MEGADIVERSE COUNTRIES: AN INTEGRATIVE MULTIVARIATE ANALYSIS OF SPECIES RICHNESS, ITS DRIVERS, AND CONSERVATION CHALLENGES IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT GOAL 15 – LIFE ON LAND

PAÍSES MEGADIVERSOS: UMA ANÁLISE MULTIVARIADA INTEGRATIVA DA RIQUEZA DE ESPÉCIES, DE SEUS FATORES DETERMINANTES E DOS DESAFIOS DE CONSERVAÇÃO NO CONTEXTO DO OBJETIVO DE DESENVOLVIMENTO SUSTENTÁVEL 15 – VIDA TERRESTRE

PAÍSES MEGADIVERSOS: UN ANÁLISIS MULTIVARIADO INTEGRADOR DE LA RIQUEZA DE ESPECIES, SUS FACTORES DETERMINANTES Y LOS DESAFÍOS DE CONSERVACIÓN EN EL CONTEXTO DEL OBJETIVO DE DESARROLLO SOSTENIBLE 15 – VIDA DE LOS ECOSISTEMAS TERRESTRES

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ABSTRACT
Megadiverse countries harbor the majority of the world's biological diversity and play a pivotal role in achieving global biodiversity conservation goals. This study presents a comprehensive multivariate analysis of species richness across vascular plants and vertebrate groups in twenty megadiverse countries, examining the ecological, geographical, climatic, and evolutionary drivers underlying their exceptional biodiversity. Using comparative data on species richness, land area, and multivariate ordination techniques, we identify patterns linking tropical and subtropical climates, habitat heterogeneity, historical biogeography, and isolation processes to high levels of biodiversity and endemism. The results highlight that species richness is not strictly proportional to country size, as smaller tropical nations such as Ecuador and Malaysia exhibit disproportionately high biodiversity densities. In addition to identifying biodiversity patterns, this study discusses the major conservation challenges faced by megadiverse countries, including deforestation, habitat fragmentation, climate change, and unsustainable resource use. Framed within the context of Sustainable Development Goal 15 (Life on Land), the findings emphasize the critical importance of megadiverse countries for global biodiversity conservation and the urgent need for integrated, socially inclusive, and sustainable conservation strategies aligned with the objectives of the 2030 Agenda.

Keywords: Megadiverse Countries. Species Richness. Biodiversity Hotspots. Multivariate Analysis. Conservation Biology. Sustainable Development Goal 15. Life on Land.

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RESUMO
Os países megadiversos abrigam a maior parte da diversidade biológica mundial e desempenham um papel fundamental na consecução dos objetivos globais de conservação da biodiversidade. Este estudo apresenta uma análise multivariada abrangente da riqueza de espécies de plantas vasculares e de grupos de vertebrados em vinte países megadiversos, examinando os fatores ecológicos, geográficos, climáticos e evolutivos subjacentes à sua biodiversidade excepcional. Utilizando dados comparativos de riqueza de espécies, área territorial e técnicas de ordenação multivariada, identificam-se padrões que associam climas tropicais e subtropicais, heterogeneidade de habitats, biogeografia histórica e processos de isolamento a elevados níveis de biodiversidade e endemismo. Os resultados destacam que a riqueza de espécies não é estritamente proporcional ao tamanho do país, uma vez que nações tropicais menores, como Equador e Malásia, apresentam densidades de biodiversidade desproporcionalmente altas. Além de identificar padrões de biodiversidade, o estudo discute os principais desafios de conservação enfrentados pelos países megadiversos, incluindo desmatamento, fragmentação de habitats, mudanças climáticas e uso insustentável dos recursos naturais. Inseridos no contexto do Objetivo de Desenvolvimento Sustentável 15 (Vida Terrestre), os achados enfatizam a importância crítica dos países megadiversos para a conservação global da biodiversidade e a necessidade urgente de estratégias de conservação integradas, socialmente inclusivas e sustentáveis, alinhadas aos objetivos da Agenda 2030.

Palavras-chave: Países Megadiversos. Riqueza de Espécies. Hotspots de Biodiversidade. Análise Multivariada. Biologia da Conservação. Objetivo de Desenvolvimento Sustentável 15. Vida Terrestre.

RESUMEN
Los países megadiversos albergan la mayor parte de la diversidad biológica del mundo y desempeñan un papel fundamental en el logro de los objetivos globales de conservación de la biodiversidad. Este estudio presenta un análisis multivariado integral de la riqueza de especies de plantas vasculares y de grupos de vertebrados en veinte países megadiversos, examinando los factores ecológicos, geográficos, climáticos y evolutivos que subyacen a su biodiversidad excepcional. Mediante el uso de datos comparativos de riqueza de especies, superficie territorial y técnicas de ordenación multivariada, se identifican patrones que vinculan climas tropicales y subtropicales, heterogeneidad de hábitats, biogeografía histórica y procesos de aislamiento con altos niveles de biodiversidad y endemismo. Los resultados destacan que la riqueza de especies no es estrictamente proporcional al tamaño del país, ya que naciones tropicales más pequeñas, como Ecuador y Malasia, presentan densidades de biodiversidad desproporcionadamente altas. Además de identificar patrones de biodiversidad, el estudio analiza los principales desafíos de conservación que enfrentan los países megadiversos, incluidos la deforestación, la fragmentación de hábitats, el cambio climático y el uso insostenible de los recursos naturales. Enmarcados en el contexto del Objetivo de Desarrollo Sostenible 15 (Vida de los Ecosistemas Terrestres), los hallazgos enfatizan la importancia crítica de los países megadiversos para la conservación global de la biodiversidad y la necesidad urgente de estrategias de conservación integradas, socialmente inclusivas y sostenibles, alineadas con los objetivos de la Agenda 2030.

Palabras clave*:* Países Megadiversos. Riqueza de Especies. Hotspots de Biodidad. Análisis Multivariado. Biología de la Conservación. Objetivo de Desarrollo Sostenible 15. Vida de los Ecosistemas Terrestres.

1 INTRODUCTION

Megadiverse countries constitute a small group of nations that collectively harbor the majority of the planet's biological diversity and exceptionally high levels of endemism. These countries play a decisive role in global biodiversity conservation due to their ecological richness, evolutionary uniqueness, and irreplaceable biological resources (Mittermeier et al., 1998). Understanding what defines a megadiverse country, the drivers behind their extraordinary species richness, and the implications for conservation is essential in addressing current global environmental challenges.

In the context of accelerating biodiversity loss, habitat degradation, and climate change, megadiverse countries are central to the achievement of Sustainable Development Goal 15 (Life on Land), which aims to protect, restore, and promote the sustainable use of terrestrial ecosystems and halt biodiversity loss. This article examines the defining characteristics of megadiverse countries, analyzes the ecological and biogeographical drivers of their biodiversity through a multivariate approach, and discusses the conservation challenges they face in an increasingly anthropogenic world.

2 WHAT DEFINES MEGADIVERSE COUNTRIES?

Megadiverse countries are characterized by exceptionally high species richness across multiple taxa, elevated levels of endemism, and the presence of unique and highly diverse ecosystems. These nations contain a substantial proportion of the world's species, making them critical reservoirs of global biodiversity (Mittermeier et al., 1998; Yánez, 2014). The concept of megadiversity was formalized by Conservation International, which originally identified 17 countries as megadiverse, including Brazil, Indonesia, Mexico, and Australia (Mittermeier, 1997).

According to updated assessments, the number of megadiverse countries has increased to 20 (Appendix 1), based on criteria such as total species richness, endemism, and ecosystem diversity (Nash, 2022). Collectively, these countries harbor approximately 70% of the planet's known species while occupying only a small fraction of the Earth's surface, underscoring their disproportionate importance for global biodiversity conservation.

3 DRIVERS OF HIGH BIODIVERSITY IN MEGADIVERSE COUNTRIES: SELECTED CASE STUDIES

The exceptional biodiversity of megadiverse countries arises from a combination of geographic, climatic, and evolutionary factors. Tropical and subtropical regions tend to exhibit higher species richness due to long-term climatic stability, high energy availability, and reduced seasonal extremes, which promote diversification and lower extinction rates (Wiens & Donoghue, 2004).

Brazil exemplifies this pattern through the Amazon Rainforest, one of the most biodiverse regions on Earth, hosting approximately 10% of all known species. The vast extent of tropical forests and the presence of diverse microhabitats have facilitated extensive species diversification over evolutionary timescales (Hoorn et al., 2010).

Evolutionary history also plays a key role. Isolated systems such as islands and mountain ranges often exhibit accelerated speciation rates, leading to high endemism. Madagascar and the Galapagos Islands, isolated for over 80 and 5 million years respectively, are classic examples, with unique flora and fauna that evolved independently from continental lineages (Vences et al., 2009; Yánez, 2011).

3.1 MEGADIVERSE COUNTRIES IN LATIN AMERICA AND NORTH AMERICA

Brazil is widely recognized as the most megadiverse country globally, containing between 15% and 20% of the world's known species. It hosts two major biodiversity hotspots—the Atlantic Forest and the Cerrado—and the largest continuous mangrove system in the world, as well as the only coral reef system in the South Atlantic (Abranches, 2020).

Perú is another megadiverse country with extraordinary ecological heterogeneity, encompassing Amazonian rainforests, Andean Mountain systems, and a productive Pacific coastline. It hosts over 20,000 plant species and more than 1,800 bird species. The Humboldt Current sustains one of the world's most productive marine ecosystems, reinforcing Peru's global importance for biodiversity conservation (Mittermeier et al., 2004; Mittermeier et al., 2011).

Ecuador stands out as the country with the highest species richness per unit area worldwide. Despite its relatively small size, Ecuador hosts over 18,000 vascular plant species and nearly 5,000 vertebrate species. The north–south orientation of the Andes creates sharp altitudinal gradients and diverse microclimates, while its equatorial location provides climatic stability. Marine biodiversity is further enhanced by the interaction of the cold Humboldt Current and warm El Niño–Panamá currents. Major biodiversity hotspots include the Chocó, Tumbesian region, Amazon Basin, Andean Highlands, and the Galápagos Islands (Bass et al., 2010; Mestanza-Ramón et al., 2020; Yánez 2016; Yánez et al., 2013).

Other megadiverse countries in Latin America with no less surprising figures include: Mexico, Colombia, Bolivia, Venezuela, and in North America: the United States (Appendix 1).

3.2 MEGADIVERSE COUNTRIES IN ASIA, OCEANIA AND AFRICA

China ranks among the world's megadiverse countries due to its vast land area, climatic gradients, and complex topography. It hosts approximately 10% of global plant species and 14% of animal species ((China.org.cn, 2010; Mi et al., 2021). Mountain ranges such as the Himalayas and Qinling Mountains generate diverse microclimates, while extensive coastlines and marine currents promote genetic connectivity in coastal ecosystems.

India supports approximately 7–8% of the world's species, facilitated by its wide range of ecosystems, from deserts and tropical forests to alpine environments. The Himalayas and Western Ghats serve as major biodiversity hotspots with high endemism, shaped by climatic seasonality and biogeographical transitions (Champion & Seth, 1968; Myers et al., 2000).

Indonesia and Malaysia are key components of the Southeast Asian megadiversity complex. Indonesia's archipelagic structure and location within the Coral Triangle foster extreme marine and terrestrial biodiversity, while Malaysia's ancient tropical rainforests—some over 130 million years old—support a high number of endemic and endangered species (Bellwood & Hughes, 2001; Nash, 2022; Ratnayeke et al., 2018).

Other megadiverse countries in Asia with amazing levels of biodiversity are Myanmar, Thailand, Vietnam, and in Oceania: Australia and Papua New Guinea (Appendix 1).

It is also important, of course, to mention countries in Africa such as: DR Congo, South Africa and Tanzania (Appendix 1). Each of the 20 megadiverse countries has its own ecological, evolutionary, and biogeographical drivers that explain their exceptionally high levels of biological diversity.

4 SPECIES RICHNESS ACROSS TAXA AND COUNTRY AREA

A defining feature of megadiverse countries is their exceptional species richness across multiple taxonomic groups. Amphibian diversity is particularly high in countries such as Brazil, Colombia Ecuador and Perú, while plant diversity peaks in nations like Brazil, China, India, Colombia, South Africa, Venezuela, Mexico and Australia (Frost, 2011; Govaerts, 2001; Yánez, 2014). Importantly, species richness is not linearly related to land area. Smaller tropical countries, notably Vietnam, Malaysia and Ecuador, exhibit remarkably high biodiversity densities due to their ecological heterogeneity and complex biogeography (Bass et al., 2010; Yánez, 2014).

Figure 1 ranks the 20 megadiverse countries from largest to smallest according to land area. The figure emphasizes the wide variation in territorial extent among these nations, from continental-scale countries (United States, China Brazil, Australia) to smaller ones (Vietnam, Malaysia, Ecuador). This ordering provides a structural framework for subsequent comparisons, as land area represents a fundamental geographic attribute that can influence environmental heterogeneity, ecosystem diversity, and the potential capacity to support high levels of biodiversity.

Figure 1

Megadiverse countries ordered by land area (square kilometers)

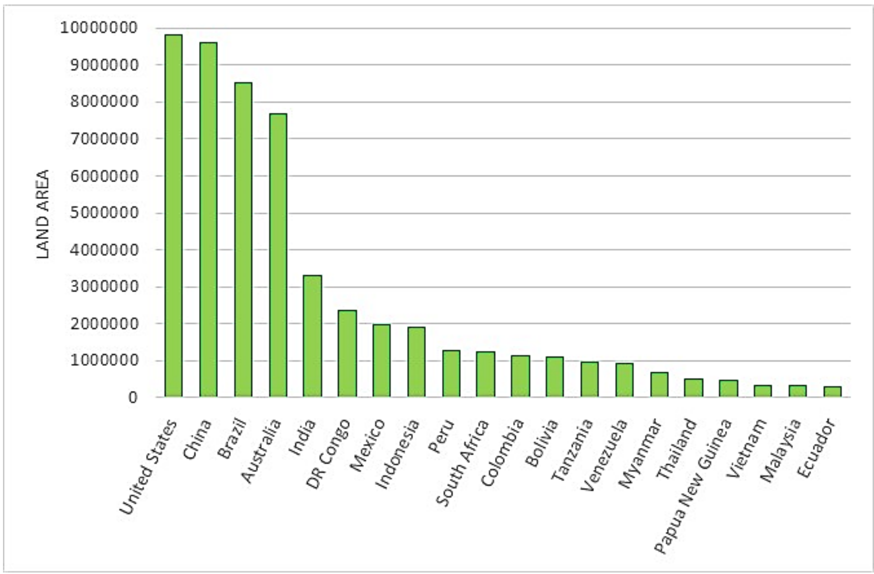


Figure 2 illustrates the distribution of vascular plant species richness among the 20 megadiverse countries, ranked from largest to smallest (considering the number of vascular plant species). A clear gradient is observed, with India, Brazil, and China leading the ranking and exhibiting the highest levels of species richness, while countries with smaller territorial extent show comparatively lower values. This pattern suggests a relatively general relationship between country size and floristic richness, while also indicating that biogeographic, climatic, and evolutionary factors play a significant role beyond land area alone.

Figure 2

Megadiverse Countries Ranked by Absolute Richness of Vascular Plant Species

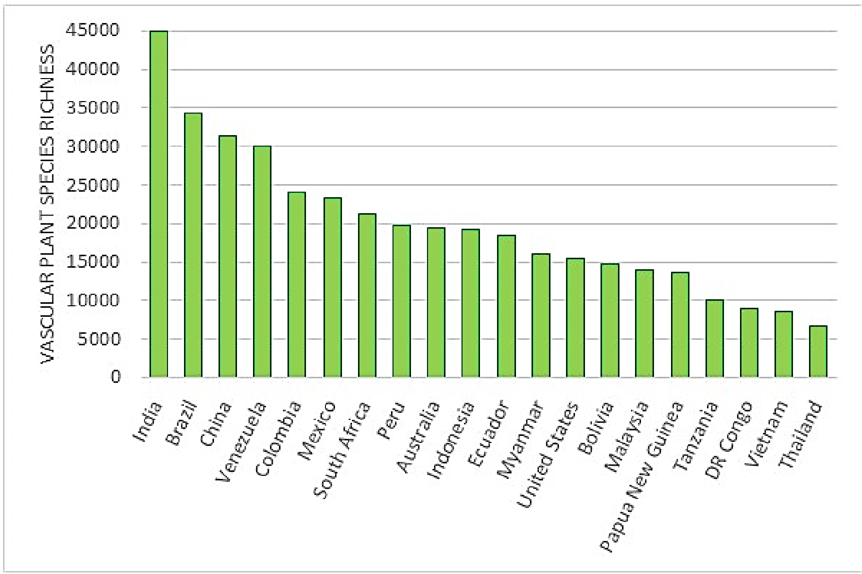
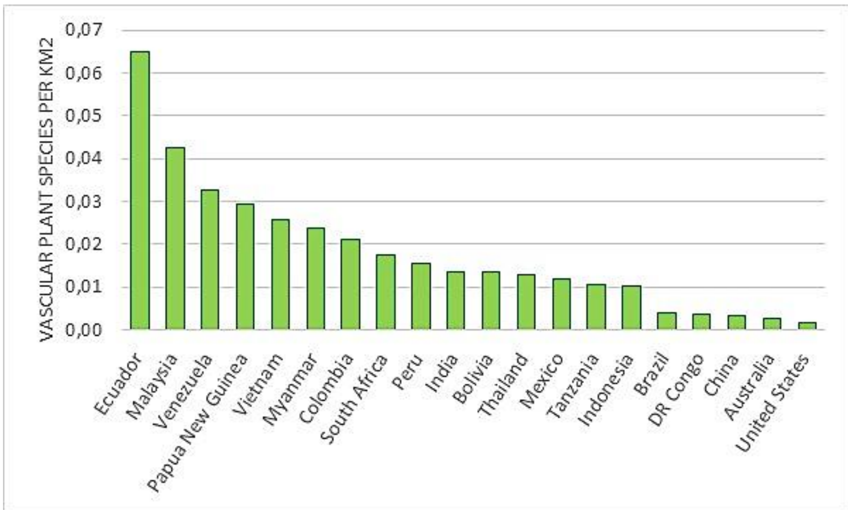


Figure 3 depicts vascular plant species richness standardized by land area unit, expressed as the number of species per square kilometer across the 20 megadiverse countries. The figure reveals a markedly different pattern from absolute richness values, with Ecuador showing the highest species density, followed by Malaysia, Venezuela, and Papua New Guinea. In contrast, large continental countries such as Brazil, China, Australia, and the United States exhibit comparatively low species densities. These results highlight the role of topographic complexity, climatic gradients, and historical biogeography in concentrating plant diversity, and demonstrate that biodiversity density metrics provide critical insights beyond total species counts or country size alone.

Figure 3

Megadiverse countries ranked by plant species richness per square kilometer



5 MULTIVARIATE PATTERNS OF BIODIVERSITY

5.1 CLUSTER ANALYSIS

To achieve comparative analysis of the different megadiverse countries depending on their similarity (based on the absolute species number of plants and vertebrates per country; but without necessarily considering the number of species directly shared among countries; Appendix 1), an Agglomerative Cluster Analysis was applied using Community Analysis Package 4.0 (Pisces Conservation Ltd., 2014).

The Agglomerative Cluster Analysis, using Euclidean distances as a measure of dissimilarity, is a statistical method employed to group elements or samples (in this case megadiverse countries).

With this technique, the mathematical distances could be used to quantify the difference between pairs of samples, focusing the analysis on the species number per country.

The analysis begins by treating each sample (one country) as its own cluster and then iteratively merges the closest clusters with another sample until a predefined number of clusters or a suitable clustering solution is achieved, based on the data from the Appendix 1.

This method is particularly useful in ecological studies for classifying sites, communities or habitats by their species richness and/or species composition, revealing patterns of biodiversity and community structure (Legendre and Legendre, 2012; Yánez et al., 2013).

Agglomerative clustering techniques are widely used in biology and ecology to create dendrograms that illustrate the formation of clusters among elements of interest. These dendrograms visually represent how these elements resemble one another while differing from others, providing valuable findings into their relationships and patterns (Clarke et al., 2016; Kassambara, 2017; Yánez, 2005).

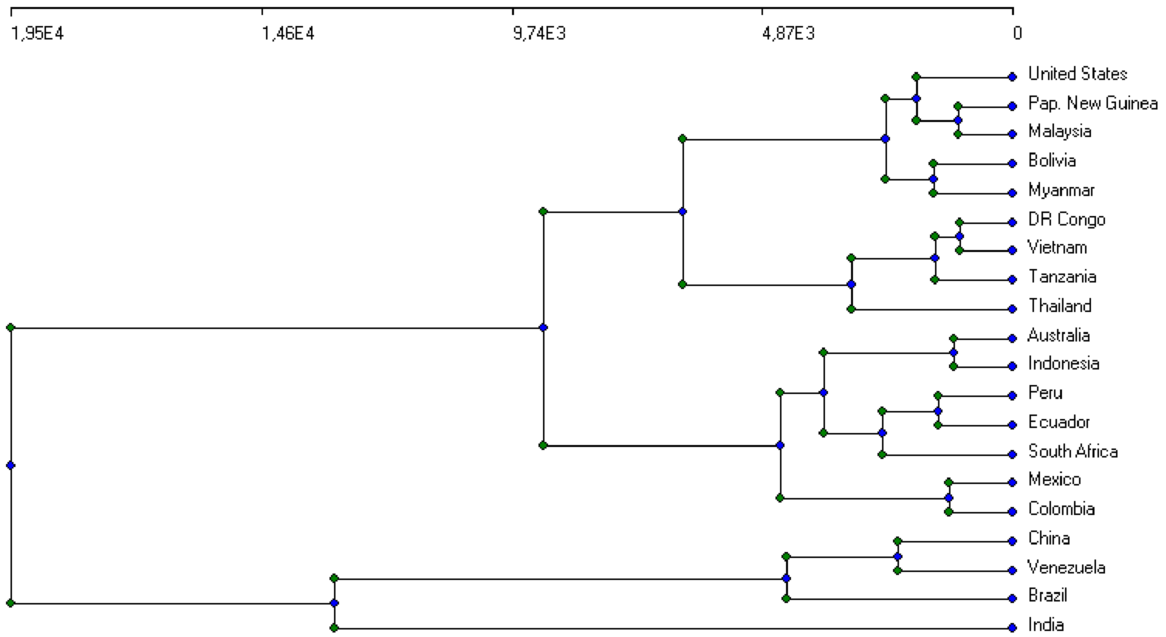
This technique was used to evaluate groups of megadiverse countries that exhibit similar species numbers in the six selected biological groups. Figure 4 shows that the first clade comprises China, Venezuela, Brazil, and India, which group together due to their similar levels of species richness in vascular plants, birds, mammals, reptiles, amphibians, and fishes. The second clade includes Australia and Colombia, with Indonesia, Peru, Ecuador, South Africa, and Mexico nested within this group, reflecting comparable species richness across all the taxonomic groups analyzed.

A third clade is formed by the United States, Papua New Guinea, Malaysia, Myanmar, and Bolivia, driven by similar species richness in the analyzed biological groups.

Finally, the clade with the lowest overall species richness consists of Vietnam, the Democratic Republic of the Congo, Tanzania, and Thailand, which share relatively similar species richness across all analyzed groups (Foro Económico Mundial, 2024).

Figure 4

Cladogram of megadiverse countries. The species richness of vascular plants and vertebrates (fishes, amphibians, reptiles, birds and mammals) have been considered using an agglomerative method based on the Average Union Method (McQuitty's) and Euclidean distances as a measure of dissimilarity



5.2 PRINCIPAL COMPONENT ANALYSIS

Principal Component Analysis (PCA) is other multivariate useful model that extracts the main patterns of a data set, considering variables and characteristics called Principal Components which are combined linearly in order to explain the variance of all variables (Greenacre et al., 2022; Wold et al., 1987; Yánez, 2005).

PCA is a statistical ordination technique used to simplify the complexity of high-dimensional data (Appendix 1) while retaining its essential patterns and relationships. It does this by transforming the original variables (in our case: the species richness in different biological groups) into a new set of uncorrelated variables called principal components, which are ordered so that the first few retain most of the variation present in the original variables. PCA helps in identifying the underlying structure of the data, reducing dimensionality, and highlighting important relationships between variables. It is a statistical technique that effectively summarize the essential information in the data (Jolliffe and Cadima, 2016) and it is widely used in various fields such as biology, ecology, and social sciences to make data analysis more manageable and insightful (Abdi and Williams, 2010; Molina et al., 2018).

PCA was employed in this study using Community Analysis Package 4.0 (Pisces Conservation Ltd., 2014) to explore the relationships among megadiverse countries, as well as their associations, considering the species richness in six different biological groups (Appendix 1). These relationships were visualized through one Ordination Plot, providing a clearer and more comprehensive representation of the 20 megadiverse countries and their relationships among them and with six biological groups considered.

Figure 5 illustrates the formation of four functional groups of megadiverse countries. In some cases, these groups appear to be loosely associated due to geographical proximity.

When the graph is examined from left to right, a clear ordering emerges based on biodiversity levels in both flora and fauna. Brazil is positioned on the left, while Thailand, located on the far right, representing the country with the highest and the lowest overall biodiversity respectively, among the 20 megadiverse countries.

Additionally, when the land area vector is considered, the countries on the left side of the ordination plot correspond to those with the largest territorial extent, while those on the right are the smallest.

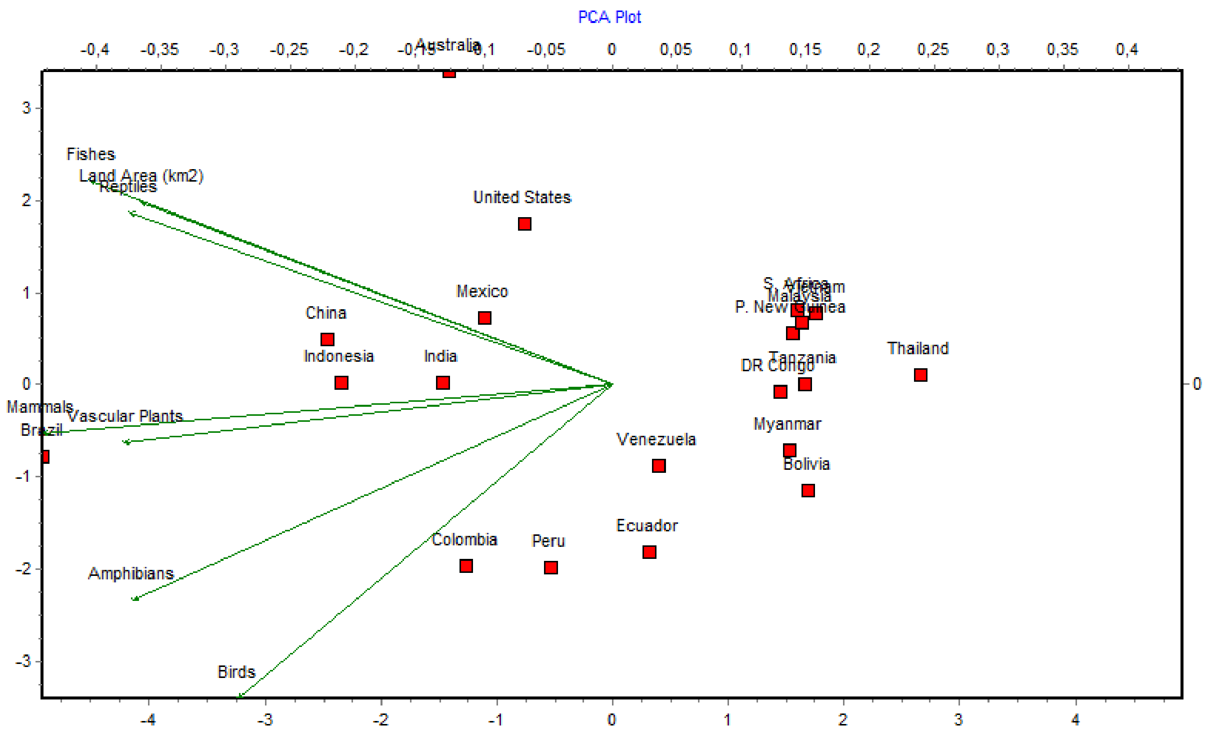
Also, countries tend to cluster near the biodiversity variables in which they exhibit the greatest values. For example, Ecuador, Venezuela, Colombia, and Peru are positioned closer to the variables representing birds, amphibians, mammals, and vascular plants, taxonomic groups in which these countries show particularly high species diversity. A similar pattern is observed for another functional mathematical group composed of China, Indonesia, Mexico, the United States, India, and Australia, which are characterized by high species richness in fishes, reptiles, mammals and vascular plants.

The next group, composed by South Africa, Malaysia, Vietnam, Papua New Guinea, Tanzania, the Democratic Republic of the Congo, Myanmar, Bolivia, and Thailand shows similar lower species richness numbers across the studied biological groups.

Particularly, analyses of vascular plant richness across the twenty megadiverse countries reveal a strong concentration of plant diversity in tropical and subtropical regions. Countries such as Brazil China, Indonesia, and India, lead in absolute plant species richness, while Colombia, Perú, Ecuador, Mexico, Venezuela, Australia and the United States also display exceptionally high diversity.

Figure 5

Ordination Plot (based on a PCA using a Correlation matrix) of the 20 megadiverse countries and the species richness of vascular plants and vertebrates (fishes, amphibians, reptiles, birds and mammals) and the land area per country have been considered (Appendix 1). Note: F1 (horizontal axis) absorbed 51.2% of the variance; F2 (vertical), 22.6%.



6 CONSERVATION CONSIDERATIONS IN THE CONTEXT OF SDG 15

Multivariate clustering and ordination analyses identify distinct groups of countries with similar biodiversity profiles, reflecting similar favorable climatic conditions, biogeographical histories, and ecosystem structures. These results reinforce the conclusion that climate stability, habitat heterogeneity, and evolutionary history are stronger predictors of biodiversity than land area alone.

Despite their ecological importance, megadiverse countries face severe conservation challenges. Deforestation, habitat fragmentation, climate change, and illegal wildlife trade threaten biodiversity across these regions (Myers et al., 2000). For example, deforestation in the Brazilian Amazon has accelerated due to agricultural expansion and illegal logging (Fearnside, 2005), while Indonesia's marine ecosystems are increasingly affected by overfishing, coral bleaching, and pollution (Cinner et al., 2016).

Achieving the targets of Sustainable Development Goal 15 (Life on Land) in megadiverse countries requires integrated conservation strategies that balance biodiversity protection with socioeconomic development. Community-based conservation, international cooperation, and sustainable economic incentives—such as REDD+ and Global Environment Facility initiatives—are essential for long-term success (Angelsen, 2009; Maizland, 2024; Roe, 2008).

7 CONCLUSIONS

Megadiverse countries and the effective management of their ecosystems are indispensable for the conservation of global biodiversity and the achievement of SDG 15 (Life on Land). Their extraordinary species richness, high endemism, and unique ecosystems make them central to global conservation efforts. However, escalating environmental pressures threaten the integrity of these ecosystems. Multivariate analyses reveal indirectly that biodiversity patterns are shaped primarily by climatic stability, habitat diversity, and evolutionary history rather than land area alone. Protecting megadiverse countries through coordinated, inclusive, and sustainable strategies is essential to safeguard Earth's biological heritage for future generations.

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REFERENCES

Abdi, H. & Williams, L. (2010). Principal component analysis. *Wiley interdisciplinary reviews: computational statistics*, 2(4):433–459.

Abranches, S. (2020). Biological megadiversity as a tool of soft power and development for Brazil. *Brazilian Political Science Review*, 14(2), e0006.

Angelsen, A. (2009). *Realising REDD+: National strategy and policy options*. CIFOR.

Bass, M. S., Finer, M., Jenkins, C. N., Kreft, H., Cisneros-Heredia, D. F., McCracken, S. F., ... & Walters, R. A. (2010). Global conservation significance of Ecuador's Yasuní National Park. *PLoS One*, *5*(1), e8767.

Bellwood, D. R., & Hughes, T. P. (2001). Regional-scale assembly rules and biodiversity of coral reefs. *Science*, *292*(5521), 1532-1535.

Champion, H. G., & Seth, S. K. (1968). *A revised survey of the forest types of India.* Manager of Publications.

China.org.cn. (2010). China: One of the megadiverse countries. http://www.china.org.cn/environment/biodiversity/2010-04/21/content_19874903.htm

Cinner, J. E., McClanahan, T. R., Graham, N. A., Pratchett, M. S., Wilson, S. K., & Raina, J. B. (2016). Gear-based fisheries management as a potential adaptive response to climate change and coral mortality. *Journal of Applied Ecology*, *46*(3), 724-732.

Clarke, K., Somerfield, P., & Gorley, R. (2016). Clustering in non-parametric multivariate analyses. *Journal of Experimental Marine Biology and Ecology, 483*:147–155.

Foro Económico Mundial. (2024). *Día Mundial del Medio Ambiente 2024: 17 países megadiversos*. https://www.weforum.org/stories/2024/06/environment-day-biodiversity-world-megadiverse-countries/

Fearnside, P. M. (2005). Deforestation in Brazilian Amazonia: History, rates, and consequences. *Conservation Biology*, *19*(3), 680-688.

Frost, D. R. (2011). *Amphibian species of the world: an online reference*. American Museum of Natural History.

Govaerts, R. (2001). How many species of seed plants are there? *Taxon*, *50*(4), 1085-1090.

Greenacre, M., Groenen, P., Hastie, T., d'Enza, A., Markos, A., & Tuzhilina, E. (2022). Principal component analysis. *Nature Reviews Methods Primers*, *2*(1):100.

Hoorn, C., Wesselingh, F. P., ter Steege, H., Bermudez, M. A., Mora, A., Sevink, J., ... & Antonelli, A. (2010). Amazonia through time: Andean uplift, climate change, landscape evolution, and biodiversity. *Science*, *330*(6006), 927-931.

Jolliffe, I. & Cadima, J. (2016). Principal component analysis: a review and recent developments. *Philosophical transactions of the royal society A: Mathematical, Physical and Engineering Sciences*, 374(2065):20150202.

Kassambara, A. (2017). *Agglomerative hierarchical clustering*. Data Novia.

Legendre, P., & Legendre, L. (2012). *Numerical Ecology*. Springer Series in Statistics, 3rd ed. edition.

Maizland, L. (2024). The push to conserve 30 percent of the planet: What's at stake? Council on Foreign Relations. https://www.cfr.org/article/goal-conserve-30-percent-planet2030-biodiversity-climate

Mestanza-Ramón, C., Henkanaththegedara, S. M., Vásconez Duchicela, P., Vargas Tierras, Y., Sánchez Capa, M., Constante Mejía, D., ... & Mestanza Ramón, P. (2020). In-situ and ex-situ biodiversity conservation in Ecuador: A review of policies, actions and challenges. *Diversity, 12*(8), 315.

Mi, X., Feng, G., Hu, Y., Zhang, J., Chen, L., Corlett, R. T., ... & Ma, K. (2021). The global significance of biodiversity science in China: An overview. *National Science Review*, *8*(7), nwab032.

Mittermeier, R. A., Myers, N., Gil, P. R., & Mittermeier, C. G. (1997). *Megadiversity: Earth's biologically wealthiest nations*. CEMEX / Conservation International.

Mittermeier, R. A., Myers, N., Thomsen, J. B., da Fonseca, G. A., & Olivieri, S. (1998). Biodiversity hotspots and major tropical wilderness areas: Approaches to setting conservation priorities. *Conservation Biology*, *12*(3), 516-520.

Mittermeier, R. A. et al. (2004). *Hotspots revisited: Earth's biologically richest and most endangered terrestrial ecoregions*. CEMEX.

Mittermeier, R. A., Turner, W. R., Larsen, F. W., Brooks, T. M., & Gascon, C. (2011). Global biodiversity conservation: The critical role of hotspots. In *Biodiversity hotspots* (pp. 3-22). Springer.

Molina, M., Terneus, E., Yánez, P., & Cueva, M. (2018). Resilience of phytoplankton community in the Andean Papallacta lagoon and its tributaries, eight years after an oil spill. *LA GRANJA. Revista de Ciencias de la Vida, 28*(2):67–83.

Myers, N., Mittermeier, R. A., Mittermeier, C. G., Da Fonseca, G. A., & Kent, J. (2000). Biodiversity hotspots for conservation priorities. *Nature*, *403*(6772), 853-858.

Nash, M. H. (2022). *The 201 most (& least) biodiverse countries*. The Swiftest. https://theswiftest.com/biodiversity-index/

Pisces Conservation Ltd. (2014). *Community Analysis Package* (Version 4.0) [Software]. Pisces Conservation Ltd.

Ratnayeke, S., van Manen, F. T., Clements, G. R., Kulaimi, N. A. M., & Sharp, S. P. (2018). Carnivore hotspots in Peninsular Malaysia and their landscape attributes. *PloS One*, *13*(4), e0194217.

Roe, D. (2008). The origins and evolution of the conservation-poverty debate: A review of key literature, events and policy processes. *Oryx*, *42*(4), 491-503.

The Swiftest. (2022). *Biodiversity index*. The Swiftest. https://theswiftest.com/biodiversity-index/

Vences, M., Wollenberg, K. C., Vieites, D. R., & Lees, D. C. (2009). Madagascar as a model region of species diversification. *Trends in Ecology & Evolution*, *24*(8), 456-465.

Wiens, J. J., & Donoghue, M. J. (2004). Historical biogeography, ecology and species richness. *Trends in Ecology & Evolution*, *19*(12), 639-644.

Wold, S., Esbensen, K., & Geladi, P. (1987). Principal component analysis. Chimometrics and intelligent laboratory systems. In *Conference on Emerging Technologies Factory Automation Efta, number 2*, pp. 704–706.

WorldAtlas. (2005). The world’s 17 megadiverse countries. https://www.worldatlas.com/articles/ecologically-megadiverse-countries-of-the-world.html

Yánez, P. (2005). *Biometría y Bioestadística fundamentales*. *Analizando la estructura numérica de la información en proyectos ecológicos*. FHGO.

Yánez, P. (2011). Variables ecológicas, evolutivas y de conservación en ambientes insulares: el caso Galápagos. *Qualitas*, *1*, 25-39.

Yánez, P. (2014). *Ecología y biodiversidad: un enfoque desde el neotrópico*. UNIBE/UIDE.

Yánez, P. (2016). Las áreas naturales protegidas del Ecuador: características y problemática general. *Qualitas*, *11*, 41-55.

Yánez, P., Benavides, J., & Quishpe, C. (2013). Multivariate characterization of the entities that make up the patrimony of natural areas of the Ecuadorian State: Phase I. *La Granja, 18*(2): 5-32.

APPENDIX

Table 1

Species richness across six biological groups and land area in 20 megadiverse countries, ordered from largest to smallest (adapted from The Swiftest, 2022)

	Countries	Birds	Amphibians	Fish	Mammals	Reptiles	Vascular Plants	Area in km2
1	United States	844	326	3081	531	556	15500	9833517
2	China	1285	540	3476	622	554	31362	9596961
3	Brazil	1816	1141	4738	693	847	34387	8515767
4	Australia	725	245	4992	355	1131	19324	7692024
5	India	1212	446	2601	440	715	45000	3287263
6	DR Congo	1110	227	1528	465	313	8860	2344858
7	Mexico	1105	411	2629	533	988	23385	1964375
8	Indonesia	1723	383	4813	729	773	19232	1904569
9	Peru	1861	655	1583	490	510	19812	1285216
10	South Africa	762	132	2094	331	421	21250	1221037
11	Colombia	1863	812	2105	477	634	24025	1141748
12	Bolivia	1435	259	407	382	315	14729	1098581
13	Tanzania	1074	207	1773	412	346	10100	947303
14	Venezuela	1386	365	1735	376	419	30000	916445
15	Myanmar	1034	540	1088	304	364	16000	676578
16	Thailand	936	153	215	314	468	6600	513120
17	Papua New Guinea	743	416	2884	282	384	13634	462840
18	Vietnam	835	263	2423	313	512	8500	331212
19	Malaysia	721	278	1951	348	502	14060	330803
20	Ecuador	1629	659	1111	392	492	18466	283561