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Procedia Earth and Planetary Science 00 (2017) 000–000

Procedia
Earth and Planetary Science

www.elsevier.com/locate/procedia

15th Water-Rock Interaction International Symposium, WRI-15

Hydrochemistry of Mediterranean Temporary Ponds and associated groundwater in SW Portugal

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Abstract

Under the project LIFE Charcos we aim to understand the influence of groundwater in the water balance and hydrochemistry of Mediterranean Temporary Ponds, located in Costa Sudoeste in Portugal, to explain the variations observed in biodiversity between ponds. This paper represents a first step for establishing a relationship between the chemical composition of the ponds waters and the chemical composition of its associated groundwater. Most of the sampled waters are circum-neutral with very low mineralization (TDS < 1000 mg/L) and show varied composition. In the north of the Costa Sudoeste the ponds waters are mostly of sodium-chloride type and have mixed composition at south. During the ongoing project surface water and groundwater samples will continue to be collected and results will be updated.

Peer-review under responsibility of the organizing committee of WRI-15.

Keywords: Groundwater dependent ecossystems; wetlands; temporary pools

1. Introduction

Mediterranean Temporary Ponds (MTP) are classified as priority habitats (3170*) in Annex I of the Habitat Directive (Council Directive 92/43/CEE). Despite this conservation status, in Portugal, this habitat has suffered continuous degradation and loss disappearing at a fast rate[1].

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They are subjected to strong anthropogenic pressures, such as alterations in hydrological functioning (drainage, over-exploitation of groundwater resources, deep soil turning, flattening the surface topography or transformation into permanent reservoirs for irrigation), water pollution (increase of nutrients, pesticides or heavy metals levels), excessive grazing, among others. The ongoing project LIFE Charcos: Temporary Ponds Conservation in the Southwest Coast of Portugal aims to halt the loss of this habitat in SW Portugal, enhancing its conservation status, through conservation and demonstration of management actions[2]. In Portugal, the existing studies about this habitat are specially focused on their bio-ecology, and the available information is still not enough to understand the differences that occur between the several studied ponds, even in very close ponds[1]. However the current knowledge has been sufficient to allow the understanding that the evolution of the hydroperiod (inundation period), which varies between years (regarding its beginning and length) depending on climate conditions, is extremely important in the control of diversity and maintenance of plant and animal communities within these habitats[1,3,4,5,6]. Local hydrogeological properties influence the water supply and the hydroperiod of these ponds[7], and geology might control physical and chemical hydrology[8]. Although ephemeral, the hydroperiod of most of these ponds is longer than the corresponding simple accumulation of rainwater on depressions of land with low permeability, being extended by the connection to groundwater to which they are hydraulically connected[2]. Under the LIFE Charcos project we aim to understand the influence of groundwater in the pond's water balance and hydrochemistry and consequentially on ponds biodiversity. The analysis of the hydrogeological contexts of MTP occurrence reveal that the ponds do not tend to be located on the area of the most important aquifer systems of the Post-Paleozoic edges of the country, but in the area of undifferentiated aquifers[9]. Most of the ponds are located in small topographical depressions on Quaternary sedimentary deposits that cover crystalline rocks (carbonic schist and greywackes). The latter are less permeable than the Plio-Pleistocene cover sediments providing the rise of groundwater levels, which intersects periodically the topographic surface. There are also some ponds that are not located in the sedimentary deposits but in the covering deposits, with very low permeability, that result from the weathering of the underlying schist and greywackes. According to the current knowledge, it can be considered that the ponds have different dependence degree on groundwater levels according to the pond's conceptual functioning typology[10,11]. This paper represents a first step for establishing the relationship between the chemical composition of ponds waters and associated groundwater, as an attempt to explain variations observed in ponds biodiversity.

2. Study Area

The studied ponds are located in the coastal plain of Southwest Portugal (Fig. 1a), which runs north-south for about 100 km long, with a variable width between 5 to 15 km and rising above sea level from 50 to 150 m. The study area is classified under the European Natura 2000 Network as Site of Community Importance (SCI Costa Sudoeste), and in part also protected at the national level by the Southwest Alentejo and Vicentine Coast Natural Park (PNSACV). The climate follows a typical Mediterranean semi-arid regime with an oceanic influence. For the study time frame the mean annual precipitation was of about 565 mm and 497 mm, for the hydrological years of 2013/2014 and 2014/2015, falling mainly from October to April, the mean winter temperature was of 12.4ºC and 10.6ºC and summer temperatures of 19.2ºC and 19.8ºC, respectively.

3. Methods

The sampling was performed during the hydrological years of 2013/2014, 2014/2015 and 2015/2016. Water samples were collected in 84 MTP once in the hydroperiod. For 4 selected MTP water samples were collected 3 times during the hydroperiod: beginning, middle and end; groundwater samples were collected in nearby wells (Pc) and in small-diameter hand-augered piezometers (Pz), 4 times during each hydrological year: beginning, middle and end of the hydroperiod, and dry season. A total of 103 surface water and 30 groundwater samples were collected so far, but the results here presented are from 56 pounds and 11 well/piezometers. Sampling will continue until the hydrological year 2016/2017. Water temperature, pH, conductivity, dissolved oxygen and turbidity were measured *in situ*. Water samples were collected and transported at low temperature to the Sanitary Engineering Lab (LES - University of Algarve), where all analysis were carried out. Nitrates, nitrites, ammonia, phosphates, sulphates and silica were quantified by molecular absorption spectrometry[12,13]. Alkalinity and chlorides were measured by titration

methods and fluorides by potentiometry[12]. Calcium, magnesium, sodium, potassium, iron and manganese were analysed by atomic absorption spectrometry-AAS with flame atomization[12]. QualiGraf software, version 1.1, was used to construct Piper diagrams and identify hydrochemical facies.

4. Results and discussion

Most of the sampled waters are circum-neutral with very low mineralization (TDS < 1000 mg/L). Ponds water samples show a varied composition as can be seen in the Piper diagram plot (Fig. 1b): 44 are of sodium-chloride type, 7 are sodium-mixed, 2 sodium-bicarbonate, 2 mixed-chloride and 1 mixed-mixed. The spatial variation of hydrochemical facies of the Ponds waters are represented in Fig. 1a. The ponds located further north are mostly of sodium-chloride type (sectors 2, 3 and 4), contrasting with a more varied composition of ponds in the south of the studied area (sector 6). The sampled groundwaters are of sodium-chloride (8) and sodium-mixed (3) types (blue circles in Fig. 1c). The temporal variation of the waters composition of the 4 monitored MTP and nearby groundwaters is also represented on a Piper diagram, in Fig. 1c. At this point it is not possible to establishing a relationship between the chemical composition of the surface and groundwater. Both ponds waters and groundwaters present a chemical facies that fluctuates between sodium-chloride and sodium-mixed types.

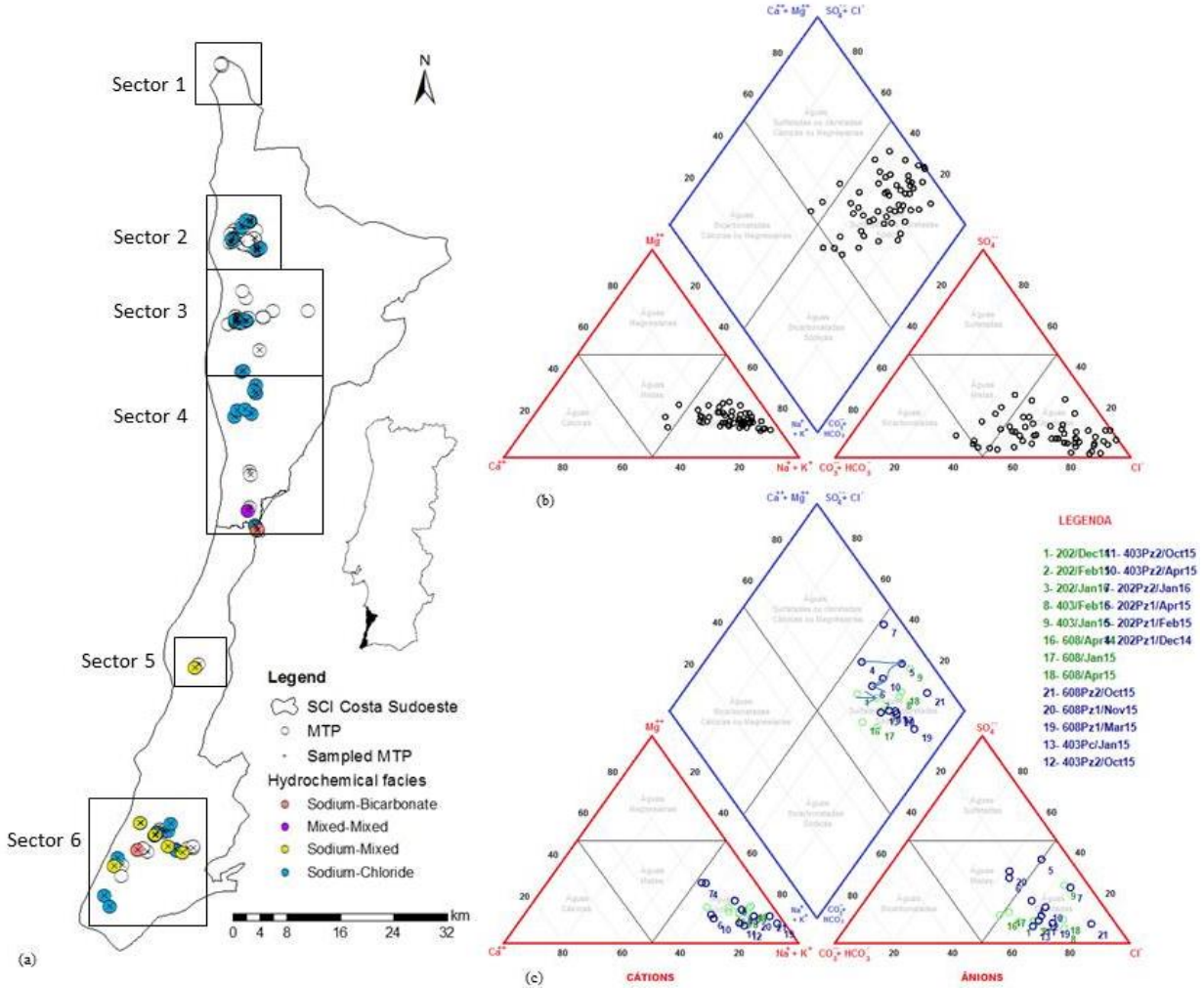

Fig. 1. (a) Location of the identified MTP in the SCI Costa Sudoeste and geographical distribution of the hydrochemical facies of the sampled MTP; (b) Chemical composition of ponds water on a Piper diagram; (c) Temporal variation of chemical composition of groundwater (blue circles) and nearby ponds water (green circles) on a Piper diagram.

For the monitored pond located in sector 2 it was possible to notice that the pond hydrochemistry presents a steady sodium-chloride facies while groundwater hydrochemistry changes from sodium-chloride to sodium-mixed as levels drop down and chloride concentrations diminish. Moreover attempts to establish relationships between hydrochemistry, degree of mineralization[14], MTP hydrological/hydrogeological conceptual functioning contexts, ponds soil type, geology, and biodiversity are being carry out and continuing sampling will supply updated data.

5. Final Remarks

This paper represents a first step to identify the chemical composition of MTP waters and associated groundwaters and to trying to understand if the hydrochemical facies of the ponds waters are inherited from the associated groundwater and if these relationships between ponds and groundwater chemical composition may explain the variations observed in biodiversity between ponds. Most of the sampled waters are circum-neutral with very low mineralization (TDS < 1000 mg/L). Ponds water are mainly sodium-chloride type, though ponds at south show more mixed compositions. Groundwaters chemistry fluctuates between sodium-chloride and sodium-mixed types. These are still preliminary results and relationships are still being evaluated. Therefore, a long-term observation will provide information for a better understanding of the structure and functioning of these complex ecosystems and develop suitable strategies for the successful management and conservation of the habitat.

Acknowledgements

The authors would like to thank the financial support of the LIFE Charcos project (LIFE12 NAT/PT/000997), from the European Union LIFE programme.

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