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The problem of land occupation in the Protection Perimeter area of groundwater abstractions for medical spas: the case of São Pedro do Sul medical spa (Portugal)

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ABSTRACT

Thermalism or the use of medical spas is an activity with very remote origins, all over the world, especially in mountain areas, in the interior of territories, in places where special groundwaters emerge, often hot, and which were used by societies over time in health benefits. In Portugal, currently, thermalism is a very regulated activity. The fundamental pillar of such activity is the exploitation of special groundwater, but only after it has been classified as natural mineral water (NMW). The NMW, over time, must maintain its quality and physical-chemical stability, otherwise, it loses its classification and can close the medical spa. To this end, there are several mechanisms to defend the quality of the resource, one of them being the Protection Perimeter (PP) of the groundwater abstractions, to "try to regulate" potential human actions to mitigate potential harmful actions to the quality of the resource. Thus, after framing the subject under study, this paper makes a synthetic presentation of the PP and the geomorphological, geological, and hydrogeological aspects associated with the São Pedro do Sul Medical Spa. The following presents the methodological aspects of the problem under study. Then, in some detail, the results of technical reports prepared over two and a half decades are presented, with reference to technical and scientific aspects used in their preparation, namely the scenarios of potential contamination of NMW from the potential pretensions. Finally, some conclusions and recommendations on the global methodology of this type of situation are presented.

Keywords: natural mineral water, abstractions, protection perimeter, limitations to anthropic actions, potential contamination scenarios

1 INTRODUCTION

The use of medical spas in Portugal has a millenary tradition, rooted mainly in the Roman occupation around 2000 years ago. The thermal spa of São Pedro do Sul (SPS) is a good example of such a situation, where a museum was recently inaugurated with a component of recovery of constructive and structural elements, of the interesting Roman baths (CMSPS,2023). The recent publication by Ferreira Gomes and Carriço (2022) presents an overview of the main landmarks of human occupation of the study area. Currently, in this thermal spa, there are two thermal bathhouses in operation throughout the year, and they are supplied by NMW from two groundwater abstractions: the Traditional Spring (NT) and Well AC1. It should be noted that the term "abstraction" is understood as the process of taking water from a source (Eurostat, 2023).

The NMW, being a special underground water resource, the Portuguese State requires by law that the abstractions and their associated aquifer system be safeguarded by an area of the territory, called Protection Perimeter (PP). The PP, according to Portuguese legislation (PD, 2015), is organized into three zones (Figure 1): the Immediate Zone (IZ), Intermediate Zone (MZ), and Extended Zone (EZ), with these zones developing around the abstractions, with greater extensions for the water recharge areas, whose configuration is a consequence of the geomorphological, geological, and hydrogeological conditions of each case. In the IZ, closest to the abstractions, many restrictions are imposed on the use of the territory, both in its occupation and in limiting the movement of people and goods, while in the

intermediate and extended zones, the limitations are not so demanding. SPS medical spa, is equipment much sought by the population not only for health reasons but also for tourism. The zone of the SPS medical spa is a region with high demand, having many pretensions of different types, from the construction of new hotels, new buildings with apartments, commercial spaces, leisure equipment areas, swimming pools, sports centres, groundwater abstractions, service spaces (car repair shops, car wash centres, fuel filling stations), among many others. Therefore, a pretension is the action or effect of someone having the intention to do something. The pretensions integrated into the PP zones, being diverse, and in different locations, will be potentially harmful from the outset, so that, the administrative decision-makers of the territory, in compliance with the good rules and the law, need duly grounded technical reports, on the various cases, to take the decision of acceptance or not of such pretensions.

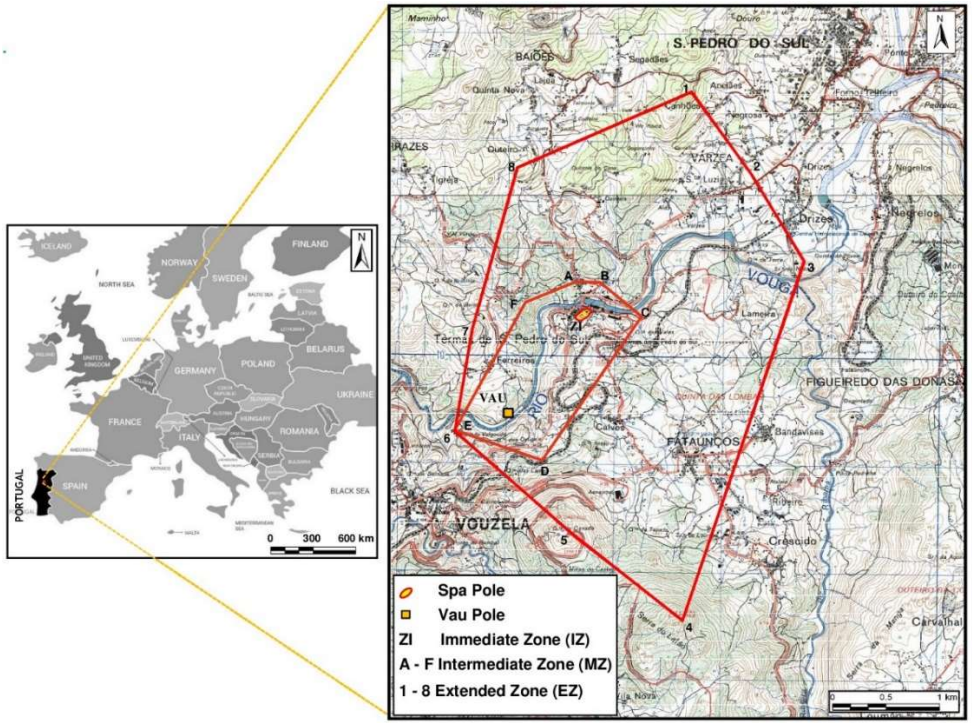

Figure 1. *Framing of the area under study (a), and breakdown of the zones of the PP of the SPS medical spa (b): IM – Immediate Zone, MZ – Intermediate Zone, EZ – Extended Zone*

The PP of the SPS medical spa (Figure 1b) was published in PD (2012), having followed the one presented in detail in the paper "Protection areas of São Pedro do Sul spa, Portugal" in 2001 (Ferreira Gomes et al., 2001). In the present paper, it is important to highlight the various limitations for the three PP zones, according to the Portuguese law (PD,2015), being according to the following:
- Immediate Zone (IZ) are forbidden: a) the carrying out of urban operations and any interventions in that area, even if exempt from prior control; b) underground surveys and works; c) landfills or other operations involving or having the effect of modifications on the ground; d) the use of organic or chemical fertilizers, insecticides, pesticides, or any other chemicals; e) the discharge of wastewater and the abandonment or disposal of waste; f) agriculture, pig raising, intensive grazing, and similar activities; g) the execution of wastewater drainage, collection, and treatment infrastructures. In this zone, IZ, is subject to prior authorization from competent administrative authorities, the cutting of trees and shrubs, the destruction of plantations, and the demolition of buildings of any kind. Also, in IZ, the works referred to in items a), b), c), and g), when taking advantage of the conservation and exploitation of the resource (NMW), may be authorized by the competent administrative entities.
- Intermediate Zone (MZ): the activities foreseen for the IZ may be accepted here, after being subjected to the analysis of the competent administrative entities, but only in situations where it is proven that they do not result in any damage to the conservation or exploitation of the resource.
- Extended Zone (EZ): the activities foreseen in IZ may be forbidden, based on the risks of interference or contamination of the resource (NMW), by order of a member of the Government, responsible for the area of geology.

Thus, it is in the context of the elements previously mentioned that this paper appears, in order to systematize the case studies treated in technical reports of the responsibility of the Technical Director

(TD) of SPS medical spa resulting from different pretensions for the territory of the PP, which were developed over about 25 years. The objective is to present the aspects of the methodological procedure followed, and the main technical-scientific aspects involved, with the respective systematization and discussions, to contribute to a more effective defence of the hydromineral resources that serve thermalism. It is emphasized that the current Portuguese law that imposes the implementation of PPs, as well as the integration of a TD associated with each NMW concession is Law 54 of 2015 (PD,2015), which is an update of Decree-Law 90/90 (PD,1990b), and it was only from that year onwards that the conditions were created for the implementation of PPs and all this problem. The implementation of the law had an evolutionary process, and in the SPS medical spa, it was only in 1997 that the technical reports on the various pretensions associated with the territory of the PP began to be made, which at that time, not being published in the Republic Diary, but already had the configuration as the previously presented and shown in Figure 1b.

2 MORPHOLOGICAL, GEOLOGICAL AND HYDROGEOLOGICAL ELEMENTS

The geomorphological, geological, and hydrogeological aspects were the basis for the construction of the PP of the SPS medical spa. Based on them, the hydrogeological model of the NMW that supplies the SPS medical spa was advanced by Haven et al. (1985), whose main aspects are presented in Figure 2. According to that model, precipitation in mountainous areas at altitudes between 250 and 600m approximately, falls on the territory of the region and infiltrates the surface lands, essentially on the granite of Vouzela, in the Ribamá Fault zone. The resulting underground flows evolve in depth, acquiring their own chemical composition, depending on the water-rock interactions, favored by the increase in temperature in depth, to then start ascending, until the surface in places of altitude order of 150 to 155m, and in particular naturally in the Traditional Spring (NT) in the SPS medical spa zone (Spa Pole), and in the Vau Spring (NV), of the Pole of Vau, in a geological-structural situation associated with the Termas Fault. Due to the favorable hydrogeological characteristics in the areas of the NMW springs, several prospection and investigation boreholes were drilled, highlighting in the proximity of NT, the Well AC1, semi-vertical, with a length of 500 m, and its head at an elevation asl of 152.3 m. The SPS medical spa is currently supplied by NT and AC1, with a total available artesian flow of about 17 L/s, at a temperature of 67.5ºC. Geological and hydrogeological aspects with some detail about the study area can be observed in Pereira and Ferreira (1985), Ferreira Gomes et al. (2001) and Ferreira Gomes (2019). The main geological units can be seen on the maps in Figures 2 and 3. It is worth emphasizing that it is on the granitic rocks of the "Vouzela granite" unit, of the type "medium to coarse grain granite with two micas", that most of the area of the territory associated with the aquifer system under study is developed. The NMW discharge sites, which are NT and NV, occur in the "São Pedro do Sul granite" unit, constituted by a medium to fine grain granite. The aquifer system in the discharge zone is of fissural and semi-confined type.

3 ASPECTS OF PROCEDURAL METHODOLOGY

On methodological aspects, in relation to the problem being studied, it is very important to emphasize that everything starts with the need for someone (the Promoter) to want to do something (to have a pretension) within the territory of the PP of the SPS medical spa, provided that this pretension, from the outset, may endanger the quality of the NMW in the abstractions, or even in the aquifer system of NMW. Depending on the type of pretension, the Promoter gathers the elements that clarify such pretension and requests the licensing entities to be granted a license for this purpose. Most pretensions in the region under study are made to the Municipality of São Pedro do Sul (CMSPS), because they are related to works, whether for the construction of new buildings, or for rehabilitation, conservation, and expansion of old buildings. The pretension, or the request to CMSPS, can be carried out in different phases: i) plan of intentions on the pretension, as for example, the intention to build something; ii) complete projects (with architecture, engineering specialties, among others), or even, iii) legalization of something already built. The ideal situation regarding the pretension should always be in case (i) so that there are no unnecessary expenditures of money, and even major problems, because some cases may not be accepted. Sometimes, there are “bold” Promoters who work without a license (situation iii); these may not be clearly accepted, with very serious consequences, including the reset of initial situations, with hassle and time spent unnecessarily. Besides CMSPS, for certain types of pretensions, there may be other licensing authorities, such as the Portuguese Environment Agency (APA) for pretensions

associated with the prospection and abstraction of groundwater for agricultural, human consumption, industrial and other uses.

In the following, the competent entities, in the various sectors (CMSPS, APA, and others), before concluding the process, and with the pretension within the PP, request a technical report on it from the Directorate-General of Energy and Geology (DGEG), which is the entity that represents the Portuguese State in the sector of NMW. The DGEG, in turn, has the common practice of, before closing its technical report, requesting a prior technical report from the Technical Director (TD) of the resource concession, corresponding to the area of the PP in question, as this person has local knowledge and experience of all aspects associated with the exploration of the resource and the characteristics of the territory, namely of the hydrogeological aspects of the different aquifer systems in the region.

The methodology used by the TD in the realization of the technical report always follows two main parts: 1st Part, generically designated as “Introduction”; and a 2nd Part often called as” Technical Aspects and Advice”. In the Introduction, at first, the technical report is bureaucratically framed, discriminating the entity that requests the technical report, and the claimant or promoter for the pretension in question; in a second moment, the characteristics of the pretension are explained; in a third moment, the location of the pretension is framed in relation to the territorial management plans, namely the Municipal Director Plan (PDM) and the Perimeter of Protection (PP); finally, in this first part, it is mentioned whether the location of the pretension is served by the infrastructure networks, namely drinking water and wastewater networks, whose lack of the latter may condition the pretension from the outset. In this first part, whenever it comes to cases that are potentially very harmful to the maintenance of the quality of the NMW and its associated aquifer system, considerations are made in a summarised way about the state of the art of this theme, highlighting historical cases about effective situations in environmental contamination, namely underground.

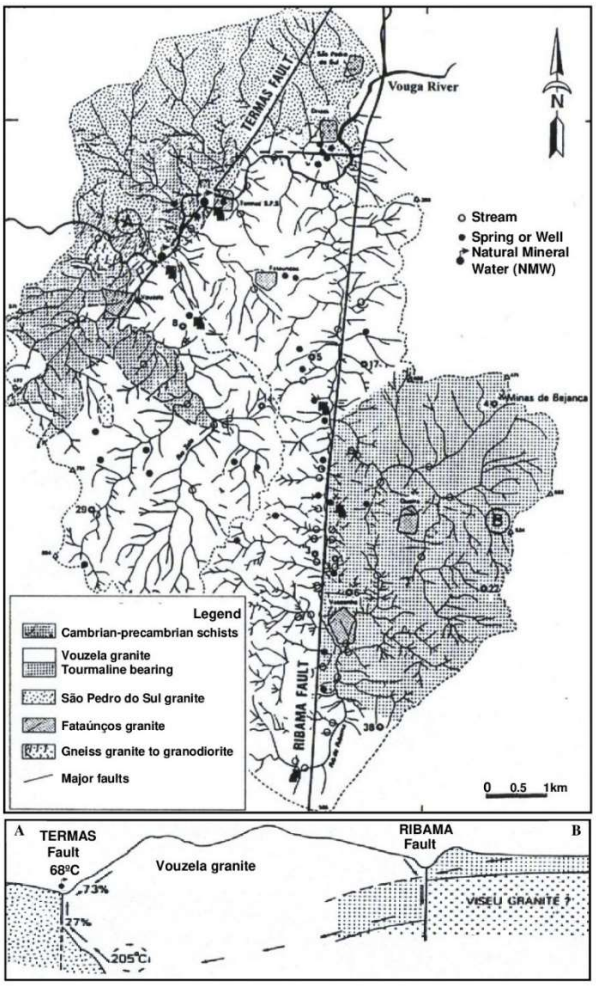

Figure 2. *Sketch on the hydrogeologic model of São Pedro do Sul NMW (according to Haven et al., 1985, in Ferreira Gomes et al., 2001)*

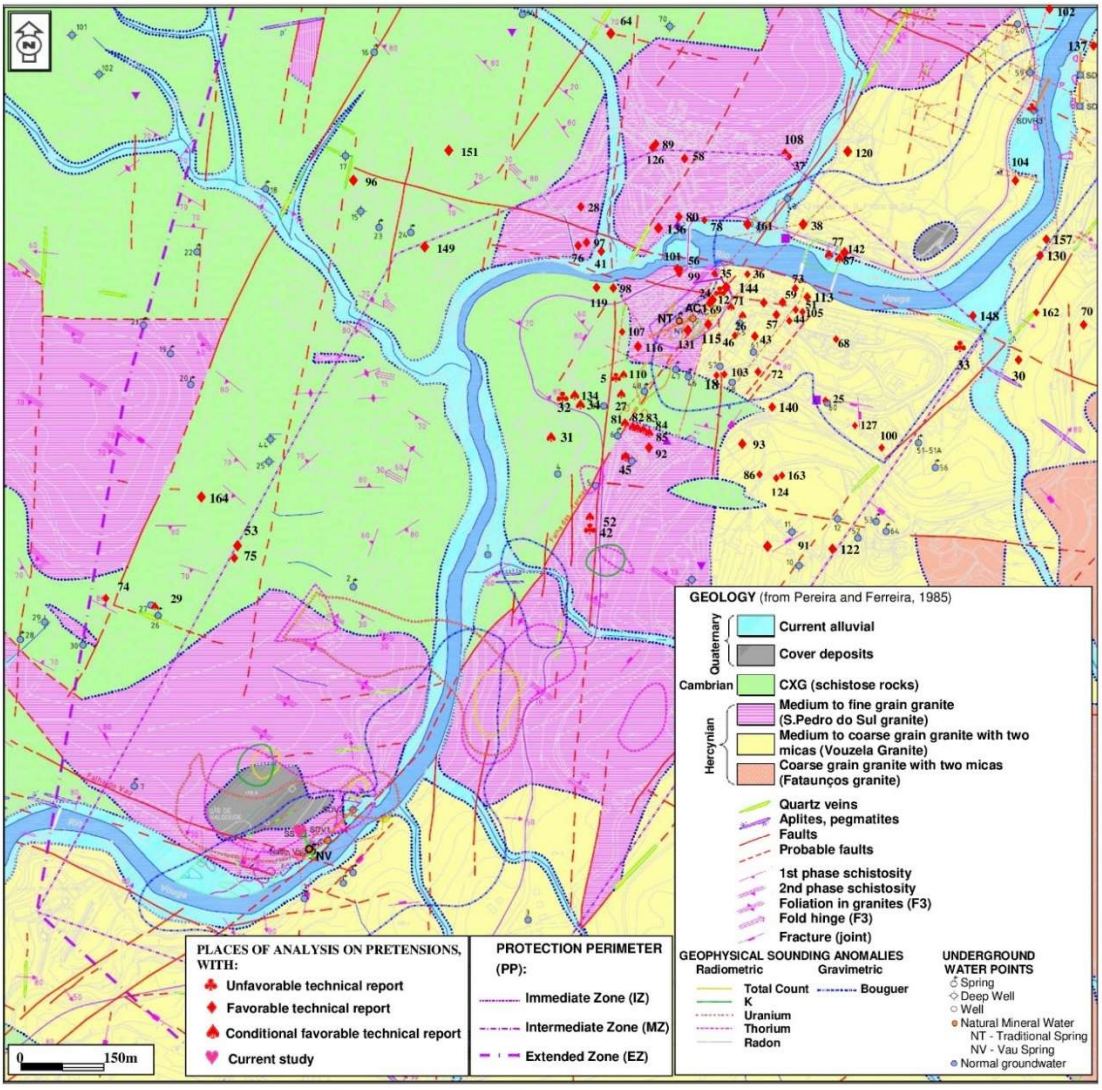

Figure 3. *Extract of the geological-structural map of the area under study, with the implantation on the same of the main places of pretension in the PP territory of SPS medical spa*

The second part includes several moments: i) spatial scenario: distances of the pretension site in relation to the position of the NMW abstractions, as well as their elevations (asl); ii) Morphological scenery in the context of infiltration and runoff of surface fluids: analysis of potential infiltration and runoff of surface water, given the situation of the main elements involved (site and surrounding area of the project and relations with the zones of the abstractions) and the relationship with the natural drainage network (position of streams and topography); iii) geological-geotechnical scenario: lithologies of the area of the project, and of the surrounding territory up to the zones of the groundwater abstractions; whenever possible, aspects on the degree of meteoric alteration and fracturing of the various lithological types are given; the occurrence of singular geological structures is analysed in detail, namely extensive veins and faults, with possible relations or implications for the NMW aquifer system, and in particular by highlighting potential scenarios in which such structures may serve as hydraulic conduits for surface fluids to the deep aquifer system; iv) hydrogeological scenario: construction of potential geohydraulic models, involving relations between precipitation, potential sources of pollution, from the air (smoke, aerosols, and others) in relation to wind direction, surface infiltration throughout the territory, and at sink locations, underground flow from leaks of fluids of various origins (depending on the type of pretension), to the NMW aquifer system and abstractions. Depending on the type of pretension, the scenarios can be several, highlighting also the particularity about interference between groundwater abstractions of the same type of NMW and other abstractions with normal groundwater. In the development of the geohydraulic model of each case, analytical and sometimes numerical methods are used, namely the Feflow software (DHI-WASY,2009), but these last with some difficulty, because we are dealing with very complex fissure environments, with fractures of various types, from limiting faults to the fluid percolation, to veins, enhancers of fluid circulation.

Finally, on the second part of the TD technical report, and to conclude the same, an opinion is issued on the pretension, according to 3 main situations: Favorable (F), Conditionally Favorable (Fc), and Unfavorable (U). In situation F, sometimes some recommendations are presented, about constructive aspects, drainage, waterproofing, and use of materials, among others. In the case of Fc situations, several impositions are always presented, namely, the implementation of waterproofing in the finishing of certain works, the elimination of gardens with irrigation, the implementation of piezometers to monitor the quality of groundwater over time, the construction of a visit floor, under the area where certain equipment is installed, as is the case of fuel tanks or even aqualudic equipment, in order to visually monitor the leakage of fluids and prevent them from continuing into the underground environment. Some concrete situations will be presented in item 4.

It is important to mention that the DT technical reports are not binding, as they are sent to the DGEG, and this entity issues a definitive and binding (mandatory) Official Letter/DGEG technical report. In general, the DGEG technical report is based on the TD technical report, which, having a different structure, presents in most situations the same elements, including in Fc situations, the same constraints, also imposing on the owner of the pretension, the mandatory communication to the TD of the start date of the work and the need to harmonize various situations, namely even, in some cases, the work schedule, so that the TD can monitor the work very rigorously, particularly in the initial stages of excavations, earthmoving, groundwater drainage, records of the type of groundwater, or even monitoring/managing the construction of special equipment such as piezometers. There is a particularity of the situations of prospection and research of groundwaters, where there is guidance for the DT rigorously monitor the entire mechanical prospecting phase, construction of the abstraction until the final pumping test, with total harmonization of what happens simultaneously in the NMW abstractions. In order to highlight the importance of all these types of situations, is still mentioned the requirement that is frequent in the DGEG technical report: "if, during the works, alterations of any nature are made to the hydromineral resource (NMW), the work, in accordance with the indications of the TD and with the agreement of the DGEG, must be suspended and only resumed after the causes have been identified and remedied".

In the case of pretensions regarding legalization of works already carried out, concluded and implemented, in which the TD issued a favourable opinion, there are situations in which the DGEG also issues a favourable opinion, closing the process without the need for further interventions by the TD. In most situations, the TD accompanies the work, with the necessary interventions, and at the end of the work, makes a technical report on the situation to be sent to the DGEG, proposing the closure of the process. There are cases where problems arise during the course of the work, requiring interaction with the project designer, owner of the work, concessionaire, with meetings, alterations to the project and the preparation of partial reports by the TD, recording the fundamental elements necessary for posterity, with a view to defending the resource (NMW).

Still, on methodologies and procedures, it is emphasized that occasionally there are special pretensions, and before that be proposed at a higher level, the TD is previously requested to give an informal opinion, which, if it turns out to be unfavourable, sometimes the promoter ends up giving up on the same intention. There are other situations where there is a favourable opinion with many conditions that make the work so expensive that the promoter ends up giving up.

4 RESULTS AND DISCUSSION

The results of this item correspond to the activity of the Technical Directory of the SPS medical spa, with the TD technical reports issued from 1997 to the present. TD technical reports were issued in 164 situations, with many types of pretensions, frequently for different places.

The location of the pretensions closest to the NMW abstractions is presented on the geological-structural map in Figure 3, and in particular, those in the very close area are shown in Figure 4. Those maps are often used to contribute to the preparation of TD technical report, namely for the construction of the probable geohydrologic scenario or model, involving the location of the pretension, as a potential source of contamination, in different situations, depending on the objective of each pretension, and the position of the NMW abstractions. As a result of this analysis, TD technical reports are issued, with three main situations, as already detailed in the previous item, being the following: favourable (F), conditioned favourable (Fc), and unfavourable (U). Function of such situations, the corresponding places are

presented in the maps of figures 3 and 4, with the following nomenclatures: ♦ - diamonds (F), ♠ - spades (Fc), and ♣ - clubs (U). When these maps are used in the drafting stage of each opinion, the symbol ♥ (hearts) is placed over the site in question. Those symbols, which are commonly known to people, try to convey the message about the favorability of the pretension in a spontaneous way to the reader. The symbol corresponding to the moment under analysis (♥ hearts), symbolizes the fact that the TD technical report is drawn up in such a way that as far as possible it is favorable, without placing obstacles and/or constraints on isolated initiatives.

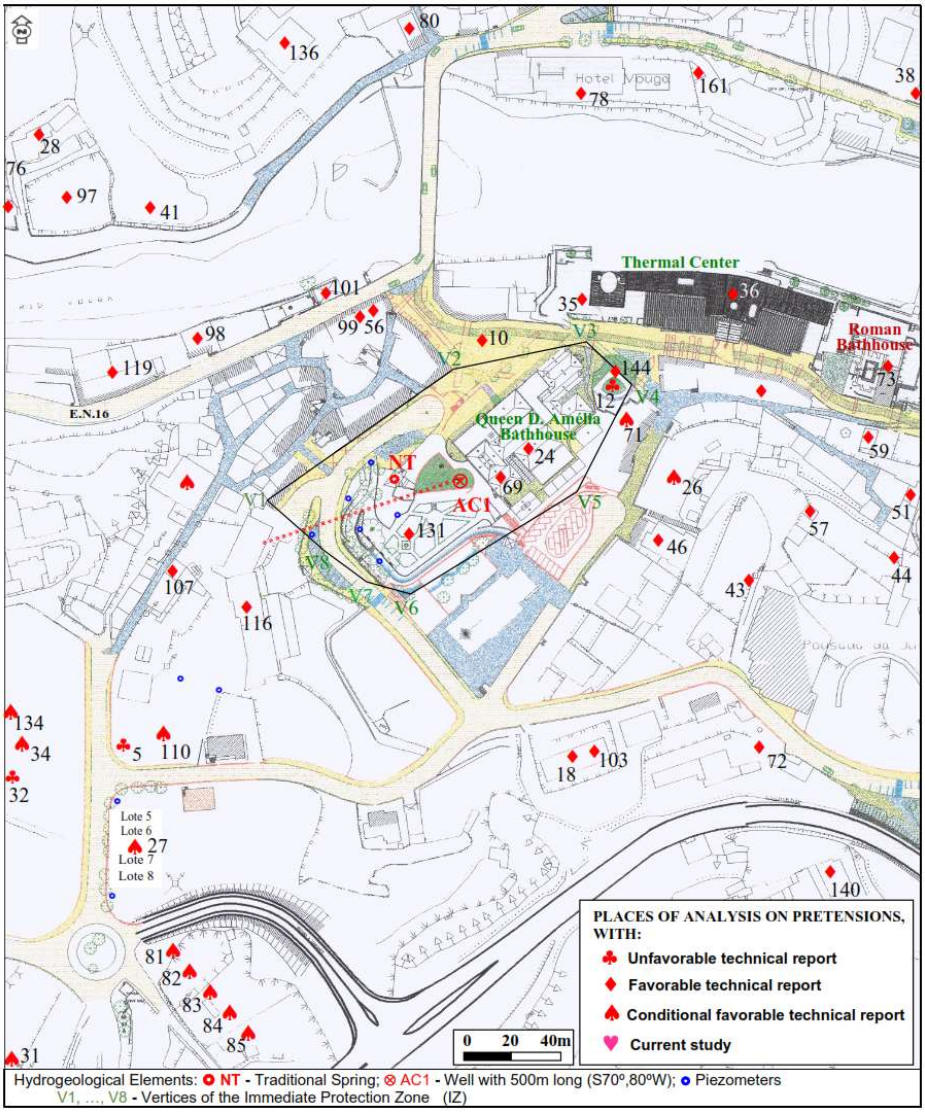

Figure 4. *Pretension places in the areas closest to the NMW abstractions (NT and Well AC1) of the SPS medical spa, and discrimination of the type of technical report (favorable, conditional favorable, and unfavorable)*

The various types of pretensions are organised into different groups, as presented in Table 1, being according to the following:

Group I - Pretensions directly associated with the NMW resource, namely rehabilitation works, expansion of the thermal spas, and also private health, wellbeing and aqua-leisure equipments;
Group II - Hotel Units;
Group III - Multi-Purpose Buildings;
Group IV - Family housing;
Group V - Works of little relevance;
Group VI - Groundwater abstractions and/or use of groundwater;
Group VII- Clean energy installations;
Group VIII - Potentially very dangerous equipment, and solid waste disposal;
Group IX - Other situations.

Table 1. *Organization of the pretensions targeted by the DT technical report, associated with the territory of the PP of SPS medical spa, its framing with the main land use plans, and situation on its favourability (164 pretensions analysed, from 1997 to the present)* [a]

Group	Main Types of Pretensions	PP Zone	PDM	Decision
I	Pretensions directly associated with the NMW resource, namely rehabilitation works, expansion of medical spas, and associated equipment to improve the exploitation of the resource; this group also includes health, geriatric, and wellness equipment, private spas, aqualudic facilities, swimming pools, among other	2IZ, 9MZ, 3EZ	12US, 2SES	7F,1Fr, 6Fc
II	Hotel units: rehabilitation/ extension/ construction from scratch, such as hotels, guesthouses, residential, hostels, local accommodation	20MZ 5 EZ	21US, 3SES, 1RAN	17F, 6Fr, 2Fc
III	Multipurpose buildings, housing and commerce, clean services such as family apartments and commerce on lower floors (shops, bars, bakeries, insurance, and others)	4MZ	4US	2F, 2Fc
IV	Family housing: renovation/extension/construction from scratch, such as single-family houses, multifamily houses, apartment blocks	22MZ, 18EZ	26US, 9AS, 3FS, 2REN	26F, 11Fc, 3Fr
V	Works of little relevance, such as agricultural sheds, retaining walls, dividing walls, urban sheds, porches, annexes for storage, works only inside buildings (without excavations)	1IZ, 17MZ, 14EZ	24US, 3FS, 2AS, 1REN, 1RAN, 1SES	32F
VI	Groundwater abstractions and/or use of groundwater, such as boreholes, wells	3MZ, 9EZ	2US, 9AS, 1REN	10F, 2U
VII	Clean energy installations, such as gas tanks, geothermal, electricity grid	4IZ, 5MZ, 3EZ	10US, 1US & REN, 1REN&RAN	12F
VIII	Potentially very dangerous equipment, such as petrol stations, machine shops, car wash stations, car parking, agricultural park, and solid waste disposal	2IZ, 7MZ, 3EZ	10US, 1REN, 1REN, &RAN	1F, 3Fc, 8U
IX	Other situations with potential interference in NMW quality, such as PP reconfiguration, global urban infrastructures, geotechnical studies, prospection and research of resources (metallic, geothermal), exploration and quality of NMW, special projects (aquaculture, and others)	4IZ, 5MZ, 1out PP	6US,1SES, 2US, REN & RAN, 1REN,RAN & others	3F, 3Fr, 1Fc, 3U

[a] Territory organisation situation (PDM - Plan Director Municipal): US - Urban spaces and/or to be urbanized, SES - Special equipment spaces, RAN - National Agricultural Reserve, REN - National Ecological Reserve; FS - Forest Spaces, AS - Agricultural Spaces. TD technical report situation: F- Favourable, Fr- Favourable with recommendations; Fc.- Favourable conditioned, U- Unfavourable.

Of the various groups, Group VIII deserves to be mentioned, for being the one that presented the most U opinions, naturally because those activities are potentially dangerous to the quality of the resource. Regarding these aspects, a recent study (Ferreira Gomes et al.2022a) has shown that rainwater itself, near the medical spa, is sometimes contaminated, particularly with heavy metal elements, so one must be very careful with pretensions that release into the atmosphere smoke from various sources, from burning waste, burning fuels, including from traffic, droplets of hydrocarbons and aerosols resulting from various activities such as automatic car washes, car painting, among many others. The aerial intersection by rain of such products leads to their infiltration into the aquifer systems and consequently can evolve into NMW. Regarding this type of situation, we highlight the situation of Pretension 42 (Figure 3), for the construction from scratch of a Fuel filling Station and Automobile Workshop and associated equipment, with ♣ - U, in 2009; later, after many adjustments and alterations to the project, Pretension 52, took ♠ - Fc in 2011. There is the understanding, that due to the constraints imposed (in 2011), from bunkers in reinforced concrete visitable by the TD, to observe in the future the elevated fuel tanks, to the construction of several special piezometers, to monitor the quality of groundwater in the surrounding area, among others, led to the increase in the cost of the work that the Promoter eventually changed the strategy. It is appreciated that currently the promoters of such a pretension, used their investments for a different pretension in a relatively nearby place (77), with aqualudic equipment, and that took ♠ -

Fc in preliminary studies phase, in 2017, then in completed project phase (pretension 87) in 2018, again takes ♠ - Fc, and finally already in construction phase (pretension 142) in 2022 took finally ♦ - F.

It is also worth mentioning the situation of pretension 5, to drill a borehole for groundwater with objectives in aqualudic and geothermal applications, in a situation that took ♣ - U; then, some years later, for the same place, pretension 110 (Figures 3 and 4), to build 2 swimming pools with normal water use, having the TD technical report taken ♠ - Fc. The fact that this last pretension was favourable with some conditions, led to the detailed follow-up of the construction, and the realization of 2 special piezometers, imposed, to monitor the groundwater in places immediately downstream of the pools. This case study can be seen in detail in a recent paper by Ferreira Gomes et al. (2022b).

It should also be noted the fact of that all of the 32 cases in Group V, works of little relevance, received an F (♦) opinion. These cases, with great probability, due to their characteristics, will always receive an F, whereby, in order to reduce bureaucracy, the cases located in EZ of the PP, should be exempt from this type of procedure.

5 CONCLUSIONS AND RECOMMENDATIONS

The practice of thermalism in São Pedro do Sul, is already thousands of years old. However, the evolution of society that is increasingly demanding, led to the appearance in 1990, in Portugal, of legislation (PD,1990a,b) which, among many important aspects associated with the development and exploitation of special groundwater, defines and imposes the delimitation of a protection perimeter (PP) to the special groundwater abstractions, namely those classified as natural mineral waters (NMW) for thermalism. The PP, based on the acquired experience, is undoubtedly an instrument for defending the quality of the NMW, so that it is not contaminated by bad management practices, occupation and use of the territory. In the SPS medical spa, some time elapsed before the PP was instituted. It was organized into 3 zones, Immediate (IZ), Intermediate (MZ), and Extended (EZ), occupying a global area of 979 ha. The IZ is the closest to the NMW abstractions, and the one where the most restrictions are imposed on the use of the territory; the EZ is more distant, and the one with the fewest limitations. In SPS medical spa, it was in 1997 that began the practice of performing technical studies by the Technical Director (TD) of the concession before the licensing of any work, or other pretensions that could compromise the quality of NMW. Those technical studies are called TD Technical Report and are not binding, because currently follows a specific bureaucratic procedure referred to in this work, which emphasizes that that report, usually serves as a basis for the DGEG (the institution that represents the Portuguese State in this area) to issue a final report (DGEG Technical Report), which is binding (legally imposed).

Thus, in this paper, the result and analysis of about 25 years of experience of TD is presented, with the result of 164 TD Technical Reports, which were organized into 9 groups (Table 1). From those, we point out that the ones from Group I, are the ones associated with works of the thermal bathhouses, and of other equipment of the balneotherapy domain with the use of common waters, among others, but which are all considered adequate and worthy of a thermal spa. These, for the most part, took place in the MZ, in places very close to the IZ, some in the IZ, and it should be noted that none of them was unfavorable. It is emphasized that, currently, the intentions of this group, when they put forward their official requests, already include elements necessary for the adequate defense of the quality of NMW, because the promoter was careful to previously discuss the problems with the DT.

At the extreme of that group have been the pretensions included in Group VIII, which is the one with the most unfavorable situations, and most of which have occurred in the MZ, but in places very close to the IZ border. Regarding this group of pretensions, it is worth mentioning that with the experience we have had, currently the "system" is much more ruled. There have been difficult moments, because some of the applicants (those who want to do special works/buildings/structures) do not understand why they do not have a favorable opinion for their pretension, resulting in situations of difficult resolution.

Therefore, regarding the occupation of the territory in the PP areas, there is still a long way to go in the fluidity of the processes toward society; Environmental Geotechnics, has certainly an important role in this domain, namely in situations of percolation of fluids with contaminants, in fissured rock masses, whose available software is still very modest in contributing to the resolution of this type of decisions on the favorability of occupation in PPs territories.

About the requests for pretension, it was verified that they are requested by the applicants in 3 distinct situations: i) in the phase of previous intensions; iii) in the phase of finished projects; and iii) in situations of works already carried out without licenses (therefore illegal); in the future, it would be ideal if the pretensions were as much as possible within the first group, because in this way if that pretension presents negative particularities, or if it is unsuitable for the territory of the PP, expectations are avoided, time and money are not wasted on unnecessary works and projects, and frustrations are minimized, because previous expectations are castrated from birth, and in this way, the promoters will be able to spend their energies and financing on pretensions suitable and harmonious with the territory of the PPs. Regarding the process methodology, it is admitted that the pretensions of group V, works of little relevance, as long as they are in the EZ, should not be subject to this type of procedure, for reasons of reducing the work of excessive bureaucracy, and therefore the licensing entities must issue a license without the formalities involving the TD and the DGEG.

Finally, we should mention the advantage of transmitting technical-scientific knowledge from the academic world to society, with small conferences in the auditoriums of the Medical Spa and neighboring hotels on the theme addressed in this paper, with concrete cases from the PP area and other regions, involving local people, often proponents of various claims, together with thermal users, resulting in excellent moments of education on the good rules of human occupation in these territories.

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REFERENCES

CMSPS (2003). Museum: Ruins of the Roman Bathhouse. Câmara Municipal de São Pedro do Sul_ Museu: Ruínas do Balneário Romano. Available in: http://www.cm-spsul.pt/conteudo.asp?idcat=415

DHI-WASY (2009). Feflow 5.4. Finite Element Subsurface Flow & Transport Simulation System. Installation Guide & Demosntration Exercise. DHI-WASY GmbH. Berlin, Germany.

Eurostat (2023). Glossary: Water abstraction. Eurostat – Statistics Explained. Available in: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Water_abstraction

Ferreira-Gomes, L. M. (2019). São Pedro do Sul medical spa: other non-therapeutic uses of thermal water. Geonovas, 32 (1), 3-21 (in Portuguese).

Ferreira-Gomes, L. M., Albuquerque, F. J. A. & Fresco, H. (2001). Protection areas of S.Pedro do Sul Spa, Portugal. Engineering Geology, 60 (1-4), 341-349. https://doi.org/10.1016/S0013-7952(00)00114-9

Ferreira-Gomes, L.M., Alves, J., Jorge, A., & Gonçalves, L. (2022). Territory occupation in the protection perimeter area of the SPS medical spa - the situation of the new aquatic leisure equipment of Hotel do Parque (Portugal). 7th World Multidisciplinary Civil Eng.-Architecture-Urban Planning Symp., 10p.,Prague, Czech Republic.

Ferreira–Gomes & Carriço, A. (2022). The spa space over time: the case of the SPS medical spa (Portugal). World Multidisciplinary Civil Eng.-Architecture-Urban Planning Symp. (WMCAUS) 2021. AIP Conf. Proc. 2574; pp. 080001-1:10; https://doi.org/10.1063/5.0106525

Ferreira-Gomes, L M., Tavares Jorge, A. I. S., Gonçalves, L. F. & Almeida, S. M. S. (2022). Chemical quality of rainwater and surface runoff water in the proximity of the abstractions that supply the SPS medical spa (Portugal). Water Quality - New Perspectives, IntechOpen, 32 p. doi: http://dx.doi.org/10.5772/intechopen.107164

Haven, H. L. T., Konings, R., Schoonen, M., Jansen, J., Vriend, S., Weijden, H., & Buitenkamp, J. (1985). Geochemical studies in the drainage basin of the Vouga river (Portugal); A model for the origin of hydrothermal water in the Vouzela region. Chemical Geology, 51, 225- 238.

PD (1990a). Approves the natural mineral water regulation, Dec.-Lei nº86/90, D.R., 63,1254-1264 (in Portuguese).

PD (1990b). Approves the bases for the legal regime of the revelation and exploitation of geological resources, Dec.-Lei nº90/90, D.R., 63, 1297-1304 (in Portuguese).

PD (2012). Portaria nº 147/2012, Publication of the Protection Perimeter of Termas de São Pedro do Sul; D.R. 49, 8683-8664 (in Portuguese).

PD (2015). Approves the bases for the legal regime of the revelation and exploitation of geological resources, Lei nº54/2015, D.R., 119, 4296-4308 (in Portuguese).

Pereira, E. & Ferreira, N. (1985). Regional geology and structural control of the thermal springs of S. Pedro do Sul, Comun. Serv. Geol. Portugal, 71, (1), 17-25 (in Portuguese).