Boletín de la Asociación de Geógrafos Españoles N.º 71 - 2016, págs. 467-471
I.S.S.N.: 0212-9426

DISTRIBUTION LEOPARD SPATIAL PATTERN TYPE IN ARID AND SEMIARID REGIONS OF THE WORLD

José Fuentes Delgado[1]
Diego Varga Linde[2,3]
Martí Boada Junca[1,3]
[1]Department of Geography. Autonomous University of Barcelona
[2]Department of Geography. University of Girona
[3]Institute of Environmental Science and Technology. Autonomous University of Barcelona
mcfuentes2@hotmail.com, diego.varga@udg.edu, diego.varga@uab.cat, marti.boada@uab.cat

I. INTRODUCTION

In arid and semiarid areas of the world (Meigg, 1953) over the past 50 years has shown the presence of spatial patterns at regional and local levels where the vegetation form regular patterns (Slatyer, 1959; Warren, 1973; Worrall, 1959). These can be observed mainly from remote sensors mounted on satellite or airborne platforms. With constant and greater increase in coverage and spatial resolution of cartographic information, it has been seen in more detail at a global level. The presence of these behaviors in the distribution of vegetation patterns consist primarily of heterogenia matrix coverage. Low plant apparently has been destabilized with consequent rupture of the matrix system. This cover plant reveals areas of bare soil or light soil and vegetation zones spaced regularly usually interspersed with short stature or slightly higher carrying vegetation areas are homogeneous in composition from the standpoint of soil and vegetation surrounding climate. In some ecosystems forming dense patches bands or stripes. Communities that exhibit this pattern are generically referred to as banding or "pattern tiger." In other ecosystems, patches of dense vegetation are irregular in shape following the above analogy, here are known as green zones or "leopard pattern" (Aguiar, 1999). Spatial patterns in vegetation in arid and semi-arid areas, occurs in the form of stripes (Tiger bush), mazes, points (Leopard bush) and gaps (Rietkerk, 2008). They are characterized by a regular spacing between patches of vegetation and can span hundreds or thousands of square kilometers of arid or desert areas.

Direct relations between environmental variables with the appearance and behavior patterns determined specifical leopard style in arid and semiarid areas based on actual field data of two parts of the world and bibliographic references and predictors of environmental variables. Globally, together with an empirical mathematical model. This is not a sentence. In order to isolate the environmental conditions that determine their existence in various arid areas, on the assumption that in different parts of the world these variables will be similar. Finally resulting contrasting sites with high spatial resolution images to verify the results.

II. METHODOLOGY

II.1. Sample patterns

The points of presence leopard patterns around the world were collected from bibliographic information and data collected in the field in areas not previously reported as is the case in the Guajira Peninsula in Colombia and areas of Almeria and Murcia in Spain The landmarks of information literature were verified using high resolution images available services in the BingMaps and Google Earth line. These systems include hundreds of terabytes in aerial and satellite imagery. In many areas, the maximum resolution is less than one meter. After verifying all locations 150 points of presence worldwide Leopard pattern were determined.

II.2. Environmental variables and climate data

Environmental variables refined the application of modeling technique in conjunction with a maximum entropy model. We worked with a set of predefined bioclimatic variables to characterize the environmental space where climatic, topographic and soil variables are distributed. The temperature and annual precipitation were obtained from WorldClim (http://WorldClim.org) within its global climate data base for environmental modeling (1950-2000) (Hijmans, 2005). Overall aridity index and extraterrestrial solar radiation are based on modeling and analysis by Antonio Trabucco (offered online by the CGIAR-CSI with support from the International Center for Tropical Agriculture CIAT are at once the model using data WorldClim available). The elevation was based on full for the world in version 4available from the CGIAR-CSI SRTM 90m derived data base (Jarvis, 2008) Data Shuttle Radar Topography Mission (SRTM). Finally, basis of global harmonized soil data Harmonized World Soil Database (HWSD) (Nachtergaele, 2012) all layers were cut into the same spatial reference and pixel size to be processed in raster format...

II.3. Model potential distribution

In recent years has gained strength using techniques based on specific algorithms such as maximum entropy and genetic algorithms (Phillips, 2006; Stockwell, 1992 and 1999). They have resulted in an exponential increase in the number of publications and associated modeling of the geographical distribution of species and ecosystems, ease of implementation and the speed with which results can be obtained (Pliscoff, 2011). To generate the empirical model potential Maxent algorithm of maximum entropy (Phillips, 2006; Elith, 2011) was used. This shows the probability that a given cell, a sample is taken presence, he uses a similarity within some environmental variables (predictors) with respect to the cells where it has been observed the species. The values of this index have higher probability values in similar spaces to where the known samples were located. The initial model generated a map of potential presence globally Leopard pattern based on the characteristics of the sites reported in the literature field and distribution.

II.4. Assessing the overall performance of the model

The overall performance of the model was evaluated by calculating the area under the curve (AUC) for which 25% of the sample points to be excluded from the records and not use them at test. The ROC curve is an indicator of a successful prediction of the presence or absence in the distribution of data within the thresholds. The results on the prediction of AUC may vary from 0-1 which indicates that the prediction is random when it is close to 0.5 and a very good prediction when the threshold is close to 1. Within the study we took into account the imitations of the AUC which refers to the variation of the value of the highest score when the sampling area is less in size distribution of the samples. Given the limitations of the AUC, this can provide valuable information to use in places with relatively homogeneous and equal samples defined scales as in our case.

III. RESULTS

The result showed the probable distribution of areas on the globe where you can show regular patterns Leopard type within the relative contributions of environmental variables in the Maxent model The predictor that had a higher percentage contribution was the overall aridity index which had a 40.2, followed predictor of overall elevation 18.3 STRM with these two variables account for over 50% of the total contribution to the most significant index values. 14.5 precipitation, temperature 12.4 and solar radiation with 9.8 and 4.9 soils.

The model revealed widespread distribution of distinctive environments for the presence of leopard patterns. I throw areas previously unidentified or very few references. These areas include Chihuahua and Sonora desert between the United States and Mexico, southern Ecuador and Galapagos Islands and northern Peru in the area of Piura, a coastal strip from Libya to Gambia, West Africa around the Sahara desert, South Africa and Namibia from Angola to the coastal strip around the Kalahari Desert. Areas around Somalia, Kenya, Yemen and Oman and finally areas on the edge of the Australian desert.

Places with distinctive environments were identified with a clear resemblance to each other. One of these features are found in the fieldwork carried out in Spain and Colombia. Where evidence of the phenomenon called evolutionary convergence (Arendt, 2008) was found in these places, leopard patterns of two species (Castela erecta and Lycium intricatum) is mainly formed. These plants belonging to different families (Simaroubaceae and Solanaceae).

These are very similar in their pheno-morphological and structural aspect but without direct biological and evolutionary connection, forming similar patterns of development in the arid environment in which they operate, being likely to be modified similarly and subject to pressures similar selection manner.

The result was accurate with an overall reliability of 91%. This was checked with samples collated in different places in the world where I verified the existence of leopard pattern in many places where there was no previous reports. Or there was no direct references due to extensive global distribution.

IV. CONCLUSIONS

It was possible to isolate a relationship of distinctive environments that clearly make patterns and are located in different parts of the world. More precisely in different continents (America, Africa, Europe and Oceania). The convergence of these places is mainly because the environment modeled factors plant forms of these areas achieving isolate similar environmental characteristics in plant species. Some of this was evident in two of the areas studied in America and Europe. The habitat generates similar spatial patterns where these plants are probably species that are not analyzed elsewhere and shed evolutionary convergence phenomena in these or similar environments containing identical genera such as the case of Prosopis in America and Acasia in Australia, Africa and Europe. The hypothesis that the distinctive atmosphere modeling phenomorphology species indicates that environmental variables only provide important information on the requirements of development leopard pattern on a regional level and must be other more locally determining factors are unknown for now (Barbier, 2006).

The leopard-like patterns are located mostly in outdoor areas or edges of vast deserts or dry coastal areas (Sahara, Kalahari, Australian desert, etc.), mainly near the coast or some type of marine influence zone. A specific feature that has not been addressed further is the possible interaction of these patterns related to the presence of nearby seagrasses in coastal areas where the presence of leopard patterns (in cases like Colombia, Spain or Australia) may have a direct bearing on local effects and nutrient supply primarily by the effects of the winds that bring sediment to nearby marine areas (Hemminga, 1990; Short, 2010).

To improve understanding of how they interact and patterns require more field research to define the plant species present, the variability of soil nutrients and relevant local environmental characteristics (wind, humidity, temperature, precipitation) besides animal consider influence. As in other studies conclude (Aguiar, 1999; Barbier, 2006; Deblauwe, 2008).

V. REFERENCES

AGUIAR, M.N.R. y SALA, O.E. (1999): "Patch structure, dynamics and implications for the functioning of arid ecosystems", *Trends in Ecology & Evolution*, 14 (7): 273-277.

ARENDT, J. y REZNICK, D. (2008): "Convergence and parallelism reconsidered: what have we learned about the genetics of adaptation?", *Trends in Ecology & Evolution*, 23 (1): 26-32.

BARBIER, N., COUTERON, P., LEJOLY, J., DEBLAUWE, V y LEJEUNE, O. (2006): "Self-organized vegetation patterning as a fingerprint of climate and human impact on semi-arid ecosystems", *Journal of Ecology*, 94 (3): 537-547.

DEBLAUWE, V., BARBIER, N., COUTERON, P., LEJEUNE, O. y BOGAERT, J. (2008): "The global biogeography of semi-arid periodic vegetation patterns", *Global Ecology and Biogeography*, 17 (6): 715-723.

ELITH, J., PHILLIPS, S.J., HASTIE, T., DUDÍK, M., CHEE, E. y YATES, C.J (2011): "A statistical explanation of MaxEnt for ecologists", *Diversity and Distributions*, 17 (1): 43-57.

HEMMINGA, M.A. y NIEUWENHUIZE, J. (1990): "Seagrass wrack-induced dune formation on a tropical coast (Banc d'Arguin, Mauritania)", *Estuarine, Coastal and Shelf Science*, 31 (4): 499-502.

HIJMANS, R.J., CAMERON, S.E., PARRA, J.L., JONES, P.G. y JARVIS, A. (2005): "Very high resolution interpolated climate surfaces for global land areas", *International Journal of Climatology*, 25 (15): 1965-1978.

JARVIS, A., REUTER, H., NELSON, A. y GUEVARA, E. (2008): "Hole-filled SRTM for the globe Version 4." Disponible en *CGIAR-SXI SRTM 90m database*: http://srtm. csi. cgiar. org.

MEIGS, P. (1953): World Distribution of Arid and Semi-arid Hot Climates. *Reviews of Research on Arid Zone Hydrology*. Paris, UNESCO.

PHILLIPS, S.J., ANDERSON, R.P. y SCHAPIRE, R.E. (2006): "Maximum entropy modeling of species geographic distributions", *Ecological Modelling*, 190 (3): 231-259.

PLISCOFF, P. y FUENTES-CASTILLO, T. (2011): "Modelación de la distribución de especies y ecosistemas en el tiempo y en el espacio: una revisión de las nuevas herramientas y enfoques disponibles", *Revista de Geografía Norte Grande*, 48: 61-79.

RIETKERK, M. y VAN DE KOPPEL, J. (2008): "Regular pattern formation in real ecosystems", *Trends in Ecology & Evolution*, 23 (3): 169-175.

SHORT, A.D. (2010): "Sediment Transport around Australia—Sources, Mechanisms, Rates, and Barrier Forms", *Journal of Coastal Research*, 26 (3): 395-402.

SLATYER, R.O. (1959): Methodology of a water balance study conducted on a desert woodland (acacia aneura f. muell.) community in central Australia. *Symposium on Plant-Water Relationships in Arid and Semi-arid Conditions*. UNESCO. Madrid, UNESCO document: 13 p.

STOCKWELL, D. (1999): "The GARP modelling system: problems and solutions to automated spatial prediction", *International Journal of Geographical Information Science*, 13(2): 143-158.

STOCKWELL, D.R.B. y NOBLE. I.R. (1992): "Induction of sets of rules from animal distribution data: A robust and informative method of data analysis", *Mathematics and Computers in Simulation*, 33(5–6): 385-390.

WARREN, A. (1973): "Some vegetation patterns in the Republic of the Sudan - a discussion", *Geoderma*, 9 (1): 75-78.

WORRALL, G. (1959): "The Butana grass patterns", *Journal of Soil Science*, 10 (1): 34-53.