# GROUNDWATER AND THE RIGHT TO WATER IN A CONTEXT OF CRISIS

**PILAR CAROLINA VILLAR**[1]

## Introduction

Groundwater is crucial for public water supply in Brazil (ANA, 2010). Despite that, water management has ignored its strategic role and prioritized surface resources. The water crisis of recent years, illustrated by the alarming level of the water reservoirs and sewage disposal in rivers, has contributed to promoting the subject of aquifer use.

The national groundwater potential is represented by 181 aquifers and aquifer systems[i], which are divided into three types: sedimentary, fractured and karst. There are 151 sedimentary aquifers, which represent the largest water reserves. Examples of aquifers in this group are: Guarani, Bauru-Caiuá, Barreiras, Urucaia/Areado, Solimões, Alter do Chão, Açu, Barreiras and Beberibe. The karst group is formed by 26 aquifers, such as Bambuí and Jandaíra. The fractured domain comprises four blocs: the Semiarid Fractured Aquifer System; Northern Fractured Aquifer System; Center South Fractured Aquifer System and the Serra Geral Aquifer (ANA, 2013, p. 54-56).

Figure 1 shows a map with the recharge areas of the main Brazilian aquifers. Those zones replenish groundwater and are the most vulnerable to contamination.

The use of aquifers in Brazil increased in the seventies and keeps growing due to several factors, such as: a) advances in hydrogeology and well drilling techniques; b) decline of extraction costs; c ) lower climate sensitivity; d ) the quality of groundwater; e) the increase in demand; and f) the deterioration of surface water (REBOUÇAS , 2006).

Although groundwater has decades of intense use, its governance is precarious. Its management faces difficulties, which exposes aquifers to overexploitation and pollution. Also there is a lack of monitoring wells and of data about their limits, lithology, water quality and quantity, rates of use and vulnerability (GOETTEN, 2015). The private perception of groundwater aggravates the situation since it stimulates illegal well drilling which can undermine the rights of licensed users and increase the risk of aquifer degradation.

The idea of a water crisis goes beyond the problem of scarcity (TROTIER, 2008) and occurs due to a combination of failures concerning sustainability, governance, inequity in access to water and democratic institutions (AGUDO, 2010). The degradation of fresh water sources creates conflicts and affects access to water, especially for poor people (AGUDO, 2010). Therefore, many social actors defend the human right to water in order to: a) prioritize human consumption over economic uses; b) create obligations for States to ensure access to water; c) prevent the privatization of water services (CASTRO, 2007).

1. Professor at the Federal University of São Paulo (UNIFESP), Baixada Santista campus. E-mail: pcvillar@gmail.com.

**Figure 1. Map of the recharge areas for the main national aquifer systems**


Source: ANA, 2005, p. 43.

This article aims to analyze the role of groundwater and its management in the current context of water crisis and addresses the need to guarantee the right to water. The paper consists of four sections. The first section examines the idea of water crisis and the progressive recognition of the human right to water. The second section discusses the importance of groundwater for public supply and the flaws in its management. The third considers the implications of irregular groundwater use. Finally conclusions are presented. The methodology is qualitative analyses of the literature, governmental reports, legislation and international documents.

## From the water crisis to the ideal of the human right to water

The notion of water crisis emerged in the early nineties (POSTEL, 1992; GLEICK, 1993) and since them it has gained strength in scientific literature, in international organizations and in the design of management policies. Overall, this discussion com-

prises a collection of crises which are related to: a) the access to and use of water; b) the availability of water resources; and c) water degradation (LALL et al, 2008). Those dimensions are linked and interconnect with other environmental problems, which can trigger or influence other crises (food, energy, ecological and productivity) whose economic, political and social consequences are distinct and unpredictable (VILLAR, 2015).

The social construction of the water crisis idea was strengthened by the perception of water as a scarce resource and therefore unable to meet the multiple demands and capable of generating conflicts (TROTTIER, 2008). The lack of adequate sanitation, industrial and agricultural pollution, rapid urbanization, unequal water distribution, climate change, population growth and consumption have contributed to this perception, since they are the main causes of water degradation (OHRE et al, 2007). Despite this, these behaviors are encouraged by the irresponsibility of governments, the lack of democracy in decision-making processes and the free market logic. Besides the environmental damage, this posture causes social problems such as poverty and inequality in access to resources (AGUDO, 2010).

Economic and scientific rationality puts its trust in a production model that ignores environmental limitations, pursues continuous growth and allows inequalities and the degradation of waters, regardless of the consequences to the environment, society and future generations. The degradation of water resources is characterized by a "depreciation process in the quantity or quality of water resources caused by human action, through the modification of climate or environmental factors, pollution or unsustainable use" (VILLAR, 2015, p. 29-30). Local reserves become exhausted or insufficient to meet demand and, as consequence, new freshwater sources or hydrographic transposition between basins are required.

The poor are more vulnerable to this process since their lack of capital and technique limits their capacity to act on the political level and to confront environmental changes (AGUDO, 2010; ALIER, 2007). Their livelihood depends directly on environmental resources, so the degradation of water means the disintegration of the material conditions of their existence (ALIER, 2007).

Aquifers play a fundamental role in world water security because groundwater represents the main source of fresh water available for mankind (SHIKLOMANOV; RODDA, 2003). Groundwater overexploitation and contamination undermine ecosystems and human supply. This scenario complicates the goal of achieving universal and equitable access to safe water, which is a challenge recognized by the international community since the seventies (CASTRO, 2007). Despite international efforts, it is estimated that 750 million people remain without access to safe water and that has serious effects on health, development and human dignity (WHO; UNICEF, 2014).

The deepening of the water crisis tends to hinder progress in water access, and that can increase conflicts between users and the number of people without access to clean drinking water. Furthermore, it encourages the privatization of water services based on the idea of market efficiency, although this assumption is not corroborated in practice (BUDDS; MCGRANAHAN, 2003). As a reaction to this situation, several national and international actors have organized to recognize access to water and sanitation as a human right (CASTRO, 2007).

International conferences and their documents have corroborated the intrinsic relation between water, environment and health, which has helped to strengthen the connection between access to water and human rights (MCCAFFREY, 2004). Also, this idea was reinforced by social movements against water services privatization and for the recognition of access to water as a fundamental right in several countries (BUDDS; MCGRANAHAN, 2003).

The human right to water was not explicitly recognized in the Universal Declaration of Human Rights, but it can be interpreted as part of the right to life, the right to an adequate standard of living, the right to the highest attainable standard of health and the rights to adequate housing and adequate food (DUPUY, 2006). Its historical bases were founded on international humanitarian law, which intended to guarantee access to water to certain groups considered vulnerable such as women, children and prisoners (DUPUY, 2006).

On the international level, the legal base of this right has gained force due to three documents: General Comment No. 15 (2002) adopted by the United Nations Committee on Economic, Social and Cultural Rights; Resolution 64/292 (2010) from the United Nations General Assembly (UNGA), which had the favorable support of Brazil; and Resolution nº 15/9 (2010) approved by the United Nations Human Rights Council (UNHRC) (WOLKMER; MELO, 2013). Since then, the UNGA and UNHRC have reaffirmed the obligation of States to achieve the progressive realization of this right[ii].

Those instruments are not binding and they have different interpretations or significances in regard to this right. However, they converge in the sense that their recognition may: a) stimulate governmental actions to ensure universal access to safe water; b) contribute to transforming access to water into an obligation that must be met by States; and c) support water management to achieve this right (GUPTA, AHLERS, AHMED, 2010; WOLKMER; MELO, 2013). Furthermore, the United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses has affirmed the need to pay special regard to the requirements of vital human needs (art. 10, § 2º).

Brazil has not expressly recognized this right in the National Legislation. However, Federal Law nº 9.433/1997, in article 1º (III), guarantees that human consumption and livestock drinking have priority in water use in situations of scarcity. Several studies have considered the access to safe water and sanitation as a fundamental right that can be inferred from the entrenched clause of human dignity, mentioned in article 1°(III) of the Federal Constitution (MIRANDOLA; SAITO, 2006; FACHIN, SILVA, 2011; FLORES, 2011; WOLKMER; MELO, 2013; VILLAR, 2013).

Brazil has met the Millennium Development Goal (MDG) target of halving the proportion of people without access to drinking water (WHO; UNICEF, 2014), nevertheless, there is concern about the quality of the water distributed. According to the National Basic Sanitation Plan "about 38 million Brazilians received water in their houses [...] that did not fully meet the water potability standards established by Regulation nº 2.914/11 of the Ministry of Health" (BRASIL, 2013, p. 32).

Additionally, the National Basic Sanitation Research revealed that only 52.2% of the municipalities have sewage systems and only 28.5% treat their effluents. On the

other hand, there is a lack of a proper sewage system in about 2,495 municipalities (IBGE, 2010, p. 47). According to WHO and UNICEF (2014), in 2014, 19% of the Brazilian population did not have access to proper sanitation systems, which puts Brazil among the worst-performing countries.

The degradation of water sources puts at risk the achievements toward reaching the goal of universal access to safe water and reinforces the need to invest in sanitation. Most of the Brazilian hydrographic regions present critical areas in regard to qualitative and/or quantitative aspects (Regulation ANA nº 62/2013), likewise the rivers in the state basins. The deterioration of surface waters and climate change tend to increase the extraction of groundwater (ANA, 2015).

Aquifers are reserves of water formed in past times that diminish the perception of the water crisis in the territories, since they give the illusion of abundance to a perverse productive system. At the same time that it demands more water, it allows the degradation of an environmental patrimony built up over years, centuries or millennia. The extraction above the recharge rate or from fossil reserves[iii] causes a local water deficit for the future. Meanwhile contamination provokes damage that makes the use of scarce resources by present and future generations impossible (VILLAR, 2015).

The recognition of the human right to water contributes to confronting the water crisis because it prioritizes the use of a sensitive resource with a high quality to meet human vital needs which are the ones related to human survival, personal hygiene, health or alimentation (AGUDO, 2010). Besides that, it attributes responsibilities to States, which should improve water management in order to guarantee the universal access to safe water, especially for poor people (AGUDO, 2010). Unfortunately, the application of water management instruments from national and state policies has failed to include aquifers and lacks transparency in groundwater use (GOETTEN, 2015).

## The hydroschizophrenia in water management and the use of groundwater

Groundwater has become a fundamental resource for public supply and other uses in Brazil (ANA, 2012). Nevertheless, water policies and legislation have ignored this water source and its connection to surface water. This phenomenon is referred to in the literature as hydroschizophrenia (JARVIS et al., 2005), because the main water resource available to mankind has been excluded from policies or managed with limitation by governments, managers and social actors.

Brazilian groundwater reserves are still being evaluated. Their estimated availability is 11,430 $m^3/s$ (exploitable reserve), which is considerably inferior to the 91,300 $m^3/s$ of the surface water reserves (ANA, 2015, p.29). So they do not represent the solution to the water crisis but are an important source, especially for public supply and human consumption (BERTOLO et al., 2015).

Despite the lack of data, most of the aquifers are considered to have their characteristics preserved (ANA, 2007a). However there is still a long way to go to accomplish a safe exploitation or an efficient management that protects aquifers from overexploitation, pollution, saltwater intrusion or impermeabilization of recharge areas.

Overexploitation lowers water levels, reduces the storage capacity of the aquifer, jeopardizes the quality of water through saltwater intrusion or contaminant migration from shallow aquifers, causes land subsidence, reduces surface water availability and endangers ecosystems. In Brazil, it occurs primarily in aquifers with low exploitable reserves like Beberibe, Inajá, Exu and Missão Velha, which cannot provide the demand imposed in the long-term (ANA, 2007b). However, it also affects large aquifers, as in the case of Ribeirão Preto which explores the Guarani aquifer and has had to establish a groundwater restriction zone for new wells (VILLAR; RIBEIRO, 2009).

Aquifer contamination is caused by various human activities[iv] and is aggravated by the fact that it is not promptly detected. Also, aquifer remediation is a complex and expensive process, which in most cases cannot reverse the damage (ZEKTSER; EVERETT, 2004). Pollution may impose restrictions to groundwater extraction, like that which has occurred in the Jurubatuba region (Alto Tietê basin) (ANA, 2007a; SÃO PAULO, 2009). Despite this situation, São Paulo state aquifers present good potability conditions, however there has been a gradual decline in water quality standards (CETESB, 2013). So, even with the regional water crisis scenario, the degradation of groundwater has been tolerated.

In Brazil, the Federal Government is responsible for editing the national general rules about water. In turn states should regulate these rules to allow their application at state level. Regardless of their limits, groundwaters are under the exclusive domain of states (article 26 (I) of the Federal Constitution). Therefore, it is the duty of States to put into practice the integrated management of groundwater resources (CAMARGO; RIBEIRO, 2009).

A number of normative legal acts were adopted at the federal level to include groundwater in water management[v] as well as specific programs such as the National Groundwater Agenda[vi] and the National Program for Groundwater[vii]. Nevertheless, there is a need for a more active role on the part of the federal sphere to support and empower the states in groundwater management (CAMARGO; RIBEIRO, 2009).

At the state level, the application of water management instruments predicted by Federal Law 9.433/1997 has been facing problems to include groundwater. The classification of water bodies into classes according to the predominant uses of groundwater (articles 9 and 10 of the Federal Law 9.433/1997 and Resolution CONAMA nº. 396/2008) has not got beyond the paper it was written on. The River Basin Management Plans have been struggling to include groundwater due to the lack of: a) piezometric monitoring networks; b) quality monitoring networks; c) geophysical and geological databases; d) application of numerical models for water resource management, e) reliable statistics on water use (GOETTEN, 2015). Without this information, water plans cannot successfully accomplish their mission of proposing strategies for the management of aquifers or guiding groundwater use. This reality impairs the proper application of other water instruments such as permit rights which are granted without due knowledge about the reserves or any monitoring of the impacts of extraction.

The exploitation of groundwater is conditioned to obtaining a water permit from the competent administrative authorities. Through this instrument, the Public Power grants to an applicant (public or private) the right to use water for a defined period within the terms and conditions of the act (ANA, 2015). In the case of legally exempt uses (article

12, § 1 of Law 9.433/1997), state laws usually requires users to register their wells with the competent government body which certifies the exempt use (SILVA et al, 2008).

Despite this requirement, statistics about groundwater use are precarious. According the National Water Agency (ANA, 2013) there are 225,868 registered wells, but the real number is estimated to be around 476,960. Most groundwater users are illegal or irregular, since they do not have a water permit or the declaration of exempt use. The difference between the number of registered wells and the estimated reality is significant and implies recognizing that Brazil does not know how much groundwater has been extracted or the effects of this extraction on ecosystems, surface waters and aquifers, or for licensed users.

Water resource pricing depends on regulation in most of the state basins (ANA, 2015), so users take a public domain resource without paying any social counterpart. Even when there is regulation, water pricing can be affected by the large number of illegal wells. Its effective application would raise funds to invest in groundwater data or infrastructure projects related to water, such as improvements in sanitation systems.

Finally, at the federal level, separate information systems have been built for surface waters (National Information System on Water Resources - SNIRH) and groundwater (Information System on Groundwater - SIAGAS). The SIAGAS is controlled by the Brazilian Geological Service (CPRM) and presents a complex interface with few data available[viii]. There is a need to integrate these systems and to coordinate them with the other environmental information systems.

Besides the lack of knowledge and the difficulties to apply the water instruments established by Law 9.433/1997, the management of groundwater faces two other challenges: the lack of social mobilization, mainly justified by the hidden and technical nature of aquifers; and the social acceptance of groundwater appropriation despite legal requirements (BOHN; GOETTEN; PRIMO, 2014; VILLAR, 2015). If these problems are not addressed, they will cause the degradation of an essential source to achieve the human right to water and will aggravate the water crisis.

Aquifers are used for public water systems even in states with high surface availability, as illustrated in table 1, which shows the participation of groundwater and surface water in Brazilian urban water supply (ANA, 2010). Data were obtained from the ATLAS BRAZIL Urban Water Supply (ANA, 2010) by consulting the link "full data" of each State in the search criterion "Evaluation Offer/Demand". The table includes the data from municipalities that identified the number of people served, the source of their water[ix] and the water demand. In the case of population and demand, the original data presented three scenarios 2010, 2015 and 2025.

The table was structured in three main columns related to each Brazilian federative unit (States and Federal District) (FU). The first one quantifies the municipalities attended by type of water source, which can be surface water supplies (SWS), groundwater supplies (GWS) and mixed water supplies (MWS). The second and third show the population attended by each type of source and the water demand estimated according the projection of 2015. In the mixed systems (using groundwater and surface waters), the original data do not particularize the amount of people served or the water quantity attended specifically by surface or groundwater sources, presenting only the total amount.

**Table 1: Participation of the different types of water sources in Brazilian Public Water Systems.**

| FU | MUNICIPALITIES ATTENDED BY TYPE OF WATER SOURCE | | | POPULATION SERVED BY TYPE OF WATER SOURCE | | | WATER DEMAND ($m^3/s$) | | |
|---|---|---|---|---|---|---|---|---|---|
| | SWS | GWS | MWS | SWS | GWS | MWS | SWS | GWS | MWS |
| RS | 134 | 286 | 67 | 7,022,791 | 980,055 | 1,789,644 | 24 | 2.8 | 5.5 |
| SC | 164 | 68 | 58 | 4,004,631 | 153,229 | 1,389,159 | 11.5 | 0.4 | 4.2 |
| PR | 86 | 221 | 89 | 4,668,143 | 1,337,385 | 3,866,634 | 12.4 | 3.3 | 10.7 |
| SP | 184 | 331 | 126 | 14,905,624 | 3,949,896 | 23,708,044 | 50 | 10.5 | 80.4 |
| MG | 512 | 170 | 171 | 10,423,514 | 1,701,061 | 6,232,664 | 28.3 | 4.5 | 17.7 |
| RJ | 78 | 1 | 11 | 14,911,844 | 27,452 | 1,165,800 | 68.3 | 0.07 | 3.2 |
| ES | 71 | - | 7 | 2,108,012 | - | 1,125,368 | 6.4 | - | 4 |
| MS | 8 | 62 | 8 | 196,685 | 835,361 | 1,131,921 | 0.5 | 2.1 | 3.3 |
| MT | 61 | 58 | 20 | 944,888 | 619,675 | 1,171,906 | 2.4 | 1.6 | 3.4 |
| GO | 152 | 56 | 38 | 1,460,307 | 396,580 | 4,070,926 | 3.8 | 1 | 11.5 |
| DF | - | - | 1 | - | - | 2,856,495 | - | - | 9.7 |
| BA | 307 | 78 | 32 | 9,956,346 | 1,502,565 | 437,318 | 31.3 | 4.2 | 1.1 |
| SE | 40 | 20 | 15 | 618,800 | 191,911 | 1,006,865 | 1.7 | 0.5 | 3 |
| AL | 75 | 16 | 11 | 1,197,009 | 174,729 | 1,245,029 | 3.3 | 0.5 | 4.3 |
| PE | 153 | 17 | 14 | 4,829,890 | 185,773 | 2,625,363 | 14.4 | 0.5 | 9.4 |
| PB | 165 | 34 | 17 | 1,922,849 | 143,617 | 962,808 | 5.2 | 0.4 | 3.5 |
| RN | 85 | 76 | 3 | 673,926 | 877,448 | 1,133,374 | 1.7 | 2.4 | 4.2 |
| CE | 108 | 64 | 12 | 5,692,860 | 1,225,234 | 355,509 | 18.6 | 3.4 | 0.9 |
| PI | 39 | 174 | 8 | 530,763 | 914,274 | 942,748 | 1.5 | 2.2 | 3.5 |
| MA | 43 | 158 | 11 | 742,285 | 2,279,674 | 1,829,587 | 2.0 | 6.1 | 6.5 |
| TO | 45 | 84 | 10 | 407,892 | 538,287 | 349,460 | 1 | 1.4 | 1.2 |
| PA | 21 | 108 | 13 | 1,025,884 | 2,415,922 | 2,696,111 | 2.7 | 6.2 | 8.1 |
| AP | 10 | 4 | 2 | 125,605 | 19,720 | 556,369 | 0.3 | 0.05 | 1.9 |
| RR | 1 | 9 | 5 | 4,561 | 40,278 | 376,246 | 0.01 | 0.1 | 1.5 |
| AM | 10 | 44 | 8 | 214,606 | 699,642 | 2,171,047 | 0.6 | 1.8 | 11 |
| AC | 16 | 4 | 2 | 521,768 | 24,854 | 90,220 | 3.1 | 0.06 | 0.2 |
| RO | 37 | 10 | 5 | 606,429 | 129,410 | 563,855 | 1.6 | 0.3 | 1.8 |
| Total | 2,605 | 2,153 | 764 | 89,717,912 | 21,364,032 | 65,850,470 | 266.6 | 56 | 216 |

Source: ANA, 2010.
Elaborated by the author.

The table shows that groundwater constitutes the only source for public supply in almost 40% of municipalities. Its use stands out in small cities because aquifers provide safe water with a low cost treatment. Nevertheless, it is also used in medium and large cities. So it benefits directly and indirectly 87,214,502 inhabitants in 2,917 municipalities, either as the only source or together with surface waters in mixed systems. In addition, in rural areas, it is responsible for supplying 55.3 % of private households (IBGE , 2009).

The demand for groundwater is significant in terms of quantity and number of municipalities or population supplied, especially in the following states: Amazonas, Mato Grosso, Mato Grosso do Sul, Maranhão, Pará, Paraná, Piauí, Rio Grande do Norte, Rio Grande do Sul, Roraima, São Paulo and Tocantins. In some cases its use surpasses the surface water quantities reported for isolated systems. Unfortunately it was not possible to determine its contribution to mixed systems.

Aquifer extraction is expected to increase because of the need to extend the availability of water. In 2010, most of municipalities had already reported problems in their water systems. For instance 2,551 cities need an expansion of their water sources and 472 required a new source (ANA, 2010). This scenario shows the challenge of ensuring safe water in a context of crisis, in which scarcity and degradation make allocation more difficult and one use excludes the other. From the perspective of the human right to water and article 1 (I) of Federal Law 9.433/1997, meeting human needs has priority over all other uses, but how can that priority be ensured if states ignore most users of groundwater?

## Access to groundwater versus the right to groundwater.

The hidden nature of groundwater and its relationship with soil and property rights makes it difficult to exclude users, to control the extraction or to visualize the impacts (VILLAR, 2015). Surface water runs through a visible bed and its access presupposes proximity with the water course (PURI; STRUCKMEIER, 2010). On the other hand, an aquifer is accessible to all land owners wherever it extends. For this reason it can be classified as a common pool resource (FEITELSON, 2006; GUNN, 2009; JARVIS, 2010). This term is applied to natural resources whose characteristics "make it costly (but not impossible) to exclude potential beneficiaries from obtaining benefits from its use"; while the use by one of those beneficiaries causes the decrease of the quantity available for the others (OSTROM, 1990, p. 30).

Since 2012, Brazil has experienced a decrease in surface water supply which has obliged the Government, albeit timidly, to seek measures to reduce consumption or to limit the access to water supplies (ANA, 2015). Considering these restrictions, users seek to ensure their access to water, opting for individual solutions, such as drilling a private well. Bertolo et al. (2015) warn that there are an estimated 12,000 deep wells in operation in the Alto Tietê Basin. However only 4,931 were registered in the Department of Water and Electric Energy. Furthermore, the number of unregistered wells probably has increased due to the droughts of 2013, 2014 and 2015.

The hidden nature and the characteristics of a common pool resource, as well as the lack of management and control actions by States explain the mismatch between

the number of registered wells and the estimated number of wells. More than half of them are unregistered, so they are in an illegal or irregular situation (ANA, 2013). This represents an unknown pressure on groundwater, not only because of the uncertainty about the amount of water extracted but also from the risk of punctual pollution if the well was not properly drilled or sealed, which represents a threat to all users of the aquifer.

Federal Law nº 9.433/1997 simplified the rules for drilling wells dedicated to satisfy the water needs of small rural settlements or to fulfill uses considered insignificant (article 12, § 1º). This kind of well is exempt from requiring a water permit, but state laws usually demand some kind of administrative procedure, like well registration. However, as demonstrated by the example of the Alto Tietê Basin, most of the illegal wells do not fit in the definition of exempt use and users are deliberately violating the duty of requiring a water permit. Drilling a well or exploiting groundwater without a permission is considered an administrative violation according to article 49 (V) of Federal Law nº 9.433/1997. Unfortunately, users are unlikely to be penalized due to the lack of State control.

The clandestine exploitation of groundwater ignores its possible effects on the local water availability and also violates the rights of legal users and it hampers the sustainability of water management policies since it is difficult to predict its impacts on public supply, or on licensed or exempted users. The idea of the human right to water does not support this irregular appropriation, let alone the use without control, especially in a context of water crisis. On the contrary, this right implies the strengthening and transparency of management as a way to ensure quality and quantity of water to supply human needs.

Most clandestine groundwater extractions do not intend to guarantee human rights or public interests. They are based on the private appropriation of water for productive purposes that generate private profits by dilapidating a common patrimony (AGUDO, 2010). Illegal users do not have a reason to legalize their use because there is a lack of State control and groundwater monitoring. Society cannot perceive the lowering of groundwater levels and the well itself is hidden by the walls of the property. The legalization of extraction would bring with it the burden of having to conduct water quality analysis, to pay water charges in the basins that have implemented this instrument and to run the risk of having the well closed in the case of shortage or because of the existence of a piped water system[x]. In this situation, those users who have the financial or technical means are encouraged to explore groundwater since "the marginal value product of the water is greater or equal to the marginal pumping costs (FEITELSON, 2006, p.320)", especially If they are not worried about legal issues or other users.

Thus, there is a private appropriation of groundwater without regulation which corresponds to water usurpation (KLINK; MORIANA; GARCIA, 2000). When they pump this groundwater, the owners of wells outside the permits system harm society, the users and the environment, and also aggravate the water crisis (VILLAR, 2015). The illegal pumping allows the private ownership of a resource defined by the Constitution as a common asset and diverts the water resources from their legitimate users which means a transgression of the water property regime with social and environmental impacts. This conduct may be classifiable as the crime of water usurpation under the terms of article 161 (I) of the Criminal Code[xi].

This situation raises issues concerning the perception of groundwater nature and ownership. Because of its intrinsic relation to the soil and hidden nature, users perceive its extraction as included in their property rights (VILLAR, 2015). Prior to the 1988 Federal Constitution, groundwater belonged to landowners based on the right of accession (article 526 of the 1916 Civil Code), so its appropriation was free of restraints, unless it caused damage to previous uses or public waters (article 96 of the Federal Decree nº 24.643/1934). With the 1988 Federal Constitutional, groundwater as part of the environment was considered as an asset for the common use of the people (article 225) and part of the eminent domain of the Brazilian states (article 26, I). So water rights were redefined and the nationalization of groundwater occurred, which was corroborated by article 1 (I) of Federal Law 9.433/1997 (CAMARGO; RIBEIRO, 2009).

Despite this legal transformation, reality shows that in practice groundwater has been used as if it were a private resource which can be freely pumped by landowners. After more than 18 years of Federal Law 9.433/1997, the number of illegal wells is higher than licensed ones and continues to increase due to the drought, the savings on the water bill or the autonomy of having an exclusive source (BERTOLO et al., 2015).

The lack of actions to restrict this silent expansion may be an indication that there is a social acceptance or tolerance of illegal pumping. On one hand, Public Administration has accepted that it cannot control this expansion; on the other hand, society does not see pumping groundwater as a problem but a natural consequence, given the need to supply water demand or cut costs.

However, with the increasing number of actors who decide to use groundwater illegally, the impacts on aquifers, ecosystems, licensed users and society grow. The sum of groundwater extraction leads to significant damages to water dynamics, such as overexploitation, salt intrusion and contamination of the aquifer whose consequences can be seen in wells that do not produce water as it used to be, go dry or are lost. In these cases groundwater extraction becomes more expensive since it requires a new or a deeper well and stronger pump systems (CUSTODIO, 2002).

When a well goes dry, the loss is usually assumed by the owner to be the result of a natural phenomenon. However in many cases it was caused by poor aquifer management which includes the issue of illegal users. In that situation, small users are the most affected because they possess shallower wells more vulnerable to pollution or water level drops in the aquifer. So they have a higher risk of running out of water because of the drilling costs and their limited financial capacity to replace the well. Uncontrolled use of groundwater also induces impacts on surface water availability[xii] and that affects surface water licensed users who might not realize the correlation between the reduction of surface water and aquifer overexploitation (CUSTODIO, 2002; VILLAR 2015).

Another problem of illegal uses is related to the maintenance of water and sewage systems in urban areas. The analysis of article 45 (§ 1º) of Federal Law n. 11.445/2007 indicates that, if there are public water supply systems, the use of individual solutions for water supply or disposal of sewage is not permitted (VIEGAS, 2007). In the case of illegal wells, the water charges will not be paid which encourages groundwater drilling as a way to escape the companies' service charges. In addition sewage taxes are based on the

consumption of water, so, despite the fact that the clandestine users generate wastewater, they do not have to pay for it (VIEGAS, 2007). Courts have received several lawsuits promoted by water companies which request the closure of illegal wells in many States, but mainly in Rio Grande do Sul[xiii].

Finally, the belief in the high quality of groundwater discourages users from carrying out quality analyses or limits them to mere coliforms testing. Despite generally being of good quality under natural conditions, groundwater can present quality problems due to contamination caused by anthropic or natural sources. The ingestion of groundwater with chemical anomalies or biological pathogens can cause public health problems (REBOUÇAS, 2006).

Groundwater represents the last frontier of water resources, especially because in many cases its exploitation occurs at a rate faster than its replenishment or because the reserves are not renewable. Clandestine use circumvents the discussion about the legal priority of uses, hampers water management and may divert water resources from public supply or licensed users.

## Conclusions

The lack of governance and the clandestine use of groundwater constitute a real threat to water safety and security of the public supply, which may jeopardize Brazilian' progress towards on the goal of achieving universal access to safe water. Despite the fact that groundwater availability is considerately inferior to surface waters, its role in public supply is comparable, especially taking into account the number of municipalities and people served by wells.

Groundwater has been presented more and more as part of the solution to scarcity, particularly considering the need to expand water supply and to face climate variability. However its use and management reiterate the same flaws that lead to the degradation of surface waters. Furthermore, groundwater degradation is aggravated by its hidden nature, the irreversibility of damage and illegal exploitation which allows for its private appropriation. Aquifer exploitation may help to assuage the water crisis in the short term, but its overcoming requires actions that go beyond the problem of scarcity and the search for new water sources. So it is necessary to surpass the restricted vision of "demand versus availability" and seek a change in the rationality behind the appropriation and use of water resources.

The human right to water and sanitation may contribute to this reflection since it would prioritize the use of aquifers to satisfy basic human needs and the achievement of universal access to safe drinking water, which plays a crucial role in empowering vulnerable and marginalized groups**.** This right also imposes obligations on States to improve water management; otherwise it will hardly be achieved. It would strengthen groundwater management and oblige States to stop tolerating clandestine use of aquifers, as well as making them take measures to force illegal users to respect the water permits system.

## Notes

i See a map with all Brazilian Aquifers in ANA (2013, p. 55).

ii See UNGA Res. nº 68/157 (2013) and HRC Res. nº: 15/9 (2010); 16/2 (2011); 18/1 (2011); 21/2 (2012); 24/18 (2013); e 27/7 (2014). Available at: http://www.ohchr.org/EN/Issues/WaterAnd Sanitation/SRWater/Pages/Resolutions.aspx. Consulted on: October 03, 2015.

iii In fossil aquifers, the extraction is equivalent to mining the aquifer, since the recharge is hampered by the geological structure or climate conditions.

iv For information about pollution sources see Foster and Hirata (1991). The main sources are: sewage losses; waste dams; landfills and dumps; septic tanks; dumping of sewage sludge; injection wells; agrochemicals, mining and tank leaks.

v To illustrate see National Water Resources Council Resolutions nsº 15/2001, 17/2001; 22/2002, 76/2007; 91/2008; 92/2008; 107/2010; e 126/2011 and National Environmental Council Resolution nº 396/2008.

vi It is an initiative of the National Water Agency to foster hydrogeological knowledge, technical and management capacity and to develop specific training in groundwater. Available at: http://www2.ana.gov.br/Paginas/projetos/AguasSubterraneas.aspx . Consulted on March 23, 2015.

vii The program is divided into three sub-programs: Extension of hydrogeological knowledge; Development of Institutional and Legal Aspects; and Capacity Building, Communication and Social Mobilization. See: http://www.mma.gov.br/index.php/agua/recursos-hidricos. Consulted on May 23, 2015.

viii More information at: http://siagasweb.cprm.gov.br/layout/. Access: 23/03/2015.

ix From original data 22 municipalities did not identify the type of water source, so they were excluded from the analysis presented in table 1.

x See article 45, § 1º, from the Federal Law nº. 11.445/2007. For further information see Viegas (2007).

xi In the case of mineral waters, article 2 from Federal Law nº 8.176/1991 defines the crime of water usurpation.

xii Aquifer overexploitation contributes to draining dry river flows, springs and wetlands.

xiii Search conducted in States Courts through the *Portal de Busca Unificada de Jurisprudência JusBrasil*, using the terms: "closure of well" and "public water system" without quotes. Available at: http://www.jusbrasil.com.br/jurisprudencia/. Consulted on May 3, 2015.

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# GROUNDWATER AND THE RIGHT TO WATER IN A CONTEXT OF CRISIS

**PILAR CAROLINA VILLAR**

***Abstract*:** The water crisis tends to intensify the use of groundwater, which supplies almost half of Brazilian population. Despite that, its management is precarious. The article analyses the role of groundwater and its management in the current context of water crisis and forward the need to ensure the human right to water. The methodology used is the documentary analysis of literature, legislation, international documents and governmental reports. The fragilities over management and the private appropriation of groundwater threaten water security. The water crises focus in the idea of scarcity stimulates the quest for new sources but does not face the structural flaws of the management models. So the use of aquifers reflects the same problems that have allowed the degradation of surface waters, which is aggravated by the hidden character and the irregular exploration.

***Key words***: water crises, groundwater; human right to water; aquifer management; public water supply.

***Resumo*:** A crise hídrica tende a intensificar o uso das águas subterrâneas, as quais garantem o abastecimento de quase metade da população brasileira. Apesar disso, sua gestão deixa a desejar. O artigo analisa o papel das águas subterrâneas e de sua gestão no atual contexto de crise hídrica e frente à necessidade de garantir o direito humano à água. A metodologia empregada é a análise documental da literatura especializada, legislação, documentos internacionais e relatórios governamentais. As fragilidades da gestão e a apropriação privada das águas subterrâneas à revelia das exigências legais ameaça a segurança hídrica. O foco da crise hídrica na ideia de escassez incentiva a busca de novas fontes, porém não combate as falhas estruturais do modelo de gestão. Assim o uso dos aquíferos reflete os mesmos problemas que permitiram a degradação das águas superficiais, sendo agravado pelo seu caráter oculto e pela exploração clandestina.

***Palavras Chave*:** crise hídrica; águas subterrâneas; direito humano à água; gestão dos aquíferos; abastecimento público.

***Resumen*:** La crisis hídrica intensifica el uso de las aguas subterráneas, que garantizan el abastecimiento de casi mitad de la población brasileña. A pesar de eso su gestión deja a desear. El articulo analiza el rol de esas aguas y de su gestión en el actual contexto de crisis

hídrica y frente la necesidad de garantizar el derecho humano al agua. La metodología utilizada es la análisis documental de la literatura especializada, legislación, documentos internacionales y informes gubernamentales. La fragilidad de la gestión y la apropiación privada à despecho de la ley amenaza la seguridad hídrica. El foco de la crisis hídrica centrado en la idea de escasez incentiva la búsqueda por nuevas fuentes, pero no combate las fallas estructurales del modelo de gestión. Así el uso de los acuíferos refleja los problemas que permitieron la degradación de las aguas superficiales, siendo agravados por su carácter oculto y la exploración clandestina.

***Palabras clave*:** crisis del agua; aguas subterráneas; derecho humano al agua; gestión de acuíferos; abastecimiento público.