

Legal Aspects Of Groundwater Ownership In Spain

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Abstract: *Spain's 1985 Water Law gave special significance to the Registry and the Catalogue, two legal figures that allowed the co-existence of public and private groundwater ownership. Twenty years later, the situation of the Catalogue and the Registry is quite deficient. As a consequence, adequate groundwater management in Spain seems extremely difficult. This paper comments on the three main actions taken by the Government since 1985: first, the "Groundwater Registry and Catalogue Update Program" (ARYCA), a 42M€ project of the Ministry of Public Works, the results of which have not lived up to expectations; second, the Transient Disposition of the National Water Plan Law (2001) with regard to the "closure of the inscription period for private wells." The results of this action are still uncertain; and thirdly, the "Update Program for the Registry and Catalogue Books" (ALBERCA), a 155M€ initiative of the Ministry of the Environment which is yet to be implemented.*

Keywords: *Registry, Catalogue, concession, wells, ARYCA, ALBERCA, Spain.*

Introduction

In the second half of the 20th century, agriculture in arid and semiarid countries has experienced a true "Silent Revolution" of intensive groundwater use (Fornés et al., 2004). Groundwater irrigation is more productive in economic (€/m³) and social terms (jobs/m³) than surface water irrigation. As a result, millions of individual farmers worldwide have attained significant social and economic benefits by drilling their own wells. Indeed, groundwater has become an increasingly important resource during that period. About 20% of worldwide irrigation, 50% of drinking water supply needs and 40% of industrial water demands are now met by groundwater (United Nations, 2003).

Governmental water authorities have generally played a secondary role, often limited to certain direct or indirect subsidies, and seldom related to planning. As a

result, groundwater abstraction has escaped control, and therefore appropriate management, in many arid and semiarid countries worldwide (Llamas and Martínez-Santos, 2004).

This paper focuses on the situation of groundwater ownership in Spain, as well as on the legal actions taken by the government since 1985. It does not consider the Canary and Balearic Islands, the Galician coast or the internal basins of Catalonia, all of which are dependent on their own regional governments, rather than the central government of Spain.

Legal Background

Since Spain's first Water Law in 1866, most surface waters have been considered public domain. This is a corollary of the idea that neither the market nor individuals can guarantee an adequate sharing

of this limited resource. The government then becomes responsible for “assigning, ordering and compatibilizing the different uses of water” (Del Saz, 2002). From a surface water standpoint the 1866 Law does not contribute anything new. Instead, it follows the traditional criteria of Spanish and Roman law: surface waters of rivers and basins were always public domain.

These principles were not considered applicable to groundwater, which was therefore excluded from public ownership. This is largely a consequence of the low importance of groundwater resources at the time. In addition, quantitative hydrogeological methods were yet to become widespread and most groundwater-related issues were surrounded by a halo of mystery and uncertainty.

Spain was not an isolated case. Other examples can be found in arid and semiarid regions worldwide. Take for instance the US. In *Frazier vs Brown* (1861), the Ohio Court ruled that “because the existence, origin, movement and course of such waters, and the causes that govern and direct their movement are so secret, occult and concealed, an attempt to administer any set of legal rules in respect to them would therefore be practically impossible”. This is obviously no longer the case, as hydrogeology has since developed into a solid scientific discipline. Thus, in 1984 the same U.S. Court overturned *Frazier* (*Cline vs American Aggregates*): “[S]cientific knowledge in the field of hydrology has advanced in the past decade to the point that water tables and sources are more readily discoverable (...) Thus, liability can now be fairly adjudicated with these advances, which were sorely lacking when this Court decided *Frazier* more than a century ago” (Fetter, 1994).

The 1866 and 1879 Spanish Water Laws, the latter valid until 1985, allowed for a dual ownership regime: public for surface waters and private for groundwater, although there are some exceptions to this rule. Apparently, small springs, rivers and lakes occurring naturally within private land could also be considered under private ownership in certain cases (Moreu, personal communication).

According to the 1879 Water Law, ordinary (domestic use) wells were property of the landowner, while water from artesian wells or galleries was owned by whoever found them. Legal constraints on private ownership of groundwater were generally small and arose as a means to avoid damages to third parties. These included a minimal distance between wells, as well as other limitations designed to avoid interference with public surface waters and to guarantee the safety of buildings, railways and roads.

Groundwater is still private property in many countries. Significant examples (legal peculiarities aside) include California and Texas in the United States, Portugal and France in the European Union and China and India in Asia.

The 1985 reforms of Spain’s Water Law put groundwater under public ownership. While this posed an evident change in groundwater rights, the practical implications of the law have not been so significant. The 1985 Water Law did introduce significant changes for those wells drilled from 1986 onwards. However, these are only a very small share of the total. Therefore, the 1985 Water Law left things more or less as they were with regard to the pre-existing wells, which are still the overwhelming majority (Moreu, 2002). This non-committed approach on the part of the legislator is sometimes interpreted as a way of escaping potential social and political unrest.

The 1985 Water Law created a “Registry” and a “Catalogue” (see below) as instruments for groundwater management. These have given rise to an important argument over private and public well ownership, a debate which was fuelled by the 2001 National Water Plan.

Groundwater ownership in Spain and the 1985 Water Law

The Preamble to Spain’s 1985 Water Law declares groundwater and surface water part of the same hydrological cycle and thus in the public domain. Therefore, its main innovation is that the state, not individuals, is responsible for groundwater

management. An important implication of this claim is that groundwater rights can be quantified accurately beforehand, thus ensuring a more rational use of the resource (Moreu, 2002).

Article 72 of the 1985 Water Law states that basin authorities will set up a "Public Water Registry" and a "Catalogue of Private Waters". These administrative bodies were designed to keep track of the ownership and characteristics of every well. Under the Law, all well owners must join one of these bodies and basin authorities can apply coercive fines in order to enforce this rule.

Existing wells included in the Registry acquired the legal status of "temporary private wells." In practice, this means that private ownership is respected for 50 years. After that period, ownership is transferred to the state, although an "administrative concession" is to be granted so that the former owner can still make use of the well. A three-year deadline (December 31, 1988) was set to join the Registry.

Alternatively, well owners wishing to maintain private ownership might choose to apply for inclusion in the "Catalogue of Private Waters". Groundwater users failing to comply with the three-year deadline would be in a similar situation (maintain private ownership), but would still be under a legal obligation to apply for the Catalogue. Thus, those who privately owned wells under the 1879 Water Law might continue to do so. However, they would not be granted administrative protection under the 1985 Water Law.

As a consequence, the inclusion of wells in either the Registry or the Catalogue constituted a legal imposition on all owners. However, those failing to join would still be in full possession of their rights, because inclusion in the Catalogue was not a prerequisite for ownership (Del Saz, 2002). To address this problem, the 2001 National Water Plan Law added a Transient Disposition, which made it difficult to attain recognition for those private waters not yet included in the Catalogue.

Groundwater Ownership In Spain From January 1,

1989

The three-year deadline and the legal advantages of the Registry had a two-fold aim: first, to ensure diligence among applicants so that an inventory of wells could be compiled as soon as possible; and second, to encourage applicants to join the Registry instead of the Catalogue so that, ideally, groundwater would be all public domain within 50 years.

The desired effect was not achieved. Moreu (2002) estimates that only 10-20% of well owners joined the Registry in time. These owners will lose their private ownership in 50 years (between 2036 and 2038). In contrast, those who, because of either distrust or misinformation, did not join (an overwhelming 80-90%), will forcefully maintain their private ownership for an indefinite period. Thus, even if the 1985 Water Law states that groundwater belongs to the public domain, the reality is quite different. In fact most of it is still under private ownership by law.

This situation is further aggravated by a newer constrain: illegal wells. "Hydrological insubordination" has become widespread in many of Spain's aquifers. In this regard, a more proactive approach on the part of legislators and Basin Authorities would be desirable, especially since approximately half of Spain's irrigated production is due to groundwater (Llamas, 2004). The existing legal and technical instruments seem unsuitable to bring such anarchy under control (Moreu, 2002; Díaz Mora, 2002; Yagüe et al., 2003).

Governmental Action: Comments

Groundwater Registry and Catalogue Update Program (ARYCA)

The White Book of Groundwater (MOPTMA-MINER, 1994) outlines a program of action for groundwater management. Perhaps the most important one among the initiatives is the inventory of wells, with an estimated cost of 25M€. Thus, the program acknowledges the insufficiency of existing data, which is often obtained from indirect indicators, such as population and irrigated area.

It is noteworthy that the allocated funds (25M€) are remarkably low in comparison with the analyses carried out for the parliamentary debate on the 1985 Water Law. At that time, Llamas and Custodio (1985) calculated a total of half a million wells. The cost of incorporating each one of these to the Registry or the Catalogue was estimated to be between 300€ and 600€ (i.e. a total cost of 150M€ to 300M€).

ARYCA was presented in 1995 by the Ministry of Public Works, Transport and the Environment as an ambitious attempt to solve the legal situation of Spain's wells. The "General Subdirection for Management of the Public Hydraulic Domain" was the official authority in charge and the objective of the project was to update the administrative situation of wells in Spain. Three main lines of action were proposed to this effect:

- a) Inventory of unregistered wells.
- b) Completion of all administrative tasks in relation to registered wells.
- c) Review of registered wells prior to their inclusion in the new Basin Registry.

The initial budget was 42M€, although by 2000 the amount spent was nearly 66M€. It is worth noting that the situation had not improved significantly by that time (Llamas et al., 2001). The White Book of Water in Spain described the situation as "very discouraging" (MIMAM, 2000). This source mentions an estimated total of 458,966 wells, out of which 244,703 had already been declared and 109,021 were registered. These figures did not include the Canary and Balearic Islands, the Galician coast or the internal basins of Catalonia, all of which are dependent on regional, rather than the central, government. In addition, the White Book acknowledges that this total probably underestimates the actual number of wells: "currently, the total number of wells could be over a million, which gives an idea of the global importance of groundwater resources" (MIMAM, 2000). Other authors (Llamas et al., 2001) estimate the total number of wells around 2 million (4 wells/km²). These authors argue that thousands of wells have been drilled in areas of Spain where groundwater use was traditionally considered irrelevant. This is the case in Galicia (Samper, 2000) and in the greater

Madrid.

Llamas et al. (2001) estimated Spain's well density based on the characteristics of aquifer areas (overexploited, intensively exploited, rest of aquifers, and areas without significant aquifers). Considering this, as well as the legalization cost estimated by ARYCA for each well, the total cost of the inventory would be approximately 420M€. Although this figure greatly exceeds the allocated funds, it is only equivalent to the cost of two or three medium-size dams (insignificant in comparison with the over one hundred new dams proposed by the 2001 National Water Plan Law). Therefore, the 420M€ figure would be hardly significant given the greater comparative value of groundwater over surface water irrigation.

The head of the General Office for Management of the Public Hydraulic Domain, in charge of the ARYCA program, evaluates its results positively: "A long and arduous task has been carried out, and has contributed to partially fulfill the objectives of the program. In addition, the need to approach the Registry update from a different point of view has been identified" (Yagüe et al., 2003). Nevertheless, it is acknowledged that "the basic (and now urgent) purpose of the Administration in regard to water management is to compile a complete Registry database, with homogeneous basin-wide criteria, and capable of yielding valid statistical information." It is important to point out that these proposals, as well as the rationale behind them, were already outlined almost 20 years earlier in the "Scientific and Technical Report for the 1985 Water Law" (Llamas and Custodio, 1985). This indicates the passivity towards groundwater issues traditionally shown by the Office of Hydraulic Works (currently General Water Office).

The Official Registry data in January 2002 estimated a total of 433,576 wells, out of which 43.2% were registered, while 13.4% were undergoing registration procedures and 43.4% were not yet registered (Yagüe et al., 2003). It is worth noting that this total estimate has been assumed by the new ALBERCA project (MIMAM, 2000).

Ferrer et al. (2003) conclude that "[t]he current

situation is unsatisfactory: the Registries have not fulfilled their objective, and there is a pressing need for update and modernization.” These authors provide a series of reasons why the ARYCA program fell well short of expectations:

- a) Moderate investment: The program was based on a large number of small contracts and was therefore difficult to coordinate.
- b) Short contract length: This is hardly compatible with the foreseeable complexity of the required administrative processes.
- c) Absence of prior groundwork: This claim is related to the coordination and homogenization of procedures between the different Basin Authorities (and even within some of them).
- d) Non-existence of a common software support.
- e) Lack of coordination between administrative resolutions and the Registry.

The 2001 National Water Plan Law and the closure of the Catalogue of Private Waters

As stated before, the 1985 Water Law ruled that each Basin Authority should create a Catalogue of Private Waters. This would provide a legal alternative designed to maintain their status, for those owners of private wells under the 1879 Water Law. Besides, the Catalogue was intended to allow the administration to know, control, plan and protect Spain’s aquifer systems (Del Saz, 2002).

The White Book of Water (MIMAM, 2000) states that only 8% of the estimated number of private wells had been registered in the Catalogue. The Second Transient Disposition of the 2001 National Water Plan Law set a three month deadline for the closing of the Catalogue. After October 26, 2001, no further applications were to be processed.

In the words of Moreu (2002), the contents of this Transient Disposition could be summarised as follows: “[i]f the Catalogue application is not submitted in within three months, property rights will not be recognised unless the well owner presents a firm judicial ruling in his/her favor”. This applies whether the ruling is given

before or after the 2001 National Water Plan Law.

According to the same author, a ruling given before the 2001 Law would imply an indiscriminate alienation of property rights contrary to article 33.3 of the Constitution. Further complications would arise from the likely fact that most private water owners would not submit their applications within such a short period of time, which was during the summer holidays. The other possibility, a ruling given before the 2001 Law, would involve a long legal battle, between 8 and 12 years should the case reach the Supreme Court, in which the owner would try to assert a previously acquired right. Moreu (2002) defines this potential situation as “a limitation to private property so draconian (...) that could be considered contrary to articles 53.1 and 24.1 of the Constitution.”

These authors have no official global knowledge of the response of groundwater users to this law. Personal communications suggest that not many well owners submitted their applications before the deadline. The Jucar Basin seems an exception, as apparently over half of the existing well owners have already applied to the Catalogue. Other owners have just registered their wells in the Private Property Registry.

The experience of the 1985 Water Law showed a three-year period to be insufficient for the adaption of existing wells to a new legal framework. Several legal complications have arisen as a result. For one, 80-90% of wells are still undeclared and therefore in uncertain legal position. On the other hand, thousands of well owners who actually applied to the Registry or the Catalogue have submitted administrative appeals against the decision of the corresponding Basin Authority. At times, these administrators have found themselves unable to process so many cases. Díaz Mora (2002), Water Commissioner and later President of the Guadiana Basin Authority, states that 12,000 applications were lodged on December 31, 1988, the 1985 Water Law Registry deadline. Processing these applications did not begin until 1994. In this particular case, the tidal wave of applications and appeals overwhelms the capacity not only of the Guadiana Basin Authority, but also that of the regional justice courts of Castilla-La Mancha

and Extremadura. To add further complexity to the problem, these courts often differ in their application of legal criteria (García Carretero, 2003).

Update Program for the Registry and Catalogue Books (ALBERCA)

The 2001 National Water Plan Law states that the Water Registries are important tools for the management of water resources. Perhaps in view of the results of the ARYCA project, the Ministry of the Environment launched the ALBERCA program in autumn 2001. This program was managed by the General Office for Management of the Public Hydraulic Domain and the General Office of Information Systems and Services, with the cooperation of Tragsatec, a public company. The groundwork for this project was based on the previous work this company carried out for different Basin Authorities, particularly for the Guadiana (Ferrer et al., 2003).

The main goal of the ALBERCA program was to achieve homogeneous basin-wide procedures in order to solve the legal situation of Spain's wells (Ferrer et al., 2003; Yagüe et al., 2003). This is partly achieved by means of integrated computer support. By September 2004, the ALBERCA program had been implemented in seven out of Spain's nine administrative basins. Similar management tools had recently been developed and installed in the Norte and Ebro basins. The administration deemed appropriate the adaptation of these newly created instruments rather than discarding them in favor of ALBERCA technology. The project will end by 2008, 23 years after the 1985 enactment of the Water Law (Yagüe et al., 2004).

Development and implementation of the ALBERCA technology has been carried out with help from Tragsatec. Three main sections exist within the program:

- a) Technical courses for Water Authority staff.
- b) Modification of the existing administrative methods in order to adapt them to the ALBERCA system.
- c) Translation of the existing information into computer support.

The total number of contracted technical assistances is 75, with an investment of 155M€. Note that this investment is considerably lower than the 420M€ estimated by Llamas et al. (2001).

Nonetheless, the ALBERCA program does not seem to address the situation of those wells whose owners never applied to the Registry or the Catalogue. In addition, it also seems to ignore the thousands of illegal wells drilled from 1986. Therefore, the number of existing wells outside the ALBERCA program might total over one million. This is certainly a large share of Spain's groundwater use.

Rodríguez de Liébana (2002), the President of the Guadiana Basin Authority, acknowledged the existence of 25,000 illegal wells within his jurisdiction. Data from certain municipalities suggests that this number might be even higher: indeed, some areas presented a ratio of 1.5 illegal wells for every legal one. In Andalusia, Vives (2003) estimated the irrigated surface to have grown by 54,000 ha between 1998 and 2002. Out of those, 38,000 ha correspond to groundwater irrigation, much of it from illegal wells.

In 2002, the Jucar Basin Authority was one of the first ones to implement the ALBERCA program. With regard to the information systems, the former Water Commissioner and his collaborators have identified a series of potential problems (Ferrer et al., 2003):

- a) Achieving an effective management of servers, databases, software applications, documents and geographical information systems. The centralized nature of the system has been a crucial help in getting the program off the ground. The basin-wide system could prove vulnerable to certain incidents, especially given the everyday pressure of users who expect guaranteed service.
- b) Clearly defining the competences of the General Direction of Hydraulic Works, the General Office of Information Systems and Services, and the basin authorities. This is essential in order to achieve an efficient allocation of technical and economic resources.
- c) Achieving a comprehensive coordination between

technical and computer-related work. This is key to the adequate development and enhancement of computer applications.

d) Addressing the technical difficulties related to enhancing the structure of the existing databases while keeping the systems operational.

e) Increasing the system's efficiency to suit the needs of an increasing number of users.

It is still early to assess the results of the ALBERCA program. Ferrer et al. (2004) estimate that about 300,000 applications had already been incorporated to the ALBERCA database. Furthermore, Yagüe et al. (2004) state that the ALBERCA program was at that time only 30% operational. This presents a new opportunity to update and enhance the effectiveness of Spain's Hydraulic Administration, as well as to complete the Registry. These tools are essential for adequate water management and for meeting the environmental requirements of the European Water Framework Directive. This new initiative, however, may have arrived too late: twenty years after the 1985 Water Law, the Registry is still in a clearly unsatisfactory state. While it is true that the role of groundwater in Spain's water policy is better understood today than it was before, improvements take place very slowly, causing significant damage to Spain's economy and environment.

Conclusions

The 1985 Water Law declares groundwater in Spain to be public property. Reality is however different. Only those wells whose drilling was authorised after January 1, 1986, yield public waters. All other wells are private: either temporarily (until 2036 to 2038 if administrative protection has been granted), or perpetually.

Overall, the legal situation of groundwater in Spain is still uncertain 20 years after the 1985 Water Law. The total number of wells is still not known accurately. This situation was described as "very discouraging" by the White Book of Water (MIMAM, 2000). "Hydrological insubordination" has added further complexity to the problem: wells (perhaps

most) are drilled today without authorisation from basin authorities. In turn, these authorities are unable to manage groundwater resources, often due to the lack of an appropriate mindset or the necessary means and support.

In addition, the 1985 Water Law ignores important issues which have been the source of thousands of appeals against the decisions of Basin Authorities regarding private well ownership. Basin Authorities have often found themselves unable to deal with the amount of paperwork. In addition, the opinion of a recognised legal expert (Moreu, 2002) suggests that the Second Transient Disposition of the 2001 National Water Plan Law might be contrary to the Constitution. Should this hypothesis be confirmed, the current confusion over groundwater's legal ownership would increase.

In order to solve the legal situation of groundwater, the administration launched the 66M€ ARYCA program. This program was not very effective in meeting the expected goals. In 2002, the Ministry of the Environment launched the 155M€ ALBERCA program. While it is still early to assess its results, this initiative seems to ignore an important share of the existing wells. Therefore, while this can be considered an interesting step forward, it is probably insufficient

A transparent assessment of the role of groundwater in Spain's water policy is probably a more suitable solution to the current problems. Political willingness is essential to success.

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References

- Del Saz, S. (2002) Cuál es el contenido de los derechos privados sobre las aguas subterráneas?, in: Del Saz, S., Fornés, J., and Llamas, M.R. (eds.) *Régimen jurídico de las aguas subterráneas* (Madrid, Spain, Fundación Marcelino Botín and Ediciones Mundi-Prensa).
- Díaz Mora, J. (2002) La clarificación jurídica de los acuíferos sobreexplotados. El caso de La Mancha, in: Del Saz, S., Fornés, J., and Llamas, M.R. (eds) *Régimen jurídico de las aguas subterráneas* (Madrid, Spain, Fundación Marcelino Botín and Ediciones Mundi-Prensa).
- Ferrer, J., Gullón, N. and Xuclá, R.S. (2003) La implantación del Proyecto ALBERCA en la Confederación Hidrográfica del Júcar, *Congreso Nacional de la Ingeniería Civil*, Madrid, pp. 183-193.
- Ferrer, J., Palmero, C., Gullón, N., Yagüe, J. and Xuclá, R.S. (2004) El Proyecto ALBERCA como ejercicio de modernización y coordinación entre Administraciones, *Actas del II Congreso Internacional de Ingeniería Civil, Territorio y Medio Ambiente*. Santiago de Compostela, Grupo III - La Gestión del Agua. Tomo II, pp. 975-986.
- Fetter, C.W. (1994) *Applied Hydrogeology* (New Jersey, Prentice Hall).
- Fornés, J.M., de la Hera, A. and Llamas, M.R. (2004) The silent revolution of groundwater intensive use and its influence in Spain, *Proceedings of the Workshop on Water and Politics: Understanding*

- the role of politics in water management*, The World Water Council, Marseille, 26-27 February 2004.
- García Carretero, M. (2003) Situación legal de las aguas subterráneas en la cuenca alta del Guadiana, in: Coletto, C., Martínez-Cortina, L., and M.R. Llamas (eds) *Conflictos entre el desarrollo de las aguas subterráneas y la conservación de los humedales: la cuenca alta del Guadiana* (Madrid, Spain, Fundación Marcelino Botín and Ediciones Mundi-Prensa).
- Llamas, M.R. (2004) La Gestión Social del Agua, in: Santafé, J.M. and Bru, C. (eds) *Jornadas Internacionales. El Agua: Nuevas Fronteras. Nuevas Visiones* (Caja de Ahorros del Mediterráneo).
- Llamas, M.R. and Custodio, E. (1985) *Informe científico-técnico al proyecto de Ley de Aguas* (Madrid, Spain, Instituto de Estudios Económicos).
- Llamas, M.R., Fornés, J.M., Hernández-Mora, N. and Martínez Cortina, L. (2001) *Aguas subterráneas: retos y oportunidades* (Madrid, Spain, Fundación Marcelino Botín y Ediciones Mundi-Prensa).
- Llamas, M.R. and Martínez-Santos, P. (2004) Coping with the Silent Revolution of Intensive Groundwater Use, *Proceeding of the International Water Demand Management Conference*, May 30 - June 3, 2004, Dead Sea, Jordan, 17 pp.
- MIMAM (2000). *Libro Blanco del Agua en España*. Ministry of the Environment.
- MOPTMA-MINER. (1994). *Libro Blanco de las Aguas Subterráneas* (Ministerio de Obras Públicas, Transportes y Medio Ambiente, y Ministerio de Industria y Energía).
- Moreu, J.L. (2002) Los problemas de la legislación sobre aguas subterráneas en España: posibles soluciones, in: S. Del Saz, J.M. Fornés y M.R. Llamas (eds.) *Régimen jurídico de las aguas subterráneas* (Madrid, Spain, Fundación Marcelino Botín y Ediciones Mundi-Prensa).
- Rodríguez de Liébana, J.P. (2002) Comentario a la ponencia "La clarificación jurídica de los acuíferos sobreexplotados. El caso de La Mancha, in: Del Saz, S., Fornés, J.M. and Llamas, M.R. (eds.) *Régimen jurídico de las aguas subterráneas* (Madrid, Spain, Fundación Marcelino Botín and Ediciones Mundi-Prensa).
- Samper, J. (2000) Estado actual del conocimiento de las aguas subterráneas en las cuencas del Noroeste de España, *Jornadas sobre las aguas subterráneas en el Noroeste de la Península Ibérica* (La Coruña).
- United Nations. (2003) *Water for People, Water for Life* (Paris, UNESCO-WWAP).
- Yagüe, J., Villarroya, C. and Xuclá, R.S. (2003) Proyecto ALBERCA: modernización de los Registros de Aguas, *Congreso Nacional de la Ingeniería Civil*. Madrid, pp. 1853-1861.
- Yagüe, J., Villarroya, C. and Xuclá, R.S. (2004) Evaluación del grado de avance del Programa ALBERCA, *VIII Simposio de Hidrogeología*. Zaragoza, Tomo XXVII, pp. 453-461.
- Vives, R. (2003) Economic and Social Profitability of Water Use for Irrigation in Andalucía, *Water International*, 28 (3), pp. 326-333.