Infectious diseases and climate: Leptospirosis in northeastearn Argentina as study case

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FICH

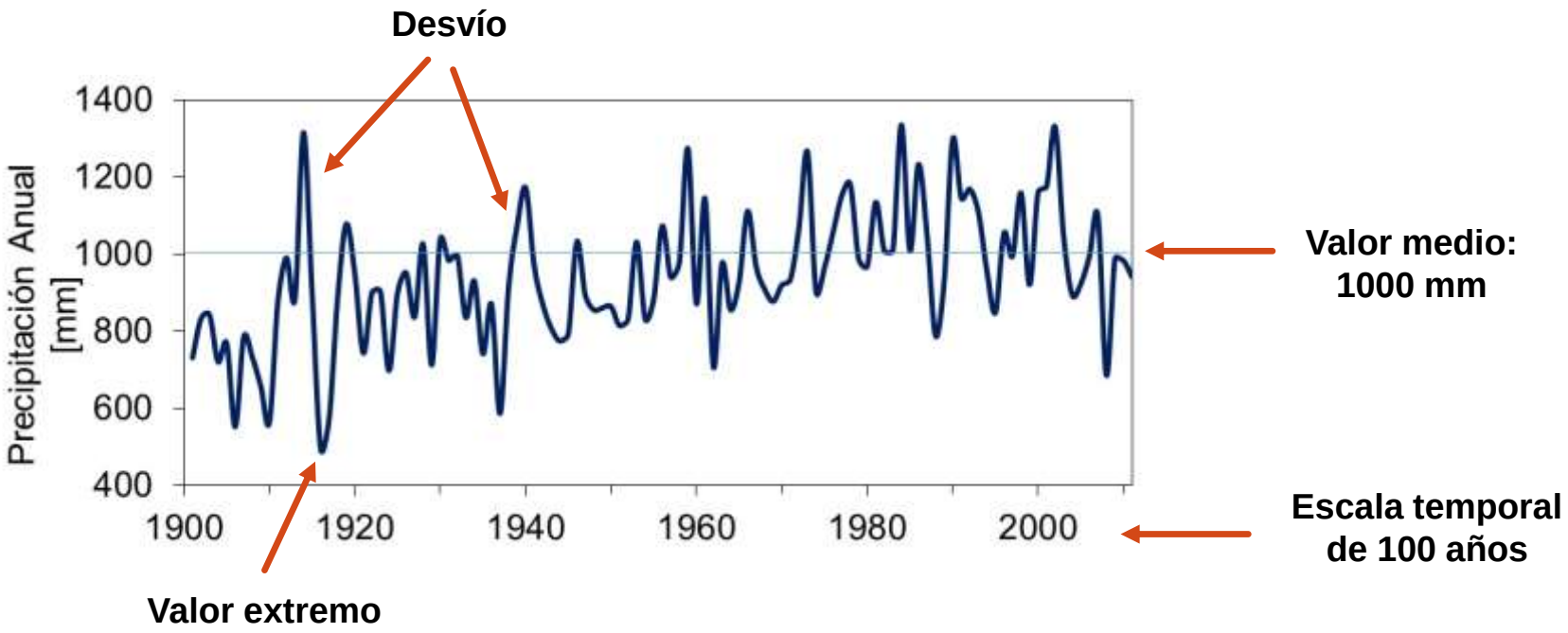
cevarcam

CONICET

OUTLINE

- Variability and Climate Change (CC)
- Global Phenomena
- What happened in the last 100 years?
- Future Climate Scenarios
- Impact of CC on Health
- Impacts in our region: Leptospirosis
- Modelling of Leptospirosis

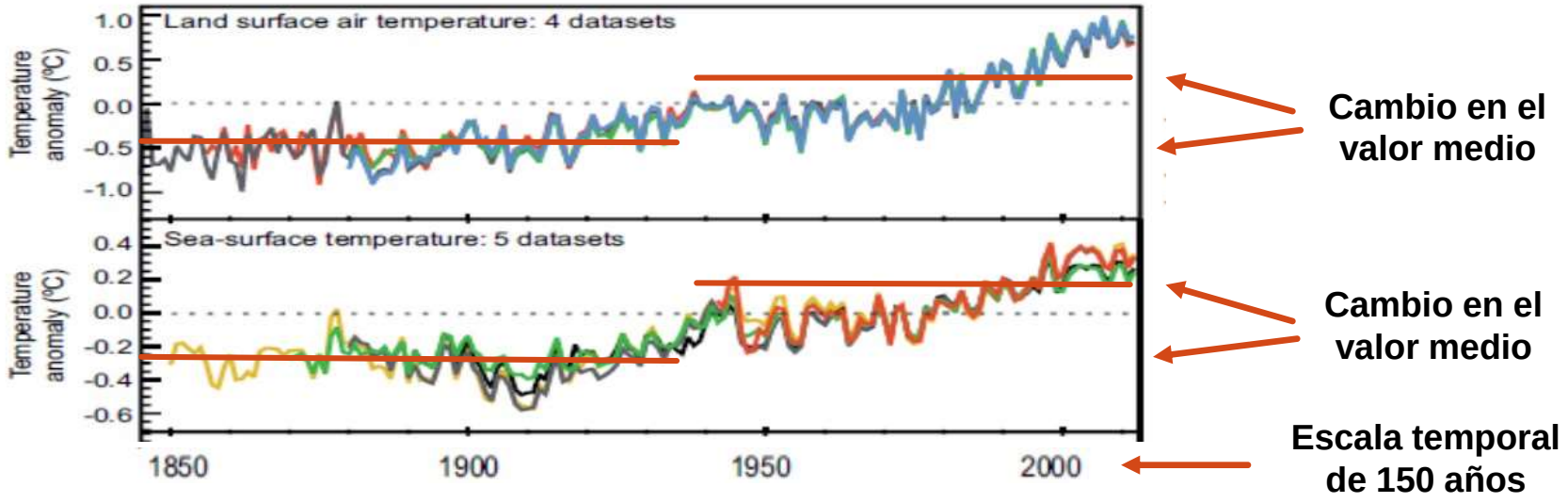
Climatic Variability



It refers to variations in the **average state** and other statistical properties (standard deviation, occurrence of extremes) of the weather on all **temporal and spatial scales** excluding individual weather events (IPCC, 2014).

CLIMATIC CHANGE (CC)

Fuente: Stocker et al. (2013)



Change in the **average state** of the climate that can be identified by changes in the average or in the variability of its properties and that **persists for an extended period**, typically decades or more extensive (IPCC, 2014).

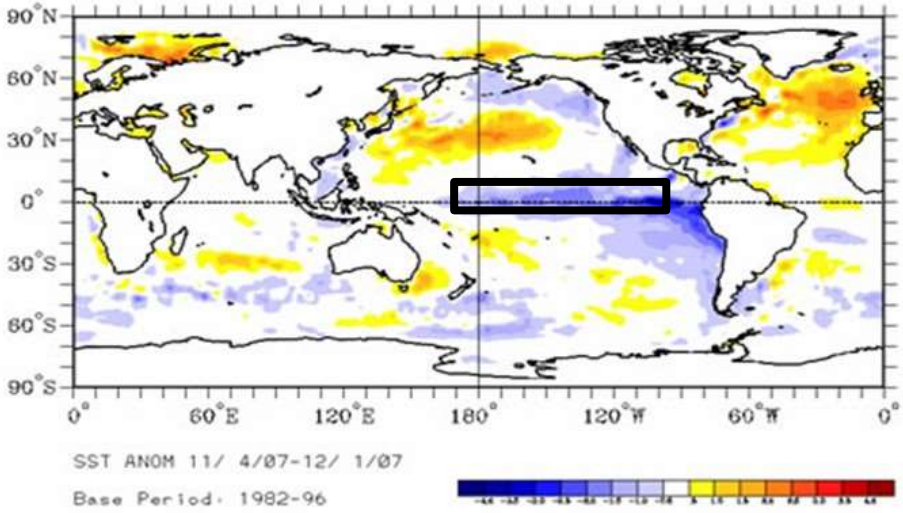
Corollary: Climate change may be due to internal natural processes of the climate system or to external forces such as modulations in solar cycles, volcanic eruptions and persistent anthropic changes in the composition of the atmosphere or land use.

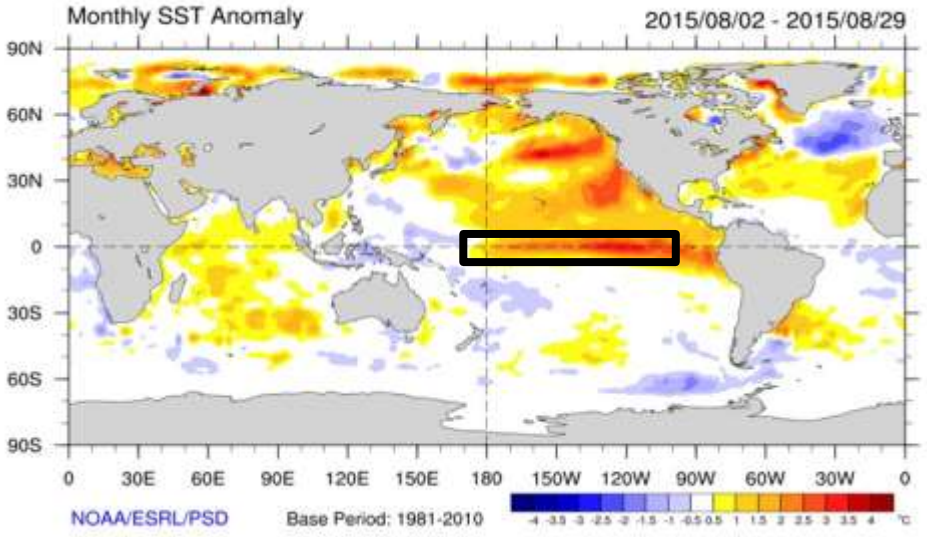
GLOBAL PHENOMENA THAT INFLUENCE IN THE EAST SOUTH AMERICA CLIMATE

WHAT IS PHENOMENA EL NIÑO (ENSO)?

Recurring weather pattern that implies changes in the surface temperature of the ocean in the central and eastern part of the tropical Pacific

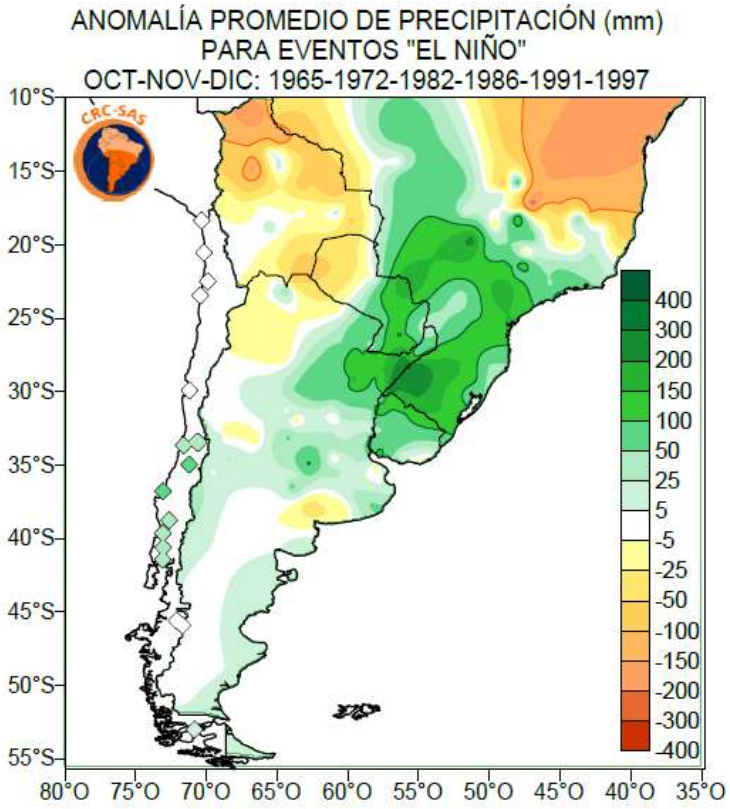
La Niña ⟵ Extreme Phases ⟶ El Niño





GLOBAL PHENOMENA THAT INFLUENCE IN THE EAST SOUTH AMERICA CLIMATE

HOW THE EL NIÑO AFFECTS SOUTHAMERICA?



Precipitation **higher** than normal:

- South of Brasil
- East of Paraguay
- **Northeast of Argentina**
- Uruguay

Precipitaction **below** normal:

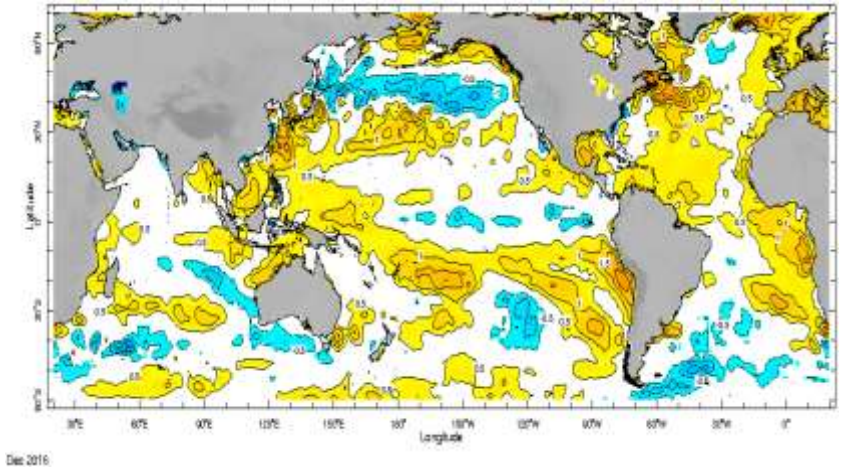
- Brasil (Norht of 20ºS)
- West of Paraguay
- Northwest of Argentina
- Bolivia

GLOBAL PHENOMENA THAT INFLUENCE IN THE EAST SOUTH AMERICA CLIMATE

Then, NIÑO = FLOOD and NIÑA = DROUGHT?

NOT NECESSARILY!

ENERO 2017: WEAK NIÑA



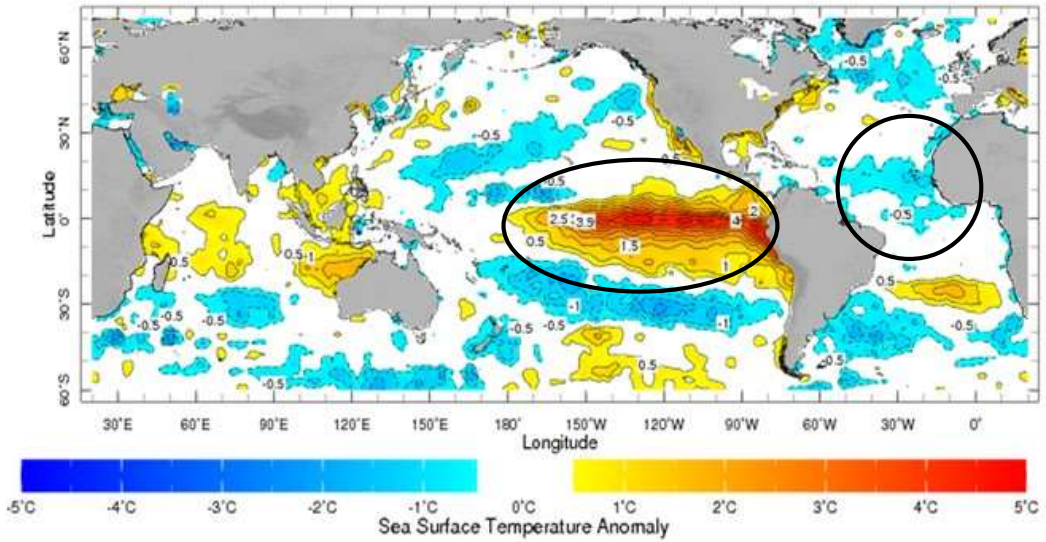
CONVECTIVE INTENSE RAINS

INTRA-SEASONAL FORCING SIS:
ASSOCIATED WITH WEEK PHENOMENA AND STRONG CONVECTIVE ACTIVITY

GLOBAL PHENOMENA THAT INFLUENCE IN THE EAST SOUTH AMERICA CLIMATE

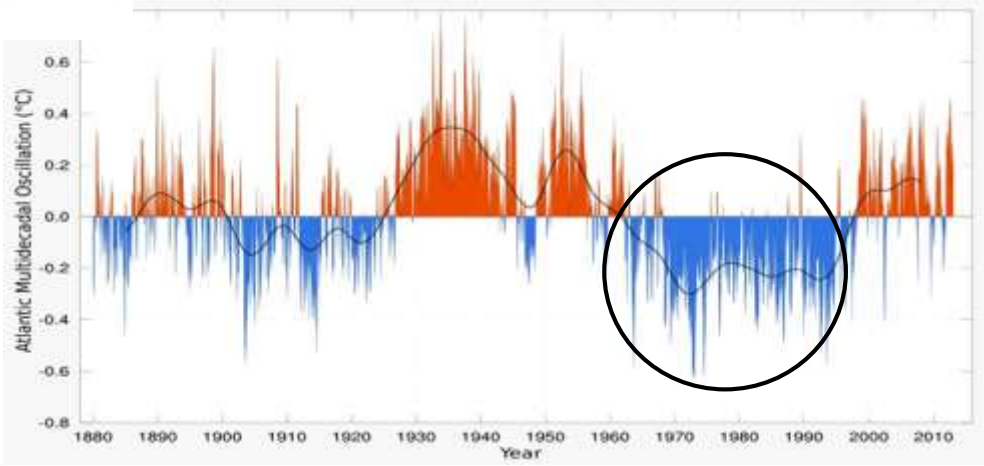
IS THE PHENOMENA “EL NIÑO” THE ONLY FORCING?

EL NIÑO 1982-1983

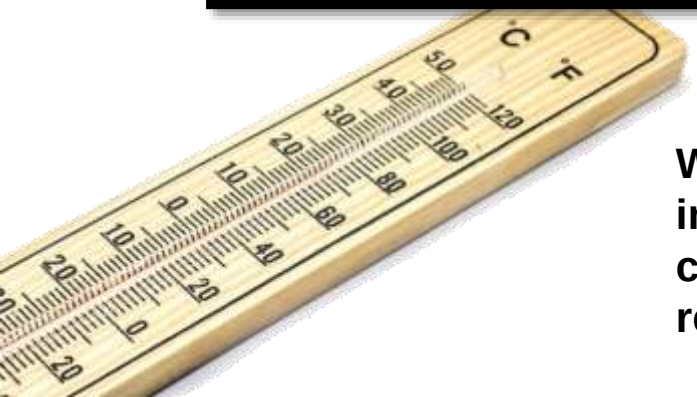


NO!

ATLÁNTICO (OSCILACION MULTIDECADAL)

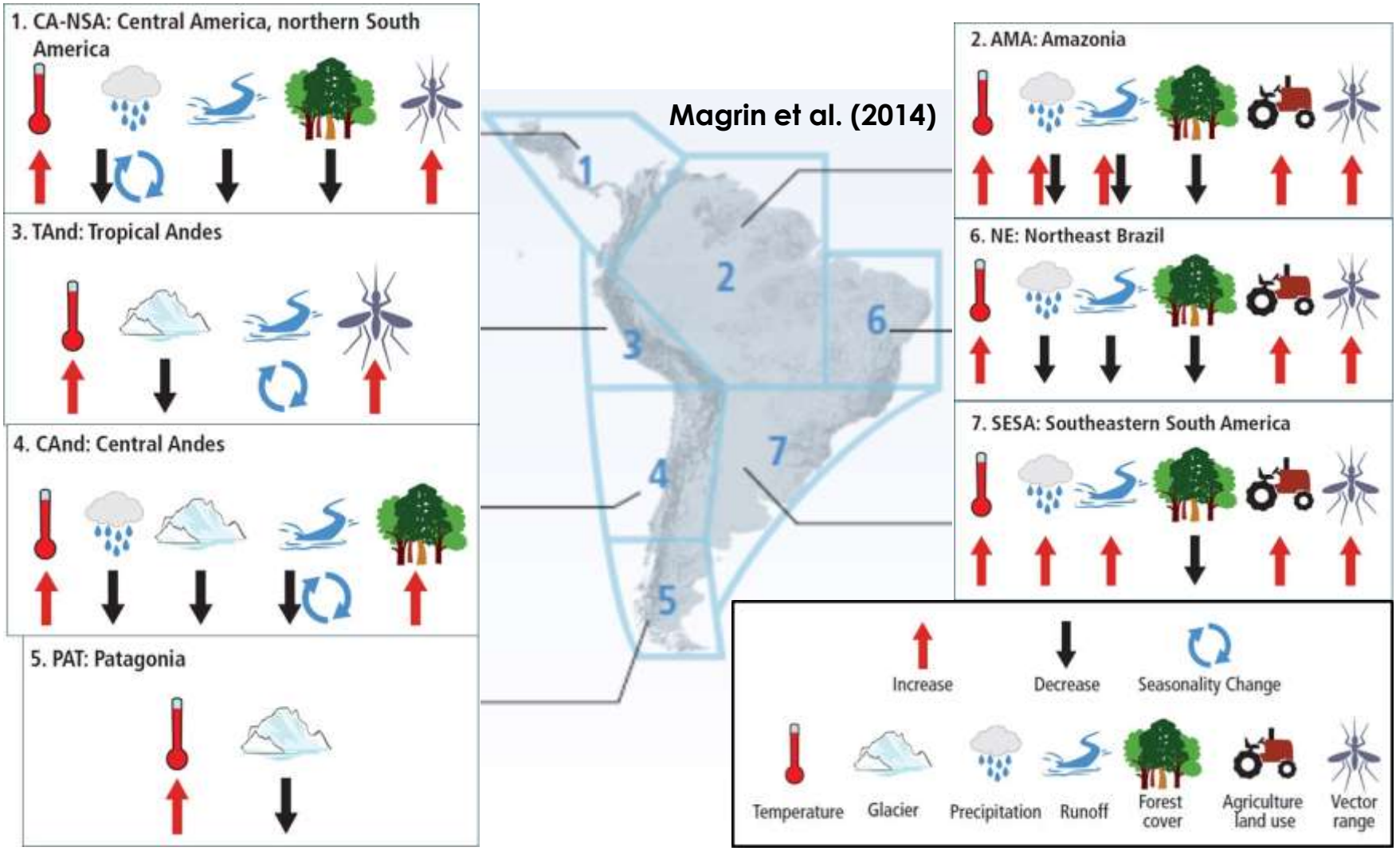


CC ANTHROPIC CAUSES



When the concentration of greenhouse gases increases in the atmosphere, the amount of energy that cannot escape into space is increasing, and it returns reflected to the surface by increasing the temperature.

OBSERVED CHANGES



WHAT HAPPENED IN THE LAST 100 YEARS?

Increase in extreme precipitation and temperature events

Tendencia hacia condiciones más cálidas


Santa Fe. Enero 2014

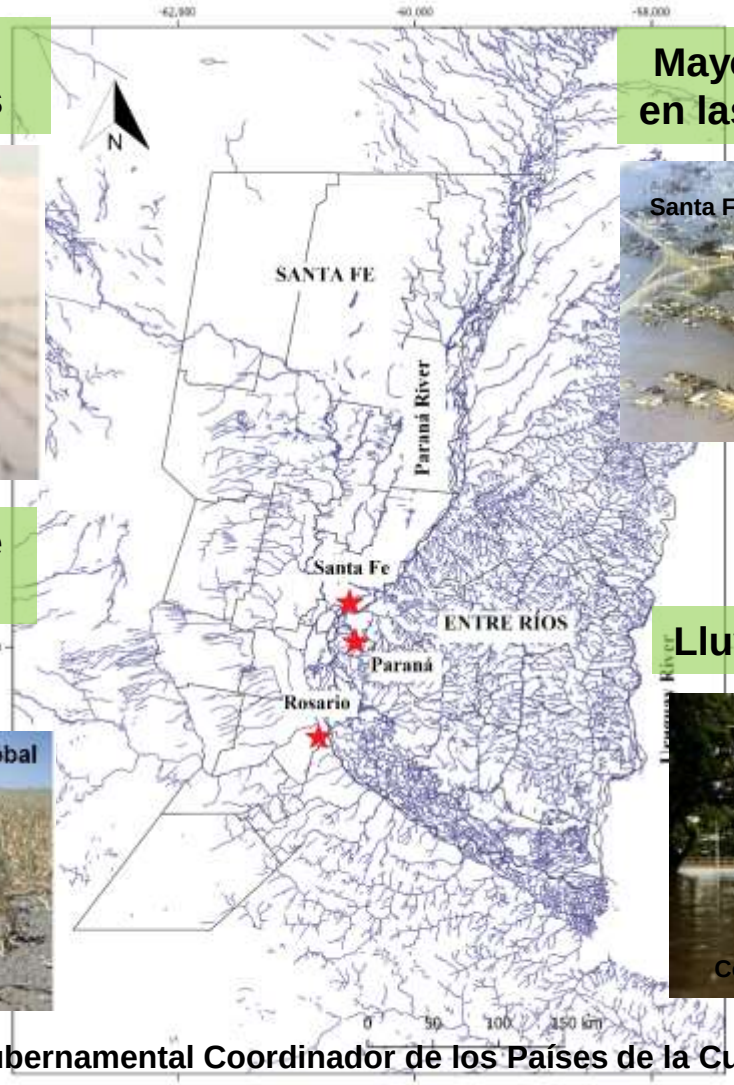
Mayor frecuencia y severidad en las crecidas e inundaciones


Santa Fe (La Guardia). 1983

Incremento en frecuencia de sequías estacionales


Arroyo "Cululú". Julio 2009. Elisa


Maíz. Enero 2012. San Cristóbal



Lluvias intensas más asiduas

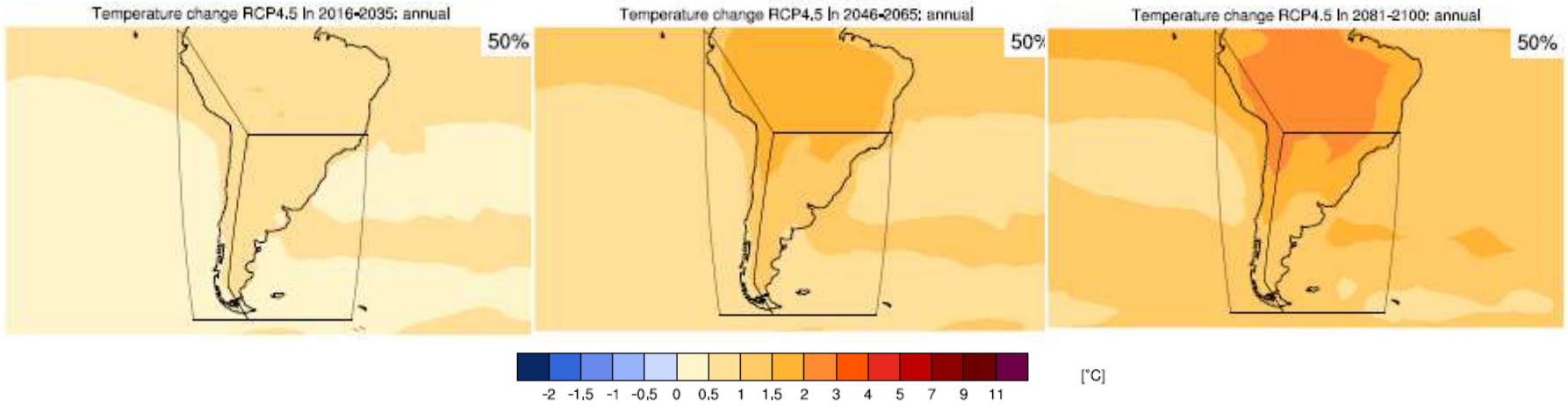

Concordia. Enero 2019

Fuente: Comité Intergubernamental Coordinador de los Países de la Cuenca del Plata (CIC)

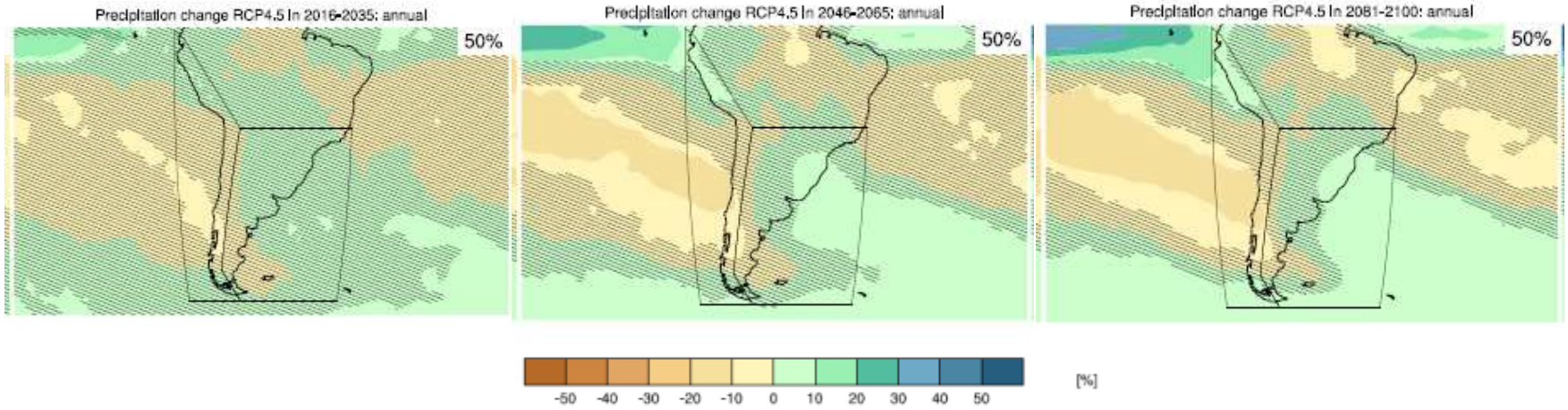
FUTURE CLIMATIC SCENARIOS

2016-2035 **2046-2065** **2081-2100**

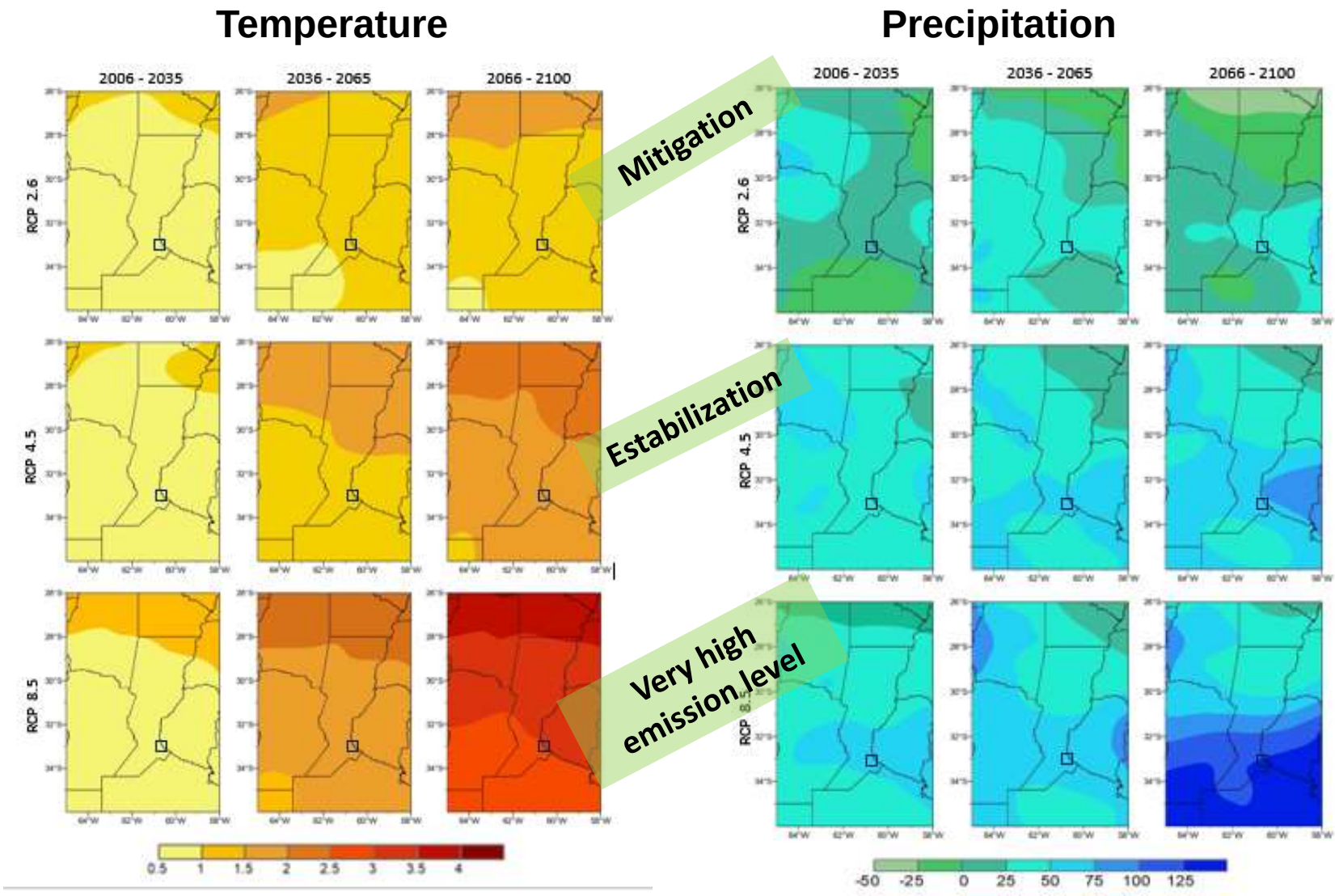
Annual Temperature changes (°C) (RCP4.5, estabilization)



Annual Precipitation changes (%) (RCP4.5, estabilization)



FUTURE CLIMATIC SCENARIOS



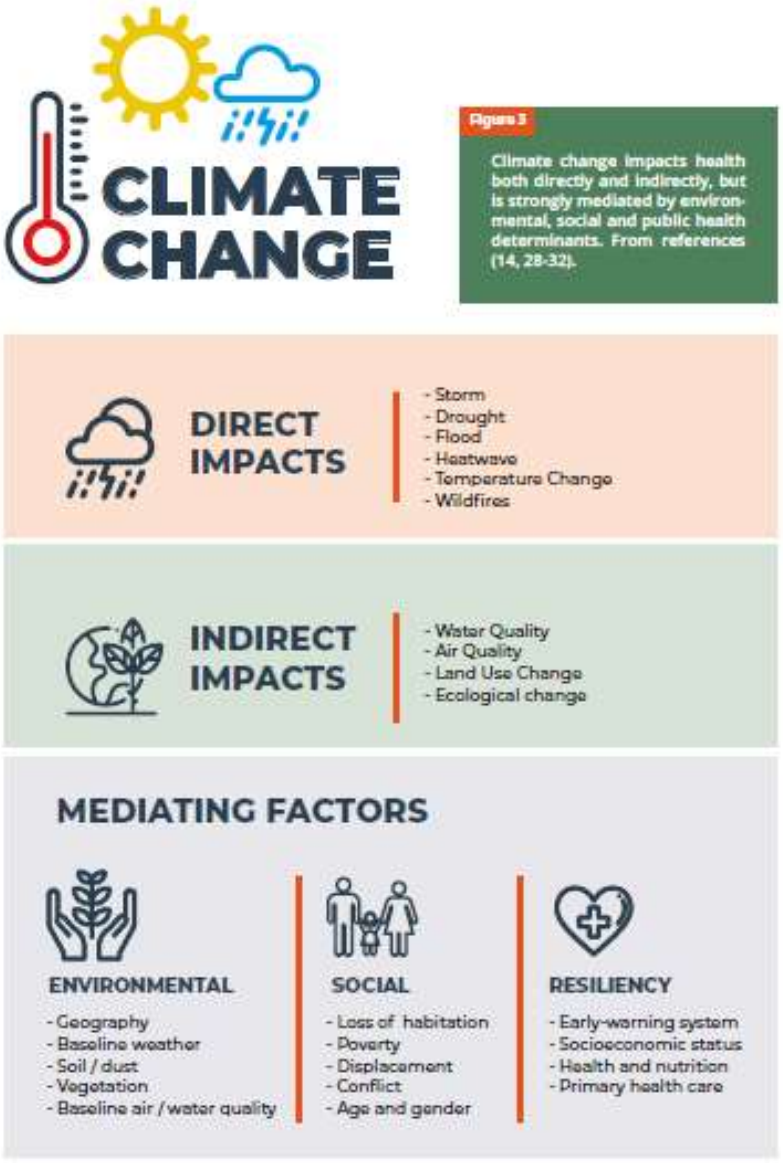
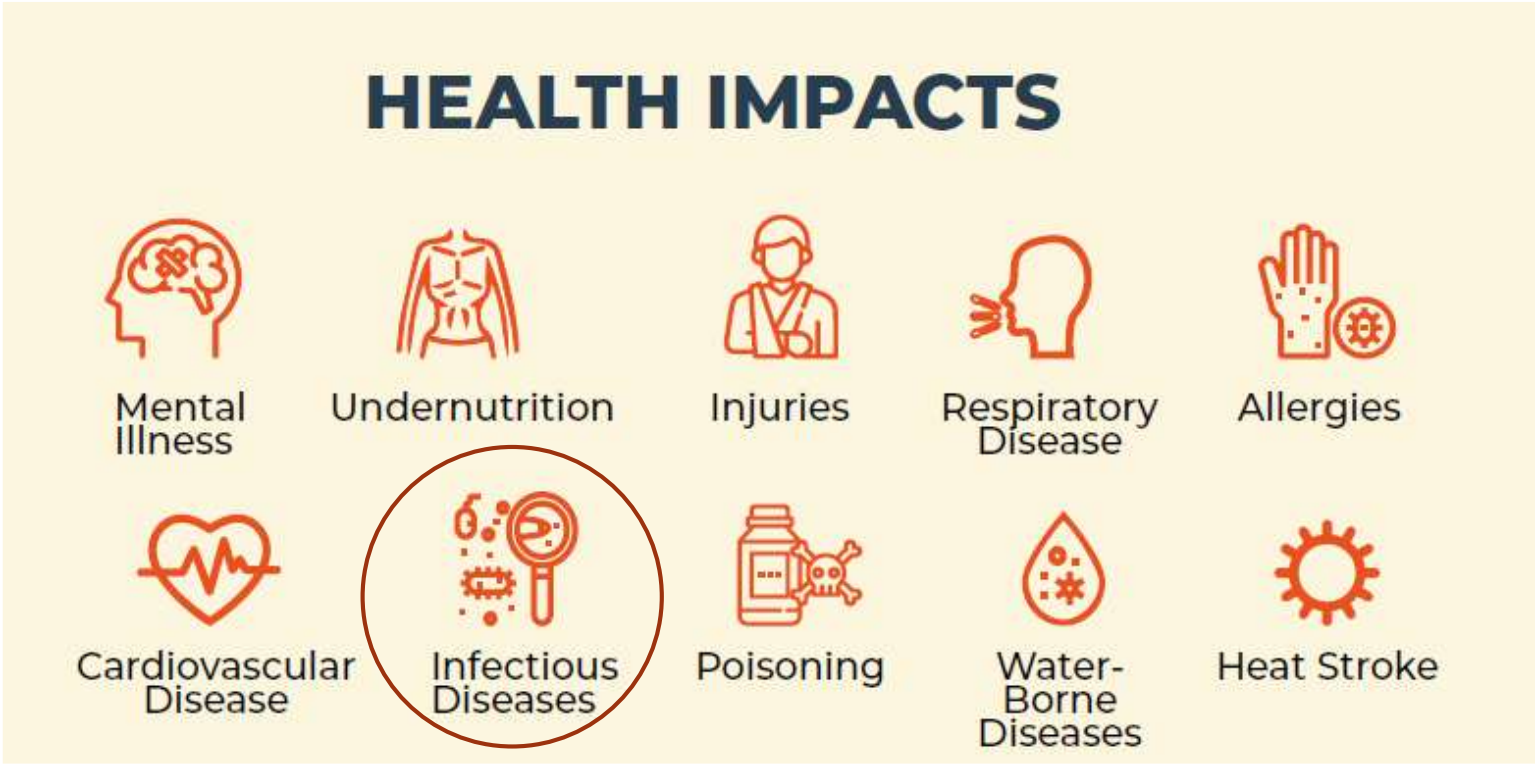


Figure 3

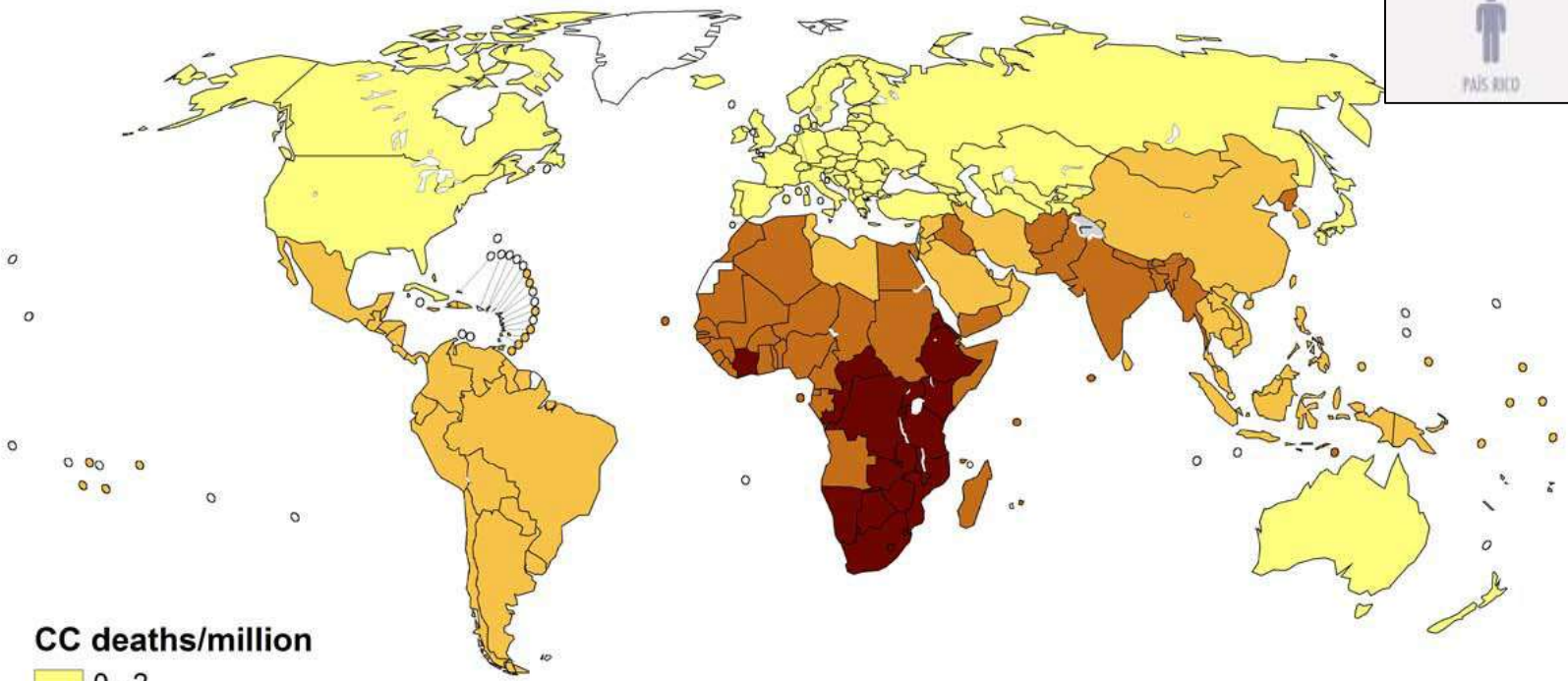
Climate change impacts health both directly and indirectly, but is strongly mediated by environmental, social and public health determinants. From references (14, 28-32).

Resiliency: is the ability to recover and adapt to changes that the climate could potentially generate, without adverse effects being definitive.


HEALTH IMPACTS
Mental Illness
Undernutrition
Injuries
Respiratory Disease
Allergies
Cardiovascular Disease
Infectious Diseases
Poisoning
Water-Borne Diseases
Heat Stroke

PARADOX: CC, HEALTH, NH and SH

Deaths from climate change



Estimates by WHO sub-region for 2000 (WHO World Health Report, 2002).

International Journal of Infectious Diseases 67 (2018) 25–35

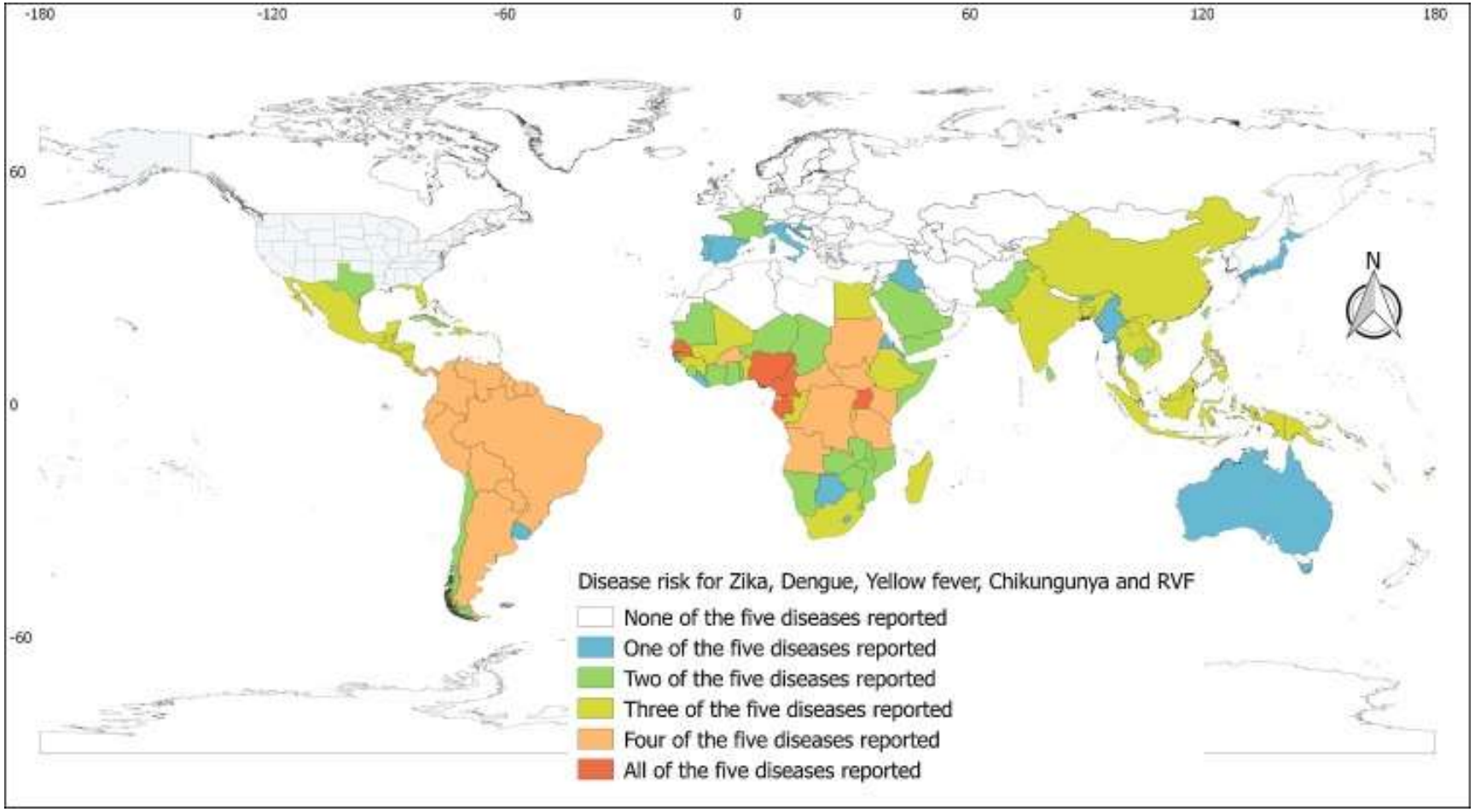
Contents lists available at ScienceDirect

International Journal of Infectious Diseases

journal homepage: www.elsevier.com/locate/ijid

Global risk mapping for major diseases transmitted by *Aedes aegypti* and *Aedes albopictus*

Samson Leta[a,*], Tariku Jibat Beyene[a], Eva M. De Clercq[b], Kebede Amenu[a], Moritz U.G. Kraemer[c,d,e], Crawford W. Revie[f]



Science of the Total Environment 694 (2019) 133651

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Spatio-temporal analysis of leptospirosis incidence and its relationship with hydroclimatic indicators in northeastern Argentina

María S. López [a,b,*], Gabriela V. Müller [a,b], Miguel A. Lovino [a,b], Andrea A. Gómez [a,b], Walter F. Sione [c], Luis Aragonés Pomares [d]

Incidence of confirmed cases of Leptospirosis in the provinces of Santa Fe and Entre Ríos (2009-2018).

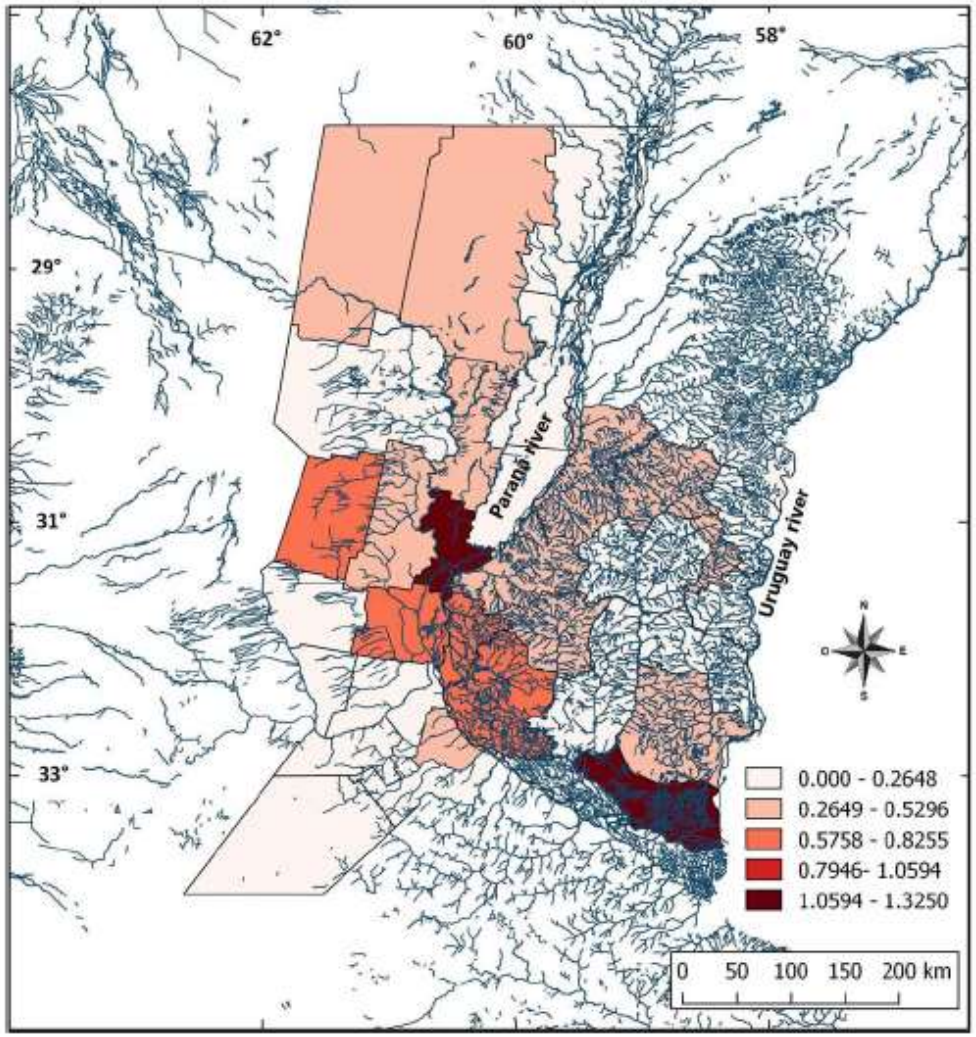
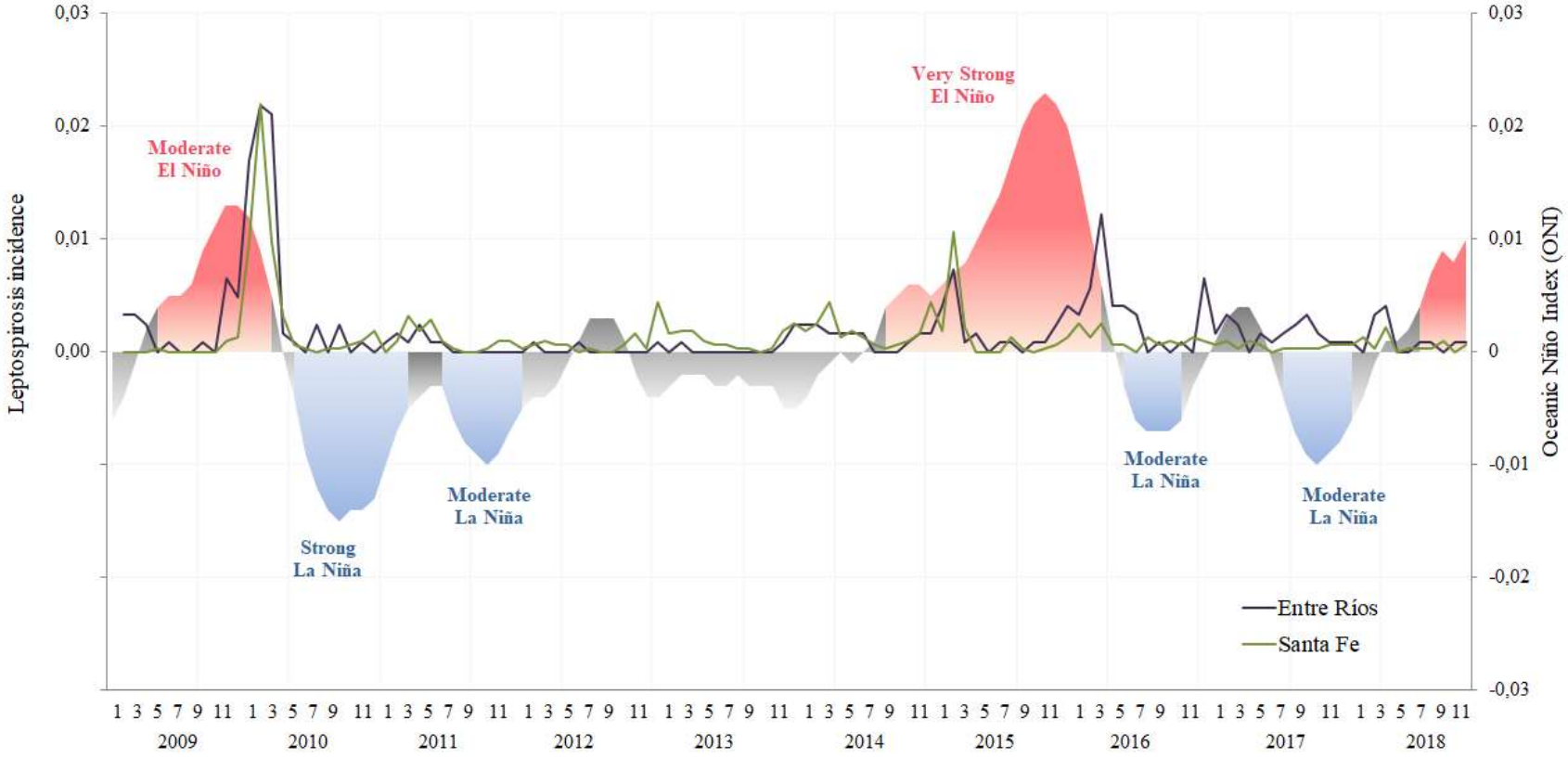


Fig. 2. Incidence of leptospirosis in Santa Fe and Entre Ríos provinces (period 2009–2018). Number of cases is calculated in relation to the population by departments.

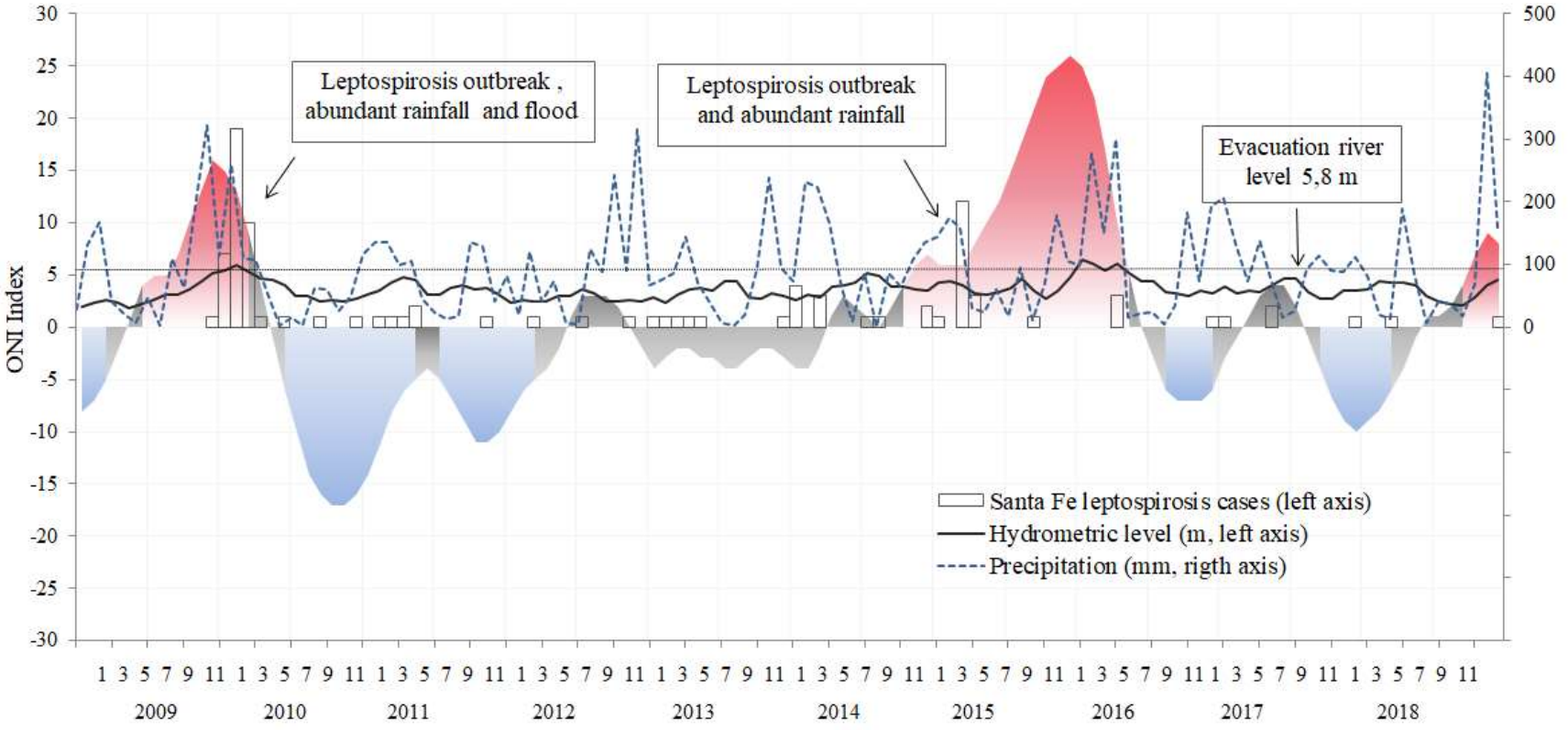
Leptosipirosis is a zoonosis caused by the spirochete bacteria *Leptospira interrogans* and its principal vector are rats.

Impacts in our region: Leptospirosis



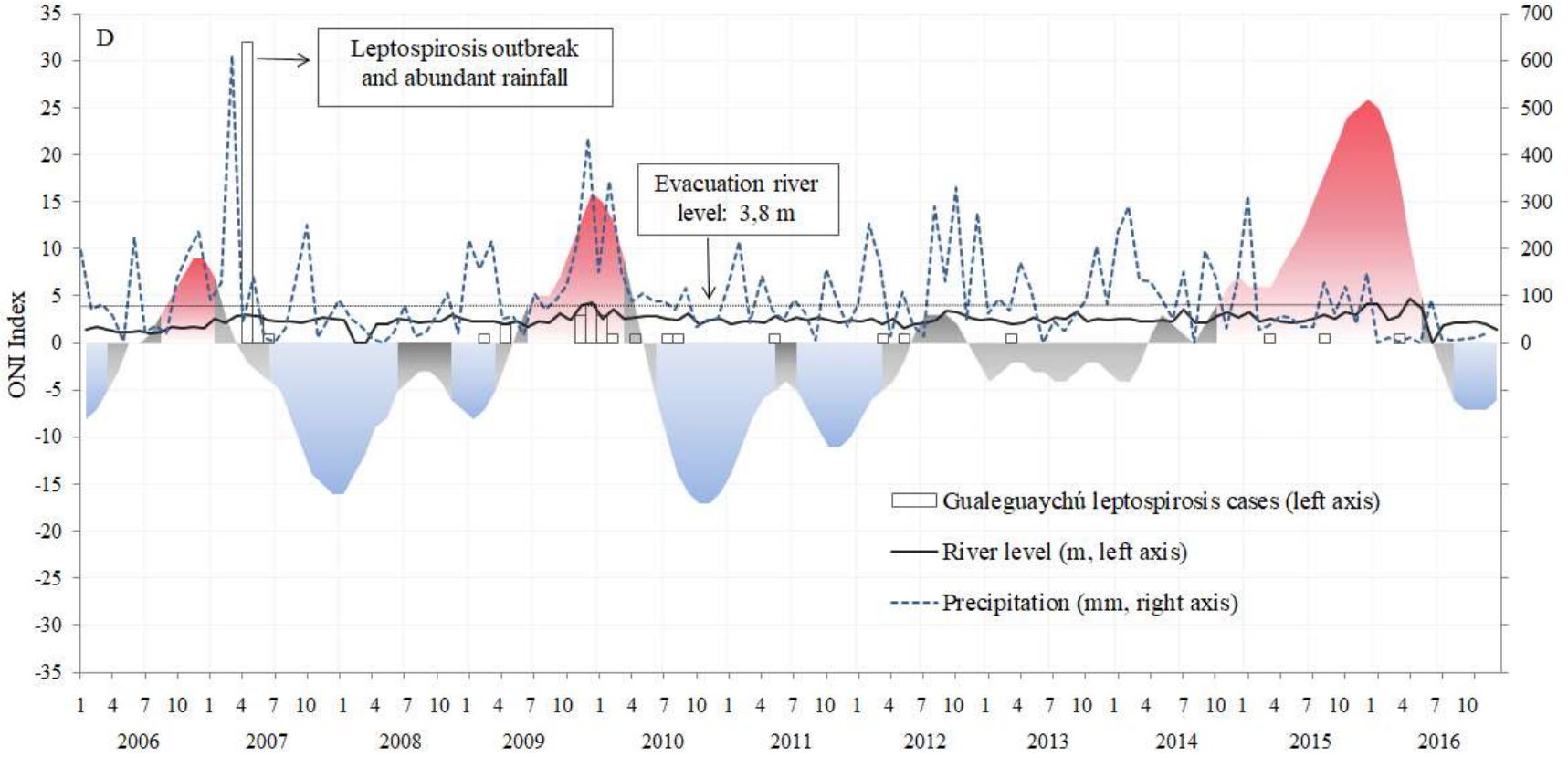
Casos de Leptospirosis en función del índice ONI las provincias de Santa Fe y Entre Ríos (2009-2018).

Impacts in our region: Leptospirosis



Casos de Leptospirosis en función de variables hidro-climáticas en la ciudad de Santa Fe (2009-2018).

Impacts in our region: Leptospirosis



Casos de Leptospirosis en función de variables hidro-climáticas en la ciudad de Gualeguaychú (2006-2018).

MATHEMATICAL MODELLING

Dynamic epidemiological modeling as a tool for **monitoring, prediction, evaluation** and **early warning** of the response of infectious diseases to different hydroclimatic phenomena.

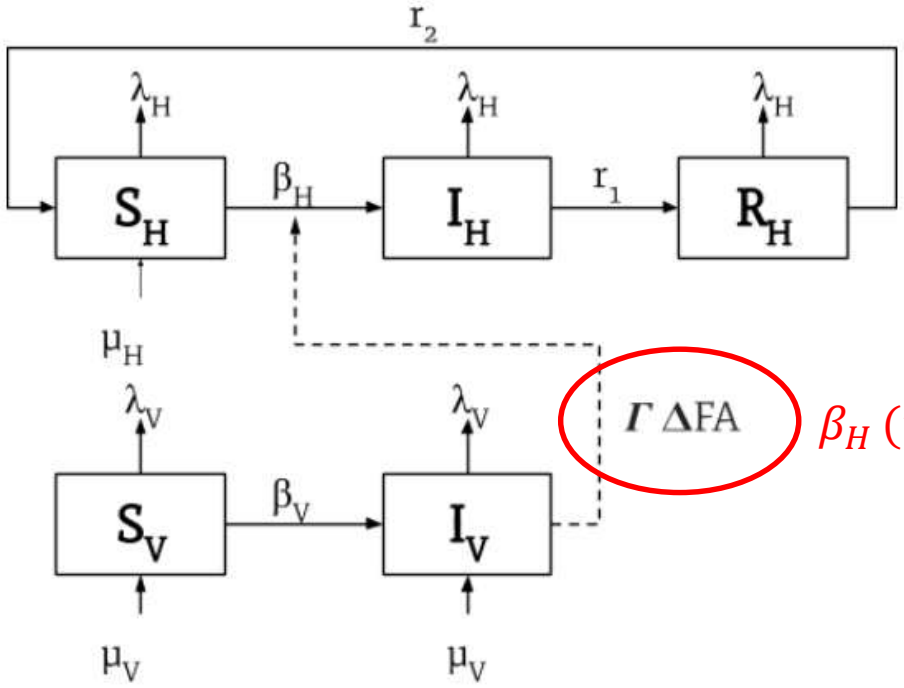
CLIMATIC SERVICES APPLIED ON HEALTH

To be effective:

- Reliable data
- Interdisciplinary work (health proffesionals, biologist,, engineers, programmers, decision makers, etc.)

MATHEMATICAL MODELLING

SIR model of leptospirosis



$\beta_H(t) = k\boldsymbol{\Gamma}(t, a, loc)\boldsymbol{\Delta FA}(t)$

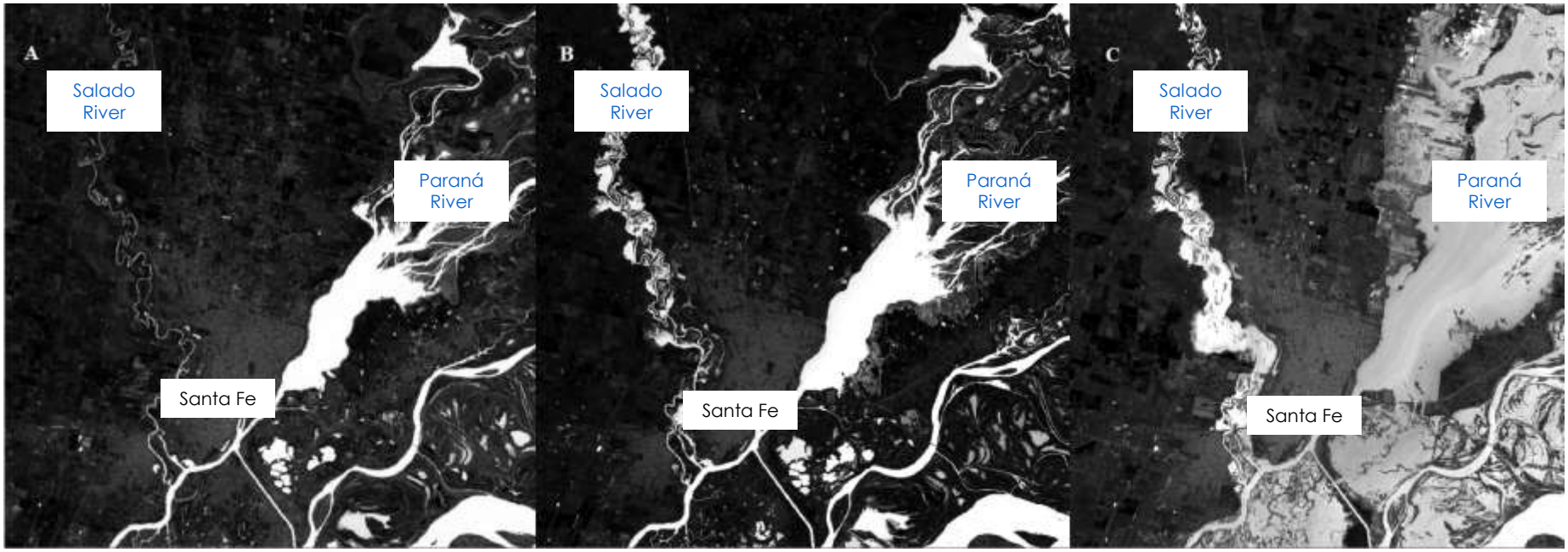
- S_H (Susceptible Human)
- I_H (Infected Human)
- R_H (Recovered Human)
- S_V (Susceptible vector)
- I_V (Infected Vector)

$\boldsymbol{\Gamma}(t, a, loc)$: gamma distribution for precipitation (from Triampo et. al 2007)

$\boldsymbol{\Delta FA}(t)$: variation of flooded area in function of hydrometric levels.

Although the behavior of the rats is based on the availability of food in the garbage or similar, they prefer to be far from humans. However, in flood time their space is contracted then the chances of coming into contact with humans increases.

MATHEMATICAL MODELLING



2009
Minimum h

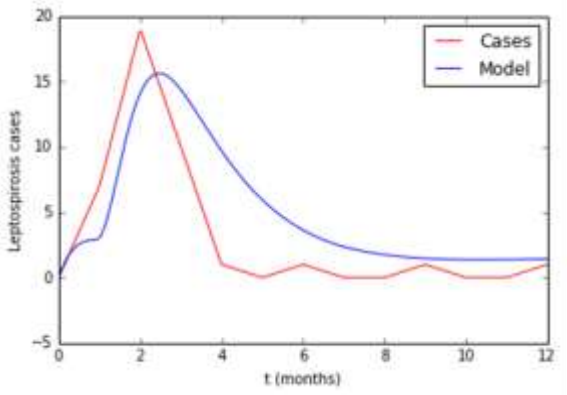
2015
Mean h

2009
Maximun h

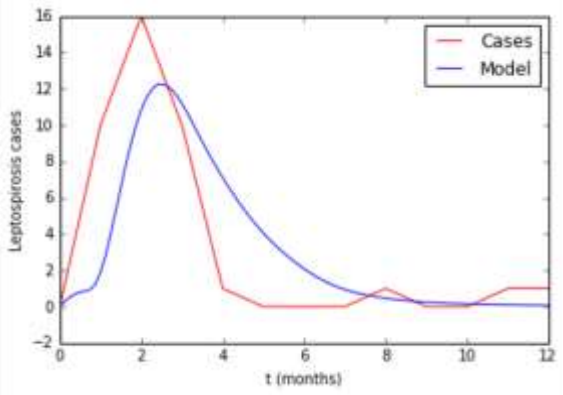
$$\boldsymbol{\Delta FA = f(h,t)}$$

MATHEMATICAL MODELLING

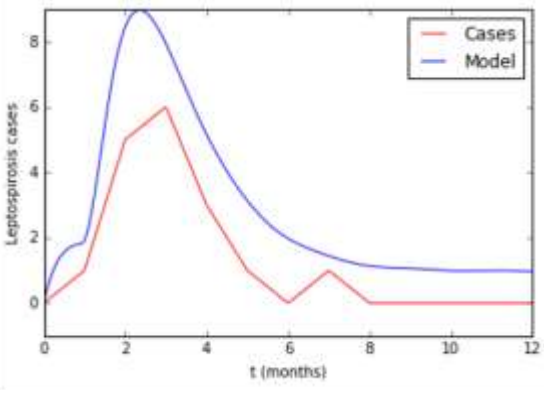
Results for 2010 outbreak



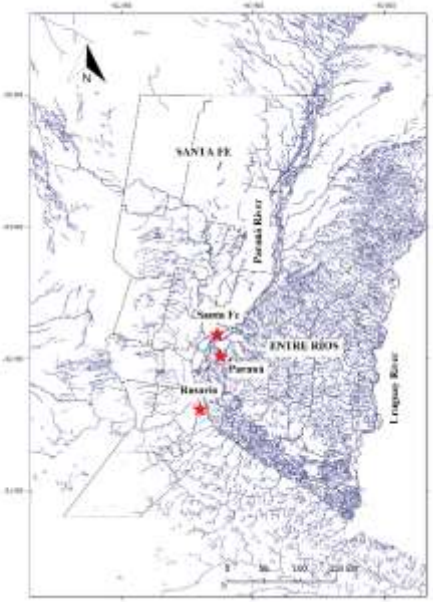
Santa Fe



Rosario



Paraná



MATHEMATICAL MODELLING

Estatistical modelling of leptospirosis

Comparison of semiparametric methods:

- Classic ARIMA
- A new alternative ARIMAX.
- Semi-Functional Partial Linear Regression (SFPLR)

In particular, SFPLR is a method that allow the use of (hydroclimatic) covariables (non.-stationary) which could improve the prediction of outbreaks of leptospirosis.

Santa Fe

Method	NSE	RMSE
ARIMA	-5.00	0.91
ARIMAX	-9.20	1.19
SFPLR	**-1.40**	**0.58**

Paraná

Method	NSE	RMSE
ARIMA	-2.38	0.87
ARIMAX	-1.63	0.76
SFPLR	**-0.50**	**0.58**

Rosario

Method	NSE	RMSE
ARIMA	**-0.63**	**0.82**
ARIMAX	-0.83	0.87
SFPLR	**-0.63**	**0.82**

THANK YOU!! OBRIGADA!!

Well, I don't understand this about climate change …

Bem, ainda eu não entendo isso sobre mudanças climáticas ...

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Entre Ríos y Santa Fe siguen en alerta por las inundaciones

Las lluvias volvieron a complicar la situación en Concordia y las zonas afectadas. El Servicio Meteorológico mantuvo el alerta por tormentas.

infobae

ARGENTINA

Las inundaciones en Entre Ríos, las peores en 50 años por la crecida del río Uruguay

Gustavo Bordet sostuvo que "la proyección" es que el nivel del agua siga creciendo hasta mañana y remarcó que "esto es algo inédito" en "los últimos 50 años". Ya son dos las víctimas por las inundaciones en el Litoral

OBJETIVOS DEL DESARROLLO SOSTENIBLE

El 25 de septiembre de 2015, los líderes mundiales adoptaron un conjunto de objetivos globales para erradicar la pobreza, proteger el planeta y asegurar la prosperidad para todos como parte de una nueva agenda de desarrollo sostenible. Cada objetivo tiene metas específicas que deben alcanzarse en los próximos 15 años.

Para alcanzar estas metas, todo el mundo tiene que hacer su parte:
los gobiernos, el sector privado, la sociedad civil y personas como nosotros