

**WEATHER PHENOMENON ENSO IMPACT OF ON COVERAGE LAND
BETWEEN 10° AND 40° LATITUDE IN SOUTH AMERICA**

**GLOBE COLLABORATIVE PROJECT IN THE REGION OF LATIN
AMERICA AND THE CARIBBEAN.**

ARGENTINA, PERU AND URUGUAY

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Gratitudes:

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Abstract

With the purpose of knowing the effects of the weather phenomenon ENSO OVER THE flora coverage between 10° and 40° off South America, a collaborative project between three GLOBE countries of the Region of Latin America and The Caribbean: Argentina, Peru and Uruguay, took place (have been carried out)

In each country, GLOBE teachers along with their secondary level students (Argentina), University level (Peru) and primary level (Uruguay) selected a study site and described land coverage, following GLOBE protocols of site selection, GPS, manual mapping of land coverage, digital mapping and biometrics. Subsequently with the help of satellite images the NVDI index for Niña, Niño and neutral years were determinate.

The results allowed better knowing of the fact that the weather variability that The Niña brings has a negative impact over the study sited of Argentina and Peru, and a positive impact for Peru. This last country characterized because of having a major human influence in the vegetation management and the water level of the Lake that hosts, and in which the dynamic growth of vegetation majorly depends.

2. Investigation questions

Water disponibility is one of the most important variables for the distribution and growth of living organisms over the planet (Arnell *et al.*, 2001 y Viviroli *et al.*, 2003), being precipitation, the weather variable that has a larger impact over the amount of water available in the site, in which depend basically the growth of vegetation.

Up to now many studies to know how precipitation patron through time had taken place, fact which allows global precipitation models to be established. However, many of these models are not enough clear to explain what happens with precipitation when the weather variability phenomenon known as El Niño Southern Oscillation – ENSO (Poveda *et al.*, 2006) which contains two extreme phases, one warm (El Niño) and one cold (La Niña), which changes worlds precipitation patrons, temperature and pressure. The role that this changes have over vegetation had recently started to be explored. (Lü *et al.*, 2012).

During El Niño, Peru's north coast presents humid, warm and rainy summers, ending to cause floods. In the South of Brazil and northern Argentina similar conditions, experiments more humid conditions that normal, especially during spring and summer.

For its part La Niña, is correlated with dry periods. The particularity of ENSO relies in that no episode is the same to the other, and that it varies depending on the season that takes place. How much influence does El Niño y La Niña have over the availability of water of a place and therefore in its vegetation coverage? ¿Is the impact of El Niño y La Niña the same in Argentina, Peru and Uruguay? Are the main question that this investigation is trying to answer.

3. Hypothesis

La Niña has a negative impact over the growth and hardness of the vegetation that covers the region, whereas El Niño has a negative impact over them.

4. Investigation Plan

The aim of this investigation was to study the impact of the weather phenomenon ENSO on coverage land between 10° and 40° latitude in South America. The project was done in a collaborative way between teachers and GLOBE students, from institutions of different academic levels and different countries. The objective of this research was to study the effects of ENSO weather phenomenon on land cover between 10° and 40° latitude in South America. The work was done collaboratively between teachers and students of institutions GLOBE different academic levels and three different countries. The work teams are described below:

Argentina: a) María Inés Amato - Colegio Carmen Arriola de Marín - Buenos Aires, y
b) Ana Prieto - María Eugenia Bertossi - CEI “San Ignacio” - Junín de los Andes. Both institutions are high schools.

- Perú: Claudia Caro - Universidad Nacional Agraria La Molina – Lima
- Uruguay: Patricia Piriz - Club de Ciencias Bénticos – Montevideo. GLOBE Alumni.

Along the development of the investigation, two face to face meeting appointments were carried out, with the aim of shearing work methodologies and results. Also online conferences were made to promote the exchange, with the support of three scientists:

Dra. Madeleine Renom de Uruguay (meteorology specialist), Dr. Ricardo Chrobak de Argentina (science teaching specialist) and Dr. Vasco Mantas of Portugal.

5. Investigation methods

Two study sites were set in mountain areas, and two in prairie areas, as is shown in Fig.1

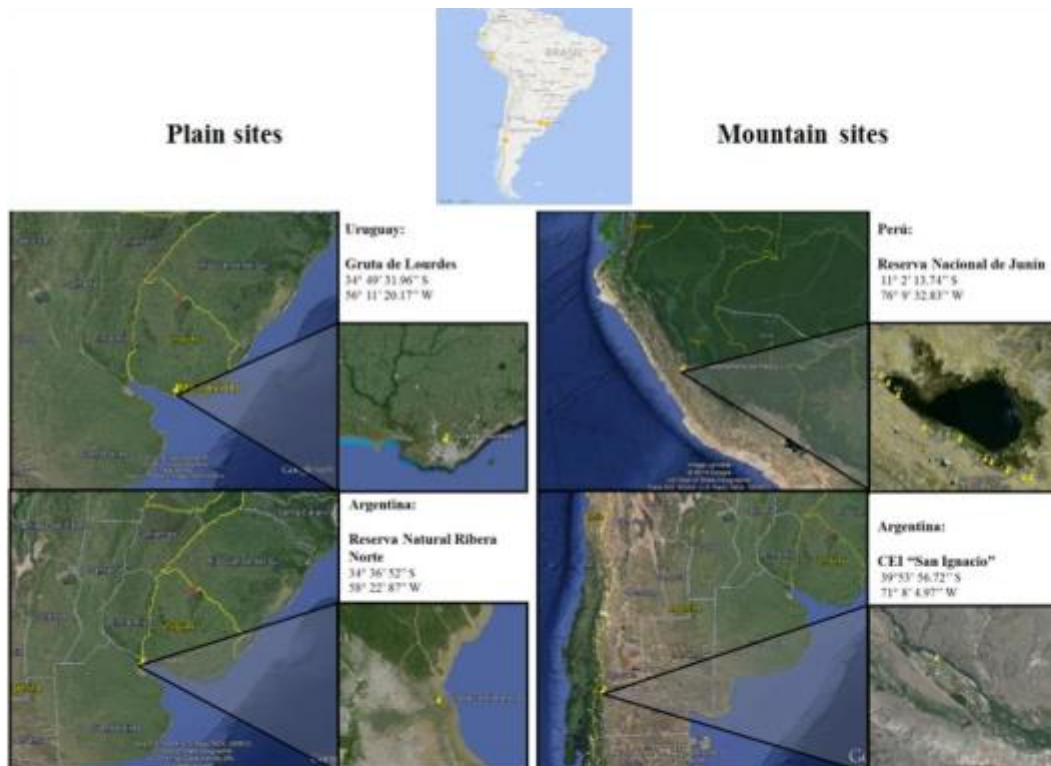


Figure 1. Study Sites.

In Uruguay it was worked in the Gruta de Lourdes, a natural area at 19 msl, where the Lourdes Virgin is venerated, located on the capital's city periphery, at the shore of Arroyo Miguelete, main fresh water course of the city, with presents plants of short appearance.

In Peru it was worked in the Reserva Nacional de Junín, area of conservation altoandina at 4000 msl, characterized because of hosting area de the second biggest lake of Peru (Lago Junin) and ecosystems of productive pastures.

In Junín de los Andes, Argentina, we worked in the Valle de San Cabao 800 msl, place that has a forest cover in consequence of the contribution of water from the river Chimehuin and the rains that falls on the Andes, forming numerous wetlands that are part of the Lanin National Park.

In Buenos Aires, Argentina, we worked inside the North Shore Municipal National Park, a very dynamic environment that is constantly advancing towards the Rio de la Plata, with typical wetland vegetation.

To verify changes in land cover, a description of the coverage was done in each country, using the GLOBE protocols site selection, GPS, manual mapping, computerized mapping and Biometry (GLOBE, 2005), which allowed to assign MUC codes to each study site.

Then, we proceeded to compare satellite images from Niño, Niña and neutral years of each country, calculating the Normalized Vegetation Difference Index – NVDI (Chen et al., 2014) with the BEAM VISAT software to know the variation spatiotemporal of the changes of vegetation according to the meteorological phenomena already explained.

6. Data

Peru: Fig.2 show the map of unsupervised classification of Junin, with MUC codes and with local denominations for each type of vegetation cover. The dominant coverage corresponds to the MUC-4351, area of wet grassland pedding size, known locally as “bofedales”. The second dominant type corresponds to the MUC-4251, dry grassland

area of low slope, known as Puna grass. Additionally, field verification allowed observing the anthropogenic impact on vegetation due to urbanization and extraction activities such as grazing and burning of reeds, being the MUC-4351, the most affected area.

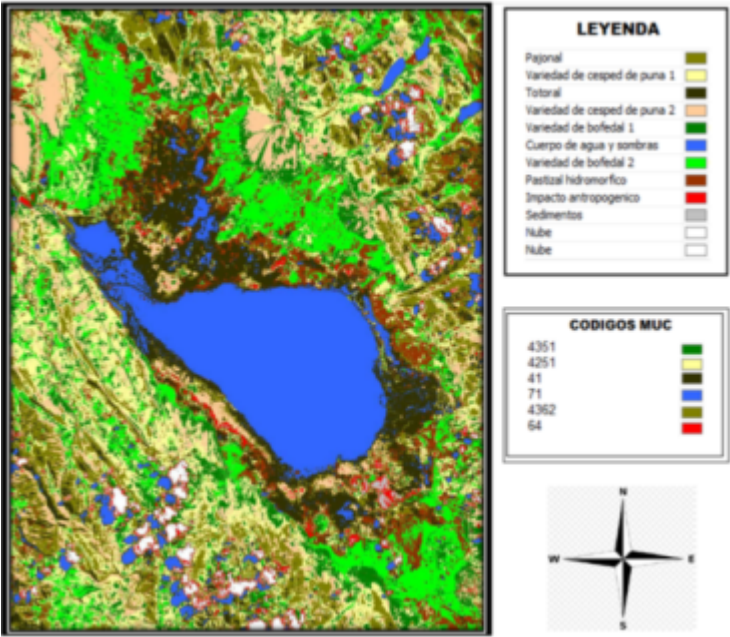


Figure 2. Unsupervised classifications of land cover in Junin National Reserve. August 2013.



Figure 3. Sampling areas.

Argentina: Fig.4 shoes the MUC-312 area corresponding to a herbaceous-shrub steppe is the predominant species whose neneo mixed with coiron and others. The MUC-62 area has grassland meadows with dense grass (clover and rushes) adapted to large amounts of water. The meadows are used for grazing cattle. The MUC-2112 corresponds to forest of “chacay”, while MUC-81 corresponds to orchards. More than 50% of the land is not covered.



Figure.4 Manual classifications of land cover in the CEI "San Ignacio". Google Earth Image- October 2013.



Figure.5. Photos of the sampling site.

The North Bank of Argentina (Fig.6) presents a MUC-0121 area that corresponds to a mixed forest where plants typical of the "cut" combined with other riparian forest dominated. The MUC-41 area is dominated by large herbs such as cattails, wild grasses, cattails and saw grass. In the MUC-013 ceibos area predominate, in the MUC-014 area, willow shrub layer with mauve and tomatillo, the MUC-0141 area is dominated by alder and finally the MUC-63 area is dominated by reeds.



Figure. 6. Manual classification of land cover in the Ribera Norte Natural Park. Image Google-Earth, May 2014.



Figure 7. Photos of one of the sampling sites in the Ribera Norte of Argentina.

Uruguay

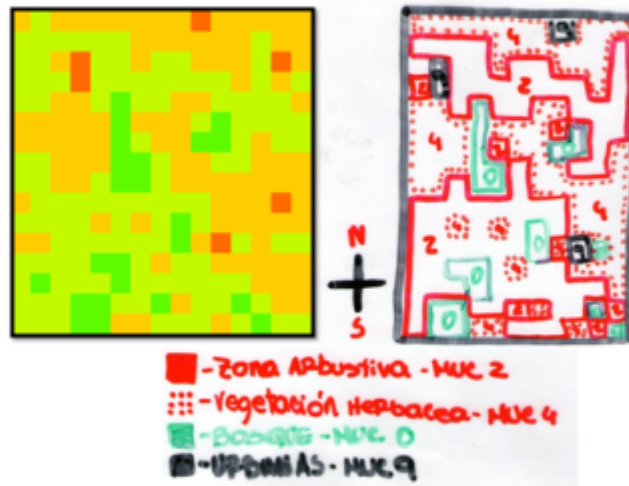


Figure 8. Manual classification of land cover in the Gruta de Lourdes.

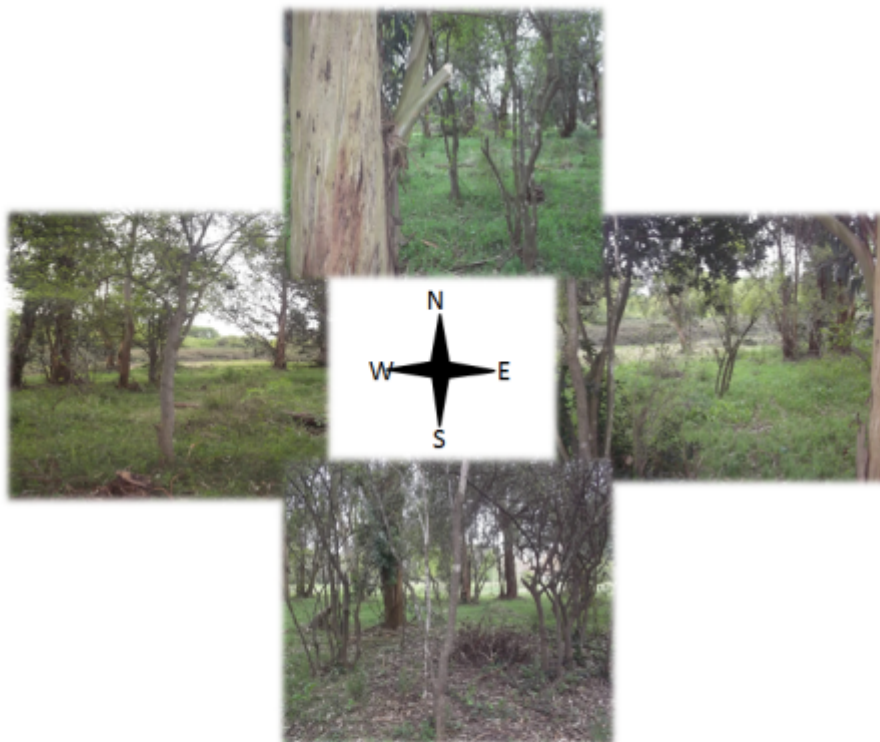


Figure 9. Sampling site photos.

In Fig.8 is displayed the study site where it was found a tree cover of 5 meters or more, covering more than 40% with a canopy cover of 58%. The soil has coverage of 70%

with a predominance of grasses (42%). The 18% are broadleaf weeds and 10% are bushes. Eucalyptus is the dominant species (introduced species) of 23m to 35m in height with a circumference of 170cm to 283cm. Celtis tala (native tree) is the co-dominant species, with a high of 5m to 8.5m and a circumference of 14cm to 25cm.

7. Data Analysis

By using the software BEAM-VISAT the following formula on Landsat TM images were used to calculate the NDVI vegetation index.

$$NDVI = \frac{Band\ 4 - Band\ 3}{Band\ 4 + Band\ 3}$$

Where:

Band 4 = Near-infrared

Band 3 = Red

Peru:

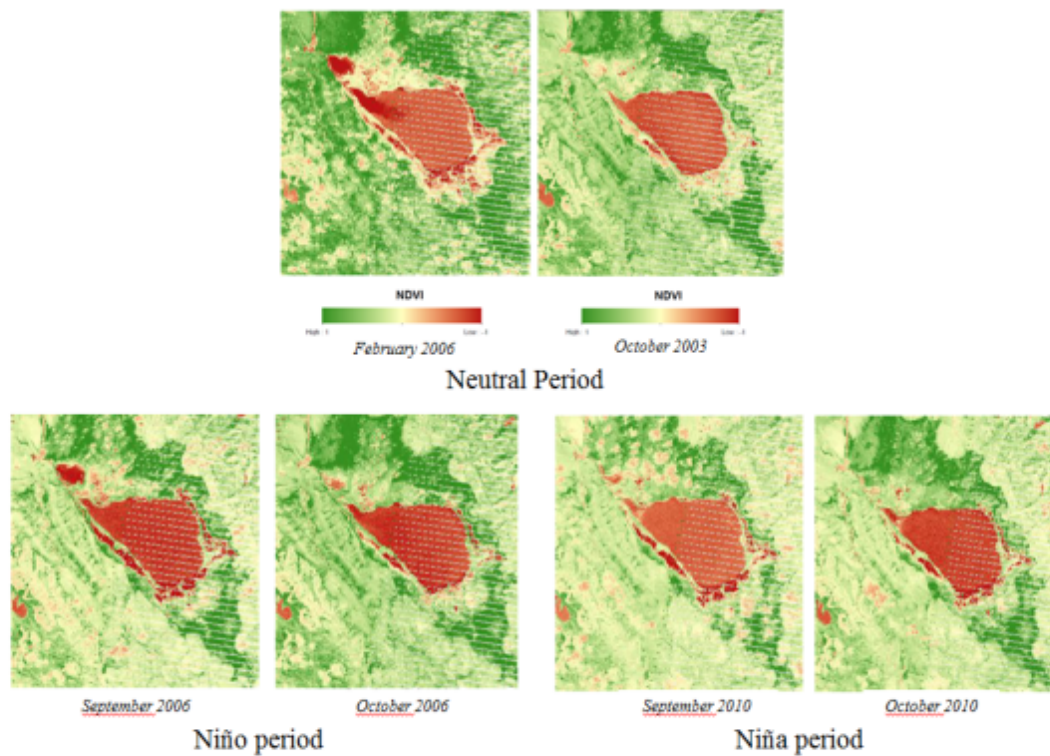


Figure 10. NVDI calculated in Junín National Reserve to neutral period, Niña and Niño.

According to the result of the NDVI present Fig.10 is suggested that in the Niño period (2006 with an annual rainfall of 655.4mm) there is a slight lack of vegetation compared to a Neutral year (with an average rainfall of 940mm). However, in 2010 the one that was presented in the Niña (with an annual rainfall of 1476.4mm) it is notable a decrease in the level of Lake Junín, which made the vegetation to extend into the free land left by the water of the lake. Something that is important to mention is that in this area there is a large human influence on controlling the level of Lake Junín and the management of grasslands (Caro, 2010) which could affect the results to argue that the effects on vegetation change only due to the presence of the ENSO phenomenon.

Argentina:

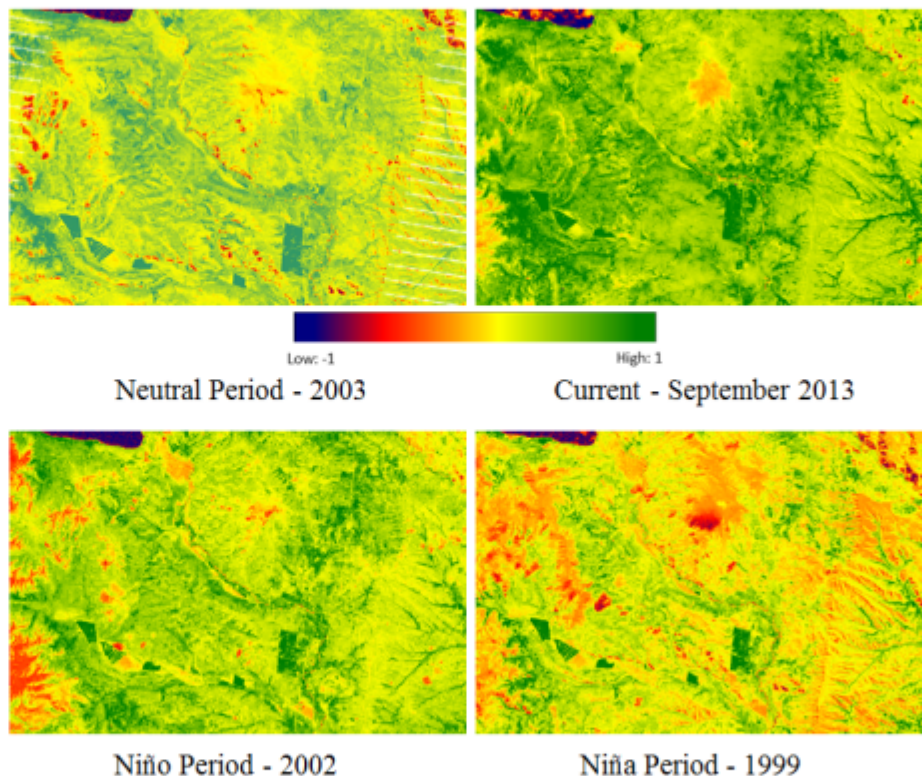


Figure 11. NDVI calculated for the Valle de San Cabao to neutral period, Niño, Niña and current image.

Fig.11 shows greater vegetation cover for the Niño year than the Niña and neutral years. These differences also occur with recorded annual rainfall: 745mm in 1999, 840mm 1059mm in 2002 and in 2003. Also in the period Niña there are highest number of fires (Prieto, et. al., 2009) recorded, probably because a smaller amount of precipitation.

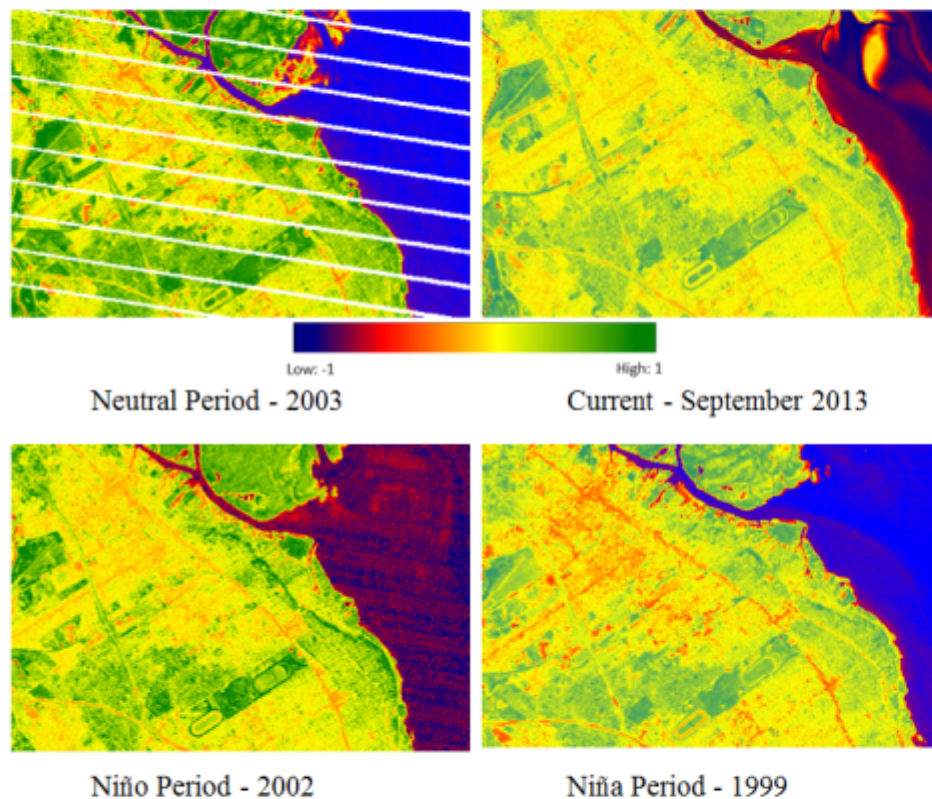


Figura.12. NDVI calculated for the Ribera Norte Natural Park to neutral period, Niño, Niña and current image.

The NDVI for the neutral period (Fig.12) doesn't show differences in the vegetation period with the Niño one. However, when Niña period is compared with the previous ones, the values are lower. These differences are also seen in the annual rains where the neutral period (1542mm) is similar to the period Niño (1621mm), but lower for the period Niña (1083mm).

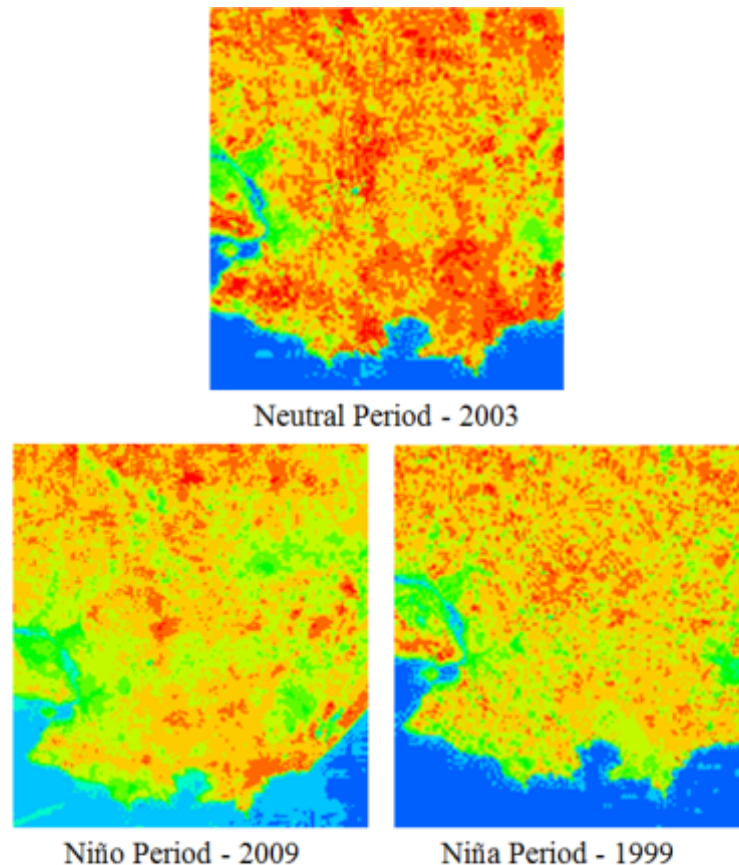


Figure 13. NDVI of Gruta de Lourdes for neutral period, Niño, Niña and current image. USGS.

Earth-Explorer

Fig.13 shows that the period NDVI Niño presents as many vegetated areas than Niña period, where a decrease of the green areas is observed. The neutral period is the one that shows the greatest decrease in vegetation cover. In this regard it is important to mention that for the neutral rainfall period is 1240,8mm, while the period Niño are 1350,5mm, and decrease for the period Niña (1028,2mm).

8. Conclusions

Water availability is the key factor in the distribution of species and the formation of vegetation groups. In the cases studied the data shows a decrease of the vegetation in the period of the phenomenon Niña for Argentina and Uruguay and an increase for Peru. Furthermore, in a year Niño the precipitations are higher in Argentina and Uruguay;

meanwhile in Peru they are lower. With these data do not reject the hypothesis proposed for the sites studied in Uruguay and Argentina but not in Peru about the negative effect of La Niña and the positive effect of El Niño on vegetation growth.

It has been shown that the ENSO phenomenon does not affects equally to Argentina, Uruguay and Peru. Being Peru the country who least resembles the other ones, which could be probably associated to a higher human influence in the area.

9. Arguments of measurement limitations

The first limitation presented was the insufficient availability of high quality satellite images from the same period of time of all the studied areas. Another factor to be taken into account is that vegetation growth does not happen immediately after precipitation, but has a delayed response that could be better verified with a more extended temporal study scale. Furthermore it could be interesting to explore the coincidence of the effects between the ENSO and the Antarctic Oscillation since variations in some periods coincide (NOAA-CPC).

10. Bibliography

Arnell N., Liu C., Compagnucci, R., Da Cunha L. Hanaki K., Howe C., Mailu G., Shiklomanov I. & Stakhiv E. 2001. Hydrology and Water Resources. In: Climate Change (2001). Impacts, Adaptation, and Vulnerability. IPCC. Cambridge University Press.

Caro, C. (2010). Grass sampling through "Champeo" activity in the Junin National Reserve during years 2004-2005. A perspective from the theory of succession: a case study in the rural community of Villa Junín. Paper for the MBA in Applied Ecology. Universidad Nacional Agraria La Molina.

- Chen, T., de Jeu, R. A. M., Liu, Y. Y., Van der Werf, G. R., & Dolman, A. J. (2014). Using satellite based soil moisture to quantify the water driven variability in NDVI: A case study over mainland Australia. *Remote Sensing of Environment*, 140, 330-338.
- GLOBE Program (2005). Teacher Guide. Globe, Washington, WA. www.globe.gov
- Lü, A., Zhu, W., & Jia, S. (2012). Assessment of the sensitivity of vegetation to El-Nino/Southern Oscillation events over China. *Advances in Space Research*, 50(10), 1362-1373.
- Malvárez, A. I. (1999). El Delta del Río Paraná como mosaico de humedales. *Tópicos sobre humedales subtropicales y templados de Sudamérica*, 35-54.
- Malvárez, A. I. (1999). *Tópicos sobre humedales subtropicales y templados de Sudamérica*. UNESCO, 228 pp.
- Poveda, G., Waylen, P. R., & Pulwarty, R. S. (2006). Annual and inter-annual variability of the present climate in northern South America and southern Mesoamerica. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 234(1), 3-27.
- Prieto A. B., Agostino P. A., Astudillo A. N., Astudillo F. S., Borguese G. H., Bastias D. A., Colín A.M.A., Martínez L. V., Paredes A., Posa D.D., Rodríguez N.B., Vázquez J.A y Vilcavil E.R. 2009. Relationship between precipitations and fires. XIII World Forestal Congress (WFC). FAO. Buenos Aires, Argentina.
- Viviroli, D., R. Weingartner y B. Messerli (2003) Assessing the hydrological significance of the world's mountains. *Mountain Research and Development* 23 (1):32-40.