes.

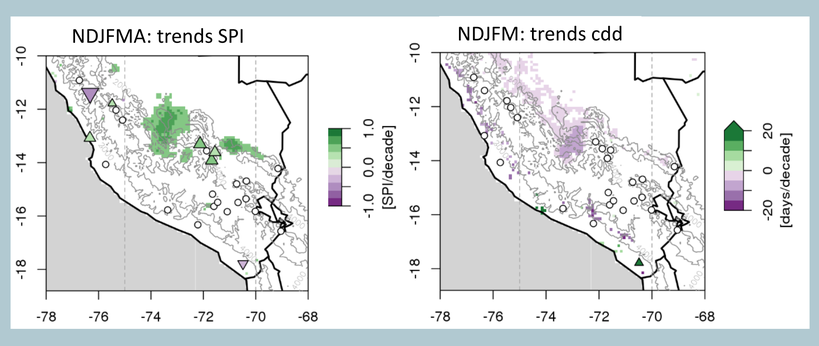
Drought



In winter months (may, june, july) cdd reach values of 25 days, however the interquartil range is large. Dry periods reduce to below ten days for Jan and Feb.

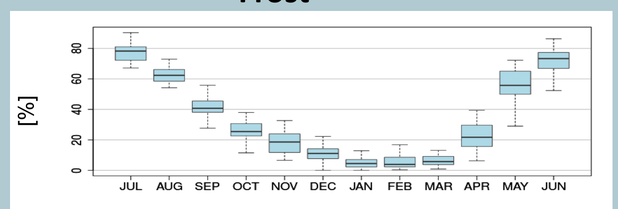


The number of CDD varies greatly within the study region. In the arid region towards the coast, spells span up to the whole time period whereas towards the amazon there are regions with no consecutive dry days. For cdd the interannual variability is highest for the mountain chain.

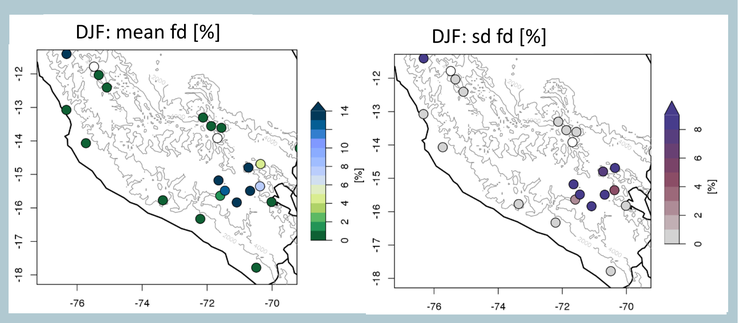


Areas along the Andes eastern slopes show significant trends towards more precipitation, whereas the highlands around Puno do not exhibit any trend. Consistent with this increase, the maximum of consequtive dry days (CDD) shows a decrease in a similar area.

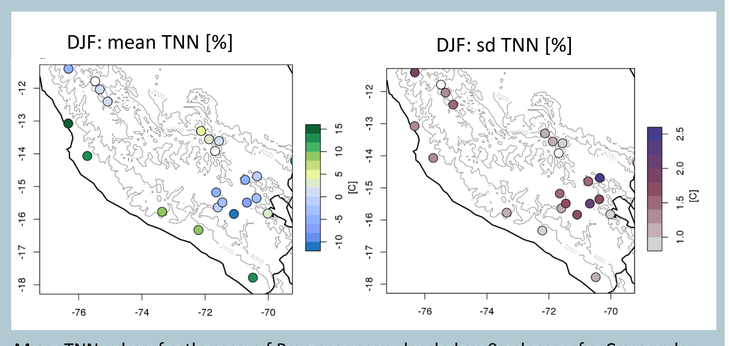
Frost



Frost can occur year around, but during the growing season it reduces to mean values below 10 % of the days. Variability is highest in arpil and may.



At higher altitude stations up to 14 % frost days occur during the austral summer DJF. The stations with a higher number of frost days also show higher standard deviations of more than 8 %. For frost days no significant trends are found in the station data.



Mean TNN values for the area of Puno are around or below 0, whereas for Cusco values are all above 0. Interannual variability is higher for stations at higher altitudes. The station of Puno shows a low variability due to it's location close to the lake Titicaca. For TNN no significant trends are found in the station data.

Conclusions

- The mean climatological values of all indices vary greatly within the region due to the complex topography, with highland stations showing a high interannual variability.
- Regionally, consistent precipitation trends are found:
  - ⇒Increasing rx7 values
  - ⇒Increasing SPI values
  - ⇒Decreasing CDD
- No significant trends are found in the station data for temperature indices (no gridded temperature dataset available)

Outlook

⇒ Further analyses with other datasets and longer time series for more robust results
⇒ Expand analysis to further indices and time periods relevant for the agricultural sector
⇒ Compare results to user perceptions on climate change and variability

References

[1] Gubler, S., et al. (2017). *The infuence of station density on climate data homogenization*. International journal of climatology, 37 (13):4670-4683.
[2] Hunziker, S., et al. (2017). *Identifying, attributing, and overcoming common data quality issues of manned station observations*. International journal of climatology, 37 (11):4131-4145.
[3] Aybar. et al. (2018). New daily gridded precipitation dataset for Peru.(in preparation)
[4] Flubacher, M. et al. (2018). Designing user-driven climate services.

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