OBSERVED CHANGES IN TEMPERATURE AND RAINFALL AND THEIR IMPACT IN AGRICULTURAL PLANNING IN THE EAST-NORTHEAST OF ARGENTINA.

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MOTIVATION

During the last decades, there have been changes in temperature and rainfall, both in the mean values and their variability, which is associated to the occurrence of extreme events. Some climate classification methodologies allow to assess the impact of climate change, while others are less sensitive.

OBJECTIVE: *analysis of the change in temperature and rainfall variability between 1940-1970 and 1980-2010, in the east-northeast of Argentina, and its impact on different climatic classifications.*

DATA: Daily rainfall and maximum and minimum temperatures of 46 stations located in the region of rainfed agriculture production in Argentina. Two exlusive perios: 1940-1970 and 1970-2010.

Source: http://wp32.at.fcen.uba.ar/ (Penalba et al, 2013)

METHODOLOGY

(a) Estimation of the monthly potential evapotranspiration (ETP) values. Thornthwaite´s method (1948) modified by Camargo et al (1999). Effective temperature: Tef (t)=0.36* [3 Tmax (t) – Tmin (t)]

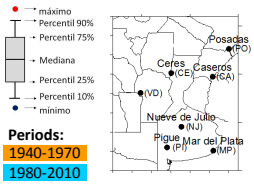
(b) Estimation of monthly Water Balance. Thornthwaite and Mather´s method (1957), Pascale and Damario (1977). Effective capacity of soil water is considered from Forte Lay and Spescha, 2001.

(C) CLIMATIC CLASSIFICATIONS:

	CLIMATIC CLASSIFICATIONS	Based on:
MI	Moisture Index (Thornthwaite y Mather, 1957)	Water Blance Components $MI = \frac{100*(EXC\ anual - DEF\ anual)}{ETP}$
AI	Arid Index (UNEP, 1992)	Monthly Accumulated Rainfall (R) and Monthly Potential Evapotranspiration (ETP) $AI=Ra/ETPa$
MFI	Modified Fourier Index (Arnoldus, 1980)	Monthly Accumulated Rainall (R) and Annual Accumulated Rainfall (Ra) $MFI=\sum(R^2/Ra)$
K-G	Köppen-Geiger classification (Köppen and Geiger, 1961)	Minimum and maximum Rainfall per semester (Rsmin, Rwmin, Rsmax, Rwmax) and Minimum temperature (Tmin). s: ONDEFM; w: AMJJAS

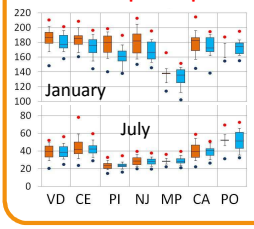
RESULTS

OBSERVED CHANGES



Periods: 1940-1970, 1980-2010

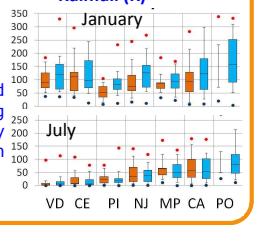
Potential Evapotranspiration (ETP)



Decrease in the ETP during January caused by decrease in temperature range.

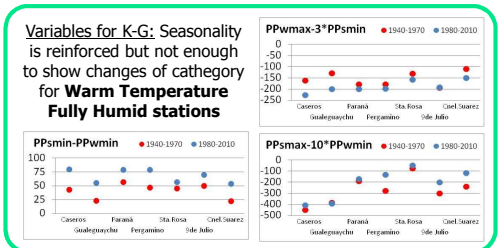
Small changes for ETP during July.

Rainfall (R)



Increase in both mean R and its variability, specially during January. Changes during July depend on the station

Variables for K-G: Seasonality is reinforced but not enough to show changes of cathegory for **Warm Temperature Fully Humid stations**



IMPACT

CHANGE IN SPATIAL DISTRIBUTION

1940-1970

1980-2010

Full colour: no change

Striped colour: change in cathegory between the two periods

INTERANNUAL VARIABILITY

Periods: 1940-1970, 1980-2010

Climate classification is better representated when the variability remains mostly in one cathegory.

DECADAL VARIABILITY

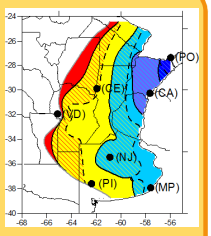
Decades:

80-89	90-99	00-10

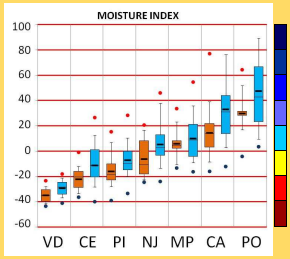
MI

Climatic Zone

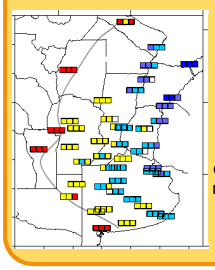
Perhumid
Humid (B4)
Humid (B3)
Humid (B2)
Humid (B1)
Moist subhumid
Dry subhumid
Semiarid
Arid



Changes in the analyzed variables lead to modifications in the Arid Index and the water balance, showing the second period wetter than the first one.



Climates were better representated for 1940-1970 period, because of the lower variability

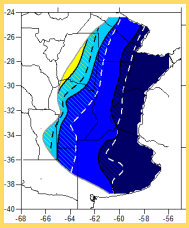


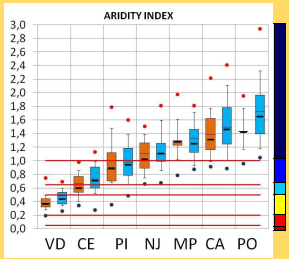
Dryer climates show lower variability. In the northeast, the last decade was more humid than the first two.

AI

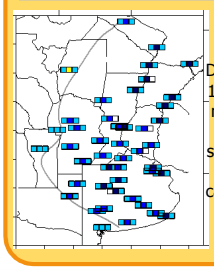
Climatic Zone

Humid
Subhumid humid
Subhumid dry
Semi-arid
Arid
Hyper-arid





Arid Index is not representing arid climatic zones, and seasonality of all the stations.

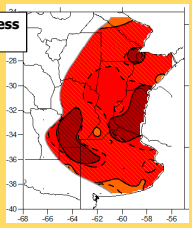


Decade 1990-1999 was the most humid. Only one station shows semi-arid categorization for one decade.

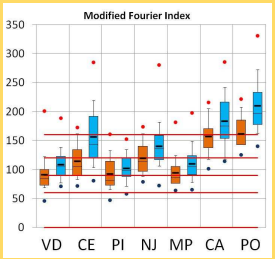
MFI

Aggressiveness of rainfall

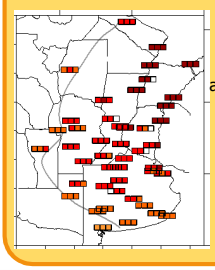
Very high
High
Moderate
Low
Very low



According to MFI, Aggressiveness of rainfall has decreased



High variability asociated to rainfall variability

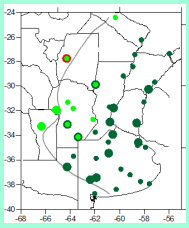


In the decade analysis, low aggressiveness of rainfall extends through a bigger region

K-G

Climate:

Arid-Steppe
Warm temperature with dry winter
Warm Temperature fully humid

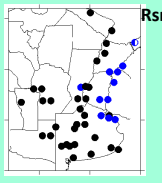


1940-1970

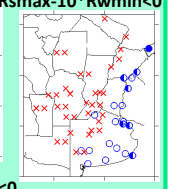
1980-2010

Most of the stations show the same category fot both periods.

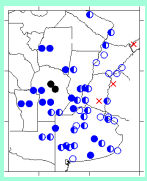
Rsmin-Rwmin>0



Rsmax-10*Rwmin<0



Rwmax-3*Rsmin<0



Percentaje of years in which the relation between variables was the same as the mean values

0% to 20%
20% to 40%
40% to 60%
60% to 80%
80% to 100%

1940-1970 ← ●● → 1980-2010

Applying the criteria for each year, the meaning is completely different from the mean terms. For example, minimum rainfall of mean values is a climatic indicator while averaging the series of minimum value for each year gives an extreme value.

DISCUSSION

Thornthwaite´s classification (Moisture Index) gave the best representation of the climatic zones. Changes in the analyzed variables lead to modifications in the water balance, showing the second period wetter than the first one. In effect, Moisture Index shows the impact of these changes: some of the eastern stations changed from "humid-wet" to "wet" while some western stations changed from "humid-dry" to "wet humid".

In the mean values, there has been a greater difference in minimum rainfall between warm and cold semester for the second period. However, these differences were not enough to show a change in Köppen-Geiger sub-classification. By contrast, the relationship between the maximum rainfall of warm semester and minimal rainfall of cold one still indicates the absence of a dry season, in almost all the stations.

The high variability highlights the vulnerability of this area in terms of agricultural planning and representativeness of the climatic classification. In general, changes would indicate a transition to a wetter climate and stronger seasonality.

ACKNOWLEDGEMENTS

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