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(Authors version)

Title

Interdisciplinary approaches to water in the Roman world

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Abstract

Water resource management refers to the process of planning, developing, and managing water resources across uses. Understanding how the Romans approached the management of water resources is crucial to our understanding of the functioning of Roman society, not least from the point of view of the agricultural economy, urban development, trade, industry, and leisure. Just as modern societies, the Romans faced numerous challenges concerning the effective and continuous distribution of water, the management of waterways for transport purposes, and, when disputes arose, how best to balance competing interests. Though much has already been written individually on these topics, there remains considerable scope for research into the Roman approach to these issues from a holistic perspective. This volume therefore introduces a series of studies from a cross-disciplinary point of view, that includes contributions by archaeologists, geomorphologists, historians, and jurists, with a view to understanding how Roman technical, social, and legal solutions worked together to produce systemic results.

Keywords

Roman law - irrigation – natural resources – rivers – fluvial transport – water distribution – ancient environment

The contributions to this special issue of *Water History* were first presented at a workshop held at the University of Edinburgh in late summer 2019¹. The idea for the workshop was conceived in Budapest in 2018, at the Ottoman Rudas Baths. In those historic surroundings, perhaps not unlike the Roman baths in many respects, the editors discussed the potential and pitfalls of approaching the management of water resources in the ancient world from a cross-disciplinary perspective. The potential for such an approach is evident: the strong imprint of waterways and water management systems in the historical record provides a solid foundation for research in this direction, with a variety of archaeological, epigraphic, literary and legal sources each contributing to a rich and diverse evidential base. At the same time, the opportunities presented by a relative abundance of evidence give rise to methodological challenges, particularly concerning the integration of the interpretation of these sources into a coherent whole. Born out of a conviction that by interdisciplinary collaboration, greater and more penetrating insights can be achieved, this issue brings together contributions that aim to make progress toward producing a holistic account of water and waterway management in the Roman world.

In addition to a fertile evidential base, the choice of water and waterways as a topic for research is informed by the centrality of water and its distribution infrastructure to ancient life in all its aspects. This much is, of course, a trite observation: what is more important is to analyse the particular ways in which water was supplied to where it was needed and, in cases of shortage or conflict, how the interests of those affected were balanced against one another. In this connection, just as much as the technical solutions that enabled both travel on water and its supply in great quantities in support of agriculture (by means of irrigation), urban

¹ The editors would like to thank Marie Curie Actions, the University of Edinburgh, and the University of Oxford, without whose funding and support the workshop would not have been possible.

development, trade, industry, and leisure, provide us with an insight into the physical infrastructure that promoted mobility and communal life, so too the human context – the social, political, legal, and economic framework – within which persons interacted in relation to water resources deepens our understanding of all these processes. Only by bringing together specialists in different fields, from jurists to archaeologists, geomorphologists to historians, can the full range of issues be properly and thoroughly explored.

Evidence requires to be interpreted in its proper context. Literary texts and inscriptions, for example, tend to focus mostly upon water resource management in a public context. Due to the nature of the texts that have survived, we have a greater insight into large projects led by public authorities than the day-to-day management of water on estates or in workshops². The most significant exception is, of course, the treatises of the Roman agronomists, who provide practical advice concerning the irrigation and drainage of agricultural land cultivated in the context of the villa economy (Willi 2021, pp. 113–178). Administrative documents, such as the texts produced in the context of the *cura riparum et alvei Tiberis*, the *cura aquarum* at Rome, and in municipal charters³, all contribute to our understanding, in both an Italian and provincial context. Archaeological findings, too, are essential in demonstrating the implementation of technical solutions. In recent years, complementing the traditional approach of studying built infrastructures, the application of scientific techniques to the analysis of archaeological materials has allowed substantial improvement in our understanding of wet areas and river environments. Our knowledge of the highly strategic network of rivers, man-made canals and port installations, of the functioning of ancient deltas, and of the influence of ancient environmental conditions on the development of water technologies, has also greatly benefited from the development of paleo-environmental studies (for example Goiran et al. 2014; Sürmelihiindi 2018; Pleuger et al. 2019)⁴.

Finally, Roman legal texts provide a rich source of insights into the legal, social and economic framework that structured the relationships between individuals in their exploitation of the natural environment. Given the importance of water and waterways to ancient life, particularly in the context of an agricultural economy, it is little surprise that these were the subject of legal innovation from the earliest stages of the city's development. In addition to the remedies referred to in the XII Tables (fifth century BCE), that protected the rights of landowners to water emanating from or running across their neighbour's property, the intervention of magistrates during the late Republic and the writings of the classical jurists through to the Severan age together comprise a substantial body of legal material concerned

² See for instance Suet. *Caes.* 44 and Cic. *Ad Att.* 328 (13.20) on Caesar's project to divert the Tiber; Suet. *Aug.* 30, for an account of Augustus' clearing of the riverbed; Tac. *Ann.* 1.76 and 1.79 on a project to divert the course of the *Nar* and of the *Glanis* under Tiberius.

³ The *cura riparum* was formally established as such under Tiberius, but a number of inscriptions placed to delimit the river banks were erected already in the 1st century BC (Lonardi 2013), while the administration of the public aqueducts of Rome has been usefully described by the *curator* S. Iulius Frontinus at the very end of the 1st century AD in his *De aquae ductu Urbis Romae* (Bruun 1991). The administration of water, either in an urban or in a rural context is frequently mentioned by municipal texts for the reason that the resource belongs to the community: see in particular the *Lex Coloniae Genetivae*, §72, §79-80, §99-100, §104 (*CIL* 2. 1022), but also the *Lex Flavia Irnitana*, Cap. 19; 82-83; 96 (*AE* 1984. 454) and the *Lex Tarentina*, Coll. I, ll. 39-42 (*CIL* 1². 590) for mentions of the municipal hydraulic infrastructures.

⁴ More references on recent studies of navigation canals in Salomon et al. (2016). See also Salomon et al. (eds) (2014) and Salomon et al. in this volume.

among other things with the management of water resources⁵. Handling these texts, however, requires sensitivity, not only to the particular intellectual context in which juristic discussions took place, but also when considering the complexity of law in practice in the ancient world, which was characterised by a form of legal pluralism (especially in the Roman provinces)

As one of the foundations of the city's civil law, the writings of the classical Roman jurists have been studied intensely by Romanists for many centuries, though principally from a legal perspective. In a review article published in 1986, F. MILLAR observed that:

“...legal writers, so central both to the character of Roman culture and (obviously enough) to the 'legacy of Rome', have attracted extraordinarily little attention from Classicists, from students of Roman historiography or even from ancient historians, for whom this gigantic body of material represents, or ought to represent, an almost inexhaustible treasure-house of economic and social history, and of ideologies, conceptions and attitudes. What proportion of the total of surviving Classical Latin prose is represented by the million-odd words of the Digest, the earlier rescripts of the Codex Justinianus, the other remains of pre-Justinianic legal writing, and by the key text of them all, Gaius' Institutes?” (Millar 1986, p. 272).

The approximate answer to this question, posed before the advent of digitisation, is that juristic writings comprise about 11–12 percent of the extant corpus of classical Latin literature through to the end of the Severan period, and an even greater proportion if the search is limited to Latin prose.⁶ In addition to this, Ulpian (early third century CE), of whose writings about 300,000 words have been preserved, is only outstripped by Cicero (c. 1 million words) and Livy (c. 500,000 words) in terms of the volume of material that has survived of their works⁷. Though it is certainly the case that, since the 1980s, classical juristic texts have attracted greater attention outside of law schools, not least from those interested in the relationship between law, society, and economy in the Roman world, the ‘treasure-house’ remains far from exhausted (Du Plessis et al. 2016; Dari-Mattiacci and Kehoe 2020)⁸. One of the central aims in organising this conference was therefore to promote the interpretation of this evidence alongside more familiar sources, as a way of approaching the activities central to ancient life from a multiplicity of different perspectives⁹.

⁵ For a collection of the relevant texts in translation, see Ware (1905).

⁶ The Perseus Digital Library's collection of Greek and Roman materials contains c. 10.5 million words in Latin, excluding the texts of the *corpus iuris civilis* but including a number of other non-classical (and even non-Roman) works (e.g., the works of St. Augustine, St. Jerome, the Venerable Bede, the Latin Vulgate, etc.). The Thesaurus Linguae Latinae (TLL), on the other hand, which provides a lexicographical slip for each occurrence of a word in the classical texts, suggests an upper bound of about 10 million words. The Packard Humanities Institute CD ROM of Latin, which is fairly comprehensive through 200 CE and contains some later materials, including legal writings authored by the Severan jurists (e.g., Ulpianus, Paulus, etc.), contains some 7.5 million words. If J.H. DEE is right that the surviving mass of Latin literature from the classical period amounts to ‘no more than 9,000,000 words’, then a reasonable estimate for the proportion contained in juristic works suggests a figure of c. 11–12 per cent (Dee 2002, p. 59; also, Bamman and Smith 2012, p. 2).

⁷ We are indebted to Dr. A.J. SILLETT at St Hilda's College, Oxford, for his estimate of the number of words that survives of the texts of Cicero (c. 400,000 of speeches, about the same again of philosophical and rhetorical works, and some 275,000 words in the Letters, though recalling that many of these were written to, rather than by, Cicero).

⁸ More particular studies include those by Bruce Frier and Luigi Capogrossi Colognesi (Frier 1980; Capogrossi Colognesi 2009), but also more recent publications (Saliou 1994; Kehoe 2007; Bannon 2009; Dubouloz 2011; Jakab 2014).

⁹ Recent years have seen a real movement towards a greater integration of the ancient sources, including texts of the Roman jurisprudence, through international research projects (“REDHIS”, ERC 2014-2020 <http://redhis.unipv.it/> headed by Dario Mantovani, or “Law, Governance and Space: Questioning the

In this regard, the topic of water and waterways offers promising avenues of research. Water continuously moves above and beneath ground. The benefits it provides and the problems it can pose are experienced in a wide range of human activities. In addition, different uses and needs generate different perceptions of the resource itself. A fisherman's perception will differ from a boatman's, a peasant's from a craftsman's, because they make different, and sometimes competing, uses of it. They do not necessarily need it at the same moment or in the same season. Some use it as a resource (e.g., for irrigation, leisure and industry), others as an environment for navigation and fishing. At the same time, one person's activities could interfere with those of the others, generating competing interests and potentially conflict between them. In each case, solutions had to be developed at a technical, social, and legal level.

The first contribution to this journal issue focuses upon the Roman *suburbium*, which well epitomises the crossroad of economic and social interests in the context of water use. However loosely delimited the area is for us, it is noted for its very dense human occupation by both living and dead, and for being an environment where the pressure on the natural resources was high (Goodman 2007). Land and water make no exception in this regard, due to the needs for housing and proximity of the urban market, on the one hand, and to the recreational uses of water and intensification of agriculture, on the other. In this specific context, CYNTHIA J. BANNON argues that a series of 1st and 2nd c. AD epitaphs show that legal rights to conduct water to tomb gardens could be economically valued, whether it came from a private plot (servitude) or from the public hydraulic network (concession). If funerary rituals required a certain amount of water, as well as the display of fountains and basins in the most luxurious resting places, the mention of water rights in language familiar to Roman private law shows that sizeable plots could also be commercially farmed.

Bannon's contribution also raises important questions concerning the interpretation of legal language in different evidential contexts. While juridical language in epitaphs is relatively common, it does not always correspond to the position set out in the legal sources. In some cases, the use of legal terminology probably aimed at impressing passers-by as well as potential litigants. The understanding of private law among Romans was likely as diverse and uneven as it is among citizens today, making the interpretation of legal terms in private inscriptions a delicate matter. In cases like those presented by Bannon, the use of legal language must be understood in the context of a discourse between the author of the text and its readers.

Turning inward toward the city centre, the model of the "consumer city" has long held an important place in the conception of ancient urban development¹⁰. This view is discussed and challenged by ELENA SÁNCHEZ LÓPEZ who examines the profusion and large range of productive activities in Roman towns. The current re-evaluation of cities as centres of production also provides scope for a reappraisal of the use of natural resources in this context¹¹. In this regard, questions remain concerning the large number of urban workshops

Foundations of the Republican Tradition", ERC 2018-2024 <https://www2.helsinki.fi/en/researchgroups/law-governance-and-space> headed by Kaius Tuori), and publications (for example Maganzani and Buzzachi 2014; Du Plessis et al. 2016; Tuori 2016).

¹⁰ The ideal-type of the « consumer city » was developed by Max Weber (Weber 2000), and reactivated by Moses Finley in two highly influential pieces (Finley 1973, 1977). The model is now very debated (Erdkamp 2001). Particularly interesting for our discussion is a reassessment of the distribution of hydraulic resources between rural and urban communities (Wilson 1999; Gazenbeek 2000; Ronin 2020, pp. 238–239).

¹¹ On this re-evaluation, see for example Monteix (2010).

that needed water, sometimes in significant quantities. Indeed, both the construction sector and the manufacturing of everyday items, such as pots, clothes, leather or metal artefacts, required significant amounts of water. Insights into the way in which workshops met this challenge are provided not only by the archaeological evidence, but also by rental contracts preserved in the Graeco-Egyptian papyri.

Though it has been rightly pointed out that such workshops could use private and self-sufficient supply systems, like wells or rainwater reservoirs, archaeologists also suspect that connection to urban aqueducts was a solution favoured by many workshops, as appears to have been the case in Pompeii. Concessions from the public distribution network have long been associated with the *luxuria* of private homes, where gardens were adorned by refreshing fountains and brooks (Dessales 2013). Texts from the *Digest*, however, along with later imperial constitutions and Frontinus' treatise on the administration of Rome's public aqueducts all refer to such concessions being granted for *privati usus*, an expression that includes workshops and business premises. Such cross-reading of the legal and archaeological documentation clearly demonstrates that the water derived from the public network was used in workspaces and that both the role of public aqueducts and the amount of water required by productive businesses must be re-evaluated from this perspective.

It is perhaps because aqueducts were prominently associated with the supposed *luxuria* of urban life, in the reconstructed model of a consumer city, that the usefulness of public distribution networks has frequently been questioned. CARLOTTA FRANCESCHELLI argues that archaeology can help nourish this debate, by considering every element of the water supply system in the urban space. The argument is made out by carefully weighing the archaeological remains, in the Italian city of Ostra in the Marches, against the legal documentation. In this *municipium* of the *Ager Gallicus*, different sources of water were used in complementarity. While the city could advantageously tap into the shallow water table, it is also assumed that a public aqueduct (not yet uncovered) was fed by the aquifers of the Apennine ridge, and by springs on the nearby valley slopes, admittedly with seasonal variations. A specific feature of the hydraulic network of Ostra, however, is the large circular reservoir thought to have collected the wastewater from the nearby baths. Wastewater could in turn be utilised by artisanal activities that did not require clean water. Franceschelli suggests that this form of recycling could be correlated with the "*aqua caduca*" mentioned by municipal laws in Rome and in Spain, and whose legal status is not yet established. Such a system of water recovery must be replaced within the general observation, made elsewhere in the Roman world, that the construction of urban aqueducts was less related to a demographic surge than to a change of lifestyle, illustrated by sanitation infrastructures, the comfort and pleasures associated with large baths complexes and running water available in the public fountains.

The exploitation of water as a natural resource has both a geographical dimension, that can be the city as a whole, or a portion of it, like the peri-urban necropolises, and a temporal dimension, firstly because water is continually running, but also because it is very likely that its availability was in many cases seasonal. Though an important factor in the context of a resource in constant motion, the temporal dimension leaves little trace in the archaeological remains. As COSIMA MÖLLER shows, however, legal texts are very informative on this particular aspect of water management.

As we know from inscriptions related to so-called "irrigation communities", but also from the *Digest*, time was used as a unit to share a same source of water between different

users, and generally to solve distribution problems in case of pressure on resources¹². Time also matters from the point of view of legal rights to draw water, since continuity is a necessary condition for exercising such a right and non-use leads to the loss of it. On the other hand, despite a long-lasting controversy between Roman jurists, the use of water from a neighbouring plot could be legally protected after a certain period of time, even though it had not been rightfully granted. In both cases, juridical texts show how continuity, from a legal perspective, refers to a right to continuously use the water, more than as an actual use of it. Roman law therefore protected the opportunity to exercise a right, as much as it protected the right itself, something that cannot be detected through archaeological investigation but that can help us to better understand the functioning of hydraulic structures¹³.

If the exploitation of water resources could generate conflicts, waterways also generated opportunities for competition. Firstly, they could be used as reservoirs, from which water would be drawn by water-lifting machines or conducted by artificial canals. Then, they could also be used not only as a source of waterfowl or fish but probably more crucially for the ancient economy, as an essential channel of communication and trade. All these aspects had to be managed with a delicate balance between opportunities and risks, whether it be prolonged low-water periods or rising floods. Fluvial dynamics also proved to be a challenge wherever estuary areas were the place of intense trading activities. Silting could hamper navigation, and in some cases slow down trade. For economic, but also social and even political reasons, like in the case of Rome itself, which relied greatly upon imports to feed its population, solutions had to be developed both at the technological and legal level.

Due to their strategic and economic importance, rivers were also the object of much attention. As M. J. CASTILLO PASCUAL argues, their navigability, in particular, was a determining factor of the trade relations between newly-conquered regions and Rome, and therefore of the organisation of such territories, their network of roads, the location of their urban centres and even their administrative divisions. The river Baetis (modern-day Guadalquivir) proves, however, to be a complicated case study. Not only did its watercourse change a lot through time, particularly at its estuary due to silting, but its alluvial plain also experienced heavy anthropisation over a long and continuous period of time, leading to major transformations in the landscape. Today's river course offers therefore only very limited help in reconstructing the ancient route. To address this shortcoming, Castillo Pascual argues that the layout of the *Via Augusta*, fairly well-documented for parts of its route, provides valuable information with which to reconstruct the course of the ancient river. Based on examples in other parts of the peninsula, the author suggests that the road was complementary to the river. Using literary texts in combination with the results of geoarchaeological studies and the location of settlements and pottery workshops thought to have been situated along the waterway, Castillo Pascual proposes a reconstruction of the most controversial stretches of the river and the conditions of its navigability. Castillo Pascual's conclusion is that the estuary area of Roman Baetica was organised so as to overcome the natural obstacles thrown up by the fluvial dynamics of the region, by creating a road and river communication axis, principally for economic reasons.

¹² In irrigation communities, time slots are frequently used to assign their share of water to each member. It is the case of the community of Lamasba in Numidia, in the first part of the 3rd c. AD (*CIL* 8. 4440), but also in many contemporary anthropological examples (Wateau 2002).

¹³ For example the cisterns of the Tiber valley, for which it has been proposed that they were connected to servitude rights (Thomas and Wilson 1994; Wilson 2008).

Agricultural and mining products were indeed fundamental assets of the province. The foundation of colonies arguably had a similar geostrategic dimension, whereas it has traditionally been regarded as a demonstration of strength. It is thus argued that the *Colonia Iulia Romula Hispalis*, founded by Julius Caesar, was conceived as a hub of road and river communications. The example of the Baetis therefore appropriately illustrates the solutions deployed to mitigate the effects of a fast-changing fluvial landscape, at the level of a province. It interestingly complements our knowledge of such risk management measures at the individual level, where private riparian property owners could resort to the legal solution of alluvion to remedy the threat posed by fluvial instability, which doctrine was developed by jurists and applied by land surveyors (Masi Doria 2004; Chouquer 2008).

Geoarchaeology enables us to better understand the influence of sedimentological and geomorphological river dynamics on harbour infrastructures and on the urban fabric of harbour cities. However, geoarchaeological studies on fluvial risk have so far been mostly focused on floods and adjustments to water levels, and much less on lateral mobility (*i.e.* width changes and lateral migrations of the river bed), whereas ancient texts show that this issue was well-known in the Roman world¹⁴. On this theme, SALOMON ET AL. demonstrate that the orientation of archaeological structures in the port cities of Ostia and Portus was dependent on the river channels and the man-made canals serving the estuary area, although in different ways. While Ostia's history dates back at least to mid-republican Rome, the colony always had to adapt and adjust to the high sedimentation rate in the estuary area. At the beginning of the 2nd c. AD, the expansion of Portus was planned in anticipation of fluvial sedimentation. Study of the core deposits and analysis of the orientation of the archaeological features show how town-planning and building in Ostia were affected by sediment deposition and lateral mobility of the river channel. The evolution of the city of Ostia can only be understood against the backdrop of its fluvial context, and the same can be said about the relationship between the two city-harbours: the design of the waterways system at Portus drew upon the experience of silting, flooding, and riverbed mobility at Ostia.

This study, and others conducted by the same team, is crucial to understanding literary texts dealing with the silting of the Tiber mouth, the difficulties posed by the construction of a harbour in Ostia and of the network of canals, roads, and towpaths¹⁵. More strikingly, the results presented here plainly show the engineering efforts, as well as the investment in work and capital, made by Roman authorities in the Portus-Ostia area, to address the risk and to continue operating ports that were key to importing goods to the capital city at the lowest transportation costs possible.

Because fluvial transport was the most cost-effective means of transport for goods, navigability was a defining aspect of rivers. It could however often clash with other compelling needs, like the access to the banks and towpaths, or the possibility to get water for the irrigation of riverside cultivation areas, which were many around large urban centres. Roman jurists fully took into account this plurality of interests, and the texts from the *Digest* show that water was not only considered as a natural resource, but as an environment too. LAURETTA MAGANZANI therefore reminds us that river management carefully addressed the

¹⁴ This can be observed not only in the jurisprudential literature and in the *Corpus agrimensorum*, but on land registries too. See the annex in Chouquer (2008, pp. 180–183).

¹⁵ Strabo (*Geographica* 5.3.5) disagrees with Dionysius of Halicarnassus (*Ant. Rom.* 3.44) about the issue of the silting. The difficulties posed by the construction of a harbour in Ostia were however apparently such a commonplace subject that it was used as an exercise for orators by Quintilian (*Inst.* 3.8.16; see also Suet., *Claud.* 20). Finally on the existence of the two harbours and the network of canals, see Pliny the Younger (*Ep.* 8.17).

fact that waterways could simultaneously constitute a valued resource and a major risk to human activity. Focusing on the *actio aquae pluviae arcendae* (action to ward off rainwater) Manganzani argues that this action could be used to prevent possible damage caused by overflowing rivers.

The economic importance of rivers, together with the variety of issues at stake, explains the number and diversity of legal rules applicable to their management. Whether it was necessary to develop solutions to address shortage and periods of low water, or floods, waterlogging, and fluvial mobility, legal remedies also went some way to addressing the risk. Risk results from the combination of a natural hazard, like a river overflowing, with the vulnerability of human assets, *i.e.* activities developed on the banks (Burton et al. 1978; Beck 1986; more specifically on flood and fluvial risks, see Vinet 2017a, b; Reghezza-Zitt 2019). The hazard becomes a disaster when the risk is being realised. Although there is nothing certain in the magnitude and frequency of a natural disaster, the exposed population is nevertheless able to evaluate the possibility that it might occur at some point. Similarly, legal solutions are developed to settle conflicts no one can know for sure with what frequency and magnitude they will break out. However, those concerned know from experience it is most likely that they will. Legal solutions, like risk management measures, are based not on the prediction of a damage (when, where and how it will happen), but on its anticipation. In this context, legal solutions can be understood as elements of the set of solutions available to communities and individuals to manage and mitigate the risk, alongside technological or social responses. That the Roman jurisprudence was developed in some ways to address natural risks is confirmed by the number of dispositions that could be applied, not only as a remedy or as a compensation for a harm done, but in anticipation of this damage, like the *actio aquae pluviae arcendae*.

The approach of past societies to water resource management, particularly in the archaeologically rich Roman context, has become a focal point for historical research. In many respects, the challenges facing the ancients were similar to those facing modern societies today. The solutions that the Romans developed, ranging from technical interventions into the natural environment, to social accommodations and the development of a legal framework, combined to produce a working system capable of meeting these challenges and to accommodate different uses of water, Roman and indigenous (Wilson 2012 ; Leone 2012). As the contributions collected in this volume show, a full appreciation of the Roman's approach to water resource management is only possible through a dedicated interdisciplinary approach, capable of explaining how interventions of different kinds reached a high degree of sophistication in their systemic interrelation.

Bibliography

Bamman D, Smith D (2012) Extracting Two Thousand Years of Latin from a Million Book Library. *J Comput Cult Herit* 5:1–13

Bannon CJ (2009) *Gardens and Neighbors: Private Water Rights in Roman Italy*. University of Michigan Press, Ann Arbor

- Beck U (1986) *Risikogesellschaft: auf dem Weg in eine andere Moderne*. Suhrkamp, Frankfurt am Main
- Bruun C (1991) *The Water Supply of Ancient Rome: a Study of Roman Imperial Administration*. The Finnish Society of Sciences and Letters, Helsinki
- Burton I, Kates RW, White GF (1978) *The environment as Hazard*. Oxford University Press, New York
- Capogrossi Colognesi L (2009) *Storia di Roma tra diritto e potere*. Il Mulino, Bologne
- Chouquer G (2008) L'eau productrice d'héritages : l'exemple de la jurisprudence antique sur l'alluvion. In: Guimier-Sorbets A-M (ed) *L'eau : enjeux, usages et représentations*. Actes du quatrième colloque de la Maison René-Ginouvès, 6-8 juin 2007. De Boccard, Paris, pp 171–183
- Dari-Mattiacci G, Kehoe DP (eds) (2020) *Roman Law and Economics*. Oxford University Press, Oxford
- Dee JH (2002) The First Downloadable Word-Frequency Database for Classical and Medieval Latin. *Class J* 98:59–67
- Dessales H (2013) *Le partage de l'eau : fontaines et distribution hydraulique dans l'habitat urbain de l'Italie romaine*. École Française de Rome, Rome
- Du Plessis PJ, Ando C, Tuori K (eds) (2016) *The Oxford Handbook of Roman Law and Society*. OUP, Oxford
- Dubouloz J (2011) *La propriété immobilière à Rome et en Italie, I^{er}-V^e siècles : organisation et transmission des *praedia urbana**. École française de Rome, Rome
- Erdkamp P (2001) Beyond the Limits of the Consumer City. A Model of the Urban and Rural Economy in the Roman World. *Hist* 50/3:332–356
- Finley M (1977) The Ancient City: From Fustel de Coulanges to Max Weber and Beyond. *Comp Stud Soc Hist* 19:305–327.
- Finley MI (1973) *The Ancient Economy*. University of California Press, Berkeley
- Frier BW (1980) *Landlords and Tenants in Imperial Rome*. Princeton University Press, Princeton
- Gazenbeek M (2000) Interaction entre aqueduc et habitat rural. Deux cas d'étude en France méditerranéenne : Nîmes et Arles. In: Jansen GCM (ed) *Cura Aquarum in Sicilia*. Proceedings of the Tenth International Congress on the History of Water Management and Hydraulic Engineering in the Mediterranean Region, Syracuse, May 16-22, 1998. Stichting Bulletin Antieke Beschaving, Leiden, pp 225–230
- Goiran J-P, Salomon F, Mazzini I, et al (2014) Geoarchaeology Confirms Location of the Ancient Harbour Basin of Ostia (Italy). *J Archaeol Sci* 41:389–398.

- Goodman PJ (2007) *The Roman city and its periphery: from Rome to Gaul*. Routledge, London
- Jakab É (2014) *Risikomanagement beim Weinkauf: Periculum und Praxis im Imperium Romanum*. C.H.Beck, Munich
- Kehoe DP (2007) *Law and Rural Economy in the Roman Empire*. University of Michigan press, Ann Arbor
- Leone A (2012) Water Management in Late Antique North Africa: Agricultural Irrigation. *Water History* 4/1: 119-133
- Lonardi A (2013) *La cura riparum et alvei Tiberis: storiografia, prosopografia e fonti epigrafiche*. Archaeopress, Oxford
- Maganzani L, Buzzachi C (eds) (2014) *Lex Rivi Hiberiensis*. Diritto e tecnica in una comunità di irrigazione della Spagna romana. Giornate di studio in ricordo di Giorgio Luraschi, 2-3 juillet 2012. Jovene Editore, Naples
- Masi Doria C (2004) Droit et nature : *inundatio, mutatio alvei et interitus rei*. Un cas entre *ius romanorum* et tradition de droit Romain. In: Clavel-Lévêque M, Hermon E (eds) *Espaces intégrés et ressources naturelles dans l'empire romain*. Actes du colloque de l'Université de Laval, Québec (5-8 mars 2003). Presses universitaires de Franche-Comté, Besançon, pp 201–218
- Millar F (1986) A New Approach to the Roman Jurists. *J Roman Stud* 76:272–280
- Monteix N (2010) *Les lieux de métier. Boutiques et ateliers d'Herculanum*. École Française de Rome, Rome
- Pleuger E, Goiran J-Ph, Mazzini I, et al (2019) Palaeogeographical and Palaeoenvironmental Reconstruction of the Medjerda Delta (Tunisia) during the Holocene. *Quat Sci Rev* 220:263–278.
- Reghezza-Zitt M (2019) Gestion de crise et incertitude(s) ou comment planifier le hors-cadre et l'inimaginable. Application aux crises résultant de crues majeures en Île-de-France. *Ann Géographie* 726:5–30
- Ronin M (2020) Funding Irrigation. Between Individual and Collective Investments. In: Erdkamp P, Verboven K, Zuiderhoek A (eds) *Capital, Investment and Innovation in the Roman World*. Oxford University Press, Oxford Studies on the Roman Economy, Oxford, pp 225–251
- Saliou C (1994) *Les lois des bâtiments : voisinage et habitat urbain dans l'Empire romain*. Recherches sur les rapports entre le droit et la construction privée, du siècle d'Auguste au siècle de Justinien. IFAPO, Beyrouth
- Salomon F, Purdue L, Goiran J-P, and Berger J-F (ed) *Roman Canals Studies*. Special issue *Water History* 6/1, 2014

- Salomon F, Keay S, Goiran J-P, et al (2016) Connecting Portus with Ostia : preliminary results of a geoarchaeological study of the navigable canal on the Isola Sacra. In: Les ports dans l'espace méditerranéen antique. Narbonne et les systèmes portuaires fluvio-lagunaires. Rev Archéologique Narbonnaise Supplément 44:293–304
- Sürmelihiindi G (2018) Palaeo-Environmental Condition Factor on the Diffusion of Ancient Water Technologies. In: Berking J (ed) Water Management in Ancient Civilizations. Edition Topoi, Berlin, pp 43–69
- Thomas R, Wilson A (1994) Water Supply for Roman Farms in Latium and South Etruria. PBSR 62:139–196
- Tuori K (2016) The Emperor of Law. The Emergence of Roman Imperial Adjudication. Oxford University Press, Oxford, New York
- Vinet F (2017a) Floods 1. Risk Knowledge. ISTE Press, London
- Vinet F (2017b) Floods 2. Risk Management. ISTE Press, London
- Ware EF (1905) Roman Water Law. Translated from the Pandects of Justinian. West Publishing, St. Paul, Minn.
- Wateau F (2002) Partager l'eau : irrigation et conflits au nord-ouest du Portugal. CNRS Éditions - Éditions de la Maison des sciences de l'homme, Paris
- Weber M (2000) Wirtschaft und Gesellschaft: die Wirtschaft und die gesellschaftlichen Ordnungen und Mächte. Nachlaß. Teilband 5, Die Stadt (First Edition: 1921). Mohr, Tübingen
- Willi A (2021) Irrigation in Roman Western Europe. Papierflieger Verlag, Schriften der Deutsche Wasserhistorische Gesellschaft, Sonderband 17, Siegburg
- Wilson A (1999) Deliveries *extra urbem*: Aqueducts and the Countryside. JRA 12:314–332
- Wilson A (2012) Water, Power and Culture in the Roman and Byzantine Worlds: an Introduction. Water History 4/1: 1-9
- Wilson A (2008) Villas, Horticulture and Irrigation Infrastructure in the Tiber Valley. In: Coarelli F, Patterson H (eds) Mercator Placidissimus. The Tiber Valley in Antiquity : New Research in the Upper and Middle River Valley. Edizioni Quasar, Rome, pp 731–768