A comparative history, from the 16th to 20th centuries, of irrigation water management in Spain, Mexico, Chile, Mendoza (Argentina) and Peru

Jacinta Palerm-Viqueira

Abstract

This paper explores the long-term development of irrigation system management, and looks at the influence of legislation, irrigation system size, scalar stress and polarized land tenure in the existence and success of self-management. The case studies are drawn from regions of the former Spanish Empire. Hispanic America, between the 16th and early 19th centuries, as part of the Spanish Empire, had a common legal framework; however, in the 19th and early 20th centuries (after the break up of the Spanish Empire), new and diverse country-based legislation developed and, in some cases, this new legislation favoured self-management.

Keywords: Centralized management; History; Irrigation water management; River water distribution management; Self-management

Introduction

The debate on the hydraulic hypothesis (the impact of large-scale irrigation water works on society) (Wittfogel, 1957) has led to the study of the relationship between hydraulic infrastructure and society. Analysis of management and governance of hydraulic infrastructure has comprised irrigation systems, hydraulic networks, command areas of reservoir dams (for example, Maass & Anderson, 1986; Hunt, 1988, 1994; Price, 1994; Cressier, 1995; Vaidyanathan, 1999). In theory, management of irrigation systems is unified; acephalous systems are rare and have been described only for very small systems (Hunt, 1988; Wade, 1988; Mabry, 2007); in the same vein, lack of institutions or a lack of overarching institutions has been linked to violence and infrastructure deterioration (Millon, 1962; Fernea, 1970; Ostrom, 1990).

It is the management of irrigation systems, and not river water distribution, that is said to be unified. There are, however, case studies on the complex management of river water, such as that of Bali.

doi: 10.2166/wp.2010.110

© IWA Publishing 2010
that have been held up as examples of decentralized management (Mabry, 2000; Erickson, 2006). Restrictions for self-management have been discussed, for example, irrigation system size (Hunt, 1988), scalar stress due to number of irrigators (Mabry, 2000; Marcus & Stanish, 2006), and type of management (bureaucratic and non-bureaucratic) (Mabry, 1996; Vaidyanathan, 1999; Palerm-Viquiera, 2006, 2009). It has also been argued that the existence of multi-community or larger self-governed institutions for water management is closely linked to a stable and long-term national or regional legal framework for self-governed institutions (Sengupta, 2002; see also Ostrom, 1990). Thus, India lacks a legal framework whereas the US, Spain, the Philippines, and Japan have legal frameworks and strong self-governed institutions (Giménez-Casalduero & Palerm-Viqueira, 2007).

Hispanic America, between the 16th and early 19th centuries, as part of the Spanish Empire, had a common legal framework. The law provided for the appointment of water judges: “We order that judges for water distribution be appointed by the Audiencia, if this is not the customary practice, then shall the Viceroy or President, City and Cabildo appoint...” (Recopilación de Leyes de los Reynos de las Indias 1681: libro 3, título 2, ley 63; see also Margadant, 1989; Dougnac, 1994). The same legal framework was seemingly also in use in Spain from the reconquista until the 1866 and 1879 water laws; the Spanish Empire-wide figure of a water judge (see Glick, 1970: 200–201) probably derived from the arabic “qadi of water”. Thus, legislation did not favour self-management. However, in the 19th and early 20th centuries, after the break up of the Spanish Empire, new and diverse country-based legislation developed and, in some cases, this new legislation favoured self-management. This paper explores the linkage of successful self-management to irrigation system size, scalar stress, polarized land tenure and favourable legislation.

Spain

Spain currently has some 3 million hectares (ha) under irrigation; two thirds of this area depends on surface water, of which 1,200,000 ha are based on old irrigation systems and 1,000,000 ha on post-1950 irrigation systems. The Spanish literature makes a distinction between the management capacity of the comunidades de regantes (water user associations) of the old and new irrigation systems. Old or traditional comunidades de regantes, composed of smallholders, are said to be more capable. The remaining third of the irrigated area employs groundwater which, since only the 1985 Water Law, is publicly owned (Pérez-Picazo, n.d.). Water management, based on the comunidades de regantes’ management of irrigation systems, complements a government river basin authority (confederación hidrográfica).

Spain has a centuries-old tradition of irrigator organizations, greatly enhanced due to the fact that, since the reconquista, the Crown specifically promoted and officially recognized irrigator organizations. Later, with the 1866 and 1879 water laws, a generalized legal framework provided for irrigator organizations (the comunidades de regantes). At the same time, existing irrigator organizations were legally recognized, thereby allowing continuity of the traditional organizations (Giménez-Casalduero & Palerm-Viqueira, 2007).

Seemingly, the legal framework for Hispanic America was also in use in Spain between the reconquista and the 19th Century water laws. For example, in Guadi, water mayors (alcaldes de aguas) were authorized by the crown in 1494; in Granada, water judges (jueces de aguas) and a water court (juzgado privativo de aguas) date from 1501, and the crown authorised by-laws in 1535.
(Diego-Velasco, 1984; González-Martín & Espinar-Moreno, 2005); and the Spanish federation of water user associations (FENACORE) currently reports associations called juzgado privativo de aguas (water court) and alcaldía juzgado de aguas (water mayor). Glick (1970) proposed that these institutions derived from the arabic “qadi of water”. He further stated (p. 200–201), “There seem to have been, thus, two models for the medieval Christian organization of irrigation administration: a cellular one, based on irrigation communities with their own elected officials, and a centralized one, in which irrigation administration was a branch of a higher jurisdiction, typically that of the town”.

The late 19th Century Spanish water laws made establishment of a comunidad de regantes mandatory when an irrigation tract shared a river off-take and had 20 or more users. In addition, the water laws (article 282 of the 1866 law, and article 242 of the 1879 law) also provided for other, non-mandatory, self-governed institutions “...along a river course... one or more central or common syndicates may be constituted by mutual agreement, in order to defend rights and to conserve and promote common interests. These will be made up of representatives from the interested comunidades”. A good example of a mutual agreement syndicate is provided by the case of the six sister ditches of the Jucar River, which between them irrigate 45,000 ha. The sister ditches of the Jucar have agreements for water distribution in drought years, and also jointly negotiate with the Jucar River confederación hidrografica (Pimentel-Equihua, 2004; Palerm-Viquiera, 2009).

The establishment of river basin authorities (confederación hidrográfica) began in the 1920s. Although these initially had a strong participatory character, this was soon lost (probably due to Franco’s dictatorship); only towards the second half of the 20th Century was user participation slowly reintroduced (Pérez-Picazo, n.d.). The latest water legislation (TRLA, 2001) renewed the continuity of the irrigator organizations and improved the participatory character of the confederaciones hidrográficas.

Chile

In Chile, water administration is fundamentally in the hands of water user organizations, as much for irrigation systems as for rivers. The total surface area under irrigation in Chile is 1,800,000 ha. Self-management capacity is impressive, with irrigation systems of 50,000 ha (Laja) and 30,000 ha (Maipo), as well as smaller irrigation systems. This is perhaps even more surprising when one considers that the expansion of irrigated agriculture occurred during the 19th Century (Astaburuaga, 2004). The success of Chilean self-management is not based, as in Spain, on centuries-old traditional irrigation organizations. Rather, Turral (1995) asserts that self-management capabilities have to do with the homogeneous nature and commercial scale of agricultural land tenure; thus, it is important to note that the 1970s land reforms apparently had some impact on water user associations (Peña-Torrealba, n.d.).

In Chile during the colonial era, as in all the Hispanic American regions, the law provided for the appointment of water judges. In Santiago, Chile, from the time of the city’s foundation until independence, water judges and building experts (alarifes) were appointed with specific water-related responsibilities (Actas de Cabildos; Guarda, 1978; Barros-Arana, 2000; see also Vergara, 1998). For example, in 1768, owing to extreme water distribution difficulties, the colonial government intervened and appointed a water judge in order to avoid “the stubborn tenacity and violence among owners”, and placed armed guards at the water off-takes to ensure a more just water distribution and thus prevent excesses (Donoso, 2003: 42).
In addition to colonial water legislation, the special case of the Maipo (Irrigation) Society was to have strong influence on the development of Chilean water legislation. The first by-laws of the Maipo Society date from 1827 and 1831. In 1832, the President of the Republic approved the Maipo Society’s Association Act. This Presidential decree also stated that “…court justice tribunals should take notice of the commitments that the Maipo canal shareholders have pledged amongst themselves and not judge on controversies that may arise among them; as shareholders have solemnly renounced to go before courts of law and have assumed the obligation to define their rights amongst themselves” (Obando, 2005). Thus, disputes between shareholders could not be taken outside the Maipo Society.

The 1832 decree was the first case in Chile when the legal personality of a water user association was recognized, and it also gave complete authority to the Maipo Society to judge on its internal issues (a capacity, which in Chile is designated as arbitro arbitrador, arbitrating arbitrator), thus providing a degree of judicial autonomy which would only be matched in the Valencia huerta, (Spain) until the 1985 Spanish water law (Giménez-Casalduero & Palerm-Viquera, 2007).

During the 19th Century, which saw both a considerable expansion of irrigated agriculture and, at the end of the century, a period of drought (Figueroa-del-Río, 1993), new water legislation was enacted. Water distribution issues amongst irrigators were taken before a judge; the judge then appointed a water judge (juez de aguas) when irrigators shared the same river water off-take, or a river judge (juez de río) when the irrigators only shared the same river water (Figueroa-del-Río, 1993; Puig, 1998; Vergara, 1998; Diagnóstico, 1999; Donoso, 2003). Currently, in the state of Montana in the United States, a similar strategy is employed (Montana Code Annotated, 2007).

In 1908, Chilean Law Number 2139 gave a legal framework to water user associations (asociaciones de canalistas: ditch associations) that shared the same river water off-take. The Maipo Canal Society lawyer used the Maipo by-laws as the basis for the new legislation, which granted legal personality as well as the judicial capacity of arbitrating arbitrator to the asociaciones de canalistas (Diagnóstico, 1999; Obando, 2005). “This law transferred to the associations all responsibility for the distribution of water pertaining to the association, and removed from the courts the hearing and sentencing of disputes pertaining to these waters, either between members or between members and the association’s board of directors. The boards of directors were granted the authority to hear and sentence as arbitrating arbitrator” (Diagnóstico, 1999: 19).

In March 1949 the Confederación de Canalistas de Chile (Chilean Ditch Federation) was formed (Sepúlveda & Sabatini, 1996); whereas in Spain the Federación Nacional de Comunidades de Regantes (National Federation of Irrigator Communities) was founded in 1955.

The 1951 Chilean Water Code legislation used, as its basis, the 19th Century legislation concerning the appointment of river judges, as well as the Chilean experience of creating organizations with legal personality. Thus, the legislation concerning juntas de vigilancia (river water user associations) granted legal personality as well as the judicial capacity of arbitrating arbitrator to the juntas de vigilancia. To this day, the person in charge of water distribution is frequently termed the river judge (Diagnóstico, 1999; Obando, 2005).

Currently in Chile, there are asociaciones de canalistas and juntas de vigilancia as well as comunidades de aguas; the latter have the same characteristics as the asociaciones de canalistas, but lack legal personality (Diagnóstico, 1999). Evidenced by one case study, differences reside not only on legal personality but also in the fact that the comunidades de aguas are user associations of a secondary ditch within an asociación de canalistas (Sepúlveda & Sabatini, 1996).
Mendoza

The Mendoza water management model is particularly interesting as it presents impressive continuity with the institution of the colonial water mayor (alcalde de aguas) as well as, since 1884, for centralizing water management in a single institution, even though management is organized by river basin. The government’s Departamento General de Irrigación currently manages water for the irrigation of 350,000 ha. This centralized management should perhaps come as no surprise, taking into account that the 16th Century Zanjon Canal had (variously) a width of 60, 40 and 20 varas (a vara is more or less equivalent to a yard, or 0.91 m) and (now called the Cacique Guaymallen Canal) irrigates 30,000 ha (Cano, 1941: 271; Rodríguez-Aguilera et al., 2006).

Whereas river and primary canal management manifests a striking continuity, water user associations (the inspecciones de cauce) for the management of secondary canals exhibit a significant discontinuity. This is due to the mid-20th Century displacement of the self-managed inspecciones de cauce by increased centralisation, as well as the more recent policy for revitalising self-management, based on combining or unifying several inspecciones de cauce in one larger association, which at least on paper implied the disappearance of the old traditional inspecciones de cauce (Bustos, 1997; Mosovich, 1999; AsIC, n.d.; Chambouleyron et al., n.d.; Diaz Araujo & Bertreanou, 2004; Maccari, 2004; Gennari et al., 2006; Torres, 2006; Ruiz-Freites, 2007).

One weakness of the inspecciones de cauce’s autonomy may be related to the fact that, since the late 19th Century, Mendoza’s irrigated land tenure is characterized by smallholders (Bustos, 1997, 2008).

The city of Mendoza was founded in the late 16th Century, c.1566, and was established on a site overlying pre-Hispanic irrigation systems. Since the first years of the founding of the city, the use and care of irrigation water courses was a function of the City Council (cabildo de la ciudad). In 1603–1606, the office of Water Mayor was instituted, which had full authority over water distribution; a few years later, additional functionaries with irrigation water duties were appointed (González, 2006; Período colonial del uso del agua, 2005; Mendoza Portal Educativo, n.d.).

After Independence, under the Republic in 1815, an alderman water judge (regidor juez de aguas) was appointed. In 1833, the Water Court office (Juzgado de Aguas) was established, apparently with the same functions as the alderman water judge. In 1844, the Reglamento General de Aguas or Reglamento para el Juzgado de Aguas (Water Regulation or Water Court Regulation) was enacted (Cano, 1941; Diaz-Araujo & Bertranou, 2004; Mendoza Portal Educativo, n.d.). The Juzgado General de Aguas (Chief Water Court) is,

an institution of a rather undefined nature, because even if at times it assumes judicial functions, surely in order to settle disputes amongst irrigators, [it] has as its basic function the management and distribution of water as revealed by the existence of a ditch rider (tomero) (Coria, 2000; see also Coria & Varo, 2000).

In addition to the Water Court regulation, there are other water regulations, specific to certain towns and ditches, government issued as well, such as: that of 1842 for the Acequia Real o del Estado (the Royal or State ditch), now called the Jarillar ditch; that of 1852 for the case El Retamo ditch; and the 1837 water regulation for the city of Villa de San Martin (Cano, 1941; Diaz-Araujo & Bertranou, 2004).

The typical water management structure of the 19th Century consisted of a government appointed water judge, supported by water lieutenant(s) (teniente de aguas) and ditch riders (tomeros). The water
lieutenant acted as the water judge’s assistant and the tomeros were charged with supervising and operating the systems. The duties and tasks of the tomero general (chief ditch rider) and the teniente general de aguas (chief water lieutenant) were regulated in Mendoza between 1822 and 1840 (González, 2006). However, for the secondary canals (locally called hijuelas), the irrigators themselves appointed a water judge and employed their own ditch riders.

The 1884 Water Law replaced the Juzgado General de Aguas (Chief Water Court) with the Chief Water Department (Departamento General de Aguas), which in 1895 changed to the Chief Irrigation Department (Departamento General de Irrigación), headed by the Chief Superintendent of Water. Apparently, 1884 also marked the end of the aforementioned local water regulations, so that water management in the province of Mendoza was completely centralized in the Chief Water Department; however, having river basin sub-delegations ensured decentralisation but “only in a bureaucratic sense” (Cano, 1941; Díaz-Arauco & Bertranou, 2004). During that same year, the 1884 Water Law also established the inspecciones de cauce, an irrigation water user association made up of irrigators who shared the same secondary canals. The inspecciones de cauce were created “ministerio legis”, that is by the sole imperative of the law (Pinto, 2006; Maccari, 2004). The legislation of Mendoza province emphasizes the autarchy (or independent self rule) of the inspecciones de cauce. For example, the 1916 Mendoza province Constitution states:

Article 187 – the irrigation laws that the legislative body may dictate should in no circumstance deprive the interested parties of canals, hijuelas and drains, of the faculty to elect their own authorities and administer their rents, without prejudice to the control by the superior irrigation authorities.

In recent studies, emphasis has been placed on the self-governance and autonomous character of the inspecciones de cauce, as well as on the mid-20th Century process of centralization, with the corresponding displacement of the inspecciones de cauce (Bustos, 1997; Mosovich, 1999; AsIC, n.d.; Torres, 2006; Ruiz-Freites, 2007). However, the emphasis on the autarchic character of the inspecciones de cauce and the supposedly participatory character they granted to overall water management seems exaggerated, considering that the average irrigated area of a given inspección de cauce – based on Torres (2006) and Chambouleyron et al. (n.d.) – consisted of 500 ha or even less.

In the 1980s, a policy for “revitalising” the inspecciones de cauce was initiated, based on their “unification”, with the objective of achieving “economies of scale” and professionalization. However unification also meant the formal disappearance of the traditional boundaries of the inspección de cauce. Some years later, in 2006, the policy consisted in the association of the inspecciones de cauce. With this most recent policy each inspección de cauce maintains its specificity and historic boundaries while linking to a second organizational tier. The unified and the associated inspecciones de cauce manage irrigation water for 10,000 to 15,000 ha (Chambouleyron et al., n.d.; Diaz-Arauco & Bertreanou, 2004; Maccari, 2004; Torres, 2006; Gennari et al., 2006; AsIC, n.d.; Ruiz-Freites, 2007).

Peru

Peru currently has an irrigated area of 1,200,000 ha. While in Chile and Mendoza the irrigated surface area expanded, in Peru the coastal irrigated surface area served by large irrigation systems declined between the 16th and 19th centuries, only recovering its pre-Hispanic extent in the 20th Century.
The irrigated areas of the *sierra* (highlands) are estimated at 246,000 ha. Information on water management for Peru is impressively rich.

The large irrigation systems of the coastal valleys have, since colonial times, had government appointed managers and, simultaneously, significant irrigator participation. Valley water was managed as a unit and was, thus, managed similarly to river basin management. Recent policy is for management to be turned over to the water user associations in a process of state downsizing (GPER, 1993). In striking contrast to the large coastal irrigation systems, the small irrigation systems of the *sierra* are self-managed.

Indian peasant communities deserve special mention for their self-management capabilities. Most ethnographic work has concerned the *sierra* Indian communities; however, coastal Indian communities also display considerable self-management capabilities. Oré (2005), for example, describes Indian communities’ participation in the maintenance work and surveillance of a large coastal irrigation system, as well as in the work on extending the main canal, by means of coordinated efforts and labour investment of the Indian communities in the early 20th Century. However, the Indian communities’ self-management capabilities were curbed when the 1969 Water Law withheld recognition of traditional Indian community authorities. The 1969 Water Law has been criticized harshly for its negative impact on the coastal and *sierra* traditional community organization (Gelles, 1984; GPER, 1993; Boelens, 2003; Boelens & Bustamante, 2005; Oré, 2005).

In Peru, noteworthy early water legislation included Viceroy Toledo’s 1577 water ordinances for Lima, which mandated that water judges be in charge of water distribution, and a 1631 Royal Decree which ordered the Lima City Council (*Cabildo*) not to appoint hacienda owners as water judges (Dougnac, 1994). A similar situation is found throughout colonial Peru. For example, the 1566 “Ordinances concerning Caciques and Indian nobles” or “Ordinances concerning Indians” dictated by Doctor Gonzalez de Cuenca in the town of Jayanca says: “I have appointed the mayors, the aldermen (*regidores*) and the water judge and have ordered what care should be taken for the election of said officials, the use and exercise of said offices and have made ordinances that you the *cacique* and the mayors and aldermen and other officials must follow in the exercise of said offices…” (Gómez-Cumpa, 2002).

However, the most relevant and well-known legislation consists of, for northern Peru, the 1699 water regulation by Antonio de Saavedra y Leiva, Superintendent Water Judge (and Dean of the Trujillo Cathedral), and, for Lima, the 1793 water regulation by Ambrosio Cerdan de Landa y Pontero, Water Judge; 19th and early 20th Century water legislation frequently refers to these regulations, and orders that they be in force/in effect (for example legislation dating from 1838, 1856, 1901, 1904a, 1917 in the *Archivo Digital de la Legislación en el Perú* – the Legislative Digital Archive of Peru).

Colonial water management legislation maintains continuity into the 19th Century, not only due to the persistence of the 1699 Saavedra and 1793 Cerdan water regulations, but also because of the continued presence of water judges. In the *Archivo Digital de la Legislación en el Perú* there are multiple references to water judges and water courts (*juzgado privativo de aguas*) between 1838 and 1901, and there is also mention of a water court in 1922; for example legislation see 1838, 1848, 1898, 1901a, 1901b, 1922 in the *Archivo Digital de la Legislación en el Perú*. In addition there is also mention of water courts in the short lived 1839 Peruvian Constitution; Article 114 of Title 14 ‘On the Judicial Authority’, which states “there will be tribunals and special courts (*juzgados privativos*) for commerce, mining, tithes, water, dams and confiscations”.

The 19th Century legislation is informative concerning how water management was structured, the organization of operation and maintenance, the staff employed in water distribution (water deputies, ditch riders, guards, and other staff – *diputados de aguas, tomeros, guardas, quebradores, comisarios*),
and the payment of dues for activities, officials and staff. Of interest is the existence of an assembly of “interested parties”: hacienda owners and smallholders (chacareros). Normal assembly meetings, in the presence of the water judge, were set; and assembly issues concerned, for example, the selection and appointment of staff, decisions on maintenance dates, and the discussion and apportioning of rates. Assembly decisions were binding and set out in minutes.

Irrigator participation in water management also seems to date from colonial times, as user participation in decision-making is stated in Viceroy Toledo’s 1577 water ordinances (Dougnac, 1994: 427–428). However, the Peruvian combination of user participation and government appointed officials for management does not yet appear to have been studied; the 1900–1906 memoirs of Enrique de Guimarães, water judge of Trujillo province during that time, would be of interest concerning this subject (cited in Klaren, 1976).

Legislation underwent changes with the promulgation of the 1902 Water Code, a code inspired by, if not directly copied from, the Spanish 1866 Water Law, or a very similar one dating from 1879. The legislation mandates water user associations (comunidad de regantes). After the new legislation was implemented, there were at least two government approved comunidad de regantes by-laws in 1904 (Archivo Digital de la Legislación en el Perú). Water management by water judges was discontinued; indeed the 1902 Water Code mandated:

Article 239: The water judge’s administrative function ceases as soon as a water user association (comunidad de regantes) has been set up and its by-laws approved by the government.

Article 240: Functions of officials appointed by Municipalities to attend to water conservation, management and distribution shall also cease when water user associations (comunidad de regantes) are set up and by-laws are government approved.

Although the comunidades de regantes represented a very successful model in Spain, in Peru they were a failure. Klaren (1976) attributes the failure of water management based on the comunidades de regantes model to land tenure polarization, as well as to increased water requirements due to the sugarcane boom. As voting shares were based on the amount of irrigated land, hacienda owners gained control over the election of the board of directors and, therefore, had control over the water manager.

The Peruvian retreat from the comunidad de regantes model was set in motion due to uprisings in the Lambayeque department; and in 1911 “a technical administration which was completely independent and removed from the interests or activities of the irrigators was implemented in the Lambayeque department. This reform was deemed very effective; later on water distribution by government officials and engineers became generalized…” (Basadre, 1968:165, see also GPER, 1993). The pertinent legislation was passed in 1917 (Law No. 2674).

The 1917 legislation called for water management to be undertaken by Technical Commissions (Comisión Técnica), later termed Technical Administrations (Administración Técnica), similar to water judge management but in the hands of engineers. The Technical Commission or Technical Administration water management went together with a policy of rationalizing watering as well as investment in new infrastructure. Charles Sutton, a US engineer is said to have played an important role in these policies. However, changes – rationalization – in water distribution met with strong opposition (GPER, 1993). User participation appears to maintain its continuity by means of the comunidades de regantes organization, as well as through the organized Indian communities.
With the agrarian reform in 1969 and new water legislation (*Ley General de Aguas*), the Technical Administration became responsible for an “Irrigation District”, a term that in Peru refers to the area of a river basin where the Technical Administration operates. The *comunidades de regantes* are replaced by *comisiones de regantes*, a water user association, composed of those irrigators who share the same river water off-take or section of an Irrigation District and by *juntas de usuarios*, a water user association composed of those irrigators sharing the same river water. The authority exercised by the Technical Administration expanded, owing to the disappearance of the haciendas as well as to lack of recognition of the traditional Indian community authorities. The Technical Administration continued to be in charge of water management in the coastal valleys until the more recent policy of state downsizing and turnover to “organized” users.

**Mexico**

Mexico went from estimates of an irrigated surface area of 600,000 to 2,000,000 ha in the early 20th Century to an estimated 6,000,000 ha in the late 20th Century. Expansion of irrigated surface area took place both within the “new” Irrigation Districts (from 1926) and also within smaller irrigation projects, located outside the Irrigation Districts. About half of the current irrigated surface area belongs to Irrigation Districts, which frequently have a nucleus of old irrigation systems (*Tamayo, 1958: 66, 67, 82; Orive-Alba, 1970; Palacios, 1997; Palerm Viquiera, 2007*).

“The 19th century was characterized by almost no water legislation, whereas . . .” In the 20th Century, Mexico witnessed an overabundance of legislation: new water laws in 1910, 1929, 1934, 1972, 1993, and 2004, as well as water law regulations in 1911, 1930, 1936 and 1994, Special Irrigation Districts (1926, 1946) and ground water legislation in 1945 and 1958 (*Lanz-Cárdenas, 1982*). Breaks in continuity occurred with the early 20th Century agrarian reforms, policy changes in the 1970s, and the massive policy changes in the 1990s (*Palerm-Viqueira, 2005*).

In Mexico between the 16th and 19th centuries, peasant communities and towns had institutions for water management: water judges (*jueces de aguas*) and, in Indian communities, a *topil* (*Meyer, 1997: 69–70*); however, there were typically no overarching institutions linking haciendas, peasant communities and towns for common water management issues. Absence of institutions meant that there were no common elected officials or common hired staff. Water management was decentralized or more precisely acephalous (*Sentencia, 1635; Convenio, 1873; Contrato, 1899; Camacho-Pichardo, 1998, 2003; Lipsett-Rivera, 1999; Salazar, 2000; Mazabel, 2001; Sánchez, 2001; Castañeda, 2004, 2005; Gómez-Carpinteiro, 2007; Romero, 2008; Sandré & Sánchez, ms)*.

Water management, in the absence of overarching institutions linking haciendas, peasant communities and towns for common water management issues, was based on established [written] arrangements. During the colonial period the typical document is a *repartimiento*, a government produced text setting out water distribution (water division and measurement structures, water turns, water storage). The *repartimiento* is the judicial outcome to a water distribution conflict and, based on the *Archivo General de la Nación* (National Archive) catalogue, all the *repartimientos* seemingly deal with river water distribution.

The lack of overarching institutions has some partial exceptions; in two cases, dating from 1625 and 1697, instructions were given that irrigators should appoint and pay a guard to supervise water distribution; and in one case the text goes on to say that, in the case that irrigators are remiss, a guard will
be appointed by the local court (Mazabel, 2001; Sentencia, 1635). There is also one documented case of a stand alone (neither town- nor community-based) irrigation institution for the Yuriria artificial lagoon; the 1780 document refers to older ordinances (1780 and 1850 documents compiled in Sandré & Sánchez, ms; Santos et al., 2006).

In the 19th Century the typical document was a private [written], frequently notarized, agreement, also centred on water distribution. How did this work in terms of water management? In late 19th Century accounts, each hacienda sent its own employees to guard and monitor water division structures, to ensure they let pass the correct amount of water; ad hoc meetings in order to coordinate maintenance are also found, although in other cases maintenance is also defined in the horizontal (written) agreements. Conflict on water management issues were settled in court. In the 19th Century, specific documents frequently refer to previous documents on water management, for example one dated 1896 refers to documents dated 1600, 1763, 1872 and 1878 which were still in force (Convenio, 1873; Contrato, 1899; Sánchez, 2001; Castañeda, 2004, 2005; Gómez-Carpinteiro, 2007; Sandré & Sánchez, ms). Therefore, apparently, Mexico experienced continuity of water management structure between the colonial period and the 19th Century.

The first federal water legislation in 1888 was preceded in several instances by state legislation. State water legislation was instituted as far as we know in the following states: Sonora (1843, 1933), Zacatecas (1862), Durango (1881), Guerrero (1898), Oaxaca (1905), Michoacán (1906), Guanajuato (1923), Nuevo León (1851, 1852, 1873, 1892, 1893), Nuevo León y Coahuila (1857, 1860, 1863) (Sandré & Sánchez, ms). However, state legislation only provided rudimentary indications, if any, concerning water management. Furthermore, no studies exist which analyse the impact of state legislation on water management.

By the late 19th Century, beginning in 1888, and throughout the 20th Century, federal legislation held that water distribution regulation was in the federal government’s purview. The federal government’s case-specific regulations were similar to a colonial repartimiento, in the sense that they dealt with water distribution. Later water legislation would also include the specifics of the water user associations (juntas de aguas) charged with the implementation of the regulations (concerning water distribution and maintenance). The juntas de aguas acted as agents of the federal government in the implementation of their regulations (Palerm-Viquiera et al., 2004; Palerm-Viqueira, 2005; Palerm-Viquiera & Rodríguez-Haros, 2005; Palerm-Viquiera et al., ms).

The 1888 water legislation dealt with river water management. Later legislation encompassed river water as well as irrigation system management regulation. Water law legislation (1910, 1929, 1934, and 1972) and water law regulations (1911, 1930, and 1936) retained the same institutional pattern of water user associations for management of rivers and irrigation systems. Only in the 1929 Water Law did a water user association (asociación de usuarios) become mandatory for users of a common off-take. The Chilean and Spanish legislation, as well as the Peruvian 1902 Water Law, made a clear differentiation between river water associations and common off-take associations, and the existence of a water user association where there is an off-take in common is mandatory. In Mexico, however, the Junta de Aguas could be composed of various other juntas de aguas, each having its own sphere of competence. Communities and ejidos (agrarian reform land tenure) with legal personality had representation in the Junta de Aguas and had total authority over management of their own water and infrastructure (Palerm-Viquiera et al., 2004; Palerm-Viqueira, 2005; Palerm-Viquiera & Rodríguez-Haros, 2005; Palerm-Viquiera et al., ms).

The juntas de aguas, based on case studies research, worked well (for example see Martínez-Saldaña & Palerm-Viquiera, 1997; Palerm-Viqueira & Martínez-Saldaña, 2000). It is quite possible that the Junta
de aguas regulations were based on previous documents and local arrangements, or at least that government officials in charge of making the junta de aguas regulations had previous documents on hand. However, the agrarian reform, as well as the 1970s and 1990s changes to water user associations, termed unidades de riego, has made follow-up of continuity difficult.

In the 1970s, a policy favouring modernisation and new hydraulic infrastructure in peasant communities organised the recipients of this investment into unidades de riego para el desarrollo rural (water user associations), later shortened to unidades de riego. Government supervision of the unidades de riego was based on a county and state grid of agricultural extension offices. The communities belonging to juntas de aguas entered the then voluntary unidades de riego programme; new, small-scale infrastructure was turned over to the irrigators of one or more communities as unidades de riego. Finally, in the 1992 (as well as the 2004) Water Law, all reference to juntas de aguas is absent. In this later legislation, the federal government had sole authority over rivers, whereas previously the junta de aguas acted as an agent of the federal government. The fate of the juntas de aguas is unclear. In some cases they converted as a whole into unidades de riego, whereas in other cases parts and pieces of the juntas de aguas either became or continued as unidades de riego; in still other cases the juntas de aguas have continued to exist even though they have no legal standing (Palerm-Viqueira, 2005; Palerm-Viquiera & Rodríguez-Haros, 2005; Palerm-Viquiera et al., 2004; Palerm-Viquiera et al., ms).

The unidades de riego model followed the Irrigation District model, an hydraulic infrastructure built and supervised or sometimes directly managed by government officials, a model emphasizing hydraulic infrastructure management rather than water management.

The Irrigation Districts were part of the national policy for the construction of hydraulic infrastructure, which began in 1926.

The Irrigation Districts frequently had a nucleus of old irrigation systems. The early policy was for partial or complete turnover (with the exception of reservoir dams) to water user associations (asociaciones de regantes at first and, later, juntas de aguas). However, during the 1950s and 1960s there was a retreat from this policy, and with the 1972 Water Law the management of Irrigation Districts became the sole purview of the federal government, even though some water user associations persisted.

More recently, during the 1990s, the government implemented a massive turnover programme. Sections of the Irrigation Districts (módulos de riego) were turned over to water user associations, and in the larger Irrigation Districts, main canals were later turned over to the associated módulos de riego (S. de R.L.: Sociedad de Responsabilidad Limitada de Interés Público y Capital Variable) (Salcedo, 2005; Palerm-Viquiera, 2007; Rodríguez-Haros, 2007).

The 1992 and 2004 Mexican water legislation calls for river basin management, however, no attempt has been made to reactivate the water user associations (juntas de aguas) devised in the late 19th Century for river water management, such a policy would resemble the Mendoza province policy of revitalisation of the inspecciones de cauce.

Conclusions

River water and irrigation system management

The first arresting similarity between regions is that there is no demarcation between river water management and irrigation system management. Separate, distinct institutions for irrigation system
management, if they exist at all, are a late development; however, institutions for management of river water distribution have been an important component throughout the centuries.

In Spain, irrigation system management institutions become separate and distinct from river water management by mandate: the 1866 and 1879 water laws called for irrigation systems and only irrigation system institutions; however, Spanish legislation did not mandate river water distribution institutions until the early 20th Century with the formation of the confederaciones hidrográficas. Although the 1866 and 1879 water laws provided for the possibility of the voluntary association of several irrigation system associations, some traditional river water institutions appear to have lost official recognition (the Orihuela juzgado privativo de aguas, for example, indicated by the fact that it was only recently officially recognized (Orihuela Digital, 2007)). 19th Century legislation converted the Granada water administration, which consisted of a centralized institution (the juzgado de aguas), into a number of comunidades de regantes (González-Martín & Espinar Moreno, 2005). In other cases, such as that of the Valencia huerta, traditional drought water distribution between irrigation systems, as well as the common water tribunal, was adhered to (Glick, 1970; Maass & Anderson, 1986).

In Chile, irrigation system management became differentiated at some point during the 19th Century when water judges were appointed for irrigation systems and river judges for river water distribution; in the 20th Century, legislation makes a distinction between irrigation system institutions and river water distribution institutions.

In Mendoza province, there is no distinction between irrigation system and river distribution management, with first the Juzgado de Aguas and later the Irrigation Department managing river water distribution and the main canals; other institutions managed the secondary canals.

In Peru, apart from the 1902 Water Law, valley wide, or sometimes even multi-valley wide water management by a government appointed water judge or, later, a government appointed Technical Administration has been the norm. In the late 20th Century, irrigation system and river water distribution institutions are differentiated and both types of institution are mandatory.

In Mexico, the colonial repartimientos and 19th Century horizontal agreements focused on river water distribution. The 1888 legislation and early 20th Century legislation called for river water distribution by self-managed institutions, and the early 20th Century policies were for river water regulation (reglamentación de corrientes) with self-managed institutions in charge of implementing the government made regulations. The self-managed institutions (juntas de aguas) were in charge of river water distribution and irrigation system management.

Debate referring to the hydraulic hypothesis has centred on a discussion of the organizational demands of hydraulic infrastructure; however, the implication here is that the organizational demands of river water distribution deserves careful attention. In particular, greater attention should be paid to traditional river water institutions or strategies. The self-managed Bali river distribution is a case in point as well as the cultural understandings concerning river water distribution among the US Hispanic acequias. The strategic place of Hispanic acequias river water distribution culture is evident through its recent clash with the official river water distribution based on prior appropriation (Crawford, 1988; Hicks & Peña, 2003; Rivera & Glick, 2003).

The embeddedness of irrigation management in a larger administrative structure (except in Mexico)

The second common factor found particularly in the Hispanic American regions, prior to Independence from the Spanish Crown, is the prevalence of a centralized model for the organization of
irrigation water administration “... one, in which irrigation administration was a branch of a higher jurisdiction, typically that of the town” (Glick, 1970: 200–201). Cases where the irrigators themselves had their own elected officials are rare; one such case is that of the aforementioned irrigation institution for the Yuriria artificial lagoon (Mexico). It should be noted that in the case of small, traditional, community-based irrigation systems, management was undertaken by the community authorities; interestingly, in the late 19th and early 20th Century in Mexico, there was a shift towards irrigator-only management due to, in at least some cases, controversies between community authorities and irrigators (Henao, 1980; Sandré & Sánchez, ms).

However, the Mexican regional case manifests some striking differences. Although communities and towns had appointed officials (juez de aguas, topil) in charge of water management, there was a lack of overarching institutions linking communities, towns and haciendas. For the colonial period, the repartimiento dealt with river water distribution management but the evidence is unclear if the repatimiento also comprised irrigation systems. In the 19th Century, the horizontal agreements also focussed on river water distribution; however, they also explicitly refer to irrigation systems (that is to hydraulic infrastructure such as barrages and canals as well as to maintenance work).

This can be viewed two ways: on the one hand, the situation in Mexico is one of acephalous management of river water distribution/irrigation systems. Thus, it is not only different from the other regional cases but also theoretically disturbing because, as argued at the beginning of this paper, in theory the management of irrigation systems is unified; acephalous systems are not only rare but are reported only for very small systems; and the lack of institutions has also been linked to violence and infrastructure deterioration.

On the other hand, it may be worth taking a closer look at the mandate in certain repartimientos, concerning irrigator-appointed guards (where irrigator coordination would be required for their appointment and for the payment of guard-salary dues) as well as other evidence of irrigator coordination, such as ad hoc meetings for maintenance purposes These situations may provide evidence of the existence of irrigator institutions without the underpinnings of a legal framework for self-managed irrigation institutions.

Due care should be taken with what is being managed. For example, horizontal agreements are also found for use of irrigation drainage water; these agreements usually encompass the system that “gives” water and the system that will make use of the water. In the Orbigo valley (Spain), in the Cuautla river (Mexico) and in the French Pyrenees, very similar solutions have been arrived at (Guillet, 2006; Rodríguez-Haros et al., 2004; Pimentel-Equihua & Palerm-Viqueira, 2006).

Irrigation management transfer (mixed success)

In the second half of the 19th Century and early 20th Century in several of the case study regions (Spain, Chile, Peru), national legislation called for a turnover of management from government appointed water judges (that is, “centralized” management) to self management. The decision for turnover does not seem to be linked to systematic regional differences in irrigation system size or in the number of irrigators.

The irrigation system management turnover went smoothly in Spain and Chile; however, the 1902 management turnover was a failure in Peru. Irrigation system size or scalar stress do not seem to have played an important part; similar sized irrigation systems to those in Peru are self-managed in both Spain and Chile, and the size of holdings in Spain constitute irrigation systems which irrigate 20,000 ha
belonging to 30,000 irrigators (Pimentel-Equihua, 2004). Rather, the failure of turnover in Peru may be linked to heterogeneity of land tenure, as well as intense growth of pressure on water resources at the beginning of the 20th Century. However, the failure of self management in Peru may also be linked to the fact that, with the 1902 Water Law, institutions were set up for irrigation system management but not for valley-wide water distribution. This also happened in Spain but it is possible that Peruvian coastal river water distribution is more complex.

In Mexico, the situation was different, as the creation of new self-managed institutions for river water distribution and irrigation system management replaced acephalous management. The success or failure of the new institutions is difficult to assess due to the simultaneous agrarian reform and the late 20th Century changeover from juntas de aguas to unidades de riego.

Legislative frameworks for water management

Legislative frameworks for water management do seem to have tremendous influence on the organization of water management. The prevalence of the “centralized” model and the lack or scarcity of cases based on the “cellular” model, “... one, based on irrigation communities with their own elected officials” (Glick, 1970: 200–201), is perhaps related to the fact that legislation for Hispanic America called for the appointment of water judges.

However, due account should be given to the fact that the information itself is based on official documents. In ethnographic studies, it is not unusual to find differences between arrangements on paper and the actual water management. More detailed ethno-historical studies describing the actual workings of water management (with details of irrigation systems and river water distribution management) are needed.

General policy implications

Paramount consideration should be given to the fact that irrigation water management designs that work well in one region can be a failure in another. Due consideration should be given to the proposition that successful outcomes for irrigation water management may be better achieved by reinforcing what works on the ground, as attested by regional history and ethnography. Therefore, ethnographic and historical case studies, encompassing formal and on the ground arrangements, are powerful tools for policy design.

Acknowledgements

Dr Linda Arnold generously helped with orientation on the New Spain juzgado de tierras y aguas\(^1\), as well as sending Archivo General de la Nación (AGN) catalogues in PDF searchable electronic formats. Israel Sandré and Francisco Javier Gómez-Carpinteiro shared Mexican colonial and

---

\(^1\) The New Spain government office: Juzgado privativo de tierras y aguas, dates from 1692. The papers are in the three Audiencia Archives: for the Mexican state of Chiapas in a Guatemala archive; for Northern Mexico and southern US in an archive in Guadalajara City; and for Central Mexico in the AGN, except those for the state of Mexico which were extracted in the 19th Century and lie in a warehouse in Toluca City.
19th Century documents. Various Latin American colleagues answered questions and shared bibliographies on water management: Alegria-Calvo, Obando, Vergara and Rojas-Calderón from Chile; Miranda, Bustos and Ruiz-Freites from Argentina; Gómez-Cumpa and Teresa Oré from Perú. Herb Eling discussed ideas on pre-Hispanic river water distribution between the irrigation systems of the Peruvian coast. Linda Arnold, Nitish Jha and Robert Hunt kindly read a preliminary draft of the paper and made very stimulating comments. Finally, much of the research was possible due to a sabbatical leave with CIESAS and UA Morelos.

References

Archivo General de la Nación (AGN), Ramo de Tierras, electronic catalogue in pdf. Searchable PDF catalogue by Linda Arnold also available online: www.agn.gob.mx (Mexico).
Bustos, R. M. (2008). Personal communication. Subject: Mendoza’s irrigated land tenure is characterized by smallholders.
Contrato de la Consolidación de Aguas, celebrado el 1° de Septiembre de 1899, entre los señores Madero, González y compañía, Lorenzo González Trevino y Ernesto Madero y Hermanos (1899). Parras, Tip. de J.P. Valdés y Cía, Sucr, Parras.
Convenio sobre aguas celebrado entre los vecinos del pueblo de Ahuehuetzingo y el dueño de la hacienda de Atencingo, 2 de abril (1873). In Archivo General de Notarías-Puebla (Izúcar de Matamoros), Libro de Protocolo, 1873, foja 24.


Ley de Aguas, Gaceta de Madrid, 19 de Junio de 1879, num. 170.

Ley de Aguas, Gaceta de Madrid, 7 de Agosto de 1866, num. 219.


Recopilación de Leyes de los Reynos de las Indias (1681). http://www.congreso.gob.pe/ntley/LeyIndiaP.htm [22 March 2007].


Sentencia [Juan González] Peñafiel (1635). Copia certificada de la simple del testimonio del Título de Aguas de la propiedad de los barrios de Oriente y poniente de esta ciudad, que existe en esta oficina en el libro cinco, volumen decimotercero, confrontada a la vez con el original que se presentó y que se expidió la presente a los Senores Isaura Flores y Gregorio Osorio, apoderados jurídicos de los expresados barrios. Izúcar de Matamoros, a 11 de agosto de 1930, Archivo personal del Sr. Guadalupe Lucero, Teruel, Tepeojuma, Puebla.


