WHY WETLANDS?

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ABSTRACT

Since the creation of Ramsar Convention on Wetlands in 1971, the term wetland has been widely and increasingly mentioned by scientists and environmental managers. During the last decades of the Twentieth Century environmental concerns due to the dramatic loss of aquatic and related habitats have made wetlands target ecosystems for their conservation and restoration. Instead of regarding them as wetlands, they were identified prior to the mid-1970s according to their typology, by numerous denominations, for example bogs, marshes, swamps, oxbow lakes, some of them constituting individual wetlands within larger wetlands like floodplains. So, why wetlands? The arrival of a single catchy term embracing a diverse constellation of aquatic and water related environments was certainly useful to know their importance relative to other kinds of ecosystems, and also to tackle their wise use. Nevertheless, the need to conserve wetland's basic resources according to ecological and human demands frequently led to a misunderstanding of the actual attributes exhibited by these specific ecosystems, being some types of aquatic ecosystems which do not fit the wetland's scientific definition, like rivers, deep lakes, and coral reefs, frequently considered as such. Through this presentation I aspire to analyze the term wetland in such a way to conciliate scientific knowledge, management plans, and natural resources conservation, as well as to contribute to harmonize different conceptual approaches, searching for the achievement of shared viewpoints which would, eventually, overcome the ambiguity going around the term wetland by which the epigraph's question still remains.

Key-words: Wetlands, Definitions, Scientific and Strategic Approache*s*.

RESUMEN

¿POR QUÉ HUMEDALES? Desde la creación de la Convención Ramsar sobre Humedales en 1971, la voz humedal ha sido mencionada ampliamente y con incrementada frecuencia, tanto por científicos como por administradores ambientales. Durante las últimas décadas del Siglo XX, las preocupaciones ambientales debidas a la alarmante pérdida de humedales, hizo que muchos esfuerzos se dirigieran a su conservación y restauración. Antes de mediados de la década de 1970, estos ecosistemas no estaban referidos con el término unificador 'humedal' recibiendo, en consecuencia, numerosas denominaciones de acuerdo con su tipología, tales como pantanos turbosos, bañados, ciénagas y lagunas semilunares, constituyendo algunos de ellos humedales individuales subsumidos en otros mayores como por ejemplo las planicies de inundación. Entonces: ¿Porqué humedales? El surgimiento de un término simple y atractivo conteniendo una diversa constelación de ambientes acuáticos y otros a ellos relacionados ha sido de utilidad para conocer su importancia, en relación con otros ecosistemas y también para adoptar su uso racional. No obstante, la necesidad de conservar los recursos básicos provistos por los humedales, de acuerdo con las demandas ecológicas y humanas ha llevado con frecuencia a interpretaciones erróneas acerca de sus verdaderos atributos, considerándose frecuentemente como humedales a determinados ambientes acuáticos que no se ajustan a su definición científica (e.g. ríos, lagos profundos y arrecifes de coral). Con esta presentación, aspiro analizar el término humedal de modo que contribuya a conciliar el conocimiento científico, los planes de manejo y conservación de los recursos naturales, y armonizar los diferentes enfoques conceptuales, en la búsqueda de lograr puntos de vista comunes que pudieran ser de utilidad para superar la ambigüedad que acompaña a la voz humedal y por la cual la pregunta del epígrafe aún persiste.

Palabras-claves: Humedales, Definiciones, Enfoques Científicos y Estratégicos.

INTRODUCTION

The spreading of the term wetland has greatly influenced on the conservation and restoration of aquatic ecosystems threatened by agricultural development, filling, drainage, dredging, peat removal, pollution, channelization, and other human impacts on natural environments (Goudie 1994). Before its acknowledgment as a special kind of ecosystem or macrosystem, depending on its magnitude and complexity, there was a clear definition of the different aquatic and semi-aquatic ecosystems it includes without any mention of the term wetland.

Although the scientific study of aquatic freshwater or brackish ecosystems *lato sensu* do not necessarily imply that of wetlands themselves, their conceptual meaning have been frequently and sometimes erroneously overlapped (e.g. Scott & Carbonell 1986, Frazier 1999). As a consequence, some confusion around the actual meaning of wetland has arisen, being quite frequent - even among ecologists and environmentalists - to ask questions such as: What does wetland really mean? Is it suitable to use the term wetland in the sense it involves all fresh water habitats, part of marine littoral zones, and other diverse related environments?

Provided the fact that the term wetland has widely spread and definitively installed in the scientific and non-scientific milieus, the following considerations are aimed at analysing the different ideas around this voice taking into account historic, scientific, and strategic approaches. It is expected this review may contribute to conciliate the many aspects dealing with wetlands in order to inquire if the different approaches followed by those people interested and attracted by them would help to improve their scientific knowledge and management plans.

A STRATEGIC VIEWPOINT

The different uses and the true meaning of the term wetland could be understood by analyzing its main definitions (Mitsch & Gosselink 2000). That one adopted by the Convention on Wetlands (Ramsar, Irán 1971) is perhaps the broadest one; it regards wetlands as: “areas of marsh, fen, peat-land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish, or salt including areas of marine water, the depth of which at low tide does not exceed 6 meters” (David *et al.* 1996, Ramsar Convention Secretariat 2004).

The preceding definition includes all ecosystems suitable for migratory water birds. Such an ecosystem embraces a large diversity of biotopes like rivers, lakes, coastal freshwater, brackish and marine ecosystems and communities, including - as an outstanding biodiverse wetland’s community- the coral reefs. The above referred environmental treaty has been formally expressed as “Convention on Wetlands of International Importance Especially as Waterfowl Habitat” and acknowledged to be the only environmental treaty focused on a special type of ecosystem.

The acceptance of a flexible criterion has led to consider wetlands from strategic and politic viewpoints in order to achieve their wise use by also protecting their associated environments, either deep lakes and river channels or uplands. Pursuing a similar objective, Cowardin *et al.* (1979) have probably included deep waters in their classification system despite the fact they described wetlands as ecosystems defined by their shallow waters, hydrophytes, hydric soils, and frequency of flooding.

From the Ramsar Convention’s perspective, the nature of wetlands as ecosystems should be kept in mind, but also their unavoidable interaction with ecosystems other than wetlands in order to ensure their survival (Schnack 1999). At its 6th Meeting, held in Brisbane, Australia in 1996, the Conference of the Contracting Parties to the Convention on Wetlands recognized the need to plan at the level of basins or watersheds in order to integrate the management of water resources and the conservation of wetlands. Fulfilling this objective was proposed as the last instance to sustain one of the most critical renewable but limited resources: the water, its availability and quality.

The incorporation of the catchy word “wetland” - though misused - would have significantly contributed to offset the social and environmental damage caused by the irrational waste and deterioration of hydric resources. The benefits achieved by the valuable task carried out by Ramsar Convention deserve a special acknowledgment. Currently, one hundred and fifty Contracting Parties to the Convention gather 1631 wetland sites, totaling ca.145 million hectares (The List of Wetlands of International Importance. The Secretariat of the Convention on Wetlands, Ramsar, Irán 1971, November 16, 2006).

SCIENTIFIC APPROACHES

Scientific definitions of wetlands should markedly restrict the diverse typology of aquatic and semi-aquatic ecosystems that fit Ramsar Convention's description. The National Research Council (NRC) of the U.S. National Academy of Sciences has probably provided one of the most scientifically sound definitions of wetland. According to the NRC (1995): "A wetland is an ecosystem that depends on constant and recurrent, shallow inundation or saturation at or near the surface of the substrate. The minimum essential characteristics of a wetland are recurrent, sustained inundation or saturation at or near the surface and the presence of physical, chemical, and biological features reflective of recurrent, sustained inundation or saturation. Common diagnostic features of wetlands are hydric soils and hydrophytic vegetation". This definition, in opposition to the one adopted by the Ramsar Convention excludes deep waters.

Shaw & Fredine (1956) were probably the first authors who made the term "wetland" widely known. According to them, "wetlands comprise lowlands, covered by shallow and sometimes temporary or intermittent waters, housing advantageous habitat for waterfowl life, including a diversity of biotopes like marshes, swamps, bogs, wet meadows, potholes, sloughs, and river overflow lands, usually with emergent vegetation, excluding streams, rivers, lakes, and water areas so temporary as to allow the development of moist soil vegetation".

The Convention on Wetlands as well as Shaw & Fredine (1956) definitions highlight the importance of wetlands as waterfowl habitat. Although this is indisputable, the waterfowl species importance as emblematic members of the higher trophic levels, has been probably over-estimated. Other wetlands dwellers (e.g. fish, amphibians, mollusks, crustaceans, insects, and even arachnids, higher plants, algae and diverse microorganisms) greatly contribute to wetlands biodiversity and play significant roles in maintaining the natural processes that characterize wetlands structure and dynamics. In fact, these organisms support the processes required for the emblematic species survival (e.g. waterfowls) and may also be excellent candidates as indicators of environmental quality of wetlands (Schnack *et al.* 1977, Solari 1984, Menni & Almirón 1994).

True wetlands are not necessarily permanent water bodies. Temporary vernal pools like those filled by rain or melted snow are prime breeding habitat for thousand species worldwide (Grall 1999). Furthermore, several artificially originated habitats have evolved toward true wetlands (Schnack *et al.* 2000).

Despite the above distinction between shallow still aquatic environments and rivers or streams, there are environments exhibiting some degree of overlapping between wetlands and running waters depending on temporal environmental variations, mostly generated by seasonal climatic changes. Let's consider a number of vegetated shallow ponds quite common in the lower Paraná river in Argentina, formed in dead arms of streams or creeks: frequently, river main channel tributaries are in time of high waters ("potamophase", *sensu* Neiff & Poi de Neiff 2002) quite deep with hard sandy beds. However, part of these running waters may be recurrently dammed up by plants' accumulation producing significant obstruction of drainage; therefore, they become phytogenic low waters ("limnophase", *sensu* Neiff & Poi de Neiff 2002) wetlands. Once the rainy season progresses water sweeps the vegetal contention away and flows cleaning and deepening the river bed, so the environment evolves again into a flowing stream (Ringuelet 1962). Nevertheless, large river's narrow stretches may be obstructed by macrophytes even during the limnophase (e.g. Paraguay River in the Pantanal at Mato Grosso).

Concerning the transitional nature frequently attributed to wetlands there is some controversy. Smith (1980) regarded wetlands as transitional zones between aquatic and terrestrial ecosystems. Bacon (1996) coincidently pointed out that the combination of aquatic and terrestrial conditions that produce what is described by the composed word "wet-lands" makes these ecosystems among the most complex of the world. Both conceptions and several others refer to a wide conception of wetlands, embracing natural processes whose occurrence highly depends on the interaction between aquatic, semi-aquatic and terrestrial systems, and the transitional habitats linking them. This scientific approach attempts to understand the spatial and temporal dynamic character of wetlands and to what extent their origin and persistence depend on related ecosystems other than wetlands themselves. The Smith's premise that wetlands are neither strictly aquatic nor terrestrial but a world midway between them (Smith 1980) would suggest that wetlands are ecotones exhibiting the high diversity determined by the joint participation of terrestrial and aquatic communities plus the species only found in wetlands themselves. Alluding to large flatlands of humid South America where the water covers the soil 30-80 % of the time within a century, Neiff *et al.* (1994) assume that the generated wetlands are not ecotones between land and water systems, because of their structural and functional patterns. But the same authors seem to agree that a given type of wetland, such as the *marginal lacustrine wetland*, a periodically flooded area adjacent to a lake, is an ecotone between terrestrial and lacustrine systems.

Traditionally, it has been assumed that the origin and extinction of wetlands implied long term water driven-plant ("hydrarch") changes by which succession progress from aquatic to terrestrial ecosystems. This model, frequently referred to as "Clementsian succession" is considered of high duration in time (hundreds to thousands of years), directional and quite predictable. Lake succession has been viewed in this long-term scale in which the basin shape, structure and dynamics are progressively affected by eutrophication, submerged plant sediment trapping, vegetal organic deposits, lake filling with sediment, bog plant growth and the generation of sites for pioneering shrubs and trees (Weller 1999). This model has been exemplified by bog lakes of north-central and northeastern United States and in northern Eurasia (Whittaker 1975), although these habitats may undergo reversal changes attributed to diverse factors, mainly physical and chemical ones. On the other hand, Gleason followers, remarkably van der Valk (1981), consider that instead of the "seres" advocated by the defenders of the hydrarch succession, wetlands succession depends mostly on specific site conditions and on chance environmental events whose outcome are differing pattern of plant settlement even in the same spatial area.

The transitional nature of wetlands would fit both, the Clementsian and the Gleasonian models. In respect to the former model, the species distributions of a given biotic community are usually associated with a gradient of environmental conditions whose edges or ecotones are areas of rapid replacement of species along the gradient. Therefore, the whole set of species associations are closed communities. Conversely, if the assemblages of species are distributed at random along the gradient, each species retains its individuality and the species associations constitute open communities (Ricklefs 1990).

Regarding large southern South American wetlands, Neiff *et al.* (1994) have considered areas where recurrent droughts and floods confer these systems a high degree of environmental diversity. Therefore, the distribution, abundance and productivity of their biota should be adapted to hydrological changes. Moreover, these authors highlighted the importance of the so called "wetlands' elasticity", the ratio between wet and dry seasons in terms of inundated area. They have remarked how this parameter may vary among different wetlands of Argentina and shown values of 12.4, 7.6, and 1.5 for Oriental Chaco, Paraná river wetlands' floodplain and Iberá System, respectively. The meaning of this parameter is associated not only to natural processes like biological cycles and population dynamics of wetlands dwellers, but also to a proactive strategy of sectoral and regional development planning to be undertaken (e.g. urban expansion design and infrastructure development).

The functional bond between river channels or deep lakes and adjacent floodplains would offer an interesting conception of wetlands. As functional units, floodplains may be defined as wetlands oscillating between terrestrial and aquatic phases, making them alternately suitable for aquatic and terrestrial organisms. Floodplains structure and dynamics may be associated to both, adjacent running waters and / or lakes as well as to other water sources, like rainfall and groundwater outcrops. Accordingly, Junk *et al.* (1989) defined floodplains as "areas that are periodically inundated by the lateral overflow of rivers or lakes and/or by direct precipitation or groundwater; the resulting physico-chemical environment causes the biota to respond by morphological, anatomical, physiological, phenological, and/or ethological adaptations and produces characteristic community structures". Neiff (1990) and Neiff *et al.* (1994) expanded this concept by remarking that the low water phase may also play an important role in these ecosystems's structure. During the period of flooding species are better interconnected and genetic flux is favored. Conversely, during periods of low water the different ecosystems are more isolated (Malvárez *et al.* 1999).

REMARKS

According to prevailing ideas sustained by the scientists dealing with wetlands, the combination of Shaw & Fredine (1956) and NRC (1995) definitions would contain their essential attributes as individual ecosystems. This may be widened by considering wetlands rather than individual ecosystems as wetlands system or macrosystems embracing a set of individual wetlands. This status, adequate for riverine wetlands and marginal lacustrine wetlands, confers the usually numerous involved ecosystems their role of functional units linking river channels or lakes and their adjacent floodplains (Junk *et al.* 1989, Neiff *et al.* 1994). The latter idea helps to understand how these systems oscillate between terrestrial and aquatic habitats, alternately appropriate for aquatic semi-aquatic and terrestrial organisms. Although this conception would reinforce the Smith's premise that wetlands may be regarded as ecotones (Smith 1980), it could be risky to generalize this affirmation; it may be more adequate to consider that as a given wetland system might eventually be ecotones, not all wetlands do so. Some wetlands may be located as isolated basins with little outflow and without adjacent lakes or river channels being the nearby aquatic system, in many instances, the groundwater aquifer (Mitsch & Gosselink 2000).

Although a scientific definition of wetland is restrictive, the inclusion of systems other than wetlands, like running waters, lakes, and marine waters is, as stated above, widely accepted by some managers and even by the Ramsar Convention. Despite the physical and functional connections of shallow standing waters with deep lakes and flowing waters, most of the scientists agree in that individual wetlands only include, independently of their covered area, shallow - or root zones- waters with hydric soils and hydrophytes.

In spite of the above considerations, some flexibility has been observed in wetland records such as in the recent revision of the status of wetlands in the United States, prepared by Dahl (2005) who has mapped both, wetland and deep water habitats. Although Dahl's work exceeds the scientific wetland's delineation it has been adopted the Cowardin's definition (Cowardin *et al.* 1979). This may be useful not only by environmental managers, but also by ecologists dealing with hydrologic aspects of river and associated wetlands. This would be exemplified, among others, by a research carried out in the River Adour in southwest France. (Brunet *et al.* 2003). There, these authors describe the role of a floodplain during a single flood event to determine a hydrologic balance that indicates the interdependence of the river channel and the floodplain in terms of water storage and aquifer recharge. Moreover, the referred interdependence is greatly determined by the 'floodplain effect' by which biological, geological, and chemical components decisively influence on the structure and functions of the biological communities housed by the complex macro-system where river and floodplain distinctly interact according to their seasonal and spatial dynamics.

An emblematic case is the Pantanal wetland, a wetlands system located at the high basin of Paraguay River in a large depression functioning as an inland delta, including a vast region of seasonally flooded savannas, islands of xerophytic scrub, and humid deciduous forest. This macrosystem, the largest wetlands system of the Western Hemisphere covers ca. 138,000 km^2, has undergone fluvial and geomorphic processes by which rivers and floodplains, including complex systems of marshlands, are differently interconnected. The drainage design of the Pantanal wetland exhibits sub-parallel lines showing alternately active, episodic and abandoned channels. Its fluvial and morphological changes are also influenced by marginal dikes. Many of these drainage lines may play important functions in maintaining the system's stability. During the flooding times they receive the running waters from the streams and rivers entering the Pantanal and distribute these waters mitigating the effects of flooding. On the other hand, during the dry season they collect the waters (Adámoli 1995). Furthermore, the remarkable high degree of connection 'river-floodplain' in the Pantanal wetland leads to its peculiar high primary and secondary productivity (Power *et al.* 1995, Hamilton *et al.* 1989, Junk *et al.* 1997, Calheiros & Hamilton 1998, Oliveira & Calheiros 2000). Provided that the Pantanal wetland is one of the most large and complex wetlands systems worldwide, its deep analysis exceeds the objective of this presentation. However, the intricate interactions between still and running waters, and their biotic and non biotic components constitute an excellent case study to delineate the true nature of individual wetlands. Each of the numerous shallow aquatic and semi-aquatic biotopes housed by the Pantanal wetlands system, containing hydrophytic vegetation and hydric soils may be regarded as wetlands *stricto sensu*. They may interact with similar ecosystems as well as with ecosystems other than true individual wetlands, like streams, rivers, and upland natural and also be affected by productive activities such as barge loaded with cattle or minerals, silos for storage of grains, fisheries, etc. (Huszar *et al.* 1999)

Hydrologic and biological natural cycles linking running waters and their floodplains, have been in many instances dramatically altered by human interventions on both related systems. The utmost interference against the joint role of rivers, and adjacent wetlands system in governing natural cycles has been the location of big cities within large rivers floodplains, formerly occupied by numerous and typologically diverse wetlands. This is remarkable in northeastern Argentina, on the right margin of the Middle Paraná River. Part of capital cities of the provinces of Santa Fe, Chaco, and Formosa have settled in this Paraná River wetlands' floodplain, notably widened during the wet season. They undergo frequent floods, requiring the recurrent adoption of structural measures, either to prevent or mitigate social and economic damages, but frequently adding negative impacts on natural systems (De Francesco *et al.* 2000).

The lax criterion adopted by some managers and environmentalists to interpret the actual nature of wetlands would allow to take the advantage of different approaches in order to strengthen those policies aimed at preserving wetlands and related environments. However, as for the academic milieu, ecologists should not underestimate the actual scientific meaning of wetlands, which though the numerous known definitions would reasonably fit, from my point of view, to those above referred from the US National Research Council (NRC 1995) being therefore their main distinctive traits: shallow waters, hydric soils and hydrophytic vegetation. Moreover, an individual wetland may be regarded as such if it includes the above distinctive characters, regardless its origin. Borrow pits, obstructed ditches, enclosed areas protected by dikes, and further aquatic and semi-aquatic man-made habitats can accumulate a given volume of water from rainfall, freatic outcrops and/or running waters overflows. Some of these artificially originated wetlands can undergo physical and biotic changes leading to the joint presence of hydric soils, hydrophytes, and biotic communities, constituting genuine wetlands (Schnack *et al.* 2000).

The above reflection does not deny that the global water crisis imposes a close communication between different outlooks around wetlands not only to link efforts directed to their wise use, but also to finally achieve a shared conception of these ecosystems. Accomplishing this aspiration would greatly contribute to design appropriate and proactive strategic management policies, plans and programs for wetlands conservation.

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