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Geodiversity Research at the Crossroads: Two Sides of the Same Coin

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Geodiversity research is a growing industry. However, in contrast to diversity studies in other branches of natural sciences, geodiversity specialists have only paid attention to one side of the coin. They focused on the conservation of geological heritage (geoconservation) and its role/use for economic development through geotourism. Most geodiversity experts forgot the more strictly scientific side of the coin such as the use of standard techniques to inventory georesources and analyze their spatial patterns. Furthermore, the lack of a consensual definition with universal classifications and standards to carryout inventories inhibits progress in the inventory and quantification of planetary geodiversity. Even though most definitions of geodiversity include soil resources, pedodiversity is generally ignored in geodiversity research and publications. On the other hand, pedodiversity studies tended to follow the path previously created by biodiversity experts over a period of decades, although they have not convinced policymakers to approve strategies to preserve global soil resources (parks, pedosites, reserves, etc.). Biodiversity studies paid attention to the role of diversity in the structure and function of biocenosis, ecosystems, and biomes, with preservation being placed in the hands of experts in conservation biology. The structure and dynamics of all the Earth surface systems could be analyzed using the standard mathematical tools developed for biodiversity studies and that have been applied with success in pedodiversity analyses. In fact, most of the patterns detected in biodiversity also appear in pedodiversity. According to the canons of the philosophy of science, geodiversity has not reached a paradigm shift, despite the claims of some geodiversity experts. Thus, geodiversity research is at a crossroads as it seeks to reach a genuine paradigm shift.

Keywords: pedodiversity, biodiversity, standardized methods, geotourism, geological heritage, universal classification

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INTRODUCTION

There has been considerable interest in geodiversity and pedodiversity studies in recent decades. Pedodiversity studies the different types of soils found in a given area, while geodiversity studies the different types of geologic resources in a given area. Pedodiversity is considered part of geodiversity in many definitions and popular concepts that include geology, landforms and soil (Sharples, 1993; Gray, 2004). However, in practice pedodiversity and geodiversity involved different experts and traditions; they grew from different starting points and have ended up in different places.

There are many common aspects that could be shared by all natural diversity studies irrespective of the natural resources involved (Ibáñez et al., 2021a; Ibáñez et al., 2021b). However, these common aspects have not been adequately studied and debated. Quantitative techniques that were developed and refined by biodiversity researchers over decades to support biodiversity studies are also applicable to geodiversity and pedodiversity analysis. Soil scientists studying pedodiversity followed the same techniques as mathematical ecologists, but geoscientists studying geodiversity focused on the implementation of proposals aimed at preserving geological heritage and popularising it among the general public for economic and social purposes (e.g., geosites, geoparks, geotourism). Current approaches to propose and quantify diversity with index and statistical models are well known and described in the literature on soils and ecology but usually ignored in the geodiversity literature. Thus, at this time it is possible compare biodiversity and pedodiversity studies at all scales, in contrast to geodiversity findings which cannot be compared to other diversity studies. This paper serves as a heuristic brainstorm and calls for action to solve this paradox. A staring point could be the following broad definition of diversity proposed by (Huston, 1994):

"The concept of diversity has two primary components, and two unavoidable value judgements. The primary components are statistical properties that are common to any mixture of different objects, whether the objects are balls of different colours, segments of DNA that code for different proteins, species or higher taxonomic levels, or soil types or habitat patches on a landscape. Each of these groups of items has two fundamental properties: 1) the number of different types of objects (e.g., species, soil types) in the mixture or sample; and 2) the relative number or amount of each different type of object. The value judgements are 1) whether the selected classes are different enough to be considered separate types of objects; and 2) whether the objects in a particular class are similar enough to be considered the same type. On these distinctions hangs the quantification of biological diversity" (Huston, 1994; p. 65).

BIODIVERSITY AND PEDODIVERSITY VERSUS GEODIVERSITY: TWO DIVERGENT TRAJECTORIES

As pedodiversity and geodiversity diverged it is not currently possible to compare the results of geodiversity and pedodiversity research. To get to the point where biodiversity, geodiversity and pedodiversity results could be compared, it will be necessary to 1) follow uniform mathematical procedures in all natural resources analysis, 2) propose consensual and universal taxonomies that will be accepted for each of the natural resources and 3) to face the difficult task of investigating new indices that can integrate the diversity of all geodiversity resources with their idiosyncratic taxonomies (e.g., lithodiversity, landforms or geomorphologic diversities, etc.) into a single value.

The experts on biodiversity cannot agree on a single specific founder, with opinion frequently being that biodiversity studies matured slowly according to the inputs of different authors over a period of years (e.g., Ibáñez and Bockheim, 2013; Ibáñez, 2017). Biological and/or ecological diversity research and concepts, as well as the mathematical tools to quantify diversity, were developed at the beginning of the 20th century. Maximum interest in biodiversity work was reached between the 1950s and 1970s. This work was important in the development of theoretical ecology in addition to being considered the central core of conservation biology. The term "biodiversity" as a description of biological diversity was proposed much later by Rosen in 1985 in the frame of congresses and convections, and was finally popularized during the Convention of Biological Diversity at the Rio de Janeiro Summit in 1992 (see the history in Harper and Hawksworth, 1994). Biodiversity research was born to improve our knowledge of the structure and dynamics of ecosystems, whereas the formulation of statistical tools and preservation strategies received attention from researchers and policy makers later in biodiversity history. For example, several experts on conservation biology believe the foundation of this discipline should be considered the publication of the theoretical paper "Theory of Island Biogeography" by MacArthur and Wilson (1967), being corroborated in a plethora of publications in the following decades.

Although there is some almost forgotten precedent in the scientific literature, research on pedodiversity began in earnest in 1990. It took the formal progress made by biodiversity experts as a starting point and tried to detect similarities and differences between the spatial patterns detected by biodiversity research and those researching abiotic resources such as soils and soilscapes. In fact, as early as 1993, the date when Sharples is credited with coining the term geodiversity (Sharples, 1993), pedologists began to find evidence that 1) the spatial patterns detected in biodiversity and pedodiversity were strikingly similar and 2) there are several lines of evidence that the same could occur with respect to lithodiversity and geomorphological diversity (De-Alba et al., 1993; Ibáñez et al., 2012a; Ibáñez et al., 2012b). In fact years latter Ibáñez and Effland (2011) compiled previous and added new evidence in the paper "Toward a Theory of Island Pedogeography," showing that the predictions of MacArthur and Wilson's equilibrium theory are applicable to pedodiversity. This requires only one (the power law that relates the number of species in the area with an exponent of 0.25) of the several premises (latitude, longitude, distance to the continents) proposed by those legendary ecologists to corroborate the theory (island area). Thus, the theory of island biogeography should be revisited by experts in biodiversity and conservation biology to clarify the role of the other above-mentioned premises.

The relationship between pedodiversity and below-ground biodiversity has received much less study (Wardle et al., 2004). The same can be said of the relationship between the assemblages of the different soil horizons in which a pedotaxa can be stratified (genetic pedodiversity) and the communities that host each of them (Doblas-Miranda et al., 2009). This is one of the alarming omissions in our understanding of soil biodiversity that should be addressed in the future. However, several studies have shown that different pedotaxa types (Garbeva et al., 2004; Fierer and Jackson, 2006; Gagelidze et al., 2018) and different soil horizon types

(Ekelund et al., 2001; Fierer et al., 2003; Rosling et al., 2003; Hansel et al., 2008; Doblas-Miranda et al., 2009; Eilers et al., 2012; Costantini and Mocali, 2022) house different assemblages of soil organisms, which indicates soil horizons should be considered in defining the variety of habitats utilized by soil organisms. It has been demonstrated that geographical spaces with low pedodiversity are also poor in above-ground biodiversity (see Ibáñez and Bockheim, 2013; Ibáñez, 2017; and chapters therein; Rillig et al., 2019). Therefore, if we want to preserve biodiversity, we must also preserve pedodiversity (Ibáñez et al., 2003; Ibáñez and Feoli, 2012; Guerra et al., 2021). For this reason, various soil scientists have proposed the creation of networks of soil reserves and/or the inclusion of pedodiversity in other programs related to the preservation of nature (Ibáñez et al., 2003; Ibáñez and Feoli, 2012; Gerasimova et al., 2014; Costantini and L'Abate, 2009; Costantini and L'Abate, 2016). However, it is important to note that we are aware of these limitations and needs precisely because biodiversity and pedodiversity studies utilized uniform methods and techniques, allowing results to be compared and contrasted.

In summary, pedologists followed the path already traveled by biodiversity experts: analyzing the spatial patterns based on the taxa detected and the percentage that each one occupies in the study area. In fact, published pedodiversity research preceded the more general geodiversity research (Ibáñez et al., 1990; De-Alba et al., 1993; Ibáñez et al., 1994; Ibáñez et al., 1995), despite the fact that geodiversity experts will often claim pedodiversity as part of their objects of study. Pedodiversity efforts with a view to the preservation of soil resources (e.g., design of networks of natural soil reserves. etc.) were not intended to take place at the political level, and there was no legislative push for this purpose (against the support of the EU Parliament at the beginning of the 21st century).

The history of geodiversity studies followed a very different path. The UNESCO International Symposium on the Conservation of Geological Heritage was held in 1991 and approved the "International declaration of the rights of the memory of the Earth." This was a hugely important political step forward in the conservation of the world's geological heritage. The true call to action began in 1996 during the 30th International Geological Congress held in Beijing (China), where the concept of the geopark was proposed to reinforce the initiatives of geoconservation. From that moment, geodiversity experts became more concerned with geoconservation and geoheritage, almost completely ignoring the detection of possible spatial patterns of geological resources. As a result of the successes of these political decisions the number of publications on geoheritage grew fast (Ibáñez et al., 2019). Thus, geodiversity studies that were born under the umbrella of conservation purposes did not pay much attention to the analysis and quantification of geodiversity of Earth surface systems in a scientifically sound way, as was the case for biodiversity and pedodiversity studies. Under the umbrella of the UNESCO label, the selection of geoparks demands that political socioeconomic requirements be incorporated, but the latter should be not considered in the inventory of the "best sites" to be preserved from a scientific point of view. Such requirements should be considered separately from scientific analysis.

The question of the approach to diversity studies also has implications for major global challenges facing our modern world. Degradation of the biosphere and geosphere has profoundly altered the pedosphere. Several studies show a loss of pedodiversity in certain countries and geographical areas, and the transformation of some pedotaxa in others (Amundson et al., 2003; Dobrovolsky and Nikitin, 2009; Lo Papa et al., 2011). However, human actions have transformed the pedosphere to such an extent that new anthropogenic taxa are included in soil taxonomies, such as the WRB Technosols (FAO). Therefore, some publications show the loss of certain types of natural soils and their replacement by others of anthropogenic origin (Xuelei et al., 2003; Zhang et al., 2007; Ibáñez et al., 2015).

The definition of diversity proposed by Huston (1994), as with most diversity definitions, demands discerning types of objects, which implies having classifications that discern between them. Contrary to the estimation of biodiversity and pedodiversity that only paid attention to a single resource, any estimation of several diversities simultaneously, as is contemplated by the definition of geodiversity, is a challenge from a mathematical point of view that has been not solved due to the lack of standardized typology (Ibáñez et al., 2019). Consequently, the quantification of geodiversity faces some difficult challenges. Unlike biodiversity and soil diversity, there are no universal classifications of lithology and geomorphology or in the worst-case landforms. Without classifications and inventories, the quantification of geodiversity is impossible. There are also no satisfactory tools to quantify diversities of different resources in a single index (Ibáñez and Brevik, 2019). Geodiversity experts make use of "ad hoc" and "site specific" classifications and thus it is not feasible to compare the estimates made in different territories and environments. This fact prevents obtaining a picture of the geodiversity of the world (a "geodiversity inventory," using the term common in bio- and pedodiversity). However, a major challenge is also generated in the very definition of the several resources to be considered in the concept of geodiversity. Many authors consider minerals, sediments, fossils, water etc. (**Figure 1**) to be part of geodiversity (Brilha, 2014). The enormous influence of Gray's seminal book, as well as the definition proposed by Gray, contemplates geology, landforms and soils (Gray, 2004; Gray, 2008a; Gray, 2021). It is paradoxical

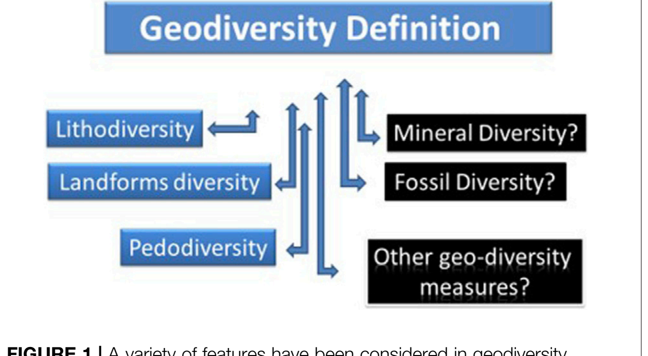

FIGURE 1 | A variety of features have been considered in geodiversity studies, with the exact features depending on the given researcher and study.

that geodiversity experts mostly ignore soils and include other natural resources according to their own preferences. Therefore, such a fact makes it difficult to limit the object of study: geodiversity of what? What resource is to be preserved?

Gray claims that the emergence of geodiversity studies means, *de facto*, a "change of paradigm" (Gray, 2008a; Gray, 2008b). The term paradigm has several meanings, but in science it is usually reserved to that proposed by Thomas Kuhn in his book "The Structure of Scientific Revolutions" (Kuhn, 1962), where it refers to drastic changes in previously accepted basic assumptions in a scientific discipline. Any reader who knows Kuhn's contribution to the philosophy of science will understand that geodiversity studies cannot be considered, in any way, a paradigm shift. In the best of cases, when the previously described problems are solved, the geosciences should detect the universal ubiquity of geospatial patterns and propose predictive tools that help us progress in the knowledge of the structure and dynamics of the geosphere in the broad sense. Only on these grounds it is permissible talk of a true paradigm shift. The preservation of resources per se should not be considered a paradigm shift, but the important (but not particularly novel) "legal" possibility of conserving certain valuable geological spaces. The intrinsic value of these geologic spaces cannot be appreciated without a global inventory of the natural resources involved (diversity inventory). A mature discipline demands 1) creation of new science and philosophy, 2) educating new members (students), and 3) an impact on cultural practices (Kuhn, 1962). Current geodiversity practices have led to the second and probably the third items on this list, but the lack of standardized methods and techniques has hampered the first.

A HISTORY CONDITIONED BY THE FIRST PUBLICATIONS IN EACH SCIENTIFIC FIELD?

With the exception of the predictions of MacArthur and Wilson's equilibrium theory, the current pillars concerning biodiversity have been published over decades by different authors and from different perspectives. In the same way, the foundations of pedodiversity studies have been the fruit of various researchers over more than 20 years. However, it seems that the magnificent book written by Murray Gray is considered the foundational act for geodiversity. This publication has conditioned a large part of later studies. Regardless of the quality of this book, such a collective way of proceeding seems to have closed the doors to other perspectives, and diverse perspectives are always enriching. In the future geodiversity studies should cover many more topics than today. Geodiversity should be much more than geoparks, geosites, geotourism, and geoconservation.

In a bibliometric analysis, Ibáñez et al. (2019) documented both the lack of attention to soil resources in geodiversity studies, as well as the geographic bias of the UNESCO geoparks to countries where tourism makes up a large share of the gross domestic product (GNP). Thus, the current distribution of UNESCO geoparks is strongly biased and is unlikely to be representative of global geodiversity. For example, in Europe the countries with the largest number of UNESCO Geoparks clearly correlate with those states in which tourism contributes a particularly large share to their gross national product.

FROM GEOPEDOLOGY CLASSIFICATION AND INVENTORIES TO GEODIVERSITY ANALYSIS

Geopedology is a branch of the soil sciences that attempts to link soils, geology and landforms (e.g., Zinck, 1988; Zinck, 2013). It is notable that this scientific approach takes into account the same resources that are considered in the definition of geodiversity proposed by Gray (2004). Zinck (2013) and Zinck et al. (2015) proposed a methodology of classification and inventories that consider several geological features at the same time, in addition to lithology, geomorphology and soils, that could be very useful to the quantification of geodiversity and should be analyzed by geodiversity experts (see also Toomanian, 2013; Saldaña, 2016; Ibáñez and Brevik, 2022).

More specifically, the categories of the hierarchical classification proposed by Zinck (1988) are the following: 1) geostructure; 2) morphogenic environment; 3) geomorphic landscape; 4) relief/molding; 5) lithology/facies; and 6) terrain form/landform (**Figure 2**; **Table 1**). Each of the categories of the hierarchical system is subdivided into various precisely defined and detailed

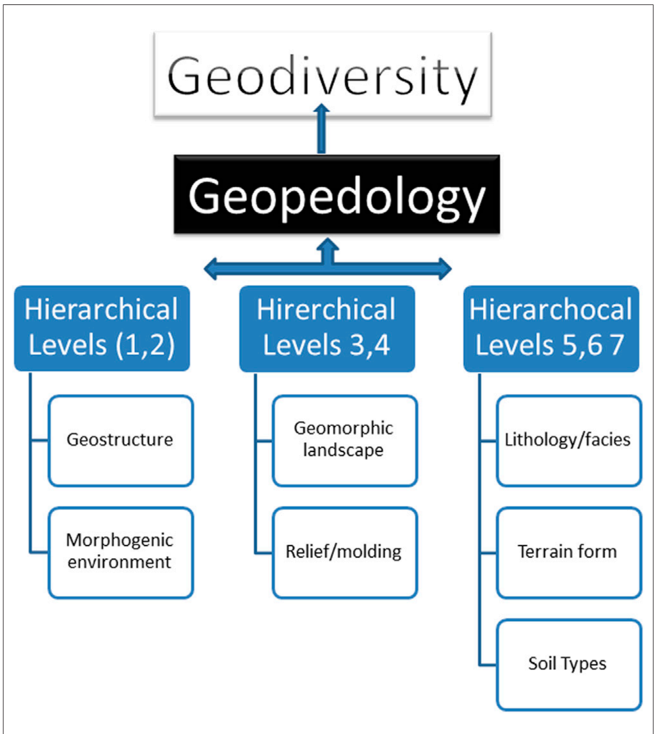

FIGURE 2 | Diagrammatic depiction of Zinck et al. (2005) geopedology concept.

TABLE 1 | Synopsis of the geoform classification system from Zinck et al. (2015).

Level	Category	Generic concept	Short definition
1	Order	Geostructure	Large continental portion characterized by a type of geologic macro-structure (e.g., cordillera, geosyncline, shield)
2	Suborder	Morphogenic environment	Broad type of biophysical environment originated and controlled by a style of internal and/or external geodynamics (e.g. structural, depositional, erosional, etc.)
3	Group	Geomorphic landscape	Large portion of land/terrain characterized by given physiographic features: it corresponds to a repetition of similar relief/molding types or an association of dissimilar relief/molding types (e.g., valley, plateau, mountain, etc.)
4	Subgroup	Relief/molding	Relief type originated by a given combination of topography and geologic structure (e.g., cuesta, horst, etc.). Molding type determined by specific morphoclimatic conditions and/or morphogenic processes (e.g., glacis, terrace, delta, etc.)
5	Family	Lithology/facies	Petrographic nature of the bedrocks (e.g., gneiss, limestone, etc.) or origin/nature of the unconsolidated cover formations (e.g., periglacial, lacustrine, alluvial, etc.)
6	Subfamily	Landform/terrain form	Basic geoform type characterized by a unique combination of geometry, dynamics, and history

taxa. Simplifying the structure proposed by Alfred Zinck (much more precise and detailed), it is notable that soils (soil associations, etc.) are located at the lowest level of the hierarchy. As can be seen, the geopedological hierarchy contains all the elements to quantitatively estimate geodiversity from a nested hierarchical structure and with very precise terms. This methodology was developed by Zinck over a number of years and has been tested in several countries. All data required to estimate geodiversity would be found in the same geospatial database. Using the geopedological approach some authors (Toomanian, 2013; Ibáñez and Gómez, 2016; Saldaña, 2016) showed that landforms geodiversity and pedodiversity follow the same spatial patterns.

GEODIVERSITY LESSONS FROM BIODIVERSITY AND PEDODIVERSITY STUDIES

What are the lessons that geodiversity researchers can draw from biodiversity and pedodiversity studies? Geological resources are quite broad by their nature and are very different than biological resources. For this reason it was once thought that the former should not follow the same patterns as the latter (a hypothesis to be corroborated) and therefore would demand other perspectives and approaches. However, pedodiversity studies followed the approaches and methodologies previously worked out for biodiversity work by ecologists, testing step by step, pattern by pattern, and finding similar results. And it was precisely the experts in soil science who detected many similar spatial patterns in relation to lithology and geomorphology as well.

A fascinating exception in the geodiversity literature involved mineral diversity. R.M. Hazen as well as G. Ausubel et al. used a universal classification of mineral types and the global Mindat database (https://www.mindat.org/), which specifies mineralogic spatial distribution at the worldwide level, to carry out very interesting research that reached conclusions similar to those detected in pedodiversity analysis (Hystad et al., 2015a; Hystad et al., 2015b; Hazen et al., 2015; Hazen and Ausubel, 2016). These authors were able to predict the number of mineral species not yet described as well as their relative abundance, global spatial patterns, the proportion of minerals in the planet that occur due to the influence of life, and propose models of mineral evolution throughout the history of the Earth. However, against the importance of these findings it is surprising that such studies have not aroused broader interest in the geodiversity community (Ibáñez et al., 2021a; Ibáñez et al., 2021b).

The quantification of pedodiversity is not limited to enumerating the pedotaxa present in a given geographical space, which requires deep statistical analysis. Pedodiversity experts have made use of the same mathematical tools used by biodiversity experts, along with adding some. There are different ways of measuring diversity, the following being the most basic and widely used:

(1) Indices of richness; the number of taxa (for example, biological species, communities, pedotaxa, soilscapes) known to occur in a defined sampling area.
(2) Indices based on proportional abundance of each taxon; not only the number but also the relative abundance (for example, the relative area occupied by each pedotaxon) is taken into account.
(3) Indices based on sets of parameters and models describing the distribution of abundance of categories of taxa (organisms) in a given ecosystem or soilscape.
(4) Indices based on distribution models addressing how diversity increases according to increase in the size of the studied area (richness-area interrelationships).

Over the last 20–25 years pedologists applied techniques such as these that were developed by mathematical ecologists, with the purpose of detecting similarities and differences in biodiversity and pedodiversity analysis, also taking into account geomorphological diversity and lithodiversity as it relates to both these natural resources. In most of the cases the patterns detected are irrespective of whether the resources are biological or non-biological (see Toomanian, 2013; Ibáñez and Bockheim, 2013; Saldaña, 2016; Ibáñez, 2017; Ibáñez and Pfeifer, 2022, etc.). The regularities detected are surprisingly similar. The same is true concerning the mathematical structure of pedological and biological classifications (see Ibáñez and Montanarella, 2013) and evidence exists to support the same regarding geopedological classifications and soil survey standards (Ibáñez et al., 2009). Unfortunately, the lack of universal classifications for lithologies and landforms has not allowed the same analysis of these resources. It is notable that it seems in all cases 1) the patterns detected are common to all non-linear or complex systems and thus 2) the presence of fractal scaling laws is the rule (Ibáñez et al., 2021a; Ibáñez et al., 2021b). The variety of mathematical tools used is summarized in works by Ibáñez and Bockheim (2013), Ibáñez and Montanarella (2013), Ibáñez (2017) and Ibáñez and Pfeiffer (2022).

Of the 300 to 400 publications on pedodiversity published to date, it appears that the spatial and temporal patterns of soil distribution on the landscape are strikingly similar to those of above-ground biodiversity, creating the following macroecological patterns: 1) species (taxa)–area relationships; 2) local–regional richness relationships; 3) latitudinal gradients in species richness; 4) altitudinal gradients in species richness; 5) species–range size relationships; 6) nestedness of species occurrence; 7); abundance–range size distributions; and 8) species–abundance distributions (e.g., Ibáñez and Bockheim, 2013 and chapters therein), among others. Pedodiversity tools have been applied to the following research lines:

(1) The use of mathematical diversity tools to detect soil spatial patterns, including pedodiversity–area and pedodiversity–time relations;
(2) Patterns of pedological assemblages (soil horizons –pedogenetic pedodiversity, soil types or pedotaxa –taxonomic pedodiversity, genesis of soilscapes and soil regions –megapedodiversity, etc.);
(3) Quantitative mathematical concepts and tools useful in soil geography such as quantification of soil endemism, soil minorities or soils at risk of extinction (endangered soils);
(4) Pedodiversity indices and their relationships with non-linear or complex systems, or dissipative structures in pedology such as convergent versus divergent pedogenesis (e.g., Phillips, 2016; Phillips, 2017);
(5) Areas selected to be designated as natural reserves for soil preservation;
(6) Other regularities in soil assemblages such as potential nesting among them, species–range size distribution, scale invariance, or scale dependence of soilscape patterns;
(7) Geopedological perspective: Comparison of diversity patterns in space and time of different natural resources (e.g., soils, rocks, landforms, minerals, biological diversity);
(8) Mathematical analysis of the structure of pedological and biological taxonomies;
(9) Relationships between mathematical tools of diversity and properties of free scaling laws (e.g., fractals and multifractals);
(10) Use of diversity mathematical tools to analyze the structures of maps; and
(11) Cognitive bias in taxonomies, soil mapping and scales, as well as diversity results.

Ibáñez et al. (2021a), Ibáñez et al. (2021b) and Jiang and Brandt (2016) (e.g., 2016, among other papers) detected similar patterns in artificial bodies and resources such as land system diversity inventories and urban maps, among many others. They conjectured that the patterns detected in ecological and geological *sensu lato* resources are the result of all of them being non-linear or complex systems with the signature of fractal and multifractal structures. The same occurs with mental constructs such as the structure of taxonomies or mapping standards. Ibáñez et al. (2021a) and Ibáñez et al. (2021b) conjectured that our mind works to emulate natural patterns or that our inventories and maps suffer a cognitive bias.

CONCLUSION

Geodiversity studies are a growing area, particularly because of interest in creating UNESCO geoparks. However, the experts in this branch of geosciences have largely not followed methods and techniques developed in previous studies of diversity for other natural resources (e.g., biodiversity, pedodiversity). This ignores the fact that preservation of geological resources is only one side of the coin, the other being the importance of scientifically analysing and cataloguing geodiversity and being able to compare geodiversity to other forms of natural diversity. Detecting the structural and spatial patterns that the different components of the terrestrial surface system follows is extremely important.

Geodiversity experts have avoided laying the most elementary foundations of a mature discipline, starting with 1) the very definition of geodiversity; 2) what resources should be considered; 3) the universal classification of these resources; 4) robust tools for the quantification of geodiversity; and 5) the ability to compare geodiversity studies, both to other geodiversity studies and to other natural diversity studies such as biodiversity, pedodiversity, etc. This approach has hindered the scientific progress of the discipline. The preservation of geological resources is a good thing, but geodiversity work as it currently exists cannot be considered a paradigm shift from a scientific point of view.

AUTHOR CONTRIBUTIONS

Conceptualization, JI; Methodology, JI and EB; Formal analysis, JI and EB; Investigation, JI and EB; Resources, JI and EB; Writing—original draft preparation, JI and EB; Writing—review and editing, JI and EB; Project administration, JI. All authors have read and agreed to the published version of the manuscript.

CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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