A Changing Definition of Estuary? Adjusting Concepts to Intermittently Closed and Open Coastal Systems

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What kind of coastal systems do we include in the definition of an estuary? In a simple description, it has been considered that estuaries are systems with a significant riverine input and free connection to the sea, involving in its essence a salinity gradient from freshwater to marine waters [1]. However, in nature we can find several variations of this assumption, such as intermittently open and closed coastal lagoons and lakes, as well as situations of hypersalinity, which are influenced by freshwaters [2]. These are especially relevant in the southern hemisphere, in countries such as Australia and South Africa [3,4]. However, despite being frequently disregarded, similar ecosystems can be found worldwide, including in Europe. We can now find several articles in the literature arguing that, although not classical, these systems should be considered as estuarine ecosystems, leaving the scientific community with the challenge of revising the existent definitions [5-7].

Historically, there had been little agreement on the definition of estuary until the 1964 Estuaries symposium, where significant discussion towards a common definition took place [6,8,9]. Pritchard provided in 1967 the first definition which was accepted by most scientists [1]. He defined estuary as 'a semi-enclosed coastal body of water, which has a free connection with the open sea, and within which sea water is measurably diluted with fresh water derived from land drainage'. The statement is based in the type of connectivity with the sea and the salinity gradient from freshwater until the maximum value found in open seawaters. By that time this was consensual given that most studies were done in the northern hemisphere, where the river flow is generally significant throughout the year [6]. However, this did not take into account the systems located in the southern hemisphere, where the dry weather in the summer may last for several months, ceasing the riverine flow [8,10]. Additionally, the longshore transport may give the final contribution for the isolation of the system from the marine waters, leading to long periods of closure due to the accumulation of sediments and the formation of sand barriers. These intermittently open and closed ecosystems, with only seasonal freshwater flow, were not clearly included in the Pritchard’s definition. In 1980 and 1981, Day [11,12] attempted to adjust the definition and stated that an estuary is 'a partially enclosed coastal body of water which is either permanently or periodically open to the sea and within which there is a measurable variation of salinity due to the mixture of sea water with fresh water derived from land drainage'. Day’s definition recognizes the existence of closed estuaries which are only temporarily connected with the sea. However, it does not clearly consider the situations of hypersalinity which are common in these intermittently closed estuaries located in regions where the weather is warm. To overcome this issue, Potter et al. [6] has recently introduced the effects of high evaporative water loss in estuaries allowing salinities to be higher than natural sea water.

It may seem that this issue is not scientifically critical but it does play an important role in the classification and assessment of systems, as well as in their management. For example, the European Water Framework Directive (WFD) provides several specifications and definitions that need to be followed in order to implement the directive [13]. Surface water bodies are divided in coastal and transitional waters and ecological quality assessments, which evaluate several biological elements such as phytoplankton, macroalgae or macrofauna and fish communities, are performed according to that aggregation. Transitional waters were defined as ‘bodies of surface water in the vicinity of river mouths which are partially saline in character as a result of their proximity to coastal waters but which are substantially influenced by freshwater flow’ [13]. This definition is less restrictive and more flexible than the one generally accepted for estuaries (i.e. Pritchard). Thus it includes several systems such as intermittent open and closed coastal lagoons influenced by freshwater flow, which are not easily considered as estuaries. It is therefore essential to clarify and harmonize definitions.

The adjustment of the estuary definition to intermittently open and closed systems, which may frequently include situations of hypersaline waters, may have repercussions at different levels. By widening the salinity boundaries, estuarian species will include those strictly adapted to restricted salinity ranges (i.e. stenohaline) and the more tolerant species (i.e. euryhaline). Species that are able to tolerate extreme high salinities will also be considered as part of the estuarine ecosystem. Whitfield et al. [7] has already discussed the implications of this adjustment for the estuarine ecology, especially in terms of the Remane model. According to the authors, the Remane diagram, which describes the species diversity across a salinity gradient, now considers new important ecological features. These comprehend information on the dominance of the different groups according to their salinity tolerances (e.g. freshwater, estuarine and marine species), until a salinity value of 60.

In a recent review, Whitfield and Elliott [14] included the intermittent open and closed systems in the definition of estuary, so that an estuary is ‘a semi-enclosed coastal body of water which is connected to the sea either permanently or periodically, has a salinity that is different from that of the adjacent open ocean due to freshwater inputs, and includes a characteristic biota’. However, nothing is explicitly stated about high evaporation and increase in salinity to levels higher than the ones existent in natural seawater. Further discussion is therefore still needed to achieve a consensual definition that is both detailed and widely applicable.

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