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Iberian colonisations and water distribution systems (15th-16th c.). A comparative approach[1]

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Abstract

Some years ago, M. Barceló and Th. F. Glick stressed the tencency to stability both of irrigation systems and of water distribution procedures in medieval contexts. The Iberian conquests in the peninsula, in the Canary islands and in the Americas developed between the 12th and the 16th centuries give rise to issues on continuity and changes of irrigated agriculture in the new colonial contexts. This paper explores to which extent and how the new productive choices and political organisation of the colonial societies were adapted to follow the original design and distribution systems. The case of the ancient Andalusi huerta of Casarabonela (Malaga), a Castilian conquest of the late 15th century, is analysed and compared to other Iberian examples from Valencia and Granada, principally. A further comparison is stablished with the colonial managements of irrigation systems in Gran Canaria and in early colonial Peru.

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A crucial question is whether scarcity was taken into account in the design of the original layout and the original water allocation criteria in preconquest systems, or whether it was only considered a factor with the imposition of new productive and management strategies. The decisive question is how to establish the chronology and nature of these processes of substitution, which sometimes took centuries to unfold. In this sense, the “growth” thresholds of the original systems have to be considered, since this was the point from which the original water allocation system would have become obsolete and non-functional.

Keywords:

Irrigation systems, water distribution, Casarabonela, Iberian conquests, early colonial societies

Introduction

In a seminal article published in 1989, M. Barceló formulated the main principles followed in the construction and management of irrigation systems in al-Andalus.2 One of these principles was that of rigidity (but not of immutability): this means that these systems tended to maintain the articulation of water catchment points, channels and irrigated fields, despite eventual changes in management criteria, such as those which occurred after al-Andalus was conquered by the Iberian feudal kingdoms, which is the case that we shall focus

[2]Miquel Barceló, “El diseño de espacios irrigados en Al-Andalus: un enunciado de principios generales,” in *El agua en zonas áridas*, ed. Lorenzo Cara (Almería: Instituto de Estudios Almerienses, 1989), XV–L.

on in the following paragraphs. Despite the scantiness of the empirical evidence available to Barceló at the time, his proposal was solid, and it has been vindicated by the case studies carried out thereafter in different regions of the Iberian Peninsula and the Balearic Islands.3

Before M. Barceló's work led to the development of this avenue of research, the methodology of which came to be known as "hydraulic archaeology," the notion of "design," borrowed from the field of 20th-century hydraulic engineering, had already been used with reference to irrigation systems.4 Also, the comparison of different irrigation systems in the regions of Valencia and Murcia (Spain) and in some areas in California, Colorado and Utah (USA), enabled A. Maass and R. Anderson to claim that these systems

[3]The bibliography on this topic is enormous. For a recent state of the question, see Helena Kirchner, "Archeologia degli spazi irrigati medievali e le loro forme di gestione sociale," in *L'acqua nei secoli altomedievali. Atti delle LV Settimane, I* (Spoleto: Centro Italiano di Studi sull'Alto Medioevo, 2008), 471–503; and, Enric Guinot and Ferran Esquilache, "La reorganización del paisaje agrario en la huerta de Valencia después de la conquista cristiana. El sistema hidráulico y el parcelario de Montcada y Benifaraig en el siglo XIII," *Debates de arqueología medieval* 2 (2012): 230–1.

[4]Barceló, "El diseño de espacios irrigados"; Miquel Barceló et al., *El agua que no duerme. Fundamentos de la arqueología hidráulica andalusí* (Granada: Sierra Nevada 92/El Legado Andalusí, 1996); Thomas F. Glick and Helena Kirchner, "Hydraulic Systems and Technologies of Islamic Spain: History and Archaeology," in *Working with Water in Medieval Europe: Technology and Resource-Use*, ed. Paolo Squatriti (Leiden-Boston-Köln: Brill, 2000), 267–329. Arthur Maass, *Design of Water-Resource Systems* (Cambridge: Harvard University Press, 1962).

tend to be managed at a local level, thereby questioning the universal validity of K. Wittfogel's postulates.5

At any rate, local management — i.e. by the community or the municipality — of irrigation systems in the Iberian Peninsula had already been detected by Jaubert de Passà, C.C. Scott-Moncrieff and J. Brunhes, among others, at a much earlier date.6 In Maass's and Anderson's opinion, the criteria that determined the management of irrigation systems, which were recognisable in the operating procedures followed by the agricultural communities, were the result of predetermined principles and values, which can be summarised as follows: ensuring equity in the distribution of water and in the resolution of conflicts, facilitating the efficiency of the system, and guaranteeing that management remained in local hands.7. In order to ensure that the above-mentioned values were respected, the implementation of consistent operating

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[5]Arthur Maass and Raymond L. Anderson, *...and the Desert shall Rejoice. Conflict, Growth, and Justice en Arid Environments* (Malabar, Florida: Robert E. Krieder Publishing Company Inc., 1986). Karl A. Wittfogel, *Oriental Despotism. A Comparative Study of Total Power* (New Haven-London: Yale University Press, 1957).

[6]Jean Brunhes, *L'irrigation dans la Péninsule Ibérique et dans l'Afrique du Nord* (Paris: C. Naud 1902), 72, passim. Shortly before J. Brunhes, the Regenerationist Joaquín Costa paid close attention to the issue of community management of irrigation systems in his work *Colectivismo agrario en España* (Madrid: Imprenta de San Francisco de Sales, 1898), 533–46. Costa based his conclusions on Jaubert de Passà's *Voyage en Espagne* (Paris: Madame Huzard, 1823) and Maurice Aymard's, *Irrigations du midi de l'Espagne* (Paris: E. Lacroix, 1864). Scott-Moncrief also knew these works and noted the local management of irrigation systems during his trips in the Iberian Peninsula, France and Italy, between 1867 and 1868. Colin C. Scott-Moncrief, *Irrigation in Southern Europe* (London: E. & F. N. Spon, 1868), 122, 137–8.

[7]Maass and Anderson, *...and the Desert shall Rejoice*, 83, *passim*.

procedures and a solid social organisation at a local level was mandatory, and included the imposition of clear limits on the dimensions of the system, the uses of water, and the composition of the community of irrigators. These rules, therefore, involved placing limitations on the growth of the system and the human community alike, which was the only way to avoid the dispersion of rights and the increase of risk.8

It follows that the size of the irrigation networks, and their management, had a decisive impact on the perdurability of traditional systems. So much so that, according to E. Ostrom, G. Hardin's "tragedy of the commons," which was implicit in the perversion of community management systems, could only be avoided if clear limits were established and ways of avoiding intrusive uses were enforced.9 A number of researchers have examined this crucial aspect of community management policies and have tried to determine, on the basis of ethnographic observations, what the maximum dimensions of these traditionally managed irrigation systems were. While some authors have attempted to ascertain these limits in terms of physical dimensions, others, such as J.B. Mabry, consider that the key is the number of irrigators.10

In summary, both the institutional examination of the commons, along the lines postulated by Maass and Anderson, and the parallel research focus on design and structural perdurability, proposed by Barceló, support the idea that

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[8]Maass and Anderson, *...and the Desert shall Rejoice*, 114, 339, 368, *passim*.

[9]Elinor Ostrom, *Governing the Commons. The Evolution of Institutions for Collective Action*, (New York: Cambridge University Press, 1990). Garrett Hardin, "The Tragedy of the Commons," *Science* 162 (1968): 1243–8.

[10]Jonathan B. Mabry, "The ethnology of local irrigation," in *Canals and Communities. Small-Scale Irrigation Systems*, ed. Jonathan B. Mabry (Tucson: University of Arizona Press), 3–30.

"traditional" irrigation systems and their associated management and social structures tended towards stability. It is worth remembering, at any rate, that the joint analysis of design, operating procedures and management criteria is still in its infancy, in comparison with the development that each of these fields has undergone separately. As pointed out by Th. Glick, the arrangements for apportioning water are as "technological" as the design and the physical devices of which irrigation systems consist, so both factors should always be studied in conjunction, along the lines of the "archaeological sense of hydraulic institutions" that he postulated.11

A good deal of Maass's and Anderson's observations on irrigation systems in the Iberian Peninsula were based on Th. Glick's seminal *Irrigation and Society in Medieval Valencia*, published in 1970. In this work, Glick examined water distribution arrangements in several medieval irrigation systems in the region of Valencia and suggested that these systems tended towards stability. In addition, he proposed that these systems were managed independently, not centrally, on the basis of proportionality, as had already been pointed out by 19th-century engineers and geographers. Glick also observed that this tendency towards stability could be recognised in the continuity of water distribution systems since the "time of the Moors," a recurrent expression in Spanish and Catalan documents dating to after the Christian conquests in the 13th century. Following this idea, Glick postulated the "direct transmission of

[11]Thomas F. Glick, "El sentido arqueológico de las instituciones hidráulicas," in *II Jornadas de Cultura Islámica: Aragón vive su historia* (Madrid: Instituto Occidental de Cultura Islámica, 1992), 165–71; Thomas F. Glick, "Cap a una història institucional dels regs: un mètode d'estudi comparatiu," *Taller d'història*, 3 (1) (1994): 39–46.

Islamic customary arrangements to the new settlers."12 Later, in an even more assertive tone, Glick talked about the "ultra-stable" nature of institutionalised forms of water allocation.13

As Ostrom warned, the perdurability of hydraulic systems does not imply that water allocation regulations or even the distribution networks cannot change over time.14 Glick had already mentioned the possibility of change in his analysis of the expansion of the *huerta* of Valencia after the Christian conquest in the 13th century — a change which can be recognised in both the archival and the archaeological record.15 The key issue in this case is to ascertain the possible relationship between changes in design — mostly enlargements — and eventual transformations in water allocation systems. The enlargement of the irrigated area, at any rate, did not automatically or immediately require a change in water allocation systems. As we shall shortly see with the case of Casarabonela (Malaga, southern Spain), not all expansions were followed by a substantial modification of irrigation rules. According to S. Garrido, sometimes peasant communities defined larger areas than were to be effectively irrigated thereafter.16 As we shall see presently, this observation is

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[12]Thomas F. Glick, *Irrigation and Society in Medieval Valencia* (Cambridge: Harvard University Press, 1970), 234-9.

[13]Glick, "El sentido arqueológico," 165. On the basis of one of the principles enunciated by W. Ross Ashby with reference to living organisms. W. Ross Ashby, *Design for a Brain: The Origin of Adaptive Behavior* (New York: John Wiley and sons, Inc., 1960)

[14]Ostrom, *Governing the Commons*, 58.

[15]Glick, *Irrigation and Society*, 241. Guinot and Esquilache, "La reorganización."

[16]Samuel P. Garrido, "Las instituciones de riego en la España del este. Una reflexión a la luz de la obra de Elinor Ostrom," *Historia Agraria* 53 (2011): 13–42.

essential for a full understanding of the relationship between the enlargement of hydraulic systems and the change in water allocation systems.

If, as suggested by Glick, the well-documented references to the maintenance of irrigation procedures "like in the time of the Moors" are to be understood as a reflection of this tendency towards "ultra-stability," how and in what conditions could these procedures be maintained in the aftermath of the Christian conquests in the Iberian Peninsula? How did these systems reproduce when the productive targets were different? It seems clear that, in fact, this reproduction did not take place, because the new productive logic was oriented towards grain production and new levels of specialisation.17 So, in that case, how did the working procedures adapt to the new context and, specifically, to the changes introduced in the irrigation systems?

The first aim of this paper is to address the question of the apparent survival of old Andalusi water distribution systems after the feudal conquest, in a context in which the new social order brought about substantial changes in the productive preferences. For this reason, we shall focus first on the water distribution systems in the *huerta* of Casarabonela after the Castilian conquest of 1485. Other examples, from the Kingdom of Granada, conquered in the 15th century; and the Balearic Islands, Valencia and Murcia, which were conquered earlier (13th century), will also be examined. As we shall presently see, the evidence shows that, both before and after the conquest, there was a

[17]Some examples in Carlos Laliena and Julián Ortega, "Formas feudales de especulación agraria: villas, viñas, acequias en el sur de Aragón (ca. 1170–1240)," in *Hidráulica agraria y sociedad feudal. Prácticas, técnicas, espacios*, ed. Josep Torró and Enric Guinot (València: Universitat de València, Valencia, 2012), 79–102, and papers by Kirchner (Balearic Islands), Ardit (Valencia) and Malpica (Granada) in this volume.

wide variety of water distribution systems, although some patterns may be recognised. Following this, the chronology and context of the transformations undergone by the aforementioned examples is analysed. Finally, we attempt to compare the Iberian examples with others from the Canary Islands and the American continent. Although this comparison will be necessarily basic, it is aimed at developing one aspect within a much broader issue which has been paid little attention to date: the comparison of the new agrarian orders resulting form the late medieval and early modern Iberian, Atlantic and American conquests. Obviously, this analysis implies forfeiting the conventional academic distinction between medieval and modern history and also abandoning the notion that the so-called "reconquest" was an Iberian "internal affair," which can be considered to have been closed by 1492, and separated from the later Atlantic and American conquest and colonisation.[18]

"Like in the time of the Moors"?

Andalusi irrigation systems in the *huerta* of Valencia were substantially modified after the Christian conquest. On the one hand, after the 13th century, water allocation systems were significantly different to those systems whose design and management had been set up in Andalusi times, as was pointed out by E.

[18]The bibliography on the use of the term "reconquest" is enormous. For a recent overview Francisco García-Fitz, "La Reconquista: un estado de la cuestión," *Clío & Crimen* 6 (2009): 142–215. Some reasons to abandon the term in Josep Torró, "Pour en finir avec la 'Reconquête'. L'occupation chrétienne d'al-Andalus, la soumission et la disparition des populations musulmanes (XIIe–XIIIe siècle)," *Cahiers d'Histoire. Revue d'histoire critique* 78 (2000): 79–97. Also, Martín Ríos, *La Reconquista. Una construcción historiográfica (siglos XVI–XIX)* (Madrid: UNAM-IIH-Marcial Pons, 2011).

Guinot. On the other hand, the irrigated spaces were enlarged considerably shortly after the conquest. Water was elevated with the construction of dams and was directed towards the empty interstices between pre-existing irrigation blocks.19 The example of Valencia illustrates how the productive strategy pursued by the colonial society that emerged in the wake of the conquest often had to develop in spaces where previous construction criteria and social values — both of which determined the choice of operating procedures that were available to the peasants — had left an imprint in the form of rigid irrigation networks.

Despite what the example from Valencia suggests, however, these developments did not always involve the immediate enlargement of irrigation areas. Much to the contrary. In Menorca, for instance, Andalusi irrigated spaces did not only not grow after the conquest in the late 13th century, some were abandoned and were not reconstructed until centuries later. In general, the enlargement of the Andalusi irrigation systems in the Balearic Islands did not take place until the 17th and 18th centuries.20. The most important transformation, the "subversion" (in H. Kirchner's words) of the previous system, came with new watermills being constructed and preference being given to flour milling over irrigation. In Mallorca, Andalusi water allocation systems seem not

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[19]Enric Guinot, "La construcció d'un paisatge medieval irrigat: l'Horta de la ciutat de València," in *Natura i desenvolupament. El medi ambient a l'Edat Mitjana*, ed. Flocel Sabaté (Lleida: Pagès editors, 2007), 191–220; Guinot and Esquilache, "La reorganización."

[20]Miquel Barceló and Félix Retamero, eds., *Els barrancs tancats. L'ordre pagès al sud de Menorca en època andalusina* (Maó: Institut d'Estudis Menorquins, 2005). Helena Kirchner, "Original design, tribal management and modifications in Medieval hydraulic systems in the Balearic Islands (Spain)," *World Archaeology* 41 (1) (2009): 148–65.

to have survived the Christian conquest (1229), at least in most cases. In Sóller and Alaró, for instance, the duration of irrigation slots seems to have been drastically reduced in the late 13th century in order to guarantee the operation of the mills.21 In this case, it follows, the changes introduced in the operational procedures were not connected with any transformation of the irrigation networks, in contrast with the Valencian example.

In Murcia, on the southwest of the Iberian Peninsula, the size of the *huertas* and the water allocation systems appear to have remained essentially the same after the conquest (1266). Later, following a period of disarray, new regulations were enacted which imposed fixed time slots and overturned the Andalusi proportional system. This was a short-lived phenomenon, because in 1353 the proportional allocation system in operation before the Castilian conquest was reintroduced.22

In Granada, on the other hand, most irrigation systems went the same way as those in Valencia after the Castilian conquest in the late 15th century. The earliest written records suggest that pre-existing water allocation criteria

[21]Helena Kirchner, "'Colonització de lo regne de Mallorques qui és dins la mar.' La subversió feudal dels espais agraris andalusins a Mallorca," in *Histoire et archéologie des terres catalanes au Moyen Age*, ed. Philipe Sénac, (Perpignan: Université de Perpignan, 1995), 279–316; Maria A. Carbonero, *L'espai de l'aigua. Petita hidràulica tradicional a Mallorca*, (Palma: Consell Insular de Mallorca, 1992), 309; Helena Kirchner, "Watermills in the Balearic Islands during the Muslim Period," *Ruralia* VIII (2011): 45–55. See also her contribution, "Feudal conquest and colonisation: an archaeological insight into the transformation of Andalusi irrigated spaces in the Balearic Islands", in this volume.

[22]Denis Menjot, *Murcie castillane. Une ville au temps de la frontière (1243-milieu du XVe siècle), 2 vols.* (Madrid: Casa de Velázquez, 2002), 352–6. See also Garrido, "Las instituciones de riego," 18.

generally remained in operation, at least for a time. In some cases, for example around the Genil River, the records bear witness to the maintenance of the same water distribution systems between, at least, the 12th and the 16th centuries.23 This initial conservatism does not exclude the implementation of progressive changes as the demand for water grew, as was recently observed by F. Vidal.24 These changes were probably related to the extension of irrigation to land which had previously been used for dry land agriculture, for example in the hamlet of Armilla (Granada) in the early 16th century, and also to the introduction of crops which required large amounts of water, such as sugar cane, on the coast of Granada.25

In general, the mention in the record of customary Andalusi practices is connected with conflicts caused by the introduction of new procedures in systems that had been built according to different criteria. These conflicts came about after new agricultural strategies caused disruption and placed pressure on older networks. In consequence, the record bears witness not to the placid continuation of older practices, but to the tensions introduced by the dissolution of former agricultural strategies and the imposition of new production and

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[23]Miguel Garrido, *Los alquezares de Santa Fe* (1893), ed. Manuel Espinar (Granada: Universidad de Granada, 1990).

[24]Francisco Vidal, “La transmisión del uso y gestión del agua de al-Andalus al mundo cristiano,” in *Las huellas del Islam*, eds. Fátima Roldán and Maria M. Delgado (Huelva: Universidad de Huelva, 2008), 161–87.

[25]Garrido, *Los alquezares*, 55–6; Antonio Malpica, *Medio físico y poblamiento en el delta del Guadalfeo. Salobreña y su territorio en época medieval* (Granada: Universidad de Granada, 1996). See also A. Fábregas, “Commercial crop or plantation system? Sugarcane production from the Mediterranean to the Atlantic”, in this volume.

management criteria upon already existing irrigation networks. This disruption, however, did not preclude the transmission, even if "imperfect," of some basic principles and procedures, for example, the maintenance of a "descending" order for the allocation of irrigation turns and the organisation of time slots around prayer time.26

The example of Granada shows that the intention to maintain water allocation criteria "like it was done in the time of the Moors" (*conforme a como se hazia en tiempo de Moros*) was essentially related to the need to preserve a network of irrigation systems that became endangered after the 1492 conquest for lack of "expert knowledge", as a document dated to 1500 makes explicit.27 Something similar had happened earlier in the *huerta* of Murcia, where in 1277 king Alfonso X issued a directive ordering irrigation to be carried out "as it was done in the time of the Moors" (*como solia en tiempo de moros*) as a response to the bad management of irrigation by Christian settlers, according to D. Menjot.28

Paradoxically, it follows that the maintenance of Andalusi procedures was nothing but a reaction to the effects of the dissolution of pre-existing management systems, to the conflicts caused by the imposition of new agricultural strategies and other forms of usurpation, and to the conflicts caused by the abandonment which had befallen the irrigation networks in the wake of

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[26]We borrow the expression "imperfect transmission" from Andrew Watson, "The Imperfect Transmission of Arab Agriculture into Medieval Europe," *Sitzungsberichte der Österreichischen Akademie der Wissenschaften* 619 (1994): 199–212. Vidal, "La transmisión del uso."

[27]Vidal, "La transmisión del uso," 170-1.

[28]Denis Menjot, *Murcie castillane*, I:44; 351–2; 354.

the conquest. The survival of these systems was therefore merely circumstantial, the direct consequence of a radical transformation, and was followed by harsh adaptation processes.

The evidence available for Casarabonela (Malaga, southern Spain) offers a good insight into the organisation of irrigation in the village during the *Morisco* period, just before the final expulsion of the Andalusi inhabitants who had remained after the 1485 conquest.29 Property inventories listing the real estate owned by the expelled villagers and the distribution of land among new Castilian colonists, written soon after the expulsion in 1570, include references to water allocation systems in operation in the late 16th century. With this information, the earlier allocation criteria can also be inferred.30 The operating procedures and the changes introduced after the conquest will be discussed in connection with the other examples mentioned above and other cases from the Kingdom of Granada. A broad correspondence between water allocation sequences and the construction phases detected in Casarabonela's main irrigation network will also be proposed. Finally, a comparison between these water allocation systems and those implemented in the colonial societies in the Atlantic colonies and the American continent will also be attempted.

Casarabonela as a case study

[29]*Moriscos*: "new Christians". Muslims forcefully converted to Christianity in the Kingdom of Granada after the Albaycín revolt (Granada) in 1501.

[30]*Libro de Apeo de Casarabonela* (Archivo Histórico Provincial de Granada, L. 6467) and *Repartimiento* (Archivo Histórico Provincial de Granada, L.6468); Francisco Armada and Virgilio Martínez-Enamorado eds., *Repartimiento de los bienes de los moriscos de Casarabonela* (Málaga: Ayuntamiento de Casarabonela-Editorial Pinsapar, 2014).

Casarabonela is a well-documented example of the transformation of an Andalusi hamlet (*qarya*) into a *villa*, a term used by the Castilians to refer to a village or *madīna* in the Kingdom of Granada. Casarabonela is located to the west of the province of Malaga, in a region known as the Algarbía (al-Garbīya).31 In the 8th century, the settlement was included in the district of Cártama (*iqlīm* Qarṭama), which was created after the arrival of different Yemeni clans, detachments of the *jund* (army) of the Jordan, in the valley of the Guadalhorce River, specifically in the *chora* of Rayya (Malaga region).

We know for a fact that, at a very early date (the second half of the 8th century), under the government of ‘Abd al-Raḥmān I al-Dāḵhil, a singular event took place in this hamlet, known as the time as Qaryat Bunīla: the acclimatisation of a kind of pomegranate by the Yemeni Safar ibn ‘Ubayd Allāh al-Kala‘ī.32 This kind of pomegranate, which came to be known thereafter as *safari* in recognition of the protagonist of the event (*al-rummān al-safarī*), was brought to al-Andalus by an ambassador sent to Syria to contact ‘Abd al-

[31]On the Algarbía, or western Malaga, Virgilio Martínez-Enamorado, *Al-Andalus desde la periferia. La formación de una sociedad musulmana en tierras malagueñas (siglos VIII-X)* (Málaga: CEDMA, 2003). By the same author: “La Algarbía como realidad geo-histórica en el período de formación de al-Andalus. Una aproximación al estudio de su poblamiento rural,” in *Arqueología y Patrimonio en la Algarbía malagueña*, ed. Juan A. Martín (Málaga: CEDMA, Málaga, 2004), 57–94; “Precisiones sobre el significado concreto del término Algarbía en época andalusí,” *Al Sur de al-Andalus. Guadalhorce. Actas de la Exposición y Jornadas itinerantes sobre el Medievo en el Valle del Guadalhorce*, (Malaga: Foro Guadalhorce-Consorcio Valle del Guadalhorce, 2006), 213–26.

[32]This was published in Martínez-Enamorado, *Al-Andalus desde la periferia,* 114–6, shortly after the edition of the Arabic source on which the information is based (Ibn ‘Askar/Ibn Jamīs, *A’lām Mālaqa*, ed. ‘Abd Allāh Targī, (Beirut, 1999), 350.

Raḥmān I's sister. There, the ambassador acquired several pomegranates of the kind being cultivated in the Ruṣāfa, which he then took back to al-Andalus, where a meeting with several members of the emir's circle was organised. Among them was Safar ibn 'Ubayd Allāh al-Kalā'ī, who was a member of the army of the Jordan and was, therefore, an inhabitant of Rayya (Malaga region). Using the pomegranates obtained from 'Abd al-Raḥmān I, Safar ibn 'Ubayd Allāh al-Kalā'ī carried out several experiments in his hamlet of Rayya (Casarabonela) until his results were ready to be presented to the emir. Finally, the ruler recognised his exertions by planting the species in the Ruṣāfa (Cordoba) and other gardens, and from there the species (which thenceforth would carry the agronomist's name — *al-rummān al-safarī*) spread throughout al-Andalus and the Maghreb. This kind of pomegranate is still a well-known variety in Morocco.

This event, which in itself appears to attest to an efficient transmission of agricultural knowledge, is also proof that the eastern and western Muslim worlds had adopted a coherent agricultural system from a very early date. In some cases, the Yemeni groups of the *jund* ("army") were pioneers in the dissemination of certain species.33

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[33]The most complete account of these events is the *Nafḥ*, the major compilation of the Maghrebi (of Andalusi origins) author al-Maqqarī, published in the 16th century. Al-Maqqarī, *Nafḥ al-ṭīb min guṣn al-Andalus wa-l-raṭīb*, ed. I. 'Abbās, 8 vols. (Beirut, 1968), 467–8. This work, translated by J. Samsó, gave no indication of where exactly in the *chora* of *Rayya* this acclimatisation took place, information which is provided by Ibn 'Askar e Ibn Jamīs. Julio Samsó, *Las ciencias de los Antiguos en al-Andalus*, 2nd ed. with *addenda et corrigenda* by Julio Samsó and Miquel Forcada (Almería: Fundación Ibn Tufayl, 2011), 20–2.

Thereafter, the evolution of Casarabonela, up to the Castilian conquest, is not so well attested. We know little about the change of toponym from Qaryat Bunīla to Qaṣr Bunayra, a form which was fixed at least as early as the 10th century. We also know of the settlement's involvement in Ibn Ḥafṣūn's *fitna* (rebellion), also in the 10th century, and of its capture by Yaḥyà ibn Zakariyā' ibn Antuluh, who was initially one of Ibn Ḥafṣūn's supporters, in 923. Between this date and the Castilian conquest, the information concerning Casarabonela is sporadic and of little significance.

The Castilian conquest, which culminated on 2 June 1485, is recorded in detail in the chronicles.34 It must be highlighted that, at that time, the Andalusi community in Casarabonela took decisions collectively through the *jamā'a* of Qasr Bunayra and its communal institutions ("council of elders' or *jamā'a al-šuyūḵ*). Soon after the conquest by the Catholic Monarchs, the village's "community, bailiff and mayor" (*comunidad, é alguacil, é alcaide*) sent a letter to the sovereigns, bending to their dominion and reminding them of the community's old rights of self-governance. This is a fine example of the internal operation of communities in the Kingdom of Granada before the conquest.35

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[34]A study of the conquest by Rafael Bejarano in the introductory chapter of the edition of *Libro del Primer Repartimiento* (1487) entitled "Reconquista y Capitulación"; Rafael Bejarano, *El Repartimiento de Casarabonela* (Málaga: Diputación de Malaga, 1974), 19–32. Also in Rafael Bejarano, *Los Repartimientos de Malaga*, *IV* (Málaga: Ayuntamiento de Málaga, 2004).

[35]Carmen Trillo, "El mundo rural nazarí, una evolución a partir de al-Andalus," in *Una sociedad rural en el Mediterráneo medieval: el mundo agrícola nazarí,* ed. Carmen Trillo (Granada: Colección Gog Magog, 2003), 11-152, esp. 110. For the reference to the community, the bailiff and the mayor as political agents of Casarabonela, see Hernando del Pulgar, *Crónica de los*

This would not be the last time that these rights were brandished: fourteen years after the conquest (on 13 June 1499) “by order of the commander Juan Gaitán, governor of said city, a meeting took place in the yard of the mosque [of Casarabonela], with the participation of the bailiff alfaqui and the old Moors and other inhabitants of the village”, which means that these customs had not disappeared even in the face of the pressure posed by the new authorities.36

The “distribution” of Casarabonela, one of the many *repartimientos* carried out in the Kingdom of Granada in the late 15th century, illustrates the new conditions imposed by the conquerors. This distribution included allocating among the new Castilian settlers those properties that had been left “empty” by dead or escaped Muslims, for which distribution a comprehensive and thorough land register had to be completed. The remaining Muslims, now known as *Mudéjares*, were guaranteed, with conditions, the inviolability of their land and houses.37 The earliest phase of distribution was executed in September 1487. In December 1492, *bachiller* Serrano reorganised this early *repartimiento*, as recorded in the document analysed by R. Bejarano.38

Casarabonela stayed under the Catholic Monarch’s and the Crown’s direct jurisdiction (*realengo*). After the conquest, Christian and Muslim peasants

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Reyes Católicos, in *Crónicas de los reyes de* Castilla, vol. III, ed. Cayetano Rosell (Madrid: Ediciones Atlas, 1953), 422.

[36]Archivo de la Catedral de Málaga (ACM), leg. 63, C-70.

[37]*Mudéjar*: from the Arabic *mudajjan* > “subjected, domesticated”; Muslim who was allowed to remain under Christian authority. On the *Mudéjares* from the Kingdom of Granada, see A. Malpica, “The Kingdom of Granada. Between the culmination of a process and the beginning of a new age”, in this volume.

[38]Bejarano, *El Repartimiento de Casarabonela*.

coexisted for nearly a century. They followed very different social norms, and their management of economic assets was traditionally opposing, but they shared the same urban and agricultural spaces. One decade after the conquest, the majority of the population was still *Mudéjar* in origin: the number of registered *Mudéjar* households in 1497 was 240, and the number had increased to 280 in 1504.39

The 1492 correction of the *repartimiento* is tremendously interesting from a variety of perspectives, although, to date, it has only been examined by philologists.40 The necessary identification of the *pagos* (agricultural land plots) and their relation to their *Mudéjar* or Castilian owners needs to be achieved through textual and archaeological analysis. The *Repartimiento* contains a detailed description of the small *madīna* of Qaṣr Bunayra after the conquest, which includes the arrival of the new colonists and also the distribution of property among the Andalusi peasants.

The 1502 order that forcefully converted *Mudéjares* in *Moriscos* created deep tensions within this dual society. The *viejo* Castilian Christian population

[39]Ángel Galán and Rafael G. Peinado, *Hacienda regia y población en el Reino de Granada: La geografía morisca a comienzos del siglo XV* (Granada: Universidad de Granada, 2007), 222, table 4.

[40]Juan A. Chavarría, "La toponimia árabe del Repartimiento de Casarabonela (Malaga). Aproximación a su estudio," *Jábega* 77 (1997): 11–31; Ana Gutiérrez, "Contribution au lexique arabo-andalou: un document roman de l'Andalousie orientale," *Hespéris-Tamuda* XXXI (1993): 9–20; by the same author, "Aproximación al estudio onomástico de la *kunya* en fuentes romances de Andalucía oriental," *Anaquel de Estudios Árabes* VII (1996): 15–43, and "Aproximación a la antroponimia mudéjar-morisca de Andalucía oriental reflejada a través de documentos romances relativos a la repoblación," in *Actas del VII Simposio Internacional de Mudejarismo* (Teruel: Centro de Estudios Mudéjares, 1999), 663–78.

concentrated land and was in control of the new bureaucracy. From the outset, the new Christian authorities failed to meet the terms of capitulation, a common phenomenon in many places throughout the Kingdom of Granada in general. A first attempt at rebellion in 1487 was promptly supressed. In a well-known *Real Cédula* dated to 1502, the *old* Christians from Casarabonela were officially granted exemptions and privileges which did not extend to the Andalusi members of the community.41 Between 1502 and 1568, a latent but palpable hostility pervaded the relationship between both communities. This crystallised in the lawsuit caused by the payment of *alcabalas* and *farda del mar*.42 The dispute between the *new* Christians or *Moriscos*, who still made up the majority of the population before the great revolt (around 400 households), and the Castilian (with a little over 50 households), was rooted in the privileges and tax exemptions granted to the *old* Christians by the Catholic Monarchs in 1502.43

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[41]That same year, the Andalusi households were made to pay 1500 *maravedíes*; Ester Cruces and José M. Ruiz, *Inventario de acuerdos de las Actas Capitulares del Concejo de Málaga (1489–1516)* (Málaga: Universidad de Granada and Diputación de Malaga, 2004), 548, nº 2630.

[42]The *alcabalas* was a tax on sales, which applied to the whole of the Crown of Castile. In Arabic, *farda* was the capitation tax which each member of a group had to contribute to the overall fiscal obligations of their community. The Castilians turned this concept into a tax that was payable by all inhabitants of the Kingdom of Granada who spoke a language other than Spanish. In reality, only the small capitation tax or *tax of the sea* was demanded of the *Moriscos* (previously *Mudéjares*); the money was used for the maintenance of the coastal watchtowers. See María L. Campos, "Las rentas particulares del Reino de Granada tras la expulsión de los moriscos en 1570. La farda y la renta de población," *Chronica Nova* 16 (1998): 55–66.

[43]It seems that the population had grown before the revolt, maybe because Casarabonela, which was considered a "pacified" settlement, had become a place of refuge for fleeing *Moriscos*. Archivo General del Sello, CC, leg. 2153, fol. 128.

These exemptions, if applied, would increase the fiscal pressure posed upon the *Moriscos*, who would inevitably assume the payment of the amounts deducted from the other group. A court decision, dated to 13 January 1561, finally ruled in favour of the *old* Christians, which meant a further affront to the *Morisco* community.44

This discriminative decision came in addition to the biased action of the Tribunal of the Holy Office (Inquisition), whose actions were regarded by *new* Christians as another clog in the state's fiscal apparatus, increasing even further the already high tax pressure suffered by the *Moriscos*. Despite this, the *Morisco* population of Casarabonela endured this pacifically. Casarabonela was, in fact, the base of operations for a contingent of 150 soldiers who had been sent from Malaga at the outset of the rebellion to fight the parties of insurgent *Moriscos*. It seems clear, on top of this, that "peaceful" *Moriscos* from other nearby settlements where they were in the minority, for example El Burgo and Yunquera, took refuge in the village of Casarabonela. The loyalty shown by these *Moriscos* did not stop the Crown from deporting them and distributing their land among *old* Christians. At the end of the war, in November 1570, the *Moriscos* of Casarabonela, a total of 290 households, were transported, via Antequera, to Écija and Carmona, in the province of Seville.45

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[44]Archivo de la Alhambra, A-84–89, L-46–44. In order to follow the court proceedings, several files had to be consulted, the references for which are available in María A. Moreno, *Catálogo del Archivo Histórico de la Alhambra*, (Granada: Patronato de la Alhambra y el Generalife, 1994), index s.v. "Casarabonela."

[45]The misfortunes suffered by the *Moriscos* of Casarabonela can be consulted in Juan Aranda and Marina Martín, "Evolución demográfica y estructura de la población morisca en la ciudad de Écija," in *Actas del III Congreso de Historia de la ciudad de Écija en la Edad Media y*

After the deportations, the *apeo* (inventory) and *repartimiento* of the properties of the *Moriscos* could begin. In the two resulting documents, known as *libros de población* (population books), which complement one another, the village's territory is generically described and the rural properties are inventoried in detail. This inventory included both the land belonging to the expelled *Morisco* population and that in the hands of Castilian colonists.

Water distribution: "However much water they need, and in the right order"

Asked about the order "used for the irrigation" in Casarabonela, the *Moriscos* who worked for the *apeo* of the properties confiscated after the 1570 expulsion, answered that the fields above the village were irrigated on Mondays, Tuesdays, Wednesdays and Thursdays, between dawn and three in the afternoon. Those situated below the village, on the other hand, were irrigated on Thursdays, between three in the afternoon and sunset, plus Fridays, Saturdays and Sundays between dawn and sunset.46 Four years after the first *apeo*, the former properties of the expelled *Moriscos* were distributed among the new

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Renacimiento (Seville: Ayuntamiento de Écija, 1993), 228–53; Juan Aranda, *Moriscos y cristianos en Córdoba. El drama de la expulsión* (Córdoba: Diputación de Córdoba, 2010); Manuel F. Fernández and Rafael M. Pérez, "Notas sobre la destrucción de las comunidades moriscas malagueñas y su reconstrucción en la campiña sevillana, 1569–1610," *Areas. Revista Internacional de Ciencias Sociales*. *Los moriscos y su expulsión: nuevas perspectivas* 30 (2011): 121–39. Also, Gómez and Martínez-Enamorado eds., *Repartimiento de los bienes*. Luis del Mármol, *Historia de la Rebelión y Castigo de los moriscos*, with an introduction by Ángel Galán (Malaga: Arguval, 1991), 267–8.

[46]*Libro de Apeo de Casarabonela*. Archivo Histórico Provincial de Granada, L. 6467.

Castilian settlers. The resulting *Libro de Repartimiento* (1574-75) includes further details of the water allocation system in operation in the village. The fields located above the village were irrigated between Monday and Thursday, "until the shadows hit the rock known as Hafataltalbal."47 After this, water was re-diverted to the "river" (the main channel), and the irrigation turn for the fields below the village started. The fields of the *pagos* (blocks of land) Harça, Guasta, Garça, Carrayra and Caaçor were irrigated from Friday to Sunday. At night, all the available water was used to propel the flour and oil mills in the village (Fig. 1).48

[PLACE FIGURE 1 HERE]

This weekly organisation of irrigation was maintained without substantial changes until the second half of the 20th century. A notarial affidavit issued by the community of irrigators in 1968 referred to the validity of a set of rules passed in 1849. According to these rules, water from the Comparate Spring, the main water source for the *huerta*, was allocated thus: "until three in the afternoon, for those *huertas* that are located above the village, and between three in the afternoon and the night prayer for those that are located below the village". This was of application between Monday and Thursday. In the areas irrigated between Friday and Sunday, all of which were located below the village, no division between morning and afternoon turns existed. At night, the

[47] *Hafts al-Ṭabl* > "the rock or hill of Timbal."

[48] Armada and Martínez-Enamorado, eds., *Repartimiento de los bienes*, fol. 197.

water had to be left to run down the “river” in order to feed water troughs and irrigate other *huertas* located further down the valley.

As can be easily appreciated, the basic timeframe for irrigation remained basically the same between, at the latest, the 16th and the 20th centuries. Some essential alterations, however, took place. The 1571 *apeo* claims that irrigators took as much water as they needed, in descending order.49 This “descending order” is not quite so clearly laid out in the *Libro de Repartimiento* written four years later. In this document, the order does not seem to correspond to the proximity of the water source, but to the order of arrival of irrigators. In any case, no limitation as to the volume of water taken and the duration of irrigation (within the basic time frame) seems to have been applied. As long as the irrigator kept a tree leaf with a stone on top, no one else could make use of his water. These “old and new rules,” some of which were formalised in the 1492 dispositions, soon after the conquest, were enforced by the water bailiffs (*alcaldes del agua*).50

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[49]*Libro de Apeo de Casarabonela*, fol. 7.

[50]A petition filed to the civil governor of Malaga, and signed by a group of landowners from Casarabonela in November 1839, gives a description of the irrigation system followed in 1575: “the first to arrive to the spring leaves a signal — a leaf with a stone on top — to indicate that nobody else can take water until he is finished,” (Archivo Histórico Municipal de Casarabonela, *Expediente sobre los riegos de Casarabonela*, 1839–1840, fol. 1). We want to thank Esteban López for providing us with this document, which seems to indicate that the 19th-century irrigators knew the old system well. The reference to old and new rules in Gómez and Martínez-Enamorado, eds., *Repartimiento de los bienes*, fol. 205 and Bejarano, *Los Repartimientos de Málaga*, 169–71.

The system described by the 16th-century Castilian documents reveals the operation of a serial turn system with no limitations on the volume of water used, and with no allowance made for simultaneous irrigation. The record does not make it clear whether the order was based on topography or on the irrigators' specific demands at any given time, as was the case, for example, in Loja, in the province of Granada.51 Similarly, it is not clear whether any changes in water allocation criteria had been introduced between the *apeo* (1571) and the *repartimiento* (1574-75). In any case, the procedure followed is typical of a system in which water cannot be divorced from the size of the irrigated area and the varying needs of different crops.

The pattern followed in Casarabonela was similar or even identical to others being applied elsewhere in the Kingdom of Granada. For instance, in the nearby village of Monda, irrigators were allocated water according to their "seniority, *dulas* and proximity alone, depending on the block where each field is".52 In Tolox, again in western Malaga, irrigation was organised according to "the proximity of the block where each field is, and seniority," and in Algarrobo

[51]One of the roles of the water bailiff in Loja was to inform the farmer who was requesting water which irrigators had priority over him. Miguel Jiménez, *Los regadíos tradicionales de Loja* (Granada: Fundación Ibn al-Jatib, 2007), 189.

[52]*Dula*: from the Arabic *dawla* > "irrigation turn". See Manuel Espinar et al., "El término árabe 'turno de riego', en una alquería de las tahas de Berja y Dalías: Ambroz," in *El agua en zonas áridas. I* (Almería: Instituto de Estudios Almerienses, 1989), 123–41. For some examples of the opinion of several learned scholars from al-Andalus and the Maghreb on the seniority and proximity criteria, Vincent Lagardère, *Histoire et société en occident musulman au Moyen Âge*, (Madrid: Casa de Velázquez-CSIC, 1995), III.73; V.357; V.359; V.362. On Monda: José A. Urbano, *La villa de Monda en el siglo XVI. Apeos y primeras ordenanzas*, (Coín: G.A. Ediciones coincidentes), 167, 185, *passim*.

(Axarquía, eastern Malaga), irrigation was similarly organised "from the top down" and each irrigator could take water "whenever he needed it". The order of irrigation within each block of properties was apportioned by lot 53. On the other hand, as was the case with the mills in Casarabonela, Algarrobo's fulling mill was supplied only once the irrigation of the fields had finished. In this case, the association of the water with the irrigated space, without volume or time restrictions, reflected on the name of the *pagos*, which was known by the day on which they were allowed to irrigate.54 A similar system, i.e. water distribution on demand, in a descending order and before milling, is also documented in Benamedá (Casares, western Malaga) and Alfacar (Granada), among others.55

In contrast, in some hydraulic systems in the Alpujarras (Granada), water distribution was based on volume and time limits. This system was adopted by the Castilian settlers after the conquest. The application of time slots seems to have been a common response to water scarcity, for instance in the hamlet of Berja (Almería), among others. In the hamlet of Godco (Alboloduy, Granada),

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[53] *Libro de apeo de Tolox*, 1572, Archivo Histórico Provincial de Granada, L.6801, fol. 5v. Esteban López, *Aplicación de la "arqueología hidráulica" al estudio de las comunidades campesinas tardo-andalusíes: el caso de Tolox (Málaga)*, Masters Dissertation, (Malaga: Universidad de Malaga, 2013); http://hdl.handle.net/10481/28797 [Accessed 3 September 2014].

[54]Juan J. Bravo, "La distribución del agua de riego en Algarrobo durante su etapa morisca," in *I Coloquio de Historia y Medio Físico. El agua en zonas áridas*, ed. Lorenzo Cara (Almería: Instituto de Estudios Almerienses, 1989), 269–82.

[55]Rafael Benítez, *Moriscos y cristianos en el condado de Casares* (Córdoba: Diputación Provincial de Córdoba, 1982), 376; Ángel Barrios, *Alfacar morisco* (Granada: Universidad de Granada-Diputación Provincial de Granada, 1984), 50, 150–1.

and in the city of Granada itself, time limits applied, but when water was abundant each irrigator could take as much water as he wanted within his own time slot.56

Several authors have illustrated how diverse water distribution systems were in place around the city of Granada during the Nasrid period.57 Prior to the Castilian conquest, in the 14th and 15th centuries, several commercial transactions involving water rights have been documented in Granada and also in Almería.58 In Granada, the alienation of water rights occurred within a

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[56]Carmen Trillo, *La Alpujarra antes y después de la conquista castellana* (Granada: Universidad de Granada-Diputación Provincial de Granada, 1994), 247–50. Carmen Trillo, *Agua, tierra y hombres en al-Andalus* (Granada: Ajbar Colección, 2004), 259–67. Espinar *et al.*, "El término árabe 'turno de riego'."

[57]Trillo, *La Alpujarra*, 247; Garrido, *Los alquezares*, 38–9. Maria T. de Diego, "Las ordenanzas de las aguas de Granada," *En la España Medieval* 4 (1984): 249–75. In Murcia and Orihuela, these systems were still in operation in the 20th century. Maass and Anderson, *...and the Desert shall Rejoice*, 95. Garrido, "Las instituciones de riego", 17–9. Carmen Trillo, "El tiempo del agua. El regadío y su organización en la Granada islámica," *Acta Historia et Archaeologica Mediaevalia* 23–24 (2003): 237. More recently, Luis Martínez-Vázquez, "De tiempo inmemorial a esta parte: Alfacar y los regadíos del borde nordeste de la Vega de Granada", *Debates de Arqueología Medieval* 1 (2011): 73-103; Miguel Jiménez, "Entre la gestión comunitaria y la privada. La distribución social del agua en las alquerías de la Vega de Granada", in *El paisaje y el análisis del territorio. Reflexiones sobre el sur de al-Andalus*, ed. Miguel Jiménez (Palma: Vessants, arqueologia i cultura SL, 2014), 57-102.

[58]Antonio Malpica and Carmen Trillo, "La hidráulica nazarí. Análisis de una agricultura irrigada de origen andalusí," in *Asentamientos rurales y territorio en el Mediterráneo medieval*, ed. Carmen Trillo (Granada: Athos-Pergamos, 2002) 221–61. Trillo, *Agua, tierra y hombres*, 288. Francisco Vidal, "Water and farm estates in the Arabic documents of the Nasrid kingdom of Granada," in *From Al-Andalus to Khurasan. Documents from the Medieval Muslim World*, eds.

context of the increasing fragmentation of traditional irrigation time slots, which were organised around prayer time. This is, for example, the case in example of the Aydnamar *acequia*, which, after irrigating the land pertaining to the hamlet of Víznar, entered the city to irrigate the *cármenes*, which were estates specialised in grape production, often owned by important members of the Nasrid court.59 A diversity of water allocation systems could sometimes be found within a single hamlet, for example in Padul, to the south of the city of Granada.60

In Casarabonela, turns were ascribed to large blocks of fields. If they were ever applied, turns allotted according to family relationships have left no

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Petra Sijpesteijn et al. (Leiden-Boston: Brill, 2007), 39-58, esp. 47. Jiménez, "Entre la gestión comunitaria", 77-8. About Almería see María D. Segura, "Las fuentes de Alhadra. Abastecimiento urbano y regadío en la Almería musulmana y morisca," in *II Coloquio de Historia y Medio Físico. Agricultura y regadío*, eds. Lorenzo Cara et al. (Almería: Instituto de Estudios Almerienses, 1996), 453–63.

[59]For an early approach to the weakening of the kinship ties, see Antonio Malpica, "Relaciones entre el medio físico y los campos de cultivo en el reino de Granada antes y después de la conquista castellana (siglos XIII a XVI)," in *Homenaje a Tomás Quesada* (Granada: Universidad de Granada, 1998), 417–34; Malpica and Trillo, "La hidráulica rural nazarí"; Trillo, *Agua, tierra y hombres*, 288; Vidal, "Water and farm estates," 47. A. Malpica and C. Trillo think that the fragmentation of property and irrigation turns and the possibility of selling water rights are a sign of the decomposition of the Nasrid kinship-based irrigation organisation. Malpica and Trillo, in any case, do not discard the possibility that transactions involving water may have also be related to scarcity.

[60]Juan F. García-Pérez, "Los sistemas hidráulicos y su evolución en el Valle de Lecrín: diseño de espacios irrigados y modalidades de riego tradicionales en la alquería de al-Baḏūl," in *El paisaje y su dimensión arqueológica. Estudios sobre el sur de la Península Ibérica en la Edad Media*, ed. Miguel Jiménez & Luca Mattei (Granada: Alhulia, 2010), 249-282.

trace. Within each time slot, irrigation was organised either topographically, from the top down, or according to the principle of “first-come, first-served”, as we have seen before. As noted, morning and afternoon turns were allocated to different sets of *pagos*. There was, therefore, a time limit, although each irrigator could take as much water as he wished within that limit. Turns, it follows, applied to the block in general, and it was left to the irrigators in each block to establish their own priorities. Obviously, for this system to work smoothly, enough water to satisfy the requirements of every irrigator had to be available, and irrigators had to agree on how each of them was going to make use of the water.

Some *pagos* located below the village were irrigated from Friday to Sunday (Figure 1). The regime which was applied in these fields was different from that applied in the *pagos* above the village. In these *pagos*, which are grouped in the 1574-75 *Libro de Repartimiento* under just one toponym (Guasta, from the Arabic *al-wasṭa*, “the middle one”), irrigation continued from morning till sunset. These fields were not supplied from the Comparate spring, unlike the *pagos* irrigated from Monday to Thursday, but from the mill of Los Cubos, which is mentioned in the 1492 *repartimiento* and which, in 1571, belonged to Don Cristóbal de Córdoba, the richest man in the village. This watermill (which is currently known as Los Mizos), was the point from which the fields located below the village were still irrigated in the mid-19th century.

It is possible to interpret this Friday-to-Sunday time slot as a later addition to a pre-existing system, which included the morning and afternoon Monday-to-Thursday time slots and *pagos*. To date, it has been impossible to ascertain when this extension took place, but that it did seems to be made clear

by the different irrigation patterns and the physical layout of the system. In any case, the *pagos* that were irrigated from Friday to Sunday in the 16th century already existed before the 1485 Christian conquest, as shown by the 1492 *repartimiento*, which mentions fields, *huertas* and groves in the *pagos* located below the mill.61

Further down the system, the flat agricultural lands located outside the *huerta* (*vegas*) were also subject to irrigation. According to the report issued by Arévalo de Zuazo, *corregidor* of Malaga, after a visit to Casarabonela in 1571, these *vegas* were the same size (a hundred *fanegadas*, just over 30 hectares) as the *huertas* in the territory (*dezmería*) of Casarabonela.62 Two thirds of these *vegas* were in the hands of *old* Christians, while the remaining third was the property of *Moriscos*. With regard to the *huertas* situated near the village, the proportion was inverted: Castilians only owned about one quarter. The 1571 visit also observed that, despite "there being water to irrigate much more" land, water was scarce "most years." It would, therefore, seem that by the time the *Moriscos* were expelled, irrigation had been extended beyond the perimeter of the *huertas* irrigated from Mondays to Sundays, and that this land was mostly in the hands of *old* Christians.

In addition, after the visit, the possibility of further expanding irrigation was suggested, even if the water available was not sufficient for the regular irrigation of the *huertas* and *vegas* located in the lower stretch of the system, according to Arévalo de Zuazo's report. At any rate, we have already noted that

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[61]Bejarano, *Los Repartimientos de Málaga*, 140, 142, 153, *passim*.

[62]Archivo General del Sello (AGS), Cámara de Castilla, Leg. 2158, sf. We wish to thank Esteban López for informing us about this document and for transcribing it for us.

the extension of irrigation to the *vegas*, already attested for the late 16th century, did not modify the fact that the irrigators working the *huertas* located near the village could take as much water as they deemed necessary, as was confirmed a few years later by the 1574-75 *Libro de repartimiento*. Scarcity, it follows, must have been perceived as a problem mostly as far as the fields located outside the perimeter of the *huerta* were concerned (mostly the property of Castilians), and therefore only seen as an impediment for the further expansion of irrigation.

Notwithstanding the stability of the general framework from the 16th century onwards, the 1849 regulations reflected important changes, both in terms of the design of the system and of water allocation criteria. The most important of these was the introduction of fragmented hour-turns. This innovation was justified in the 1849 regulations by the "problems, complains and quarrels" caused by the old distribution system. In fact, in P. Madoz's *Diccionario*, published in 1847, mention was made of the "ill administration of the water flow" in Casarabonela, ill administration which posed problems for the irrigation of the maize fields and for the watering of the livestock in the lower part of the system in drought years.63 The establishment of hour-turns within the previous framework aimed to solve the problems of water scarcity during the

[63]Pascual Madoz, *Diccionario geográfico-estadístico-histórico de España y sus posesiones de ultramar* (Madrid: P. Madoz y L. Sagasti, 1847), 27. The dictionary reproduces the complaint filed, through his representative, by the Duke of Arco and other *hacendados* (landowners) to the civil governor of Malaga in 1839. These landowners lamented that, with the old customs "the turn to irrigate the lower lands comes so late that little good can be done to the maize." Archivo Histórico Municipal de Casarabonela, *Expediente sobre los riegos de Casarabonela*, 1839–1840, fol. 1).

summer; these turns were connected with the organisation of irrigation along parallel, rather than sequential, lines, and, first and foremost, with the extension of irrigation to the *vegas* and *cortijos* (large country houses-cum-estate) located in the lower end of the system, the cultivation of species that required much water, and the watering of livestock.64

The new demands ultimately forced a fundamental transformation of the former water distribution criteria. As previously noted, during the *Morisco* period water distribution was not subject to any volume or time limitations within the turn system, which probably corresponded to the original mode of organisation. Hour-based time slots were not contemplated in the water allocation systems documented for the 16th century, and neither was the possibility of irrigating more than one field simultaneously. Each irrigator received as much water as was needed and for as long as was required according to the size of their field and the crop that they were growing at any given time. In contrast, the 1849 regulations made simultaneous irrigation (between two and four fields at a time) throughout the hourly slots possible. Therefore, the customary morning or afternoon turn could be used by a larger number of irrigators. The morning and afternoon turns documented for the 16th century were, therefore, still recognisable in the 19th-century system, but now they were further divided by hour, half-hour, third-hour and quarter-hour turns according to mechanical clocks (despite the fact that the basic time turns were still regulated according to

[64]This explains the letter addressed to the mayor of Casarabonela in 1840 and signed by an irrigator who had become worse-off after changes were introduced to comply with the Duke of Arco's and other landowners' petitions. The letter mentions the scarcity resulting from the "needs of the many new *huertas* created in the last hundred years," (Archivo Municipal de Casarabonela, fol. 23).

prayer time). These subdivided turns could be divided even more or accumulated.

This strict hour-based organisation system established in 1849, must have taken into consideration the surface to be irrigated during each turn, but not the differing needs of the diverse crops, which was a major factor of proportionality, according to Maass and Anderson.65 The proportionality principle based on the crop, it follows, was superseded by the imposition of hour-based turns. Following the 1849 regulations, each irrigator knew at exactly what time he could start using water but did not know with certainty that the water so used would be sufficient to cover his needs. In any case, with the new system the differing needs could be adjusted by purchasing irrigation turns or fractions thereof.

In summary, irrigation in Casarabonela continued to be practised "as it was done in the time of the Moors" after the conquest and the expulsion of the *Moriscos* but only to a certain extent. The system was preserved untouched until the new demands posed by fields located outside the *huerta* forced the adoption of a system in which scarcity was a determinant factor. The tail-enders, who had suffered the consequences of the lack of water due to the expansion of irrigation most acutely, were particularly interested in promoting a new system which ensured that enough water reverted back to the channel to guarantee the viability of irrigation in the *vegas* and *cortijos* (estates) located

[65]Maass and Anderson, *...and the Desert shall Rejoice*, 40. In fact, *Las ordenanzas de la Comunidad de regantes de Casarabonela*, which are still in force, determine that "no irrigator will be allowed to request a greater volume of water or longer turns on the basis of his crop, beyond what is due to him by right."

towards the bottom end of the system. The expansion of irrigation, therefore, prompted the introduction of new principle which superseded the old proportionality criteria based on the needs of different crops.

In this regard, it does not appear that the management of scarcity was a major consideration in the water allocation criteria preserved after the expulsion of the *Moriscos*. This has not so much to do with the precipitation regime (annual average is 714 mm, but some years rainfall can be over 1000 mm) and the abundance of springs, but with the limitation of the irrigated area and the strictly controlled order followed for water distribution among the different blocks of land. No alternative use for the water, other than the irrigation of the *huertas* located inside the original system, was taken into consideration. At nights, water was used to propel the watermills situated within the perimeter of the system. In 1849, however, the use of water during the night for irrigation and the watering of livestock outside the *huerta* was finally regulated.

The mid-19th-century regulations reveal a fundamental breach of the original system, the threshold of which — based on the strict adherence to the Monday-to-Thursday and Friday-to-Sunday turns — had been exceeded. As pointed out by Glick, a design based on these principles was hard to enlarge without compromising the balance between irrigation rights and the surface that was to be irrigated. The violation of the proportionality principle took place in Casarabonela when the system was subject to demands from outside the original layout, which amply exceeded the system's potential for enlargement and its operating principles. This reproduced a typical pattern, which had already been detected in Valencia by Glick himself, as well as on the coast of Granada, where the phenomenon was considerably faster and the capacity

thresholds of the Nasrid systems were overtaken soon after the Castilian conquest in the 15th century, as shown by A. Malpica.66 In this sense, the expansion of species which required much water, such as sugar cane, put excessive pressure on the old systems and their water distribution criteria.

As previously noted, water allocation systems based on proportionality were common and coexisted with others in which water distribution was based on hour-long turns, both in urban and suburban contexts in and around Granada and in the region of Las Alpujarras (also near Granada).67 According to C. Trillo, in these cases the common ownership of water probably hampered the transfer of water rights to non-members of the community beyond, at most, the sale of surplus water.68

It seems clear that an hour-based system was better suited to the management and productive orientation that followed in the wake of the

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[66]Glick, "Cap a una història institucional dels regs," 40; Antonio Malpica, "Medio físico y territorio: el ejemplo de la caña de azúcar a finales de la Edad Media," in *Paisajes del azúcar. Actas del V Seminario Internacional sobre la caña de azúcar*, ed. Antonio Malpica (Granada: Universidad de Granada, 1995), 11–40; Malpica, *Medio físico y poblamiento*. See also Adela Fábregas, "Commercial crop or plantation system? Sugarcane production from the Mediterranean to the Atlantic, in this volume.

[67]Maria A. Carbonero, "Technologie hydraulique et système de distribution collective de l'eau en al-Andalus," *Revue de l'Occident musulman et de la Méditerranée*, 45 (1) 1987: 133-41, esp. 136–7; Espinar et al., "El término árabe 'dawla'," 133–4. Trillo, *La Alpujarra*, 247–50; Trillo, *Agua, tierra y hombres*, 266–7.

[68]Malpica and Trillo, "La hidráulica nazarí," 16–20; Trillo, *Agua, tierra y hombres*, 266–72. Camilo Álvarez and Margarita Jiménez, "Pleitos de agua en Granada en tiempos de Carlos V. Colección de escrituras romanceadas," in *Carlos V. Los moriscos y el Islam*, ed. Maria J. Rubiera (Alicante: Universidad de Alicante, 2001), 59–90.

Christian conquest. As the example of Casarabonela has illustrated, this system did not involve an immediate and brusque shift from one system to the other. It seems clear that irrigating "as it was done in the time of the Moors" was still done, sometimes for centuries thereafter. As is illustrated by the example of Casarabonela, the introduction of hour-based turns had a lot to do with the system's ability to assimilate additional demands posed by the enlargement of the system or the large-scale cultivation of species which demanded much water. Once these new demands could not be fitted into the old criteria, hour-based, divisible turns were imposed and the possibility of exchanging water rights created. As observed by C. Trillo in Aynadamar (Granada), whenever the land and the water could be managed separately, the number of transactions involving water was also higher, even before the Christian conquest.69 In Casarabonela, in contrast with the coast of Granada, the specialisation brought about by the conquest did not essentially take place in the old hydraulic systems, but in areas dominated by dry framing, with the introduction of extensive cereal cultivation and the planting of vineyards. As a consequence, water distribution systems did not have to be changed outright.

Despite the diversity of irrigation systems in operation before the conquest and the changes introduced thereafter, it seems clear that the tendency was not to change from hour-based systems to one where irrigators could use as much water as they needed (with the exception of hour-turn-based systems which permitted an unlimited amount of water to be used in periods of plenty). As noted, Murcia was one of the exceptions.70 Generally, the

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[69]Trillo, *Agua, tierra y hombres*, 275. Jiménez, "Entre la gestión comunitaria", 87.

[70]Denis Menjot, *Murcie castillane*, 352–3.

transformations involved the imposition of hour-based turns. These changes need to be understood in the context of the new agrarian strategies imposed after the conquest, especially the introduction of specialised crops. That is, later hour-based systems were adopted in order to adapt to new social and productive demands, and they cannot be situated in the same category as the original time-based Andalusi systems, which were designed to manage scarcity from the onset.

Other colonial irrigation systems

Studying the organisation of irrigation and hydraulic systems in other colonial (Atlantic and American) contexts can contribute to a better understanding of the transformation of Andalusi systems in the wake of the Christian conquest and vice versa. The transmission of technical knowledge has been one of the main guidelines in the study and comparison of "ancestral" irrigation systems on both sides of the Atlantic.71 Th. Glick's work on the origins of the irrigation system built in the 18th century by Canary colonists in San Antonio, Texas, is seminal to this kind of comparative effort.72 The title chosen for this work alludes to the

[71]Some examples in Jacinta Palerm, "Las galerías filtrantes o qanats en México: introducción y tipología de técnicas," *Agricultura, Sociedad y Desarrollo* 1(2) (2004): 133–45; *Riegos ancestrales en Iberoamérica*, ed. Tomás Martínez (Mexico City: Mundi-Prensa, 2009); *Sistemas ancestrales de riego a ambos lados del Atlántico*, eds. José Roldán and René Chipana (Córdoba: Universidad de Córdoba, 2011).

[72]Thomas F. Glick, *The Old World Background of the Irrigation System of San Antonio, Texas* (Texas Western Press, 1972). There is a Spanish translation, published by Universidad de Granada: *Los antecedentes en el viejo mundo del sistema de irrigación de San Antonio, Texas*, (Granada: Universidad de Granada), 2010. The citations refer to the Spanish translation.

connection between the conquest and the emergence of new societies in the medieval and modern periods, which Ch. Verlinden refers to as "medieval precedents to the American colonies."73 A few examples of how irrigation systems were managed in the Atlantic and American colonies will illustrate the need to gain a broader understanding of this crucial aspect of the relationship between the medieval and Mediterranean conquests on the one hand, and the modern and Atlantic colonies on the other.74

In Gran Canaria (Canary Islands), irrigation systems implemented in the late 15th century were determined by the hegemonic cultivation of sugar cane. The fields where this specialised crop was initially introduced made use of pre-existing indigenous irrigation networks.75 It seems that the operational criteria followed after the conquest, however, did not continue the indigenous practices. After the first batches of European colonists established a wide variety of operational criteria in the late 15th century, a proportionality system based on the amount of land owned by each irrigator within a community (*adulados*) seems to have become predominant.76 The amount of land cultivated with sugar cane and the construction of sugar processing factories soon posed new

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[73]Charles Verlinden, *Précédents mediévaux de la colonie en Amérique* (México, 1954).

[74]For a comparative analysis of irrigation institutions in different regions, see Jacinta Palerm, "Comparative History of Irrigation Water Management, from the Sixteenth to Twentieth Centuries: Spain, Mexico, Chile, Mendoza (Argentina) and Peru," *Water Policy* 12 (6) (2010): 779–97.

[75]Antonio Macías, "La colonización europea y el derecho de aguas. El ejemplo de Canarias, 1480-1525," *Hispania*, 233 (2009): 715–38.

[76]Glick, *Los antecedentes en el viejo mundo*, p. 20–7; Felipe Fernández-Armesto, *The Canary Islands After the Conquest* (Oxford: Clarendon Press, 2003), 93–113.

demands, creating a situation of scarcity and overturning the proportionality system, which was replaced by a system in which the use of water was alienated from the land and privatised; these actions set the foundations for the control exercised by the sugar-based oligarchy on the island in the first half of the 16th century. Initially, the extraordinary demands posed by the sugar industry were limited to "surplus water" (*aguas perdidas*), which was at first subject to the *ius regale*, but which ended up under the control of the Canary aristocracy of sugar.77

The corruption of the early colonial distribution system, which was plausibly adapted to the layout of indigenous hydraulic networks, was the result of pressure exercised from outside the main irrigated lands. As previously noted, the separation between water use and land took place once the initially contemplated irrigation thresholds were broken. As pointed out by Th. Glick, the breach of this principle of proportionality, according to which the amount of water used by each irrigator depended on the amount of land owned, was behind the privatisation of water distribution in the 19th century and the possibility of diverting it outside the irrigation systems.78 It was, it follows, a response to supervened, rather than originally perceived, conditions of scarcity caused by the productive patterns implanted in the colonial period.

The hydraulic systems built in the 18th century by Canary settlers in San Antonio, Texas, present us with a similar example. Initially, irrigation was organised according to a proportion between the amount of water and the

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[77]Fernández-Armesto, *The Canary Islands*, 107; Macías, "La colonización europea," 727–36. See Adela Fábregas, "Commercial crop or plantation system?", in this volume.

[78]Glick, *Los antecedentes en el viejo mundo*, 45.

amount of land. According to Glick, this system limited conflict over water use until the demands posed by both residents and new arrivals broke the initially contemplated threshold (amounting to one fifth of the total water flow) and left no other option but to make water alienable (at first, only the surplus water — *sobras*).79

As in San Antonio, the hydraulic systems constructed in missions and other colonial settlements in northern New Spain from the 16th century onwards were focused on the cultivation of cereal and were generally built anew; the pre-existing Pueblo systems were regarded as inadequate for the new productive strategy, especially in terms of the cultivation of wheat and barley.80 If there were connections between the old indigenous layouts and the new colonial networks, they seem to be hard to trace, both in the Canaries and New Spain. In both cases, irrigation was crucial to the settlement of Spanish colonists. It seems that the physical design and the water allocation systems adopted in the indigenous networks were deemed inadequate for colonial development. The specialisation in sugar in the Canaries and the importance placed on cereal cultivation in New Spain — aside from the important role played by

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[79]Glick, *Los antecedentes en el viejo mundo*, 75–78. Michael C. Meyer, *Water in the Hispanic Southwest. A Social and Legal History, 1550–1850* (Tucson: University of Arizona Press, 1996), 137.

[80]José A. Rivera, *Acequia Culture. Water, Land & Community in the Southwest* (Albuquerque: University of New Mexico Press, 1998), 8; Mark T. Lycett, "Toward a Historical Ecology of the Mission in Seventeenth-Century New Mexico," in *Indigenous Landscapes and Spanish Missions. New Perspectives from Archaeology and Ethnohistory*, eds. Lee M. Panich and Tsim D. Schneider (Tucson: University of Arizona Press, 2014), 180–3.

stockbreeding — came into being after new networks were constructed or old systems were adapted beyond recognition.

The pre-Hispanic irrigation systems that managed to survive abandonment or the decimation of the indigenous population of New Spain were, on the other hand, preserved by indigenous communities and legally protected from alienation.81 This, at least theoretical, protection, guaranteed the Pueblo communities independent access to water whenever the water supply was shared with missions, *presidios* or settlements were inhabited by colonists from central Mexico (creole, mix-raced or indigenous, for example the Tlaxcaltecas). Spanish landowners, however, had priority access to water.82 This area did not witness an ubiquitous substitution of populations, as was for example the case with the Iberian conquests; colonisation was not, therefore, based on the systematic occupation and reuse of already existing, and well-defined spaces. The "promiscuous" coexistence of two peasant populations using the same irrigation systems did not take place either, not like in Casarabonela between the 1485 conquest and the expulsion of the *Moriscos* in 1570, to name but one example.

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[81]Rivera, *Acequia Culture*, 3. Meyer, *Water in the Hispanic Southwest*, 51–8 and map on page 59.

[82]Tomás Martínez-Saldaña, "El riego tradicional en el eriazo norteño mexicano: la expansión de la herencia hidráulica agrícola mesoamericana," in *Riegos ancestrales en Iberoamérica*, 53–62. Cándido González and Rosario Realpozo, "Los sistemas hidráulicos coloniales en Colotlán Jalisco, México," in *Riegos ancestrales en Iberoamérica*, 169-175. For the forced migration of Indians in order to ensure the availability of a sufficient workforce in the *estancias*, see François Chevalier, *Land and Society in Colonial Mexico: The Great Hacienda* (Berkeley: University of California Press, 1963), 69.

The first Spanish settlers arrived in the Rímac Valley, near Lima (Peru) in 1535. The colonists' settlement and their agricultural organisation were arranged around the construction of new irrigated spaces based on Old World models.83 The pre-Hispanic hydraulic systems in the region coexisted with these new arrivals for several years, until the indigenous collapse caused by the massive depopulation that followed.84 After the usual initial desarray, the land distributions and the imposition of water allocation rules promoted by Viceroy Toledo finally institutionalised a stable system among the colonists.85 These systems were organised on the basis of the proportionality principle, between the amount of land owned and the volume of water that each irrigator was allowed to use.

Another essential aspect of the irrigation systems where Spaniards and Indians shared the same water source was the separation of the irrigation turns

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[83]Daniel Gade, "Landscape, system, and identity in the post-conquest Andes," *Annals of the Association of American Geographers*, 82 (3) (1992): 460–77, 464.

[84]Robert G. Keith, *Conquest and Agrarian Change. The Emergence of the Hacienda System on the Peruvian Coast* (Cambridge (MA)-London: Harvard University Press, 1976), 122. For an archaeological analysis of the construction techniques and the phases of the irrigation systems of the Chimu, on Peru's northern coast, see Charles R. Ortloff, "Chimu Hydraulic Technology and Statecraft on the North Coast of Peru, A.D. 1000-1470," in *Economic Aspects of Water Management in the Prehispanic New World*, eds. Vernon L. Scarborough and Barry L. Isaac (Greenwich, Connecticut-London: Jai Pres Inc., 1993), 327–67. For a compendium of hydraulic systems in South America, see William M. Denevan, *Cultivated Landscapes of Native Amazonia and the Andes* (Oxford: Oxford University Press, 2001).

[85]Robert G. Keith, *Conquest and Agrarian Change*, 123–7. Fernando Flores, *Haciendas y pueblos de Lima. Historia del valle del Rímac, III* (Lima: Fondo Editorial del Congreso del Perú-Municipalidad de Lima, 2012), 107–109, 113–114, passim.

allotted to each group. The Indians were only allowed to irrigate after sunset, once the Spaniards had finished doing so. It is possible that this distribution of the irrigation turns also reflected the higher position of the lands owned by the Spanish, as the growth patterns identified in Moche Valley, in Peru's northern coast, seem to suggest.86 Some texts refer to this distinction" as a condition meant to "prevent injury being done to the Indians." As previously noted, the authorities of New Spain also pursued the same target with their measures.87 It seems clear, in any case, that the old and the new systems had different designs and followed different operational guidelines in order to respond to production and management strategies that were interchangeable only to a degree. This justifies the decision to dismiss the construction of the *reducción* of Chuntay, in Lima, in a place "where the Indians would be surrounded by Spaniards, which is convenient to no one in the republic".88 It is likely that the Inca Garcilaso's reference to the Spaniard's lack of concern for the deterioration of indigenous irrigation systems after the conquest, especially in valley locations and on the coast, was connected with the construction of brand new hydraulic networks.89

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[86]Keith, *Conquest and Agrarian Change*, 126. Denevan, *Cultivated Landscapes*, 149. Something similar occurred in Surco, Lima, where the Spanish *haciendas* were situated up the water course and also had different turns to, and priority over, the land owned by the Indians. This changed when the Jesuits, who had a *hacienda* located below Indian land, pushed for a change of system. Nicolas P. Cushner, *Lords of the Land. Sugar, Wine and Jesuit Estates of Coastal Peru, 1600–1767* (Albany: State University of New York, 1980), 51–3.

[87]Flores, *Haciendas y pueblos de Lima*, 105–6.

[88]Flores, *Haciendas y pueblos de Lima*, 128.

[89]Quoted in Denevan, *Cultivated Landscapes*, 145.

In the Arequipa Valley, in southeast Peru, conditions were different. In the late 16th century, the Indian and Spanish *chácaras* near the city were mixed. This was caused by the opposition of *encomenderos* to the alienation of their Indian's land (land which they often ended up buying themselves) and by the fact that the Spanish preferred the land closest to the coast, where they created extensive and compact *heredades* for the cultivation of vines. Indeed, the coastal plain was the preferred location for the creation of large estates dedicated to the new colonial specialities.90

The Andean highlands did not witness the massive arrival of European immigrants or the construction of new irrigation systems. Spaniards did not regard these highlands as a suitable location for the settlement of new *vecinos*.91 Colonial order — and the fortune of the *encomenderos* — was achieved through the concentration of Indians in *reducciones* situated at the foot of the mountains and the selective preservation of pre-Hispanic social practices, including some local management practices, in what J. Murra labelled the "vertical archipelago."92 In temperate climate zones, for example in

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[90]Keith A. Davies, *Landowners in Colonial Peru*, (Austin: University of Texas Press, 1984), 31, 43, 122. Robin A. Donkin, *Agricultural Terracing in the Aboriginal New World* (Tucson: The University of Arizona Press, 1979), 25–30.

[91]Jeremy R. Mumford, *Vertical Empire. The General Resettlement of Indians in the Colonial Andes* (Durham and London: Duke University Press, 2012), 26, 34. Also, Karen Spaulding, *Huarochirí. An Andean Society Under Inca and Spanish Rule* (Stanford: Stanford University Press, 1984), 178.

[92]John V. Murra, *Formaciones económicas y políticas del mundo andino* (Lima: IEP, 1975). Jeanette E. Sherbondy, "Water and Power: The Role of Irrigation Districts in the Transition from Inca to Spanish Cuzco," in *Irrigation at High Altitudes: The Social Organization of Water Control*

Oropesa (later known as Cochabamba, Bolivia), some valley settlements controlled by Spanish and mixed-race *chacareros* and *estancieros* (landholders) used Indian Yanacona labour in agricultural spaces partially dedicated to specialised crops, which were later commercialised, in the most part, in the mining city of Potosí.93 The village of Oropesa was one of the urban settlements that emerged as a result of the migration of European colonists in the 1560s.94 In these valleys, the pre-existing irrigation sectors (*suyus*), as well as other pre-Hispanic institutions, were incorporated into the reorganised networks related to new *pueblos* and *haciendas* during the early colonial period.

The vindication of ancient practices was a common resource in lawsuits fought over the use of water, both by *encomenderos* and *hacendados* and also by the peasants themselves. As we have seen with regard to irrigation practices that were "done like in the time of the Moors," the vindication of Inca customs in Cochabamba took place within the framework of the fracture caused by the

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Systems in the Andes, eds. William P. Mitchell and David Guillet (Arlington VA, Society for Latin American Anthropology Publication Series, 1994), 69–97. Donkin, *Agricultural Terracing*, 38. See also Inge Schjellerup, "Early colonial utilization and management in Peru", in this volume.

[93]For *chácaras* and *estancias* worked by Yanacona Indians and slaves, see James Lockhart, "Encomienda and Hacienda: The Evolution of the Great Estate in the Spanish Indies," *Hispanic American Historical Review* 49 (3) (1969): 422–3. See J. M. Fradera, "The Peculiarity of the Spanish Empire (a comparative interpretation)", in this volume.

[94]Brooke Larson, *Cochabamba, 1550–1900. Colonialism and Agrarian Transformation in Bolivia* (Durham and London: Duke University Press, 1998), 73–85.

colonial usurpation of land, which was stimulated by the specialised cultivation of cereal and the priority granted to watermills.95

In Moquegua, in southern Peru, the new *heredades* destined for the cultivation of vine and wheat, and also the construction of a watermill, caused the violation of the indigenous water distribution systems and the establishment of new management criteria in the hydraulic networks situated in the Osmore Valley soon after the conquest. The record of the visit carried out by Garci Díez de San Miguel in 1567 also informs us that the Spaniards and the Indians operated segregated irrigation spaces, as in the example of the Rímac valley.96 In the Arequipa Valley, in the mid-16th century, the *estancieros* broke the pre-Hispanic *acequias* in order to divert the water towards their pastures during the dry season.97 In any case, the massive decrease in population numbers during the colonial period, especially on the Peruvian coast, was the cause of an unprecedented surplus of water, something which, presumably, also diminished the level of conflict. The growth of Andean populations in recent times and the generalisation of market crops and the privatisation of water have provoked a new situation of scarcity which has made tension to rise again, as pointed out by P. Trawick.98

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[95]Karl S. Zimmerer, "Rescaling Irrigation in Latin America: The Cultural Images and Political Ecology of Water Resources," *Ecumene* 7 (2) (2000): 165–7.

[96]Prudence M. Rice, *Vintage Moquegua. History, Wine, and Archaeology on a Colonial Peruvian Periphery* (Austin: University of Texas Press, 2011), 156.

[97]Davies, *Landowners*, 37.

[98]Paul Trawick, "The Moral Economy of Water: Equity and Antiquity in the Andean Commons," *American Anthropologist* 103 (2) (2001): 361-379, esp. 363.

The Rímac, Moquegua and Cochabamba examples are illustrative of how water allocation systems were imposed after the conquest in order to adapt to new production strategies. It is equally true that the corruption of former water distribution systems did not always take place immediately, or everywhere. According to the description of pre-Hispanic irrigation systems included by the Inca Garcilaso in his *Comentarios Reales de los Incas*, the order of water distribution followed the pattern set out by the physical position of the fields.99 On the other hand, the amount of time which each irrigator had for accessing water was determined by the amount of land possessed. It is, however, hard to believe that a single system was applied to the whole of the Inca Empire. Trawick has, nevertheless, suggested that the proportionality principle and the uniformity conveyed by this system set the general pattern in the Andes after the demographic collapse caused by the conquest. As with other Andean institutions, the Incas selected, adapted and disseminated some pre-existing local customs.

According to Trawick, these pre-Hispanic principles of proportionality and uniformity can still be recognised in Huaynacotas (Cotahuasi Valley, Arequipa, Peru). In this valley, the procedures described by Garcilaso in the 16th century still apply.100 The maintenance of indigenous —probably pre-Incan — principles and water allocation systems in Cotahuasi is an extreme example of the “ultra-stability” of irrigation institutions. The survival of the principles described by Garcilaso in this case must also be connected with the small size of the original irrigated surfaces. Otherwise, as previously noted, exterior

[99]Quoted in Trawick, “The Moral Economy of Water,” 363.

[100]Trawick, “The Moral Economy of Water,” 379.

demands would have created a situation of scarcity and forced water allocation systems to be redefined. It appears that this pressure, which had become insupportable in the long run in the other examples cited, did not materialise in Cotahuasi. As pointed out by Trawick, the decisive factor in this regard was that this area was, for centuries, bypassed by the *haciendas* system and the associated demands posed my market crops, such as alfalfa, sugar cane and other plants with high water requirements.101 In this case, the colonial order was imposed via the creation of a *reducción*: this included the creation of the current village and the rupture of the agricultural connections with neighbouring areas that were located at different altitudes, but the original water allocation systems were not broken as had been done, for instance, in Moquegua.

Conclusions

Obviously, the examples cited do not constitute an exhaustive sample of the potential transformation of water distribution systems in early colonial contexts. They are, however, sufficient for us to present a number of relevant questions from a comparative perspective, and they allow us to observe the medieval and Iberian precedents to the colonial management of irrigation systems in a different light. The example of Casarabonela is illustrative in this regard. Water distribution in Casarabonela's main hydraulic system was based, during the *Morisco* period, and probably also before then, on proportionality. Although irrigation time was limited to half-day turns, each irrigator could take as much

[101]Trawick, "The Moral Economy of Water," 362, 363, 371. On the limits of these specialisations in the *haciendas*, see Lockhart, "Encomienda and Hacienda," 425.

water as his crops needed. The limited duration of the turns forced the owners in each block of land to agree upon the amount of water that each could take.

There was another turn, from Friday to Sunday, which followed the same criteria. Irrigators in this block, which was somewhat bigger in size than the previous one, could irrigate three days a week, either in the morning or the afternoon, according to the internal distribution of the block. This block may be interpreted as an enlargement of the irrigated space which took place before the 1485 Castilian conquest. This enlargement, however, did not mean that individual turns were imposed, and the original system could be maintained without changes.

This distribution framework, including the proportionality principle and the turn sequence, was kept for centuries. The proportionality principle was institutionally abolished in the 19th century: the previous half-day turns were sub-divided into hour-turns, so irrigators had a fixed quota regardless of what they were growing. Similarly, the sequential organisation of irrigation was abandoned, and now up to four different irrigators could make use of the system at any given time. The volume of water that each irrigator could use corresponded only to the amount of land possessed, regardless of the varying needs of different crops. This change was implemented long after the expulsion of the *Moriscos* in 1570. The need to impose a new distribution system was brought about by the new demands posed by *vegas* and *cortijos* situated lower down, outside the original hydraulic system. The original water allocation system did not provide for the use of water outside the system's limits, whereas the new criteria, which were formalised in the 1849 *Reglamento*, did. It is impossible, with the information available to date, to determine the chronology

and intensity of these demands that, in the long run, broke the original thresholds of the system and demanded a new institutional setting.

Proportionality was a general principle of irrigation systems before and after the Iberian and American conquests. This proportionality could be based just on the amount of land, or it could also take into consideration the needs of the crop under cultivation. We have seen that the proportionality between the amount of land and the volume of water was used in very different contexts, for example in Cotahuasi, a presumably pre-Hispanic Andean system, on the Peruvian coast in the colonial period, in Casarabonela in the late 16th century, and in San Antonio, Texas, established by the Canary colonists in the 18th century. On the other hand, the alienation of water and land was also widespread and can be noted in, for instance, Nasrid Granada, the *adulamiento* in the Canaries after the conquest, the sale of water rights in Arequipa in the 1540s, or the recent privatisation of water in the Peruvian Andes. It is not possible, therefore, to talk about specific "indigenous" and "colonial" systems of water distribution in these terms. The possibility of alienating water was, initially, related to scarcity. The crucial question is whether scarcity was taken into account in the design of the original layout and the original water allocation criteria, or whether it was only considered a factor with the imposition of new productive and management strategies, either upon pre-existing systems or newly constructed ones.

As predicted by E. Ostrom, the aforementioned examples show that water demands, especially those posed from outside the system, were a determinant, if not the most determinant, factor in the "tragedy of the commons," which was initiated with the modification of the principles regulating the

management and operation of hydraulic systems. The construction of the colonial society involved the adoption of new productive and management agricultural criteria, including the allocation of water rights. The decisive question is how to establish the chronology and nature of these processes of substitution, which sometimes took centuries to unfold. In this sense, the "growth" thresholds of the original systems have to be considered, since this was the point from which the original water allocation system would have become obsolete and non-functional.

Another issue that lies in the comparison between the management of colonial societies is the different role that indigenous had in the management of irrigation systems. In Casarabonela, a large part of the original population remained after the conquest. Between the late 15th century and the 1570 expulsion, *Moriscos* and Castilian peasants lived in the same village and worked the fields, under a single water distribution system. The final solution, the annihilation of the Andalusi social order, demonstrates that this form of social engineering, which was put into practice in different regions of the Peninsula, sometimes for centuries, resulted in the violent coexistence of different agricultural choices; this was ultimately resolved by the expulsion and full substitution of the Andalusi peasantry. There is little doubt that this was a decisive experience in the Atlantic and American colonisation processes.[102] In 1535, the Spanish settling in the Rímac Valley, near future Lima, knew that any form of promiscuous coexistence had no place in the new order. This stage of

[102]George M. Foster's *Culture and Conquest. America's Spanish Heritage* (Chicago: Quadrangle Books, 1960) is still a mandatory reference work for the study of the processes of selection that determined which Iberian social practices were later to be reproduced in America.

the colonisation process did not involve the massive settlement of European farmers.103 The *república de los españoles* and the *república de los indios* had to be precisely defined and neatly separated from one another.104 This ideal organisation of colonial society was also reflected in some hydraulic systems, in which the Indians had their own *acequias*, or in which Indians and Spaniards had distinctly differentiated irrigation turns. The connection between the Iberian and American colonial processes is, in this field, as in so many others, a very promising field of research.

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[103]Rather, the colonists were “men of affairs,” in the words of James Lockhart’s *The men of Cajamarca: A Social and Biographical Study of the First Conquerors of Peru* (Austin: University of Texas Press, 1972).

[104]Jeremy R. Mumford, *Vertical Empire*, 47–8. There were exceptions to this, such as the above noted Spanish and Indian *chácaras* near Arequipa. In Lima, the Indians lived in the district of Santiago. In Trujillo, on the northern coast of Peru, the Spanish and Indian houses were next to each other. We do not know with certainty if this was also the case with the *huertas*. Juan Castañeda, “Indígenas entre españoles. Trujillo del Perú, 1534–1619,” *Nueva corónica* 1 (2013).

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Figures

Fig. 1 Irrigation system of Casarabonela (Málaga)