Chapter 9

Dynamic-Catenal Phytosociology for Evaluating Vegetation

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Abstract

The conservation of nature is a problem that has concerned the scientific community for many years. Plants and plant communities play a main role in evaluation and land management studies, owing to their importance as natural and cultural resources. Several studies from the perspective of flora and vegetation have been carried out in the last fifty years (some of them directly related to Phytosociology). According to that, the Dynamic-Catenal Phytosociology must be considered as a very useful tool to evaluate the conservation status of vegetation and to establish suitable models for land management. The fundamental phytosociological concepts to take into account in the evaluation processes of the conservation status of vegetation are reviewed in this study.

Keywords: Dynamic-Catenal Phytosociology, evaluation, conservation, vegetation, methods, plant communities

1. Introduction

The conservation of nature is a problem that has concerned the scientific community for many years. The biological and landscape assessment of a territory is a major phase in land use planning studies and is carried out at an early stage to determine the environmental implications as well as to assess the suitability of the territory for its planned use [1]. Although several factors (such as physical, social, economic, biotic, etc.) are known to be involved in the conservation assessment, this study only analyses the role of vegetation due to its importance as a resource and both cultural and natural heritage.

Plants and plant communities play a main role in this type of evaluation in land management studies, owing to their importance as natural and cultural resources. Several authors [2–6] have indicated that plant communities result from the interplay of many environmental variables, representing practically the completely floristic diversity, as well as many of the ecological relationships between the organisms involved. For this reason, knowledge of the flora and vegetation of a territory is essential for studying and evaluating its conservation status [7].

A great number of environmental evaluation studies from the perspective of flora and vegetation had been carried out in the last fifty years (some of them directly related to Phytosociology) can be mentioned: [2, 5–48].

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Since Phytosociology either classic Phytosociology or Dynamic-Catenal Phytosociology is the science that deals with the study of floristic composition of plant communities, their distribution and dynamism, besides the environmental factors that characterize them, this science must be considered as a useful tool to evaluate the conservation status of vegetation and to establish suitable models for land management. In this sense, it can be mentioned the comments pointed out by European researchers worried about nature conservation.

"La phytosociologie est. sans doute plus que toute autre science indispensable à l'étude et à la solution des délicats problèmes d'environnement (notamment d'évaluation et de valorisation des territoires) auxquels l'humanité est. confrontée" [22]. "Avoir une profonde connaissance phytosociologie d'un territoire permet de multiples applications de la phytosociologie pour la planification et la gestion des espaces naturels qui composent a territoire... La phytosociologie joue un rôle fondamental dans l'évaluation des valeurs biologiques du territoire..." [18].

It is noteworthy to say that in this type of studies that the biological evaluation of a territory will be more objective and easier to perform if formulations can be established to quantify the variety of environmental factors involved.

2. Fundamental phytosociological concepts to take into account in the evaluation processes of the conservation status of vegetation

Phytosociology is the part of Geobotany or Ecology that studies plant communities and their relationships with the environment. Not only classifies them and order the plant communities in a hierarchical system but also it is the science of syntaxons and association is the fundamental unit [49].

The terms Vegetal Sociology, Phytocenology and Plant Synecology have been used as synonyms. This ecological science studies biocenosis from a botanical perspective (phytocenosis), that is, it deals with plant communities, their relationships with the environment and the temporal processes that modify them.

With all this information and through an inductive and statistical method based on relevé it tries to create a universal hierarchical typology in which the association is the basic unit of the typological system.

Nowadays, the Dynamic-Catenal Phytosociology is recognized in addition to classic or Braun-Blanquet's phytosociology. The fundamental units of this science are the vegetation series or sigmetum, the permaseries or permasigmetum and the minoriseries or minorisigmetum in the Dynamic Phytosociology and the geoseries or geosigmetum, the geominoriseries or geominorisigmetum and the geopermaseries or geopermasigmetum in the Catenal Phytosociology.

The Dynamic-Catenal Phytosociology also called "Landscape Phytosociology" or "Global Phytosociology", tries to express through geobotanical and environmental sciences the biodiversity, structure and succession of the plant landscape, specifically of the natural, seminatural and anthropic terrestrial ecosystems [49].

It seems appropriate at this time to distinguish between the Dynamic Phytosociology and Catenal Phytosociology. The Dynamic Phytosociology deals with the vegetation series, with perennial and annual substitution stages and permaseries, without perennial non-nitrophilous substitution communities. The Catenal Phytosociology deals with vegetation geoseries, geominoriseries and geopermaseries.

Some concepts should be defined for a better understanding of the processes studied by the Dynamic-Catenal Phytosociology.

Let us firstly look at the concept of **succession**, which is the natural process of vegetation by which some plant communities are replaced over time by others within the same holotesela, originating different vegetative structures, which along the time can reach their final balance stage, which it is the head series or climax [49].

The succession process has been extensively studied in terrestrial ecosystems. Because of this, numerous well-known sequential models and vegetation series, both structurally and biocenotically as well as functional, are nowadays available allowing recognizing and designating the phytocenoses that go from the first colonizer stages to the climax.

But it is necessary to distinguish between the sequences that lead to the climax in a holotesela (progressive succession or progression) and those that by anthropozoogenic or natural actions remove from it (regressive succession or regression). It may also be useful to differentiate the notion of primary succession from the secondary one. The primary succession begins in environments not yet colonized and lacking of developed soils (rocky, recent fluglacial sediments, areas with totally eroded soils, etc.) while the secondary succession operates within the subserial stages of series of vegetation and pre-existing degraded soils [49].

Serial or subserial stages are all those stages that are not climax. The North American school of Clements distinguishes between the priserial associations or previous to the climax and subserial associations or after the destruction of the climax.

From a functional point of view, the initial communities only incorporate a small part of their energy availability as permanent biomass, while in the climacic forest stages the process is upturned, since energy production is mostly intended to growth, to respiration, and the maintenance of the system in its state of balance.

We have previously mentioned that the advances in Dynamic-Catenal Phytosociology have allowed us to establish well-known sequential models. Some examples are mentioned:

The characteristic climatophilous vegetation in a temperate oceanic territory (supratemperate humid bioclimatic belt) is a deciduous or marcescent forest. This vegetation can suffer alterations due to anthropic or natural (such us fire) phenomena that can cause changes in the structure and floristic composition, but also in the horizons of the soil on which it develops to a greater or lesser degree depending on the alteration intensity (**Figure 1**).

This means that deforested areas with loss of edaphic horizons are colonized almost immediately by communities of phanerophytes or nano-phanerophytes that constitute the pre-forests which are usually formed by softwood trees or brooms. These brooms are preferably constituted by *Cytisus* and *Genista* genera (**Figure 2**).

These communities sometimes share space with the communities of perennial hemicryptophytes that will make up the perennial grasslands in places with the greatest edaphic deterioration. These perennial grasslands will be replaced at the same time by chamephytic shrubland in areas where deeply destruction of the original forest soil has occurred. These soils are finally colonized in this successional process by communities of therophytes (**Figure 3**).

This example is perfectly transferable to other territories, in which depending on the climate and the soil, as well as the functionality of its vascular flora, we will find cases that are not the same but similar.

Thus, in tropical pluvial bioclimate usually an arboreal climax is replaced in a regressive successional process by up to three plant communities of phanerophytes and after that by two nanophanerophytic communities to be later substituted by a community dominated by hemicryptophytes. The last and more regressive stage is a community of chamephytic character. In fact, there would be eight serial stages in this vegetation series.

Figure 1.
Climax and serial stages of a climatophilous and acidophilous beech forest. Blechno spicant-Fagetum sylvaticae*;* Cytiso cantabrici- Genistetum polygaliphyllae; Pterosparto cantabrici-Ericetum aragonensis; Merendero pyrenaicae-Cynosuretum cristati. *Cofiñal (León, Spain).*

Figure 2.
*Forest (*Blechno spicant-Fagetum sylvaticae*) and nanophanerophytic shrubland (*Cytiso cantabrici-Genistetum polygaliphyllae*). Riaño (León, Spain).*

This model or sequence of serial stages is defined as **vegetation series** in the Dynamic-Catenal Phytosociology. It is also known **as sigmetum, sigmeto** (Spanishize) or **sinassociation**. It expresses the entire set of plant communities or steps that can be found in related tessellated spaces (superholotesela) as a result of the process of succession, which includes both the association representative of the mature and series head, like initial or subserial associations that can replace it.

Understood in this way, the vegetation series or sigmetum represents the basic unit or essential model of the Dynamic Phytosociology.

Figure 3.
Climax and serial stages of an edaphoxerophilous and basophilous beech forest. Epipactido helleborines-Fagetum sylvaticae*,* Lithodoro diffusae-Genistetum occidentalis *and* Helianthemo cantabrici-Brometum erecti*. Bernesga Valley (León, Spain).*

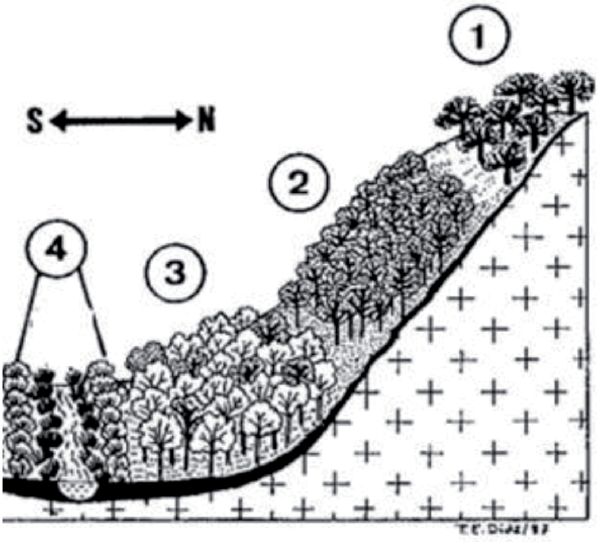

Figure 4.
1. Edaphoxerophilous vegetation series, 2. Climatophilous vegetation series, 3. Temporihygrophilous vegetation series, 4. Edaphohygrophilous vegetation series.

It is possible to differentiate between climatophilous, edaphoxerophilous, temporihygrophilous and edaphohygrophilous vegetation series (**Figure 4**).

The **climatophilous** or zonal vegetation series are those that are located in mature soils according to mesoclimate and only receive rainwater (**Figure 5**).

The **edaphoxerophilous** vegetation series are found in soils or in biotopes especially dry or xerophytic such as: lithosols, leptosols, arenosols, gipsisols, etc. These vegetation series grow in dunes, very windy places, steep slopes, ridges, slopes, etc. (**Figure 6**).

Figure 5.
Teucrio baetici-Quercetum suberis, *head series of the aljibic climatophilous and acidophilous cork oak forest.*

Figure 6.
Climax and chamephytic serial stage of an edaphoxerophilous vegetation series. Juniperetum sabino-thuriferae, Lithodoro diffusae-Genistetum scorpii. *Mirantes de Luna (León, Spain).*

The **temporihygrophilous**, **mesophytic** and **mesohygrophytic** vegetation series have extraordinary hydric contributions due to topographic reasons. These series develop in slightly flooded or very humid soils only part of the year. The soil horizons are well drained or aerated at least during the summer or the dry season.

Lastly, **edaphohygrophilous** vegetation series are those that occupy particularly humid soils and biotopes such as fluvisols, halools, histosols, etc. They are found in river beds, marshy areas, salt marshes, peat bogs… (**Figure** 7).

Subseries and vegetation faciations can be used as units of lower rank than the vegetation series. Those of higher rank, superseries, macroseries, megaseries and hyperseries can be used [45].

Figure 7.
Climax of an edaphohygrophilous vegetation series. Populo nigrae-Salicetum neotrichae. *Benavente (Zamora, Spain).*

There are other different models apart from the aforementioned vegetation series in the Dynamic-Catenal Phytosociology. **Minoriseries of vegetation** or **minorisigmetum** (Latinized expression) are plant communities with their corresponding perennial and annual substitution stages. These are found in the tessellated spaces and in their jurisdictional territories but that by exceptional environmental causes do not reach, in progressive succession, the mature stage of the habitual climatophilous or edaphophilous series head in the corresponding biogeographic and bioclimatic environment.

These plant communities have their own perennial substitution stages and can be frequent in certain zones and ecotonic areas such as: coastal cliffs with strong sea air, coastal dune systems, riverbeds, extensive peat bogs and marshes, estuaries, ridges and windy peaks, ecotonic altioreine territories with forests, etc.

Lazare [50] has recently proposed these units of Dynamic-Catenal Phytosociology with the names of "truncated series and geoseries: curtosigmetum and geocurtosigmetum", which we have preferred to translate by grammatical issues as: minoriseries and geominoriseries of vegetation (minorisigmetum and geominorisigmetum).

This is the case of the Asturian and Galician acidophilous laurels plant communities which represent the climax in highly protected areas from the very strong north-western winds on the cliffs. Their substitution stages and grasslands are dominated by *Armeria maritima*.

Also we can find nano-phanerophytic formations in the hills of the mountain passes where the wind is a determining factor for the development of the vegetation. These formations do not correspond to the bioclimatic and edaphic characteristics of the surrounding area, where the climax vegetation is a forest.

Both situations are an example of minoriseries or minorisigmetum.

Finally, we will also find **permaseries of vegetation** which are perennial, stable plant communities that configure permateselas or related permateselar complexes of exceptional biotopes such as: polar territories, hyper-deserts, peaks of high mountains, walls, cliffs, dunes, cliffs and coastal rocks beaten by sea, peat bogs, salt marshes, lagoon margins, etc. The mature or climax stage corresponds to a perennial vascular association (permassociation or permaseries), generally poorly

Figure 8.
*Geopermaseries of dune systems (*Ammophiletea australis*). Troia Peninsula (Portugal).*

Figure 9.
*Lacustrine permaseries (*Potamogetum natans *plant community). Villadangos del Páramo (León, Spain).*

stratified, lacking of perennial non-nitrophilous substitution communities. It means that, apart from the annual or ephemeral species and communities that may temporarily establish in the open or degraded spaces of such locations, it is only the perennial plants that participate in the mature community that can thrive to reorganize the same permanent plant community [49] (**Figures 8–11**).

The change of the environmental conditions of each permassociation or permaseries supposes its disappearance and its replacement by another permassociation or permaseries belonging to the same geopermaseries, without the possibility of returning to the previous situation through natural succession.

Figure 10.
*Glericolous permaseries (*Linario filicaulis-Crepidetum pygmaeae*). La Vueltona (Picos de Europa, Spain).*

Figure 11.
*Rupicolous permaseries (*Centrantho lecoqii-Saxifragetum canaliculatae*). Beberino (León, Spain).*

It is the case of a freshwater lagoon geopermaseries in which the persistence of water is not constant throughout the year. It undergoes partial or total desiccation during the summer because it loses the water table throughout the spring to recover it in autumn and having its maximum during winter (**Figure 12**).

The annual drying process previously mentioned makes the water-free spaces to be colonized by different vegetation circles (permaseries or permanent communities) along the year. It is possible to see up to seven different plant associations in some cases. Some of them are pre-spring nature; others have spring–summer character; others summer-autumnal and some annual, although these hygrophytes are all permanent. In other words, each one of them would be a permassociation (permaseries) included in the geopermaserie described.

We have to take into consideration what would happen if the lagoon was subjected to a natural process of silting. This would suppose an increasingly reduced space for the subsistence of the vegetation circles mentioned above; reaching in the future that some or all of them would disappear depending on whether the silting process is partial or total. In this last situation, the area occupied by the lagoon could be subjected to a new progressive successional process that might conclude in a climax of a series of edaphohygrophilous vegetation.

But the dynamic or successional processes not only are those that allow us to establish vegetation series or sigmetum, minoriseries or minorisigmetum or permaseries or permasigmetum. There are also those that have a progressive character towards the climax from communities structurally and floristically very distant from the mature stage corresponding to the ecological conditions (mainly climate and soil) of the territory where it is located.

These progressive processes towards the climax, according to the ecological theory, determine the recovery of the mature stage in equilibrium.

Nevertheless, it is not the most frequent process, existing ways of progression known as "pathways of urgency". They imply the overcoming in a single process of one or more of the pre-existing regressive successional stages that will preferably depend to a certain extent on the edaphic factors.

Furthermore, it is possible for a climax not to be the starting point of the regression process but being essential to go through it to reach the original mature stage. **Figure 13** shows the regressive and progressive dynamic models of vegetation.

This is the case happening when the regression process has been so strong. The plant community, which occupies the specific area where the deterioration takes place, happened to occupy a soil whose edaphoclimate does not correspond to the original one.

Giving an example:

Let us suppose a beech forest in southern exposure, at the limit of its distribution area between the Eurosiberian and Mediterranean region and therefore in a temperate oceanic bioclimate with a submediterranean variant, that undergoes a regressive

Figure 12.
Lagoon geopermaseries. Valdepolo León, Spain.

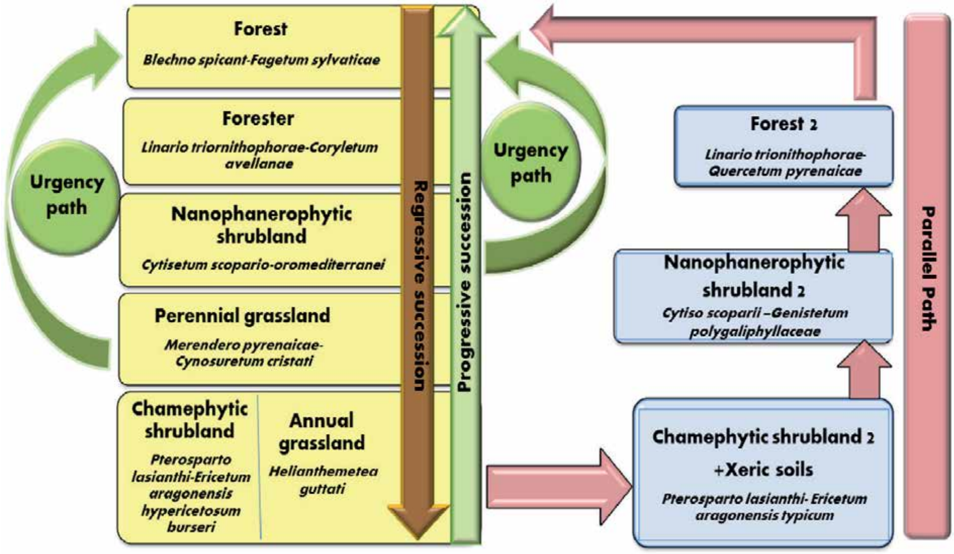

Figure 13.
Diagram showing regressive, progressive and parallel paths in vegetation dynamic.

process of wide magnitude, until reaching a serial stage or successional the chamephytic stage mainly due to soil erosion.

Under these conditions, the edaphoclimate of the soil on which this plant community grows will be clearly more xeric than in origin due to the solar radiation received. This will determine that the progressive process towards the original climax is modified, necessarily going through a marcescent forest, after reaching the original climax stage.

Picking up the **geopermaseries** concept, also called **geopermasigmetum**, it is the catenal expression of a set of contiguous permaseries or permasigmetum delimited by changing topographic or edaphic situations.

They are conditioned by extreme climatic situations (high mountains and polar areas), microtopographic or exceptional edaphic ones (walls, rocky areas, sea cliffs, salt marshes, etc.). It creates a large number of biotopes occupied by permanent perennial communities (contiguous permaseries), lacking non-nitrophilous perennial serial communities, which seem to have reached their equilibrium.

The most favorable places for the existence of geopermaseries or geopermasigmetum are cliffs, rock crevices, cliffs and littoral crags battered by seawater, peat bogs, snowdrifts, mobile dunes, shores of lagoons, water springs, etc. In addition, they are those locations that correspond to types of potential vegetation of extreme bioclimates of high mountains and Polar Regions.

The study of these groups of contiguous perennial permanent communities must be carried out within the framework of a single bioclimatic belt, in precise geomorphological limits and trying to follow the gradient of the ecological factor which determines the catena.

3. How to use these concepts for assessing the conservation status of vegetation in a specific territory?

As we have already mentioned, the greater the knowledge of the vegetation of the territory studied, the more precise will be the value of the conservation status of the vegetation.

We will always have to take into account that each plant community will be part of one of the units described above, that is, it will be permaseries of vegetation or it will be part of a minoriseries or a series of vegetation, either as climax or as a serial or successional stage, either in a regressive or a progressive sense.

In these last two cases, we must assess the position that each plant community occupies in relation to the total number of serial stages that make up the minoriseries or the vegetation series, including the anthropozoogenic communities existing in them.

A set of phytocenotic parameters (diversity, representativeness, maturity, naturalness and replaceability), territorial parameters (rarity, endemicity, relictism, finicole feature), besides environmental and cultural parameters should be added to evaluate individually the vegetation types existing in the territory under study. It would be also convenient to take into account parameters such as vulnerability, demography and fragility [7].

A very useful index for assessing the global status conservation of vegetation is the Potentially Distance Index (PDI) proposed by [7, 44]. This index is based on the premise that the conservation status of a territory is optimal when the whole of its vegetation is at the climax stage. Knowing the vegetation series and the distance of its serial stages from the climax, enable us to evaluate its conservation status independently of other territories. Therefore, PDI is founded on Dynamic-Catenal Phytosociology concepts. To apply this index, it is first necessary to establish the previous-actual vegetation cartography of the studied territory using syntaxa or syntaxon complexes according to phytosociological principles previously mentioned.

The PDI has the advantage of giving a universal application, which can provide us with an easy and valid comparison of the vegetation conservation status between different territories on the basis of their dynamic characteristics and their naturalness index. This index can offer objective and quantitative information to be applied in land management and nature conservation studies. Furthermore, it is a useful tool for restoration of potential natural vegetation in degraded areas.

Therefore the basis and interest of this index lies in the following aspects:

1. it is based on the Dynamic-Catenal Phytosociological concepts

2. the conservation status of a territory is optimal when the whole of its vegetation is at the climax stage (permaseries, climax of vegetation series and minoriseries)

3. it is objective and measurable

4. each plant community can be evaluated independently and numerically according to its inherent dynamic characteristics and its naturalness index

5. its application is universal

6. it is very useful for the restoration of potential natural vegetation in degraded areas

The formula for calculating the Potentiality Distance Index (PDI) is:

$$PDI = \sum_{i=1}^{n} \frac{\Omega\mathrm{i} * \mathrm{DIi}}{\Omega\,\mathrm{total}} \tag{1}$$

Phytosociological classes	**S**	**M**	**P**	**E**	**A**
Adiantetea capilli-veneris Br.-Bl. *in* Br.-Bl., Roussine & Nègre 1952			●		
Greeonivio aureae-Aeonietea Santos 1976			●		
Alnetea glutinosae Br.-Bl. & Tx. *ex* Westhoff & al. 1946	●				
Euphorbio paraliae-Ammophiletea australis Géhu & Rivas-Martínez *in* Rivas-Martínez & al. 2011			●		
Anomodonto viticulosi-Polypodietea cambrici Rivas-Martínez 1975			●		
Artemisietea vulgaris Lohmeyer, Preising & Tüxen *ex* von Rochow 1951					●
Asplenietea trichomanis (Br.-Bl. *in* Meier & Br.-Bl. 1934) Oberd. 1977			●		
Betulo carpaticae-Alnetea viridis Rejmánek *ex* Bœuf, Theurillat, Willner, Mucina et Simler in Bœuf & al. 2014	●				
Bidentetea tripartiate Tüxen, Lohmeyer & Preising *ex* von Rochow 1951					●
Cakiletea maritimae Tx. & Preising *ex* Br.-Bl. & Tx. 1952					●
Calluno vulgaris-Ulicetea minoris Br.-Bl. & Tx. *ex* Klika & Hadac 1944			●	●	
Carici rupestris-Kobresietea myousuroidis Ohba 1974 *nom. mut.*			●		
Cisto-Lavanduletea stoechadis Br.-Bl. *in* Br.-Bl. & al. 1940				●	
Crithmo-Staticetea Br.-Bl. *in* Br.-Bl. & al. 1952			●		
Parietarietea Rivas-Martínez *in* Rivas Goday 1964			●		
Cytisetea scopario-striati Rivas-Martínez 1974		●	●	●	
Chamaecytiso-Pinetea canariensis Rivas Goday & Esteve *ex* Esteve 1969 *nom. mut*.	●				
Kobresio myosuroidis-Seslerietea caerulea Br.-Bl. 1948 *em*. Ohba. 1974 *nom. mut.*			●		
Epilobietea angustifolii Tx. & Preising *ex* von Rochow 1951					●
Festucetea indigestae Rivas Goday & Rivas-Martínez 1971			●	●	
Festuco hystricis-Ononidetea striatae Rivas-Martínez. & al. 2002			●	●	
Festuco valesiacae-Brometea erecti Br.-Bl. & Tx. *ex* Klika & Hadăc 1944				●	
Galio aparines-Urticetea maioris Passarge *ex* Kopecký 1969					●
Geranio purpurei-Cardaminetea hirsutae (Rivas-Martínez & al. 1999) Rivas-Martínez & al. 2002					●
Halodulo wrightii-Thalassietea testudinum Den Hartog *ex* Rivas-Martínez, Fernández-González & Loidi 1999			●		
Helianthemetea guttati (Br.-Bl. in Br.-Bl. & al. 1952) Rivas Goday & Rivas-Martínez 1963				●	
Isoeto-Nanojuncetea Br.-Bl. & Tx. *ex* Westhoff & al. 1946			●		

Phytosociological classes	S	M	P	E	A
Juncetea maritimi Br.-Bl. *in* Br.-Bl. & al. 1952			●		
Caricetea curvule Br.-Bl. 1948 *nom. conserv.*			●		
Junipero sabinae-Pinetea sylvestris Rivas-Martínez 1965 *nom. inv.*	●		●		
Kleinio neriifoliae-Euphorbietea canariensis (Rivas Goday & Esteve 1965) Santos 1976			●	●	
Koelerio glaucae-Corynephoretea canescentis Klika *in* Klika & v. Novák 1941			●	●	
Lauro azoricae-Juniperetea brevifoliae Rivas-Mart. & al. *in* Rivas-Mart. & al. 2002	●				
Lemnetea Tüxen *ex* O. Bolòs & Masclans 1955			●		●
Littorelletea uniflorae Br.-Bl. & Tx. *ex* Westhoff, Dijk & Passchier. 1946			●		
Loiseleurio procumbentis-Vaccinietea microphylii Eggler *ex* Schubert 1960	●		●	●	
Lygeo sparti-Stipetea tenacissimae Rivas-Martínez. 1978 *nom. conserv. propos.*				●	
Molinio caerulae-Arrhenatheretea elatioris Tx. 1937				●	
Montio fontane-Cardaminetea *amarae* Br.-Bl. & Tx. *ex* Br.-Bl. 1948			●		
Mulgedio-Aconitetea Hadăc &Klika *in* Klika & Hadăc 1944			●		
Nardetea strictae Rivas Goday *in* Rivas Goday & Rivas-Martínez 1963			●	●	
Nerio oleandri-Tamaricetea Br.-Bl. & O. Bolòs 1958		●	●		
Rhamno crenulatae-Olecetea cerasiformis Santos *ex* Rivas-Martínez 1987 *nom. inv.*		●		●	
Oryzetea sativae Miyawaki 1960					●
Oxycocco-Sphagnetea Br.-Bl. & Tx. *ex* Westhoff & al. 1946			●		
Pegano harmalae-Salsoletea vermiculatae Br.-Bl. & O. Bolòs 1958					●
Petrocoptido pyrenaicae-Sarcocapnetea enneaphyllae Rivas-Martínez, Cantó & Izco *in* Rivas-Martínez & al. 2002			●		
Phagnalo saxatilis-Rumicetea indurati (Rivas Goday & Esteve 1972) Rivas-Martínez, Izco & Costa 1973			●		
Phragmito-Magnocaricetea Klika *in* Klika & v. Novák 1941			●		●
Poetea bulbosae Rivas Goday & Rivas-Martínez *in* Rivas-Martínez 1978					●
Polycarpaeo niveae-Traganetea moquini Santos *ex* Rivas-Martínez & Wildpret 2002	●	●			
Polygono-Poetea annuae Rivas-Martínez 1975					●
Posidonietea Den Hartog 1976			●		
Potametea Klika *in* Klika & V. Novák 1941			●		
Pruno hixae-Lauretea novocanariensis Oberd. 1965 *corr*. Rivas-Martínez, T.E. Díaz, Fernández-González, Izco, Loidi, Lousa & Penas 2002	●				

Phytosociological classes	**S**	**M**	**P**	**E**	**A**
Quercetea ilicis Br.-Bl. *ex* A. & O. Bolòs 1950	●	●		●	
Querco roboris-Fagetea sylvaticae Br.-Bl. & Vlieger *in* Vliegar 1937	●	●		●	
Rhamno catharticii-Prunetea spinosae Rivas Goday & Borja *ex* Tüxen 1962		●		●	
Rosmarinetea officinalis Rivas-Martínez, T.E. Díaz, F. Prieto, Loidi & Penas 2002				●	
Ruppietea maritimae J. Tx. 1960			●		
Saginetea maritimae Westhoff & al. 1962			●		
Salicetea herbaceae Br.-Bl. 1948			●		
Salici purpureae-Populetea nigrae (Rivas-Martínez & Cantó *ex* Rivas-Martínez & al. 1991) Rivas-Martínez & Cantó 2002	●		●		
Sarcocornietea fruticosae Br.-Bl. & Tx. *ex* A. Bolo's 1950 *nom. mut.*			●		
Scheuchzerio palustris-Caricetea nigrae Tx. 1937 *nom. mut.*			●		
Sedo albi-Scleranthetea biennis Br.-Bl. 1955				●	
Spartinetea maritimae Tx. *in* Beeftink 1962			●		
Stellarietea mediae Tüxen, Lohmeyer & Preising *ex* von Rochow 1951					●
Stipo giganteae-Agrostietea castellanae Rivas-Martínez & al. 1999				●	
Thero-Suaedetea Rivas-Martínez 1972			●		
Thlaspietea rotundifolii Br.-Bl. 1948			●		
Trifolio medii-Geranietea sanguinei T. Müller 1962				●	●
Utricularietea intermedio-minoris Pietsch 1965			●		
Vaccinio-Piceetea abietis Br.-Bl. *in* Br.-Bl., Sissingh & Vliegar 1939	●		●		
Zosteretea marinae Pignatti 1954			●		

If (S), Successional Stages, Minoriseries (M), Permaseries (P), Vegetation Series (E) are included in them or if they have Anthropozoogenic character (A) are expressed with ● [51–53]

Table 1.
Phytosociological classes of Spain and Portugal are shown in alphabetical order

Where i = i-th plant community, Ωi = surface area of i-th plant community, Ω total = total surface area occupied by all communities, DI_i = potentiality distance value of i-th community.

Its formula is as follows: $DI_i = 1 - [(3\ Pi - NIi)/3n)]$, Pi = position of i-th plant community in its respective vegetation series and minoriseries in relation to the series head, NIi = naturalness index of i-th community, n = number of serial stages in the vegetation series or minoriseries resulting from the succession process. In permaseries n = 1 because such plant communities are considered as series head.

We have:

NI = 1 for plant communities with low natural conservation and with strong human influence (distance to the optimum stage >50%);

NI = 2 for plant communities with relatively high natural conservation and with a low, but appreciable, human influence (distance to the optimum stage 30–50%);

NI = 3 for plant communities with high natural conservation without (or with very little) human influence (distance to the optimum stage <30%) [7, 44].

PDI are divided into four groups showing the distance to the series head of the studied area and therefore the global conservation status of vegetation. If the PDI value is ≤0.25 the vegetation is very distant from the climax and the conservation status is classified as "Poor". When it is >0.25 and ≤ 0.50 the vegetation is distant from the climax, and the conservation status is "Moderate". Vegetation is shown as moderately distant from climax when values are >0.50 and ≤ 0.75 and the conservation status is "Good". The conservation status is "very good" when the value is >0.75, and vegetation is not distant/too much distant to climax.

In **Table 1** are shown the relationship between vegetation series, minoriseries and permaseries with Spanish and Portuguese phytosociological classes.

4. Conclusions

The Dynamic-Catenal Phytosociology can be used to establish suitable models for land management. Fundamental concepts of this science can be applied to the Potentially Distance Index for assessing the global status conservation of vegetation. The index is universal, objective and measurable, for this reason it is a very useful tool for the restoration of potential natural vegetation in degraded areas.

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