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Chapter

Dynamic-Catenal Phytosociology for Evaluating Vegetation

Sara del Río, Raquel Alonso-Redondo,
Alejandro González-Pérez, Aitor Álvarez-Santacoloma,
Giovanni Breogán Ferreiro Lera and Ángel Peñas

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].
Vegetation Index and Dynamics

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, seminalatural 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.
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.
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).
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, halo-ols, 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].
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. [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
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.
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 (permaserseries) 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 permasersies 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
process of wide magnitude, until reaching a serial stage or successional the chame-
phytic 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 radia-
tion 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 peren-
nell serial communities, which seem to have reached their equilibrium.

The most favorable places for the existence of geopermaseries or geopermasig-
metum 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
gemorphological 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.
Vegetation Index and Dynamics

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:

\[
PDI = \sum_{i=1}^{n} \frac{\Omega_i \cdot DI_i}{\Omega_{total}}
\]
| Phytosociological classes                                               | S | M | P | E | A |
|-----------------------------------------------------------------------|---|---|---|---|---|
| **Adiantetea capilli-veneris** Br.-Bl. ex Br.-Bl., Roussine & Nègre 1952 |   |   |   |   |   |
| **Gremonia aurea-Aeonietea** Santos 1976                              |   |   |   |   |   |
| **Alnetea glutinosae** Br.-Bl. & Tx. ex Westhoff & al. 1946            |   |   | ● |   |   |
| **Euphorbio paraliae-Ammophyletea 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 carpatica-Alnetea viridis** Rejmánek ex Bœuf, Theurillat, Willner, Mucina et Simler in Bœuf & al. 2014 |   |   | ● |   |   |
| **Bidentetea tripartite** Tüxen, Lohmeyer & Preising ex von Rochow 1951 |   |   |   |   | ● |
| **Carduletae maritimae** Tx. & Preising ex Br.-Bl. & Tx. 1952           |   |   |   |   | ● |
| **Calluno vulgaris-Ulicetea minoris** Br.-Bl. & Tx. ex Klika & Hadac 1944 |   |   | ● |   |   |
| **Carici rupestris-Kobresietea myosuroidis** 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 cacerules** Br.-Bl. 1948 cm. Ohba. 1974 nom. mut. |   |   |   | ● |   |
| **Euphibetea angustifolii** Tx. & Preising ex von Rochow 1951           |   |   |   |   | ● |
| **Festucetos inductionis** Rivas Goday & Rivas-Martínez 1971            |   |   | ● |   |   |
| **Festuco hystricis-Ononidetea striatae** Rivas-Martínez. & al. 2002    |   |   | ● |   |   |
| **Festuco salsia-coe-Brometea erecti** Br.-Bl. & Tx. ex Klika & Hadac 1944 |   |   |   |   | ● |
| **Galio aparines-Urticetea majoris** Passarge ex Kopecký 1969           |   |   |   |   | ● |
| **Germanto purpurei-Cardaminetea hirsuta** (Rivas-Martínez & al. 1999) Rivas-Martínez & al. 2002 |   |   |   | ● |   |
| **Halodulo wrightii-Thalassietea testudinum** Den Hartog ex Rivas-Martínez, Fernández-González & Loidi 1999 |   |   |   | ● |   |
| **Helianthenetea 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.                                          |   |   |   |   |   |
| **Juniperetea sabinae-Pinetetea sylvestrii** Rivas-Martínez 1965 nom. inv.                |   |   |   |   |   |
| **Kleinio neriifoliae-Euphorbietea canariensis** (Rivas Goday & Esteve 1965) Santos 1976 |   |   |   |   |   |
| **Koelerio glaucae-Corynephoretea canescentis** 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 & Pascheier 1946               |   |   |   |   |   |
| **Loiseleurio procumbentis-Vaccinietea microphylli** Egglar ex Schubert 1960              |   |   |   |   |   |
| **Lygeo sparti-Stipetea tenacissimae** Rivas-Martínez, 1978 nom. conserv. propos.         |   |   |   |   |   |
| **Molinio caerulae-Arrhenatheretea elatioris** Tx. 1937                                   |   |   |   |   |   |
| **Montio fontane-Cardaminetea amarue Br.-Bl. & Tx. ex Br.-Bl. 1948**                      |   |   |   |   |   |
| **Mulgedio-Acomitetea** Hadác &Klika in Klika & Hadác 1944                                |   |   |   |   |   |
| **Nardeteta strictae** Rivas Goday in Rivas Goday & Rivas-Martínez 1963                  |   |   |   |   |   |
| **Nerio oleandri-Tamaricetea** Br.-Bl. & O. Bolòs 1958                                   |   |   |   |   |   |
| **Rhamno cremulae-Oleocetea ceraviformis** Santos ex Rivas-Martínez 1987 nom. inv.       |   |   |   |   |   |
| **Oryzetea sativae** Miyawaki 1960                                                        |   |   |   |   |   |
| **Oxyoco-Sphagneteta** Br.-Bl. & Tx. ex Westhoff & al. 1946                               |   |   |   |   |   |
| **Pegano harmalae-Salsuettea vermiculatae** Br.-Bl. & O. Bolòs 1958                       |   |   |   |   |   |
| **Petroeoide pyrenicae-Sarcocapnetea euneophyllae** Rivas-Martínez, Cantó & Izc in Rivas-Martínez & al. 2002 |   |   |   |   |   |
| **Phragno saxatilis-Rumicetea induvati** (Rivas Goday & Esteve 1972) Rivas-Martínez, Izc & Costa 1973 |   |   |   |   |   |
| **Phragno-Magnocariceta** Klika in Klika & v. Novák 1941                                  |   |   |   |   |   |
| **Poetae bulbosae** Rivas Goday & Rivas-Martínez in Rivas-Martínez 1978                  |   |   |   |   |   |
| **Polycarpaeo niveae-Traganetea moquini** Santos ex Rivas-Martínez & Wildpret 2002        |   |   |   |   |   |
| **Polygono-Poetae annuae** Rivas-Martínez 1975                                           |   |   |   |   |   |
| **Posidionietae** Den Hartog 1976                                                        |   |   |   |   |   |
| **Potaneteta** Klika in Klika & V. Novák 1941                                            |   |   |   |   |   |
| **Pruno hixae-Lauretea novocanariensis** Oberd. 1965 corr. Rivas-Martínez, T.E. Díaz, Fernández-González, Izc, Loidi, Lousa & Penas 2002 |   |   |   |   |   |
Where \( i = i \)-th plant community, \( \Omega_i \) = surface area of \( i \)-th plant community, \( \Omega_{total} \) = total surface area occupied by all communities, \( DI_i \) = potentiality distance value of \( i \)-th community.

Its formula is as follows: \( DI_i = 1 - \left[\frac{(3 Pi - NIIi)}{3n}\right]\), \( Pi \) = 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:

- \( NII = 1 \) for plant communities with low natural conservation and with strong human influence (distance to the optimum stage >50%);
- \( NII = 2 \) 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.
References

[1] Ortega R, & Rodríguez I. Manual de Gestión del Medio Ambiente. Fundación Maphre; 1996; Madrid

[2] Arnáiz C. Utilización de criterios ecológicos para la valoración del territorio. Séminaire de phytosociologie appliquée; 1981; 3, 119-126.

[3] Blandin P. Bioindicateurs et diagnostic des systèmes écologiques. Bulletin Écologie; 1986; 17(4), 214-307.

[4] Asensi A. Aplicación de la fitosociología a la evaluación del territorio. Monografías Flora Vegetación Béticas; 1990; 4-5,91-100.

[5] Géhu J.M. Sur la fragilité structurale de la frange terrestre des bords de mer et son analyse par les méthodes de la phytosociologie moderne dans un souci conservatoire. Colloques Phytosociologiques; 1992; 19, 37-44.

[6] Loidi J. Phytosociology applied to nature conservation and land management. In: Applied Ecology; 1994; Y.Song, H. Dierschke & X. Wang (eds.), Proceed. 35th Symposium IAVS in Shanghai, East China Normal Univ. Press, 17-30.

[7] Penas A, Herrero L, & del Río S. Valuation methods in vegetation and its use in land management. Acta Botanica Gallica; 2010; 157(4): 735-748.

[8] Géhu J.M. Phytosociologie et conservation de la nature. Colloques Phytosociologiques; 1988; 15, 1-7.

[9] Nef L. Considérations sur le choix des critères d’évaluation écologique. Évaluation des écosystèmes, Mons; 1977; 5-9.

[10] Nef L. Problèmes concernant les critères et l'évaluation biologique de l'environnement. Séminaire de phytosociologie appliquée; 1981; 3, 1-6.

[11] Froment A. Méthodologie des premières études d’impact écologique réalisées en Belgique pour les projets d’infrastructure routière. Séminaire de phytosociologie appliquée; 1981; 3, 15-26.

[12] Báscones J.C, & Ursúa, C. Criterios para la selección de espacios naturales protegidos en Navarra. Monografías Instituto Pirenaico de Ecología de Jaca (Homémage P.Montserrat); 1988; 4, 121-125.

[13] Dumont J.M. La conception, la réalisation et l’utilisation de la carte d’évaluation biologique de la Belgique. Colloques Phytosociologiques; 1988; 15, 117-126.

[14] Boulet V. Approches méthodologiques et phytosociologiques de la protection et de la gestion des pelouses calcicoles planitiales. Colloques Phytosociologiques; 1988; 15,417-430.

[15] Delpech R. & Philippe T. Possibilités d’application de la phytosociologie à la gestion écologique et conservatoire des communautés herbacées d’altitude de grand intérêt biologiques. Colloques Phytosociologiques; 1988; 15,487-507.

[16] Stein J. Un intermédiaire écologique adéquat en aménagement du territoire : la végétation naturelle potentielle. Colloques Phytosociologiques; 1988; 15, 569-579.

[17] Onaníndia M, Benito I, & García I. Descripción y valoración de los ecosistemas vegetales en el entorno del embalse de Urkullu (Guipúzcoa). Lurralde, 1988; 11,123-136.

[18] Bou i Tomas J. La phytosociologie et le réseau des espaces d’intérêt naturel de la Catalogne. Colloques Phytosociologiques, 1988; 15, 695-711.

[19] Géhu J.M. Étude phytoceonotique analytique et globale de l’ensemble des vases et prés salés et saumâtres de la
façade atlantique française; 1979; Ministère de L’Environnement, Bailleul.

[20] Géhu J.M. Introduction au 3e séminaire de phytosociologie appliquée. Séminaire de phytosociologie appliquée; 1981; 3.

[21] Géhu J.M. L’analyse symphytosociologique et géosymphytosociologique de l’espace. Théorie et méthodologie. Colloques Phytosociologiques, 1991; 17, 11-46.

[22] Lucas A. Une échelle de cotation des milieux naturels. Pen ar Bed n.s., 4, 72, 1-6.

[23] Géhu J.M. & J. Géhu-Franck, 1979.- Essai d’évaluation phytocoenotique de l’artificialisation des paysages. Colloques Phytosociologiques; 1973; 3, 95-120.

[24] Géhu J.M, & Géhu-Franck J. Essai d’évaluation biologique des milieux naturels. Exemples littoraux. Séminaire de phytosociologie appliquée; 1981; 3.

[25] Géhu J.M, & Géhu-Franck J. Les landes de La Poterie près de Lamballe (22), un exemple remarquable de diversité phytocénétique relictuelle; arguments pour leur protection. Colloques Phytosociologiques; 1988; 15, 299-316.

[26] Géhu J.M, & Géhu-Franck J. Essai d’évaluation phytocoenotique de l’artificialisation des paysages. Colloques Phytosociologiques; 1991; 17, 479-515.

[27] Theurillat J.P, Delarze R & Werner Ph. Inventaire des terrains secs de Suisse : le cas du Valais. Colloques Phytosociologiques; 1988; 15, 273-280.

[28] Costa M., Pérez R. & Soriano P. La vegetación como elemento de diagnóstico y valoración en la conservación del litoral. Colloques Phytosociologiques; 1988; 15, 281-298.

[29] Martín M.V, & Asensi A. Evaluación biológica del Parque Natural de la Sierra de Grazalema. Colloques Phytosociologiques; 1988; 15, 677-693.

[30] Asensi A, Díaz Garretas B, Ferre E, & Martín Osorio M.V. Aplicación de la metodología fitosociológica al análisis integrado del paisaje en el Parque Natural de la Sierra de la Nieve, Serranía de Ronda (Málaga, España). Colloques Phytosociologiques; 1991; 17, 159-175.

[31] Asensi A, Díaz Garretas B, Ferre E, & Martín Osorio M.V. Geomorfología y vegetación en el análisis del paisaje. Colloques Phytosociologiques; 1991; 17, 483-496.

[32] Asensi A, Díaz Garretas B, & Navarro P. Utilización de datos fitosociológicos en la evaluación y restauración del territorio Sierra de Gador-Campo Dalias (Almería, España). Colloques Phytosociologiques; 1997; 17, 933-950.

[33] Meaza G, & Ormaetxea O. Propuesta metodológica de valoración fitogeográfica de unidades de paisaje vegetal. Cuadernos de Sección, Historia-Geografía; 1993; 20, 21 pp.

[34] Sesma J, & Loidi J. Estudio de la vegetación de Monte Peña (Navarra) y su valoración naturalística. Príncipe de Viana, suplemento de Ciencias; 1993; 13(3), 127-168.

[35] Cano E, García-Fuentes A, Nieto J, & Torres J.A. Ensayo para la evaluación de asociaciones pertenecientes al Hábitats-(2000). XIV Jornadas de Fitosociología; 1994; Bilbao.

[36] Izco J. Biodiversidad fitocenótica: aproximación conceptual y métodos de valoración. XIV Jornadas de Fitosociología; 1994; Bilbao, 15.

[37] Díaz González T.E, Fernández Prieto J.A, Felícísimo Pérez A.M, Martínez Martínez J, & García
Dynamic-Catenal Phytosociology for Evaluating Vegetation
DOI: http://dx.doi.org/10.5772/intechopen.97426

Rodríguez, A. Valoración mediante un sistema de información geográfica de la cartografía de hábitats derivada de la Directiva 92/43/CEE existentes en Cantabria. Consejería de Agricultura. Comunidad Autónoma de Cantabria; 1996; Santander

[38] Díaz González T.E, Fernández Prieto J.A, Felicísimo Pérez A.M, Martínez Martínez J, & García Rodríguez, A. Tratamiento de los datos del inventario de hábitats derivado de la Directiva 92/43/CEE. Consejería de Agricultura, Principado de Asturias; 1996; Oviedo.

[39] Díaz González T.E, Fernández Prieto J.A. Un nuevo método para la evaluación de la cubierta vegetal de un territorio. Colloques Phytosociologiques; 1997; 27, 727-738.

[40] García-Baquero G, & Valle Gutiérrez C.J. Ensayo de valoración naturalística en el centro-oeste ibérico. Salamanca (hoja 13-19 E. 1:50.000). Studia Botanica; 1998; 17, 9-22.

[41] Cadiñanos J.A, & Meaza G. Bases para una biogeografía aplicada: criterios y sistemas de valoración de la vegetación. Ed. Geomorfa. 1998; 144 pp. Logroño.

[42] Giménez E, & Gómez F. Valoración naturalística del paraje natural de Punta Entinas-Sabinar. XVII Jornadas de Fitosociología, 1999; Jaén.

[43] Díaz González T.E, & García-Rodríguez A. Aplicaciones de la Fitosociología en la evaluación de la cubierta vegetal de un territorio: Monte la Lamiella, Valdés (Asturias). En: Vegetación y Cambios Climáticos. 2001

[44] Penas A, del Río S, & Herrero L. A new methodology for the quantitative evaluation of the conservation status of vegetation: the potentiality distance index (PDI). Fitosociología, 2005; 42(2), 23-51.

[45] Duval J. Indices agro-écologiques. Séminaire de phytosociologie appliquée; 1980; 3, 47-49.

[46] Duval J. Adjonction d’un critère “M” (valeur écosystémique d’un milieu) à l’échelle de cotation des milieux naturels de Lucas. Séminaire de phytosociologie appliquée; 1980; 3, 76-93.

[47] Batista T, Cavaco J, Mendes P, Vila-Viçosa C, Penas Á, del Río S, Cabezas J, Fernández-Pozo L, Arancibia N, & Pinto-Gomes C. Conservation status of vegetation in the North and Central area of Pardiela river basin (Évora, Portugal), Acta Botanica Gallica, 2012; 159(2): 177-185, DOI: 10.1080/12538078.2012.696932.

[48] Long P.R, Nogué S, Benz D, Willi K.J. Diversity a method to remotely model and map distribution of natural landscapes in Europe with the greatest recreational amenity value (cultural services). Frontiers of Biogeography; 2021; 13 (1): 1-13. DOI. 10.21425/FSFGB47737

[49] Rivas-Martínez S, & al. Mapa de series, geoserries y geopermeseries de vegetación de España. [Memoria del mapa de vegetación potencial de España]. Parte I. Itineria Geobotanica; 2007; 17: 5-436.

[50] Lazare J. J. 2009 Phytosociologie dynamico-caténale et gestion de la biodiversité. Acta Botanica Gallica; 156(1): 49-61.

[51] Rivas-Martínez S, Fernández-González F, Loidi J, Louš M, & Penas A. Syntaxonomical checklist of vascular plant communities of Spain and Portugal to association level. Itineria Geobotanica; 2001; 14: 7-341.

[52] Rivas-Martínez S, Díaz González T.E, Fernández-González F, Izco J, Loidi J, Louš M, & Penas A. Vascular plant communities of Spain and Portugal. Addenda to the
syntaxonomical checklist of 2001. *Itinera Geobotanica*; 2002; 15 (1-2): 5-922.

[53] Rivas-Martínez S, et al. Mapa de series, geoseries y geopermaseries de vegetación de España. [Memoria del mapa de vegetación potencial de España], Parte II. *Itinera Geobotanica*; 2011; 18 (1-2): 5-800.