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Title

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Abstract

This paper seeks to address the variety of responses to natural risks in the Roman world. Relying on geographical concepts, it shows that the management of natural risks depended on the identification of human activities as agents of the risk. It is argued that the answers provided indicate that ancient communities were well aware that they were exposing themselves to hazards in many ways, and reflect the understanding of human enterprises and activities' impact in increasing the risk. It is also argued that this perception enabled to act upon the human components of the risk, which are more easily manageable than the natural hazard itself. This study finally makes a case for the exploitation of the legal texts in Roman history. It is shown that the legal dispositions were developed as effective tools to manage the risk at the individual level of private property, because they aim at controlling human enterprises and at reconciling competing private and public interests.

Keywords

Roman law – natural risks – drainage – flood – earthquakes – rivers – terraced landscape

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1. Introduction

Observing that the magnitude of natural disasters is not necessarily related to the importance of the human, social, or economic effects they generate, geographers and sociologists have pointed out that risks are not the product of nature alone but result from the combination of a natural hazard with the vulnerability of human activities and settlements¹. For instance, a major earthquake in a deserted area will cause little damage, while a less powerful event occurring in a very populated area can be devastating. In some cases, human practices may increase the risks too. We know that clearance and cultivation on the riverbanks, for example, increase the risk of floods. Additionally, not every person, group, or society faces a natural hazard with the same resources, because natural disasters are in fact shaped by human social and economic patterns of production and land-

¹ Burton, Kates, and White 1978; Beck 1986, with a focus on the distribution of risks specific to the industrial and post-industrial world. Blaikie et al. 2004 say for their part that they seek to 'reintroduce the "human factor" into disaster studies'.

exploitation². Indeed, the vulnerability of a given group necessarily depends on a variety of elements, such as the exposure of assets or the adaptive capacity of a human system. Social and economic disparities play a key role in the way a community faces a natural disaster³. For that reason, it is crucial to our understanding of inequality in the Roman Empire to examine both how ancient communities perceived natural risks and how they could respond to them⁴.

The starting point of this investigation lies in the observation that the texts of Roman private law display a considerable number of rules and dispositions concerning floods, whereas other types of natural risks, like earthquakes, do not appear in the same documentation but tend instead to receive different answers. How do we explain the variety of answers to natural risks? How do these answers relate to the ancient understanding of natural risks, of the perception of vulnerability and of the awareness of human activities' impact?

The modern geographical concept of "risk" helps us to understand the ancient perception of natural disaster: it prompts us to investigate to what extent ancient societies were aware, not only of the direct causes (*i.e.* the natural phenomenon), but also of indirect causes (*i.e.* the human activities that can increase the effects of the phenomenon). Understanding this distinction is crucial because it makes it possible to deploy solutions focused on human activities, which are easier to handle than a natural event, and, most importantly, are subject to regulation and control. It has rightly been argued recently that preventive measures to control urban or natural risks were effectively implemented in the Roman world⁵. However, while rites of expiation, construction techniques and pieces of imperial legislation have clearly been identified as attempts deployed to manage the risks, legal solutions have so far been underestimated. Cross-read with other types of evidence, the texts of the private Roman law can nonetheless help us estimate the ancient awareness of different elements that lead to a natural disaster, from Italy to Asia, between the 2nd c. BC and the 3rd c. AD. I will argue that the reason why floods received so much attention from the jurists is because the Romans had well identified what the modern geographers call the "vulnerability" linked to human settlements, in the case of flood risks, and that jurists contributed to develop tools to reduce that vulnerability. On the other hand, that was not the case with seismic risks.

2. The management of earthquake risks

In antiquity, earthquakes were chiefly explained by divine interventions⁶. Although supernatural explanation was accepted amongst different social classes of ancient societies,

² On the cultural adaptation to the risk, see Burton, Kates, and White 1978: 34–49.

³ For a clear example in modern environmental history, see lately Kingsbury 2018.

⁴ A subject tackled from different viewpoint by Fachard et al. 2017. For a specific look at inequality from an ecological point of view, see Purcell 2017.

⁵ Deeg 2019: 204–210 *contra* Sonnabend 1999: 242. For an archaeological perspective see Allinne and Leveau 2002; Allinne, Galve, and Constante 2012.

⁶ Herodotus holds that the profanation of the temple of Poseidon by the Persians prompted the tsunami that destroyed their army while besieging Potidaea in 479 BC (Hdt. 8.129). The gods thus send signs to warn humans of such disasters as Pausanias recounts (Paus. *Achaia* 24.6). On seismic events as warning signs from the gods, see Thély 2020 Chap. 1, §17-19. It is also possible that Greek sanctuaries, particularly those with oracular functions, like Perachora Heraion, Delphi or Hierapolis, were specifically located astride seismic faults, because of the therapeutic role of groundwater and springs that active tectonic zones provide. See Stewart and Piccardi

our written sources demonstrate, however, that many of the educated elite were looking for more rational reasons⁷. Geological explanations mostly drew on Aristotle's theory that subterranean winds and flammable gas filled large underground caves, which was as misleading as it was authoritative⁸. Seneca and Pliny rightly distinguish, on the other hand, between primary and secondary waves⁹, and their propagation from the epicentre is described at different scales, from the very local to the regional extent¹⁰. Likewise, the episodes of aftershock have received ample attention¹¹. However, the understanding of geological phenomena was too low to lead to the development of a public policy intended to manage the seismic risk. The public action in fact mostly consisted in repairing the damages.

Contrary to what is sometimes claimed, there is indeed no strong evidence for the existence of a prevention policy. It is true that literary texts refer to a few pieces of regulations limiting the buildings' height, but it is questionable if the fragments often quoted intend to address seismic risks at all. Firstly, these limitations may be linked with sumptuary laws and attempts to restrain luxury and self-assertion in the last centuries of the Republic. This is, for instance, presumably the case of the *Oratio Rutilii de modo aedificiorum* that Augustus read in front of the Senate¹². Secondly, it seems that the limitation of urban constructions' height was stimulated by risks much more frequent than earthquakes which were, above all, the fires and collapses caused by the bad quality of the constructions, mostly driven by property speculation¹³. It is obviously these risks that Strabo refers to when he reports the decision taken by Augustus to limit the buildings' height to 20m (70 ft) in Rome.

Strabo, *Geographica*, 5.3.7. ἐπεμελήθη μὲν οὖν ὁ Σεβαστὸς Καῖσαρ τῶν τοιούτων ἐλαττωμάτων τῆς πόλεως, πρὸς μὲν τὰς ἐμπρήσεις συντάξας στρατιωτικὸν ἐκ τῶν ἀπελευθερωτῶν τὸ βοηθῆσον, πρὸς δὲ τὰς συμπτώσεις τὰ ὕψη τῶν καινῶν οἰκοδομημάτων καθελών, καὶ κωλύσας ἐξαιρῆσαι ποδῶν ἑβδομήκοντα τὸ πρὸς ταῖς ὁδοῖς ταῖς δημοσίαις.

Now Augustus Caesar concerned himself about such impairments of the city, organising for protection against fires a militia composed of freedmen, whose duty it was to render assistance, and also to provide against collapses, reducing the heights of the new buildings and forbidding that any structure on the public streets should rise as high as seventy feet. (Text and transl. Loeb Classical Library, Jones, 1931)

2017. Dora Crouch has observed that Greek sanctuaries were purposefully centred on natural springs: Crouch 1993: 115. More generally on religious ideas dominating Roman explanations of disasters, up to the Christian era: Toner 2013: 72–86.

⁷ On the potential social differences between the two attitudes of superstition and rationalisation, without a strict social divide between them, see Toner 2013: 67–76. For a further discussion on the association between individual behaviours (of cities, of emperors...) and natural disasters, see Borsch 2018: 130–133, 195–197.

⁸ Arist. *Mete.* 2.8.

⁹ Sen. *QNat.* 6.31.3; 6.21.2. See also Plin. *HN* 2, 82, 194.

¹⁰ Sen. *QNat.* 6. 25. 3-4; 6.6.3

¹¹ Arist. *Mete.* 2.8.367b. For a more comprehensive account of the ancient descriptions of seismic events and of the determination of their physical causes, see Bousquet 2006; Thély 2020, chap. 2. Jerry Toner also provides a useful account of ancient explanations for geological events, ranging from the action of the gods and the influence of planets on human affairs, to a “combination of logic, intuition and experience”, stressing that class difference played a significant role in the kind of explanations favoured by the Romans (Toner 2013: 67–72).

¹² Suet. *Aug.* 89.2. It is, however, not certain whether this discourse aimed at limiting the decoration of a private property or at limiting its height. P. Rutilius Rufus was perhaps an aedile of 111 BC. See Saliou 1994: 211.

¹³ On this speculation and on the particular role that fire and collapse of buildings played in the activity of speculators, see Plut. *Vit. Crass.* 2.5.

This piece is extracted from the description about the wealth of raw materials available to the Romans for the development of their city. The impairments (τῶν τοιούτων ἐλαττωμάτων τῆς πόλεως), mentioned here by Strabo, refer to his notice, earlier in the paragraph, of the recurring fires and collapses sometimes caused by property speculation (αἱ συμπτώσεις καὶ ἐμπρήσεις καὶ μεταπράσεις). Concerned by these problems, Augustus reorganised the firefighting force in 7 BC, probably after a case of arson¹⁴. The decision to limit buildings' height was presumably taken at the same moment, in order to reduce the risks in case of a fire or of a collapse. Some sixty-seven years later, the example of Nero shows that limiting the size of urban constructions, far from being part of a policy to manage the seismic risk, was actually the usual action taken by the public authorities after a major fire. In 64, Tacitus recalls that the reconstruction programme decided by the emperor addressed the fire risk by combining open spaces, to slow the spread of flames, with restrictions to the buildings' height, to minimise the damage in case of a collapse¹⁵. Imperial action, however, seems to have been regularly driven by self-interested reasons, which means that those in position to return a favour were most likely to benefit from the emperors' help¹⁶.

Late evidence associates more explicitly a public policy limiting houses' height with a seismic episode, but the ambiguity of the text prevents considering it as a positive confirmation of a public seismic risk management. The anonymous *Epitome de Caesaribus*, composed in the early years of the 5th c. AD, lists a series of disasters occurred under the reign of Trajan: a major flood of the Tiber, an earthquake felt in several provinces, a plague, famines and fires. In response, the emperor is said to have applied the usual remedy of limiting houses' height, this time to 60 feet (18m)¹⁷. The mention of the earthquake can be related to the episode described in the *De Caesaribus*, used as a source by the anonymous author of the *Epitome*, and written by Aurelius Victor about fifty years earlier¹⁸. It is stated that, at the time

¹⁴ The date is given by Cass. Dio 55.8.6-7, who mentions the στενωπάρχαι (*uicorum magistri*) chosen in each *uicus* of Rome, often amongst the freedmen, to control the slaves previously placed under the aediles' authority to fight fires. It is only in a second phase, described by Strabo when he refers to a militia of freedmen (ἀπελευθερωτοί), that the *cohortes vigilum*, constituted exclusively of freedmen were established in 6 BC. On that evolution, see Sablayrolles 1996: 24–37.

¹⁵ Tac. *Ann.* 15, 43: *Ceterum urbis quae domui supererant non, ut post Gallica incendia, nulla distinctione nec passim erecta, sed dimensis vicorum ordinibus et latis viarum spatiis cohibitaque aedificiorum altitudine ac patefactis areis additisque porticibus, quae frontem insularum protegerent* (In the capital, however, the districts spared by the palace were rebuilt, not, as after the Gallic fire, indiscriminately and piecemeal, but in measured lines of streets, with broad thoroughfares, buildings of restricted height, and open spaces, while colonnades were added as a protection to the front of the tenement-blocks). (Text and transl. Loeb Classical Library, Jackson, 1937)

¹⁶ Toner 2013: 53–55. This is also the opinion of Jones 2014, despite a long historiographical tradition that the Emperor's intervention was expected in case of a disaster (for a review of the literature, see Deeg 2019: 227–239).

¹⁷ *Epit. de Caes.* 13.12-13: 12. *Eo tempore, multo perniciosius quam sub Nerva, Tiberis inundavit magna clade aedium proximarum; et terrae motus gravis per provincias multas, atroxque pestilentia famesque et incendia facta sunt.* 13. *Quibus omnibus Traianus per exquisita remedia plurimum opitulatus est, statuens ne domorum altitudo sexaginta superaret pedes ob ruinas faciles et sumptus, si quando talia contingerent, exitiosos* (At that time, more destructively by far than under Nerva, the Tiber flooded with great devastation of close-by buildings; and there occurred a serious earthquake through many provinces and a dreadful plague and famines and fires. To all these things Trajan brought relief through remedies usually excellent, decreeing that the height of houses not exceed sixty feet on account of proneness to collapse and deadly expenses if ever things such as this should come to pass). (Text Les Belles Lettres, Festy, 1999; Transl. Canisius College Translated Texts, Banchich, 2018)

¹⁸ About the sources of the chapters 12 to 23 of the *Epitome*, see Festy 1999, p. xxiv-xxvii.

of this emperor, a quake indeed shook the earth “from Antioch to the eastern extremity of Syria” (*cum terrae motu gravi apud Antiochiam ceteraque Syriae extremis (sic) afficeretur*)¹⁹. It might very well be identified with the episode of the 13th December 115 that hit Antioch very hard while Trajan himself was there during his Parthian campaign²⁰. As for the other calamities listed by the *Epitome*, there is therefore no reason to doubt the reality of the earth tremor, especially in a region very much prone to seismic activity²¹. By contrast, the imperial response remains unclear.

Firstly, the text does not tell where exactly the decision of limiting the house height to 60 feet applied. It could be in Rome, where the flood happened, or in Syria which is presumably the region of the earthquake. Or it could have applied throughout the whole empire as we know was theoretically the case for imperial edicts, but the use of the word *statuens* is too imprecise to help us determine the type of imperial constitution referred to here²². The *Epitome* is indeed noted for its vagueness and frequent exaggeration²³. Secondly, it is not clear which of the different disasters listed was the decision precisely supposed to remedy. The text does not cast much light on that aspect: on the contrary, the plural *per exquisita remedia* implies that solutions were developed for all of them (*quibus omnibus*), but then only one is recalled. And this single solution cannot work for all the problems recorded, since it would not make much sense to limit the houses to 60 feet in response to risks of plague and famine. In the light of the two other texts, the possibility that the measure sought to address the seismic risk is therefore not very strong.

We must conclude that there is no obvious trace of seismic risk management in the public policy of the first half of the imperial period. Incidentally, it is possible that the limitation of buildings’ height played a role in case of an earthquake, but there is no positive indication that it was designed to manage this risk in particular²⁴. On the contrary, the public action against earthquakes mostly consisted in remedies rather than in prevention²⁵.

¹⁹ Aur. Vict. *Caes.* 13.11. The manuscript is faulty and should read “*Cum terrae motu gravi Antiochia ceteraque Syriae extrema afficerentur*” (Harless 1829: 267).

²⁰ Cass. Dio. 68.24-25

²¹ For the confirmation of the other events in the sources, see Sextus Aurelius Victor 1999: 106, n. 20 and 21.

²² About 40 years after the end of Trajan’s reign, Gaius draws distinctions between different types of imperial decisions (Gai. *Inst.* 1.5). In theory and by analogy with the Republican magistrates’ powers, imperial edicts applied across the emperor’s jurisdiction, *i.e.* the Empire. However, few imperial texts actually bear the label *edictum*. When they do, they rarely have a general scope, at least in the two first centuries of the imperial period: that’s the case with the *Edict of Augustus on the aqueduct at Venafrum*, which set rules for that particular facility (*CIL* 10, 4842), at a time (between 17 and 11 BC) when the nature of decreeing powers of the emperor were still being elaborated, but also of the *Edict of Domitian on veterans’ privileges* (88/89 AD), only addressed to the troops of the Tenth Fretensian Legion (Mitteis, *Chr.* p. 546-550, n. 463). Overall, it is not easy to find imperial texts addressing a general issue and applicable to the whole Empire before the *Constitutio Antoniniana* of 212.

²³ Pychlmayr 1911: IX-X; Festy 1999: L-LII. The reason of this general imprecision is that the work mainly aims at bringing to light the benevolence and magnanimity of certain emperors, only to discredit others.

²⁴ It must be noticed that, when imperial constitutions and private laws mention such height limit, they refer to the *ius ne luminibus officiator* and to the *servitutes altius tollendi aut non altius tollendi*. See for instance *Cod. Iust.* 8.10.1 on a rescript by Marcus Aurelius and Verus, or *Cod. Iust.* 8.10.12.4 on a constitution by the Emperor Zeno, the latter being specifically related to the fire risk and the sea view. For a wider discussion of these texts, see Saliou 1994: 189–228. On the *servitutes*, mentioned in D.8.2.1, D.8.2.2 or D.8.5.4, see Möller 2010: 130–158.

²⁵ Remedies provided by the imperial authorities in that regard are countless. They could consist in sending cash, but more frequently of tax rebates. See notably the example of Asia Minor in 17 AD (Tacitus *Ann.* 2.47; Suetonius *Tib.* 48.2; Cass. Dio 57.17.7-8). For a fine example of direct intervention, see *CIL* 10.1406 where Vespasian is said

Can we then find traces of seismic risk management practices in the private sphere? The most spontaneous action taken to be protected from such risk is to avoid building or living in seismic zones. Seneca thus reveals that many people fled from Campania after the earthquake of 62/63²⁶. This view is also conveyed by Tacitus: when several Asian cities competed to obtain the honour to build the regional temple to Tiberius, the people of Halicarnassus stressed that they did not suffer from any seismic event in twelve centuries, thus making their city the most suitable site for the construction of the edifice²⁷.

Technical and literary texts furthermore reveal a clear awareness of buildings' vulnerability, and a search for solutions²⁸. Strabo points out that the knowledge of building techniques designed to resist to earthquakes was shared locally in regions regularly affected²⁹. Pliny the Elder also refers to the use of an anti-seismic technique in the construction of the temple of Artemis in Ephesus: he reports that it was built on marshland, so as to protect it from the tremors of earthquakes (which contradicts the view expressed by Tacitus), and that its foundations rested on a base of charcoal covered with wool³⁰.

It is clear that the knowledge of the density, properties and best use of stones, from lava to different types of tuff, was widespread³¹. Similarly, the importance of a building's foundations was well established. However, if these practices were obviously not ignored, the most recent work on construction techniques conducted by H el ene Dessales in Pompeii and the Vesuvian area shows that they probably improved after the earthquake of 62/63, and that seismic-resistant construction practices started to be more systematically applied from that date onwards. Dessales observes how brickworks and stoneworks alternate for architectural purposes, how bricks help reinforce the quoins, and how terracotta flat tiles, cut in triangular shapes, are inserted in the masonry facings in order to hold together the rubble stone fills³². All these techniques were developed to give the walls as much solidity, and yet plasticity, as possible. The particular emphasis put on these technologies in the public and private buildings around Pompeii suggests that, in the early 60's, the colony constituted a regional centre of innovation for seismic resistant construction practices³³.

to have reconstructed a temple in Herculaneum. For other examples and an analysis of different attitudes after the disaster, see Bedon 2005. This sort of benefaction could also come from private individuals (*IGR* 3.739, with a German translation in Kokkinia 2000).

²⁶ Sen. *QNat.* 6.1.10

²⁷ Tac. *Ann.* 4.55

²⁸ Buildings' sensitivity to ageing is, for instance, well accounted for by Vitruvius who compares the respective qualities of mortar-based masonry walls (*caementum*) and of those made of bricks (*latericii*) in a discussion on their durability (*Vitr.* 2.8.8). See also Plin. *HN* 35.49.173 for a similar view on construction techniques.

²⁹ Strabo 12.8.18. The story takes place in the city of Philadelphia in Asia, in a region called Katakekaumene, situated between Lydia and Mysia.

³⁰ Plin. *HN* 36.21.95. The layer of charcoal in Ephesus has indeed been identified by archaeologists: Bammer 1993: 190–191. However surprising, the story could actually refer to a sort of base isolation system, known to protect a structure against earthquake forces in modern constructions, but also in some traditional seismic resistant techniques, notably in Japan (Nakahara et al. 2000). The text could be based on borrowings and adaptations from *Vitr. De arch.* 3.4.2; 5.12.6; 5.9.7.

³¹ Sonnabend 1999: 243–244. H el ene Dessales reviews the ancient technical literature on the subject in Dessales 2012: 473–474.

³² Plin. *HN* 2.197 explains that brick walls, vaults, door jambs and wall angles are the strongest points of a building.

³³ Dessales 2011; Dessales 2014. The observations in Pompeii are also the results of an ongoing research by the RECAP project ("REConstruire APr es un s isme"), based at the AORoc Research Centre in Paris (<http://www.archeo.ens.fr/spip.php?article1220>).

This set of evidence shows that the buildings themselves were correctly identified as vulnerable, possibly increasing the seismic risk in earthquake prone areas. Indeed, even today construction engineering is one of the few potential aspects in which human societies can intervene to protect themselves against this risk³⁴. However, no texts surviving in the *Digest* suggest that these practices were translated into legal terms. Carefulness in the completion of a construction work was part of the builder's obligations and constituted the ground for his legal responsibility. It is expressed in the legal texts by words based on the same stem as *diligens*, or by the opposition between *peritia* and *imperitia*, but earthquake resistant construction practices never formed part of it.

Vitruvius points out that architects needed some legal knowledge to prevent owners from being sued in matters regarding water drainage or common walls, once the house was built³⁵. Contractual liability was indeed a feature of *locatio conductio*, a widespread type of contract, commonly used in building activity³⁶. Parties agreed on certain rights and duties and were liable in case they did not fulfil their obligations or did not fulfil them correctly. In the case of building contracts, the *conductor* had to complete the works, but had also to ensure that they were satisfactorily carried out³⁷. He therefore had to comply with the standards of his profession, which can be understood broadly, as suggested by Gaius (2nd c. AD), who states that the contract obligations involved that the *conductor* should take all due care (*omnia facta sunt, quae diligentissimus quisque observaturus fuisset*) to successfully perform his task³⁸. Gaius further reminds us that entrepreneurs were liable for mistakes they, or their workmen, made. This liability did however not extend to damages caused by an overwhelming external event, because nothing like the "due care" described by Gaius existed in the case of seismic resistant construction practices.

D.19.2.59. *Iavolenus libro quinto ex posterioribus Labeonis. Marcius domum faciendam a Flacco conduxerat: deinde operis parte effecta terrae motu concussum erat aedificium. Massurius Sabinus, si vi naturali, veluti terrae motu hoc acciderit, Flacci esse periculum.*

Flaccus contracted to have Marcius build a house; after part of the job was finished, the structure was shaken by an earthquake. Massurius Sabinus [says that] if this occurs due to a natural force like an earthquake, Flaccus bears the risk. (Text Mommsen, Krueger, 1872; Transl. Watson 1998)

³⁴ For making this point clear regarding new constructions, but also restorations and the consolidation of a historic built environment, see for instance Romeu et al. 2011.

³⁵ Vitr. *De arch.* 1.1.10. In this case, the liability lies with the owner, the *pater familias*, not with the architect, but, in other situations, he could assume the responsibility too. For a new reading and interpretation of the text, see Saliou 2011.

³⁶ On the practical relationships between the project owner (*locator*) and the entrepreneur (*conductor*), see Saliou 2012. The scope of the *locatio conductio* is not limited to the construction business but may include activities such as transport, the hiring of workforce, or rental of movable or immovable property. On the contractual liability, and particularly on the cases where a *conductor* is released from his responsibility, see Mayer-Maly 1956: 189–214. Ulrike Babusiaux underlines the role of the contract to release the parties of their responsibility in some cases (Babusiaux 2006: 223). On the specificity of the *locatio conductio operis*, the type specifically used in the building business, see Alzon 1963.

³⁷ We know from contracts for public works that the *locator* could disapprove of the standard of the completed product and legally have the defects corrected at the *conductor's* expenses (studied by Du Plessis 2004: 290–291).

³⁸ Gaius, *Edict Prov.* 10 (D.19.2.25.7). On the content of the professional knowledge and obligations of the *conductor* Michael Rainer considers that, in Rome at least, builders had to be aware of a certain standard of innovation in their speciality (Rainer 1992: 506–507).

This text provides further details of the *conductor's* liability in a way that interests the seismic risk more specifically³⁹. It is asked here who has to bear the *periculum* of an earthquake destroying the house under construction: the *locator* Flaccus or the *conductor* Marcius, hired by Flaccus as a builder? The intricate work of citations and commentaries clearly demonstrates here the relevance of the case, in a type of contract where, most of the time, the *periculum* was borne by the *conductor*⁴⁰. Subject to many variations, the legal concept of *periculum* is used in contractual relations to indicate the risk of a loss that one party has to bear⁴¹. In the text, it consists in a *vis naturalis* (i.e. the earthquake) for which it is decided by the jurists that the *conductor* is not liable, provided that he took all due care to perform his work⁴². Consequently, the *locator* bears the *periculum* and quite rightly runs the risk of a collapse of his own property.

The absence of legal liability in case of a natural disaster is consistent in Roman law, and we find similar dispositions in other legal mechanisms, like the *actio damni infecti*, a legal action against a damage not yet done but threatening one's property⁴³. In the following text, Ulpian (beginning of the 3rd c. AD) reports Labeo's (Augustan era) and Servius' (1st half of the 1st c. BC) opinions about the conditions of this procedure.

D.39.2.24. Ulpianus libro 81 ad edictum. 3. *Haec stipulatio utrum id solum damnum contineat, quod iniuria fit, an vero omne damnum, quod extrinsecus contingat? Et Labeo quidem scribit de damno dato non posse agi, si quid forte terrae motu aut vi fluminis aliove quo casu fortuito acciderit.* 4. *Servius quoque putat, si ex aedibus promissoris vento tegulae deiectae damnum vicino dederint, ita eum teneri, si aedificii vitio id acciderit, non si violentia ventorum vel qua alia ratione, quae vim habet divinam. Labeo et rationem adicit, quo, si hoc non admittatur, iniquum erit: quo enim tam firmum aedificium est, ut fluminis aut maris aut tempestatis aut ruinae incendii aut terrae motus vim sustinere possit ?*

3. Does this stipulation cover only such injury as arises through illegal actions or any sort of injury originating externally? Labeo, at least, writes that no action can be brought over injury caused, say, by earthquake or the force of the river or any other accidental event. 4. Servius also thinks that if tiles are dislodged by the wind from a promisor's house and cause injury to his neighbor, the former is liable if this occurred because of a defect in the building but not if it occurred because of the violence of the wind or other reason having the character of an act of God. Labeo adjoins a reason for this, that is to say, that it would be unfair not to admit this rule; for what building is so secure that it can stand the shock of a river or the sea or a storm or a collapse due to a fire or earthquake? (Text Mommsen, Krueger, 1872; Transl. Watson 1998)

A property owner fearing the collapse of a neighbouring building could ask the praetor or the provincial governor to order that the owner of the threatening building give him a

³⁹ The authenticity of the text has been much discussed : see a full list of references in MacCormack 1979: 144, n. 58. Theo Mayer-Maly furthermore shows how important this discussion is to determine if earthquake constitutes a case of *vis maior* or *vis naturalis* but decides that in any case it can only be a *vis naturalis* (Mayer-Maly 1956: 191-192).

⁴⁰ The text is a commentary, by early 2nd c. jurist Javolenus, on the work of Labeo (Augustan era). It also shows that Masurius Sabinus' attention (working at the time of Tiberius) had been attracted to the topic, possibly by Labeo in the first place.

⁴¹ MacCormack 1979.

⁴² On the *vis naturalis* as a *periculum*, Kaser 1957: 191.

⁴³ On the legal action, see Watson 1968: 125–154; Rainer 1993. On the release from responsibility (although mostly focused on *vis maior*), see Giaro 1975.

cautio damni infecti (a guarantee against an anticipated injury)⁴⁴. This *cautio* is therefore a precautionary measure. It takes the form of an oral contract, a *stipulatio*, between the two neighbours and it was probably regularly (if not systematically) used in the business of selling and buying houses⁴⁵. Its effect was that the owner of the threatening building was responsible for the damages which happened to the other house in case of a collapse. No doubt it was a very useful and extensively used legal mechanism in cities crammed with unsafe *insulae*, as we learn from the literary sources⁴⁶. In this fragment, the jurists discuss the conditions to which the owner who has given a *cautio* is liable for the destructions induced by the collapse of his building. Labeo agrees with Servius that this owner is only liable for a defect in the building, and must be released from all responsibility if the damage is caused by an external element. Here, although the problematic transmission of legal texts calls for caution, we must nevertheless note a relevant difference in the way the two jurists, separated by a century, express their opinion. Servius only mentions a violent wind as an external event, called here *vis divina*, but Labeo further includes in this category a powerful flood or tide, a storm, a fire and an earthquake, and points out that no construction practice could ensure resistance to this kind of disaster⁴⁷. Even if the evidence is very thin, it is tempting to interpret this difference as an evolution from Servius to Labeo, reflecting an increased sensitivity to finding technical solutions to the seismic risk (along other sorts of natural risks) already at the beginning of the 1st c. AD, as the example given by Strabo for the city of Philadelphia in Katakekaumene plainly shows⁴⁸. Nevertheless, the final confirmation of Labeo's view by Ulpian, at the beginning of the 3rd c., demonstrates that no human activity, such as construction engineering, was ever considered by the jurists as an element of risk, even though innovative seismic resistant practices were developed, for instance in the Vesuvian area, showing that architects and entrepreneurs were aware of it⁴⁹.

Archaeological observations, as well as literary texts, show that remedies for the seismic risk were occasionally sought after, but remained limited to construction practices. This is of course explained by the overwhelming nature of earthquakes and by the limited technical means of the ancient world⁵⁰. But it also seems that it was because human activities were not sufficiently identified as agents of the risk, that only few actions were taken to try and reduce the vulnerability of human assets. In this respect, it must be stressed that poor housing was mostly the lot of the most vulnerable groups, those for whom the Roman world cared the

⁴⁴ Although it was introduced as a praetorian procedure in the course of the 2nd c. BC, it is possible that a very early version of the *actio damni infecti* existed at the time of the XII Tables (Kaser and Knütel 2008: 125, §7). About the dissemination of the procedure outside Italy, it is worth mentioning that Ulpian (beginning 3rd c. AD) mentions the possibility to address either the praetor in Rome or the governor in the provinces, thus demonstrating that the mechanism was widespread (*Ad ed.* 1, D.39.2.4.pr.).

⁴⁵ MacCormack 1971.

⁴⁶ On the legal relations between landlords and tenants in that regard, see also Frier 1980: 92–105.

⁴⁷ An “act of God” is a term still used in contract law and tort law, throughout the English-speaking world, to refer to a hazard for which no person can be held responsible (Taylor v Caldwell, 1863 - EWHC QB J1).

⁴⁸ Cf. note 29.

⁴⁹ In other cases, notably floods, jurists consider that a building must present some standard of solidity, for which the proprietor can be held accountable in the course of the *actio damni infecti*: see Servius' opinion commented by Ulpian, *Ad ed.* 81 (D.39.2.24.5), with the study of Rainer 1993: 287–290.

⁵⁰ Michael Rainer considers that jurists refer to an “overwhelming nature” by calling upon the legal concept of *iniquitas*. See the discussion in Rainer 1993: 302.

least, and therefore the most exposed to the risk⁵¹. Additionally, it is possible that public authorities didn't engage more actively through legislation, probably because major earthquakes remain occasional and are only noticed when causing great destruction in populated areas⁵². By contrast with the fire risk, which required to be managed almost on a daily basis, a large-scale seismic event was not likely to occur more than once in a generation. Dealing with the problem was therefore easily deferred and public awareness of long-return period hazards might be lacking⁵³. The case of private law is interesting because the texts of the *Digest* show how attentive the jurists were to contemporary issues. Does their reflection on the liability of builders and proprietors in case of collapse following an earthquake reflect technological evolutions in the construction practices? There is no positive evidence. Nevertheless, it is of particular interest that such developments failed to take account of the professional standards builders had to comply with, probably because of the limited effectiveness of these solutions in case of a major event. But the investigation of different types of floods will now show that natural risk management mainly depends on the awareness that human activities increase the exposure of assets to a risk.

3. Controlling flood risk: attention to the impact of human activities

Natural causes of flood hazards are more easily identified than earthquakes'. Rain is the main one, with all the seasonal variations and characteristic unpredictability of the Mediterranean climate. The temperature can then play a role on the evapotranspiration and on the snowmelt upstream with consequences downstream. Other natural causes may be interwoven with human factors: the drainage and infiltration capacities of the ground, the rising of groundwater or accumulation of run-off water may indeed originate from agricultural practices and land-clearing. If some aspects received religious explanations⁵⁴, other causes were understood by the Ancients: Dio mentions violent winds as a possible cause for the Tiber flood of 54 BC; heavy rains are held accountable for the floods of 241 BC, of 15 BC, of that occurred under Trajan's reign and that of 371 AD⁵⁵.

The analysis of various answers developed in Roman times reveals that careful distinctions were made between different types of floods, the causes of the hazard, the vulnerability of the assets and the impact of the human activities. This knowledge is translated in the response each type receives. I will examine different solutions applied in the Roman period and try to see what components of the risks they are meant to act upon. While considering them, I will try to evaluate the role and significance of legal mechanisms such as different praetorian interdicts related to the management of waterways and the *actio aquae pluviae arcendae*, the action to ward off rainwater on the slopes. It will show that the reason why they reflect an acute awareness of the impact of human enterprises on the increased risk of inundations is because they provided a tool to manage it.

⁵¹ As it is today, vulnerability to the risks, in the Roman world, was distributed differently across social groups: see Toner 2013: 87–93.

⁵² On the perception of seismicity depending on the density of population and urbanization of various regions, see the commentary on Strabo by Baladié 1980: 139–145.

⁵³ This is also what contemporary examples show (Blaikie et al. 2004: 12).

⁵⁴ For example Hes. *Op.* 483.

⁵⁵ See the references in Le Gall 1953: 31.

3.1 Management of the waterways

Due to the importance of rivers, any change of the course and characteristics of a stream had important consequences and could seriously disrupt the life of riverine communities⁵⁶. The first set of solutions against flood thus aims at managing the waterways. In that regard, the attempts to modify the riverbed and whole catchment of a river through major infrastructure works are best illustrated by the example of Rome itself. In 45 BC, a project to divert the Tiber was planned by Caesar. It was however probably related to the necessary expansion of the city towards the Campus Martius (as the title *lex de Urbe augenda* plainly expresses), rather than to an effort to control the river⁵⁷. On the other hand, Tacitus reports how Tiberius tried to regulate the water flow upstream from the city, after the disastrous floods of 12 and 15. The first recommendation of the Senate was to consult the Sibylline books, but Tiberius decided to call a technical survey too⁵⁸. The senators appointed to conduct it, L. Arruntius and Ateius Capito, proposed to divert the course of the Glanis (today's Chiani) and of the Nar (today's Nera). A central aspect of the project was to flood the fertile plains of Interamna and of Reate, to which proposition the inhabitants of these places vigorously objected. The idea was finally rejected on the ground that it would be economically damageable for the agricultural exploitation on the territory of these cities, but also that it could offend the Tiber as a divinity⁵⁹.

Trying to change the course of a river in order to counteract the effects of its seasonal surges is an attempt to act directly upon the natural event. In the context of the ancient world, such pursuit presented significant drawbacks. It could first pose religious difficulties, linked to the sacred nature of running waters. Secondly, it does not seem that the Romans had sufficient understanding of the hydrology of rivers' catchment to act efficiently on these elements⁶⁰. The problem was therefore addressed differently, as it is clearly evidenced by Augustus' works on the Tiber, which dealt with the human activities by clearing the riverbed of all its rubble and debris, and freeing the banks from any jutting building, some of which were perhaps even set up on the river-bed.

Suet. Aug. 30. *Ad coercendas inundationes alveum Tiberis laxavit ac repurgavit completum olim ruderibus et aedificiorum prolationibus coartatum.*

To control the floods, he widened and cleared out the channel of the Tiber, which had for some time been filled with rubbish and narrowed by jutting buildings. (Text and transl. Loeb Classical Library, Rolfe, 1914)

By narrowing the river channel, all the rubbish and illegal constructions were increasing the flood risks and impairing the shipping. Cleaning it was therefore probably a very obvious conclusion at a time when the most ancient districts of the city, those near the river, were already over-populated⁶¹. The response provided by Augustus is therefore directed, not towards the natural hazard, but towards the human uses of the river. It indicates that these attitudes, typical of a riverside occupation, were rightly identified as an element of the risk.

⁵⁶ For an overview of the different possible implications, see Campbell 2012: 100–116.

⁵⁷ Suet. *Caes.* 44; Cic. *Ad Att.* 328 (13.20). Le Gall 1953: 114–115; Gros 2010: 279.

⁵⁸ Tac. *Ann.* 1.76 ; 1.79

⁵⁹ For an estimate of the technical inconsistency of the project, see Le Gall 1953: 120–123. More recently on this episode and the religious aspects behind the project being called-off, see Hettinger 2018.

⁶⁰ See the conclusions of Le Gall 1953: 123.

⁶¹ Purcell 1994.

After Augustus' time, the careful watch that the urban administration was keeping over these uses led to the creation of the *cura alvei et riparum Tiberis*, probably established under Tiberius, and which can be traced down to the 4th c. when it was merged with other services of the city⁶².

Besides their mission of supervision of the river facilities like the bridges, and of control of the boatmen's corporations, the *curatores* had to make sure that the river was free from any obstacle, like fallen trees or branches impeding the traffic. They also had to mark the boundaries of the banks with the purpose of distinguishing the public from the private space (115 *stelae* are known to date). This was necessary to prevent further illegal, and damaging, occupation of the banks⁶³.

The crucial importance and many implications of the management of the river banks were indeed very well accounted for, not only from a public point of view, as the public action from the 1st c. BC demonstrates, but from a private perspective too. The praetorian interdicts, outlined as combining the protection of the public good with that of private interests, are particularly relevant in this regard⁶⁴. Issued by the praetor in his Edict, interdicts were more administrative provisory remedies than real judicial decisions⁶⁵. Given by the magistrate before any legal action was initiated, their purpose was to protect existing situations by a quick decision to make someone abstain from doing something damaging. If the trouble persisted despite the praetor's interdict, it was then possible to start a judicial proceeding⁶⁶. The management of the rivers is the object of four titles of the *Digest* commenting on interdicts. They focus on the management of the banks, the regularity of the flow and the maintenance of the navigation⁶⁷. The purpose of these dispositions is mostly to ensure that the traffic on the public waterways did not get constrained, but by doing so they address the flood risk too, thus underlining how much private and public interests were interwoven⁶⁸.

D. 43.13.1. *Ulpianus libro 68 ad edictum. pr. Ait praetor: "In flumine publico inve ripa eius facere aut in id flumen ripamve eius immittere, quo aliter aqua fluat, quam priore aestate*

⁶² Lonardi 2013: 25–27. For discussions on the date of the creation, see Le Gall 1953: 135–136; Robinson 2003: 74–75. The administration of the river and of its banks however predates the creation of the *cura* as an independent authority. Twenty inscriptions from the late Republic indicate that the censors were in charge of marking the boundaries of the river and of the banks. See Le Gall 1953: 149–166.

⁶³ See for instance the text of *CIL* 14, 4704c "*sine praeiudicio publico aut privatorum*" (without public nor private injury). On the legal definition of the river banks, see Maganzani 2010.

⁶⁴ Rainer 2019.

⁶⁵ The history of the praetorian Edict probably started as early as 367 BC, when the magistracy was created by the *Lex Licinia Sextia* (Livy 6.42), even though it is difficult to find positive traces for this early stage. Until the 2nd c. AD, interdicts were theoretically issued each year in his Edict by the new praetor taking up his office, although most of the dispositions apparently did not change considerably from one magistrate to the next. It became definitely fixed by the jurist Julian, under Emperor Hadrian, as the *Edictum perpetuum* (*Constitutio Tanta*, 18). For an historical overview of the judicial institution, especially as regards its interactions with the imperial authorities, see Guarino 1980.

⁶⁶ Kaser and Knütel 2008: 425–426.

⁶⁷ D.43.12.1, *De fluminibus. Ne quid in flumine publico ripave eius fiat, quo peius navigetur* (Rivers: to prevent anything from being done in a public river, or on its bank, to hamper navigation); D.43.13.1, *Ne quid in flumine publico fiat, quo aliter aqua fluat, atque uti priore aestate fluxit* (That nothing should be done in a public river which might cause the water to flow otherwise than it did last summer); D.43.14.1, *Ut in flumine publico navigare liceat* (To allow navigation in a public river); and D.43.15.1, *De ripa munienda* (Building-up a bank).

⁶⁸ On the protection of public and private interests by the interdict cited in D. 43.13.1, see Fiorentini 2003: 194–199.

fluxit, veto". 1. Hoc interdicto prospexit praetor, ne derivationibus minus concessis flumina excrescant vel mutatus alveus vicinis iniuriam aliquam adferat. 2. Pertinet autem ad flumina publica, sive navigabilia sunt sive non sunt. 3. Ait praetor: "Quo aliter aqua fluat, quam priore aestate fluxit": non omnis ergo, qui immisit vel qui fecit, tenetur, sed qui faciendo vel immittendo efficit aliter, quam priore aestate fluxit, aquam fluere. Quod autem ait "aliter fluat", non ad quantitatem aquae fluentis pertinet, sed ad modum et ad rigorem cursus aquae referendum est. Et generaliter dicendum est ita demum interdicto quem teneri, si mutetur aquae cursus per hoc quod factum est, dum vel depressior vel artior fiat aqua ac per hoc rapidior fit cum incommodo accolentium: et si quod aliud vitii accolae ex facto eius qui convenitur sentient, interdicto locus erit.

pr. The praetor says: "I forbid anything to be done in a public river or on its bank, or anything to be introduced into a public river or on its bank, which might cause the water to flow otherwise than it did last summer." 1. By this interdict the praetor has made provision against a river's drying up because of unauthorized tapping by watercourses, or bringing any injury to neighbors by changing its bed. 2. It applies to public rivers, navigable and unnavigable. 3. The praetor says: "which might cause the water to flow otherwise than it did last summer." So not everyone who introduced or did something is liable, but only one who by doing or introducing something causes the river to flow otherwise than it did last summer. The words "flow otherwise" do not refer to the volume of the water, but to the manner and direction of its current. So it is generally to be said that someone is liable under the interdict if what he has done changes the current by making the water deeper, or narrower and hence swifter, to the inconvenience of the neighborhood. And if the neighbors suffer some other harm because of what the person has done, the interdict will apply. (Text Mommsen, Krueger, 1872 ; Transl. Watson 1998)

Ulpian's quotation of the praetor's interdict on the flow of a public river, in his 3rd c. AD *Commentary of the Edict*, is the most complete that we possess⁶⁹. The prohibition, by the magistrate, to do anything in a public river or on its bank, or to put anything in this river or on its bank, which might modify the way the water was flowing the previous summer, was introduced in the *Edictum perpetuum* between 117 and 138 AD but is probably much older than that⁷⁰. By the end of the 1st c. BC, the *Edict* is indeed thought to have already reached its most complete form⁷¹.

The magistrate could not act on his own. On the contrary, he could only enact orders and impose restrictions when requested to by litigants. Yet, far from restricting the impact of the mechanism, it is arguably the most fundamental aspect of this interdict with respect to the flood risk management for waterside properties. We should observe here that the *praetor* provided any individual with a legal tool to contest a neighbour's right to intervene in the river or on its banks. This feature shows that risk management did not rest only in the hands of the public authorities, but was also accessible to private individuals. Another crucial aspect is that the aim of the interdict is not to remedy damage which had already happened, but to prevent any damage from happening by prohibiting the continuation of an activity that might change the flow of the river and lead to the realisation of the flood risk. This potentiality is clearly

⁶⁹ The reconstruction of the Edict by Otto Lenel relies entirely on this passage of Ulpian (Lenel 1883: 368).

⁷⁰ Hydrographic conditions of the previous summer are often taken as a reference point in legal texts. Ulpian explains later in the text (D.43.13.1.8) that it is because the natural course of a river is always more certain in summer than in winter (*quia semper certior est naturalis cursus fluminum aestate potius quam hieme*). For a discussion and other references, especially in the context of private water rights, see Capogrossi Colognesi 1966: 136, n. 231.

⁷¹ Kaser 1984: 6.

expressed by the subjunctive in the phrase *quo aliter aqua fluat* and by the assertion that the interdict is prohibitory, meaning that it forbids acting in a certain way⁷².

A remarkable correspondence can be noticed between Suetonius' account about the cleaning of the Tiber and the purpose of this interdict. The construction of houses and facilities for economic activities such as workshops or fishing in the river or on its banks, as well as the presence of debris and detritus into the river or on its banks, created a flood risk⁷³. This risk is not made explicit by the praetor but is explained by Ulpian in his commentary. Firstly, by illegally drawing water for irrigation, artisan activities or even recreational purposes (*ne derivationibus minus concessis flumina excrescent*), someone might cause the river to dry up, which will affect its navigability⁷⁴. Secondly, and this ties up more significantly with our investigation, by changing the course of the river through interventions in the bed and on the banks, someone might expose the adjacent properties to the fast-flowing water (*si mutetur aquae cursus per hoc quod factum est, dum vel depressior vel artior fiat aqua ac per hoc rapidior fit*)⁷⁵. Like Augustus' intervention, the interdict is therefore intended to act upon human activities, precisely identified as indirect causes of the risk because they may intensify the impact of the natural event, in this case the surge of the river⁷⁶.

If this set of rules was already constituted by the end of the 1st c. BC, we may then wonder why Augustus had to take public action instead of simply letting the magistrates apply the interdict. To that question, it is possible to propose several explanations. It must first be said that the river cleaning formed part of the town-planning project through which Augustus made Rome visibly the capital of his power. From his time onwards, a large part of the flood plain constituted by the Campus Martius was integrated into the city's *regio IX* and became prominent in the way the new power displayed its authority⁷⁷. It was not only a space for the renovation of republican institutions (the Pantheon was dedicated in 27, and the *Saepta Julia* in 26 BC). It was also the heart of the ruler's self-celebration, the place where he built his mausoleum in 28 and the *Ara Pacis* in 13-9 BC⁷⁸. This project necessitated some definite

⁷² Ulpian *Ad ed.* 68 (D.43.13.1.12). Interdicts concerned by interference with public ways, public rivers or *loca publica, sacra, sancta*, are often prohibitory (D.43.6 *sqq.*). According to Ulpian, the prohibitory interdict mentioned in D.43.13.1.1 is completed by a restitutory interdict, phrased in similar terms but developed to restore or undo something that has been done contrary to law (D.43.13.1.11). On the different classes of interdicts, see Buckland 1921: 724–726.

⁷³ Economic activities were numerous along rivers, even in city centres. About the organisation of the fishing industry, see Marzano 2018. The Elder Pliny refers to fish traps across the river Mincio, where thousands of eels were caught during the month of October (Plin. *HN* 9.38.74). The quality of fish caught a little downstream from the Tiber Island is discussed by Macrobius. *Sat.* 3.16.17–18; Hor. *Sat.* 2.2.31; Plin. *HN* 9.79.169; Juv. 5.104–106.

⁷⁴ The navigability issue is more comprehensively addressed in the interdict discussed in D.43.1.12.

⁷⁵ On the interpretation on this explanation of the words "*aliter fluat*" by Ulpian, especially in view of the quantity criteria, see Fiorentini 2003: 189–192. The author convincingly compares the use of the expression "*modus aquae*" in the legal text and in several fragments of the *Corpus Agrimensorum*, to conclude that the changes to the waterway mentioned in our text probably refer to the width of the river.

⁷⁶ A balance between the public interest of keeping the river free of major modifications and private interests is nonetheless introduced by a further disposition stating that "it is right to take into account the convenience and safety of the doer, but only if he does no injury to those living around" (*Oportet enim in huiusmodi rebus utilitatem et tutelam facientis spectari, sine iniuria utique accolarum*) (D.43.13.1.7)

⁷⁷ Nielsen 2014: 55–57; Purcell 1996: 187–188. The location of this new suburban scenery near the river-harbour makes it easily visible for visitors approaching the city by the Tiber, but also by the Via Flaminia (Purcell 1987: 26–27). See the description by Strabo 5.3.8.

⁷⁸ Royo 2014; Jacobs and Conlin 2014: 139–148.

actions and certainly explains why Augustus determined to conduct a large-scale dredging of the Tiber.

Additional reasons can encourage an emperor to restate an existing rule. As the later imperial legislation shows, it is a way to establish one's authority. This is the case of a decision of Gordian III, dated from 239: it reiterates the prohibition for private individuals to divert the natural course of a river, while stressing, on the other hand, that no one should be prevented from strengthening the banks bordering one's property in order to protect it from potential water surges⁷⁹. Yet, a quick survey of the legislation of this young sovereign, proclaimed emperor in the troubled context of the years 230's, shows that most of his decisions were taken during the first year of his reign, as a way to significantly assert his dominance⁸⁰.

3.2 Surface run-off and the management of the slopes

Beside river surges, floods can be caused by surface run-off. The issue has mainly been addressed regarding urban contexts where it can even increase because the water has less chances to infiltrate into the paved ground or be absorbed by the bare soil. Technical solutions were therefore developed to drain the surplus. Many Roman cities, following the example of the Cloaca Maxima in Rome, were provided with sewerage systems combining waste water and rainwater. Pompeii provides examples of street and road equipment, comprising kerbstone blockage, sidewalk ramps and modified paving stones to direct the flow of water by taking advantage of the natural slope⁸¹. These observations are widely confirmed by the texts⁸².

On the other hand, the risk created by surface run-off in the countryside has so far failed to receive much attention from scholars despite the concern that waterlogging and erosion could raise concerning the exploitation of hillsides⁸³. In Mediterranean terraced hill-slopes, drainage techniques made it possible to remove or direct the water from waterlogged areas, possibly to exploit the resource elsewhere, while terraces, dams and reservoirs help retaining and store it for subsequent use. Few texts provide information about drainage techniques related to cultivated lands. Columella explains how to design drainage ditches and canals. He describes roofed canals dug three feet deep and half filled with small stones, gravel, or even branches, and open ditches directly cut into the earth, provided that the ground was packed enough, with stones set up at each side⁸⁴. If the written evidence remains slim, it seems nonetheless that hillside settings and terraces were very common features of land exploitation in the ancient Mediterranean⁸⁵. Drainage *cuniculi*, purposefully collecting water in order to increase the availability of water resources for villas downstream, have been

⁷⁹ *Cod. Iust.* 7.41.1

⁸⁰ On the context of the election of Gordian in 238, see Le Roux 1997.

⁸¹ Combined with the sewage networks, Eric E. Poehler shows that these water management mechanisms contribute to the organization of drainage basins within the urban area, so the rainwater would not flow freely but would be efficiently controlled: Poehler 2012. Other examples have been studied: see for instance Abadie-Reynal 2003; Veyrac 2006.

⁸² Plin. *Ep.* 10.98-99; Frontin, *De Aq.* 88.3; Ulpian *Ad ed.* 71 (D.43.23.1); Venuleius, *Interdicts* 1 (D.43.23.2); *Lex Flaviae Irnitanae*, 82; *Lex Coloniae Genetivae*, 75.29-33.

⁸³ See for instance Palladius' recommendations about the relief of agricultural lands, ideally not too sloping nor too flat (Palladius *Rust.* 1.5.5).

⁸⁴ Columella, *Rust.* 2.2.9-11

⁸⁵ Harfouche 2007; Quilici Gigli 1995; Horden and Purcell 2000: 234–237. For a reconsideration of the sources, see Harfouche 2005.

observed in central Italy, as well as systems for the collection of surface run-off towards cisterns, and small dams set up across gullies and terraces⁸⁶. The purpose of these infrastructures is simultaneously to prevent the water from damaging the constructions and cultivations down the slope and to store it for irrigation of gardens, orchards, or for other purposes.

The risk posed by water on terraced cultivated hillsides was nonetheless fully acknowledged by jurists, and the structural connection between drainage and irrigation is at the core of the *Digest's* title 39.3 "Water and the action to ward off rainwater" (*De aqua et aquae pluviae arcendae*) detailing the praetor's legal action on that matter. The *actio aquae pluviae arcendae* (*actio a.p.a.*) can be traced as early as the 5th c. BC⁸⁷. It is a form of lawsuit taken against the owner of a neighbouring plot of land, either upstream or downstream, for having constructed something which might change the usual flow of rain-water to the detriment of the plaintiff's property⁸⁸. While protecting private interests, elements of title 39.3 reveal an evident understanding of the human causes at the origins of the flood and distinctly show that the *actio a.p.a.* provided legal tools to manage the risk⁸⁹.

The aim of the action is to protect private economic interests related to land exploitation. In the 1st c. BC it was agreed that the *actio a.p.a.* only lay when damage was threatening a field, not a construction⁹⁰. Farming activities, representing growing economic interests, are thus identified as the human assets exposed to the risk of erosion and waterlogging caused by rainfalls and run-off⁹¹. It must also be stressed that the action only served the purpose of resolving conflicts between private individuals and therefore did not lie against a piece of work carried out on a public property or made by a public authority like the Senate or the *princeps*⁹².

The main hazard associated with the risk is rain, especially because of its unpredictability, its potential intensity and the fact that it can happen after a long drought

⁸⁶ Drainage *cuniculi* observed north and east of Rome, in Marcellina near Tivoli or in Civit  Castellana near Viterbo, but also further south in Sperlonga (Quilici Gigli 1997: 203-204). For examples of ditches from the 4th-3rd century BCE to the Augustan era in Vallerano, south of Rome, see also Bedini 1997. Collection systems, dams and cisterns have been evidenced in Casale delle Grotte, 4 km north-east of Orbetello near the Roman colony of Cosa (on the coast some 120 km north-west of Rome), near La Mora (about 4 km north-west of Palestrina), or at the Pian delle Salse villa, near Sperlonga (Thomas and Wilson 1994: 141; Marzano 2007: 166); terraces on the southern part of the Monti Sabini (Quilici and Quilici-Gigli 2009: 222-225).

⁸⁷ FIRA, 1: *XII Tab.* 7.8a (*si aqua pluvial nocet*), based on Paulus, D.43.8.5. See also the interpretation by Pomponius, *Ex Plaut.* 7 (D.40.7.21 pr). For an extensive bibliography and a reconstruction of the main features of the action in the first stages of its development, see Agnati 2000.

⁸⁸ For a good overview of the abundant bibliography the *actio a.p.a.* has generated, see Salerno 2008: 271–272, n. 1.

⁸⁹ It was not the only possibility to deal with the risks created by run-off water. Cosima M ller reminds us that, from Servius' time onwards (1st c. BC), a new conception of land servitudes made it possible to use that particular type of convention between two neighbours to evacuate the water (M ller 2010: 272-302; M ller 2018: 24–25).

⁹⁰ This is based on the opinions of Labeo and Cascellius reported by Ulpian (Ulpian *Ad ed.* 53, D.39.3.1.17), but also on Cic. *Top.* 4.23; 10.43. Watson 1968: 172–173 believes that this rule is not much older than the time of Cicero.

⁹¹ In the time of Cicero, the scope of the action was most probably limited to the *ager Romanus*, but this changed sometime during the 1st c. AD (see M ller 2010: 295, n. 291). In the case of damage caused (or expected to be caused) to urban constructions, Ulpian notices that it is possible to bring an action to deny the right of eavesdrip (*servitus stillicendi*) or the flow of water on one's property (D. 39.3.1.17 and 19).

⁹² Paulus *Ad Sab.* 16 (D.39.3.23.pr.). This also means that the legal mechanism aimed at controlling operations of small-scale land improvement, achieved at an individual level, as has been pointed out by Scotti 2014.

and hit a dry and compacted soil. The legal definition of rainwater was extensively discussed by the Roman jurists⁹³. But rainfall was not the only identified element of the risk. On the contrary, the Roman jurists' opinions show that human activities were well acknowledged for their role in increasing the risk. This perception is revealed by the deliberations about the *opus manu factum* (a man-made work), like in the following fragment from Ulpian's *Commentary on the Edict*.

D.39.3.1. Ulpianus libro 53 ad edictum. *pr. Si cui aqua pluvia damnum dabit, actione aquae pluviae arcendae avertetur aqua. Aquam pluviam dicimus, quae de caelo cadit atque imbre excrescit, sive per se haec aqua caelestis noceat, ut Tubero ait, sive cum alia mixta sit. 1. Haec autem actio locum habet in damno nondum facto, opere tamen iam facto, hoc est de eo opere, ex quo damnum timetur: totiensque locum habet, quotiens manu facto opere agro aqua nocitura est, id est cum quis manu fecerit, quo aliter flueret, quam natura soleret, si forte immittendo eam aut maiorem fecerit aut citatiorem aut vehementiorem aut si comprimendo redundare effecit. Quod si natura aqua noceret, ea actione non continentur.*

pr. If rainwater is going to cause one injury, it can be averted by means of an action to ward off rainwater. We define "rainwater" as water which falls from the sky and is increased in quantity by a rainstorm, whether, as Tubero says, such water from the sky causes damage by itself or in conjunction with some other body of water. 1. This action is appropriate where no injury has yet been caused, but work of some sort has been carried out, that is, work from which injury is apprehended. The action is appropriate whenever water is likely to cause damage to a field as a result of a man-made construction, that is, whenever someone causes water to flow elsewhere than in its normal and natural course, for example, if by letting it in he makes the flow greater or faster or stronger than usual or if by blocking the flow he causes an overflow. But if the water causes damage naturally, the case is not covered by this action. (Text Mommsen, Krueger, 1872; Transl. Watson 1998)

Ulpian reminds us here that the *actio a.p.a.* is concerned with damage feared to be caused by rainfall (*quae de caelo cadit*) alone or combined with an additional bulk of water (*cum alia mixta sit*), coming from a swamp or from a torrent as we learn from other texts⁹⁴. The jurists nonetheless stress that the presence of rainwater is essential to allow the action⁹⁵. Another condition is that the threat is caused by a man-made work (*opere tamen iam facto, hoc est de eo opere, ex quo damnum timetur*), changing either the direction, the location or the strength of the flow as it was, naturally or not, running before the change occurred. The type of *opus manu factum* that can provide the basis for the action is not made explicit by the jurist, although we can suppose it can be any sort of dam, drain or terrace. In another fragment, Ulpian also reports a doctrinal argument involving Q. Mucius Scaevola, Aulus Ofilius and C. Trebatius Testa, which took place between the end of the 2nd and the 1st c. BC. and centred on the legal protection of agricultural practices⁹⁶. The controversy starts with Q. Mucius' opinion that furrows ploughed in order to cultivate a field cannot give grounds for the action, presumably because this activity meets the public interest of supplying the community with staples. The discussion then turns to the furrows' function, when Trebatius distinguishes between furrows apparently made to speculate on the value of the land and those made to increase production. Only the latter are excluded from the scope of the *actio*

⁹³ For elements of the problem, see Rodger 1970.

⁹⁴ Ulpian *Ad ed.* 53 (D. 39.3.1.2); Paulus *Ad ed.* 49 (D. 39.3.2.9)

⁹⁵ See the opinions of Trebatius on hot springs, reported by Ulpian *Ad ed.* 53 (D. 39.3.3.1).

⁹⁶ Ulpian *Ad ed.* 53 (D.39.3.1.3, 4, 5)

a.p.a., which means that they are generally protected from legal action even if they might cause damage to a neighbouring plot. On the contrary, furrows made for the sole purpose of increasing the value of the parcel can be the object of court proceedings, possibly as a way of reprehending speculation just as Q. Mucius seems to do⁹⁷. Both jurists finally seem to agree that the cultivation of the field requires drainage ditches but must avoid purposeful harm to a neighbour, and Ofilius adds that furrows must all have the same direction.

However convoluted some of these opinions may appear, they translate into legal terms the multiple tensions of an agrarian society at a time when the demand for staples was steadily increasing and land occupation issues were multiplying⁹⁸. Roman jurists then had to look for solutions to bring together competing interests of profit-seeking activities related to land exploitation, like agriculture or pastoralism, and to determine individual responsibilities. The different jurists' contributions clearly show that there were no straightforward answers to these problems. But what is relevant to our point is that agricultural practices were undoubtedly recognized as an agent of risk and addressed with a view to managing it⁹⁹.

The identification of the role played by human activities in the increased risk is however not sufficient to argue that the *actio a.p.a.* is a risk-management mechanism. Two further features of the legal action must therefore be considered. The first is that our *actio*, like the *cautio damni infecti*, was developed to prevent a damage from happening, not to remedy an already occurred injury. This is made explicit in the *principium* and the first paragraph of D. 39.3.1: "If rainwater is going to cause one injury, it can be averted by means of an action to ward off rainwater"; "This action is appropriate where no injury has yet been caused, but work of some sort has been carried out, that is, work from which injury is apprehended" (*Si cui aqua pluvia damnum dabit, actione aquae pluviae arcendae avertetur aqua; Haec autem actio locum habet in damno nondum facto, opere tamen iam facto, hoc est de eo opere, ex quo damnum timetur*). The defendant, if defeated, had to remove the construction and the purpose of the judgement was to restore things in a state where no danger was to be feared¹⁰⁰. The second characteristic is the fact that the anticipation of the damage must be provoked by human action, and that a natural change to the flow of the water could not constitute a legitimate basis for the action. By stressing on that point, jurists explicitly sought to act upon the only element of the risk where a legal responsibility can be established, *i.e.* the man-made work¹⁰¹.

⁹⁷ This opinion is confirmed by Labeo (D. 39.3.1.7) and by Sabinus and Cassius (D. 39.3.1.8)

⁹⁸ In a later stage of its evolution, it is thought that the action was not applied to protect one's property against the damages caused by water, but to rationalize the use of the resource and to ensure that it be available for everyone (see in particular Salerno 2007). Nonetheless, there are traces that this evolution occurred well before Justinian's era: the 4th c. land surveyor Agennius Urbicus indicates that the action can be applied for different purposes depending on the region where it is brought before the court, because some regions are deprived of water, while others suffer from excess (Agennius Urbicus, *De controversiis agrorum*, Lachmann 1 p. 63). A different application of the mechanism in Italy and Africa is also noted by Frontinus at the end of the 1st c. (S. Iulius Frontinus, *De controversiis agrorum*, Lachmann 1 p. 57).

⁹⁹ It can also be noted that the mere fact that interests were competing with each other was recognized as an agent of risk. This is noticeable in the Roman approach towards the multiplicity of needs for water during the warmest period of the year and the elevated risk of shortage ensuing from it: see Morley 2015: 80–81.

¹⁰⁰ For damages which had already happened, there are other types of legal action, like the interdict *quod vi aut clam* (see D.39.3.14.2-3 where Paulus draws a comparison with the *damni infecti*).

¹⁰¹ Ulpian *Ad ed.* 53 (D. 39.3.1.1; D. 39.3.1.10; D. 39.3.1.14; D. 39.3.1.23) reporting the opinions of Masurius Sabinus (first half of the 1st c. AD), Cassius (his student and prominent jurist) and Labeo (Augustan era).

On the other hand, the view that natural changes to the flow of water must be faced without legal recourse shows how well acknowledged was the necessity to accept the risk. The balance between legal solutions and the persistence of an unavoidable level of risk consequently depends on the debated extension of the scope of the action, and especially in relation to changes occurred naturally¹⁰².

D.39.3.2.6. Paulus libro 49 Ad edictum. *Apud Namusam relatam est, si aqua fluens iter suum stercore obstruxerit et ex restagnatione superiori agro noceat, posse cum inferiore agi, ut sinat purgari: hanc enim actionem non tantum de operibus esse utilem manu factis, uerum etiam in omnibus, quae non secundum uoluntatem sint. Labeo contra Namusam probat: ait enim naturam agri ipsam a se mutari posse et ideo, cum per se natura agri fuerit mutata, aequo animo unumquemque ferre debere, siue melior siue deterior eius condicio facta sit. Idcirco et si terrae motu aut tempestatis magnitudine soli causa mutata sit, neminem cogi posse, ut sinat in pristinam locum condicionem redigi. Sed nos etiam in hunc casum aequitatem admisimus.*

It is recorded in Namusa that if a flow of water gets blocked with dung and as a result of overflow damages a higher field, an action can be brought against the owner of the lower field to ensure that he allows the watercourse to be cleared since this action is valid not only in relation to man-made constructions but also in relation to all changes in the status quo which we do not intend to occur. Labeo approves a view opposite to that of Namusa, saying that the natural condition of a field can change of itself and that, therefore, when this happens, each party must endure the consequences with equanimity whether his individual circumstances are thereby improved or worsened, and that consequently if the character of the soil is altered by an earthquake or by a violent storm, nobody can be compelled to allow the restoration of the site to its former condition. But we allow appeal to considerations of fairness in this case as well. (Text Mommsen, Krueger, 1872; Transl. Watson 1998)

The text records two opposite opinions¹⁰³. On the one hand, 1st c. BC jurist Namusa allows the action when water flowing in a natural channel became blocked, only to compel the proprietor to have the channel cleaned, adding that “this action is valid not only in relation to man-made constructions but also in relation to all changes in the status quo which we do not intend to occur” (*hanc enim actionem non tantum de operibus esse utilem manu factis, uerum etiam in omnibus, quae non secundum uoluntatem sint*), thus putting forward the will of those who own and exploit the land. Labeo, on the other hand, refuses the action to clear the channel and adds that natural changes must be endured “with equanimity” (*aequo animo unumquemque ferre debere*)¹⁰⁴. This fragment is furthermore interesting because it brings together flood and seismic risk and uses the case of earthquakes to exemplify a sort of natural disaster that has to be endured without any possible remedy.

¹⁰² See the debate between Francesco Sitzia and Mario Bretone, especially on Labeo’s conception of nature (Bretone 1998; Sitzia 1999).

¹⁰³ For an examination of the ample controversy and exegesis on this text, see Gerken 1995. For further comments, see also Watson 2001: 142. Manlio Sargenti reminds us that the text is part of a longer fragment where different cases of threatening natural changes in the flow of water are examined. He notices that Namusa’s opinion is an isolated view and goes against the prevailing doctrine. For Sargenti, this is the trace of a prior stage of the action which goes back to Servius’ doctrine (Sargenti 1940: 42-44).

¹⁰⁴ For Mario Bretone, Namusa’s opinion must be related only to the changes occurred in the absence of a *lex agri* (a convention between the two proprietors), on which more information can be found in Ulpian *Ad ed.* 53 (D. 39.3.1.23) and in Paul, *Ad ed.* 49 (D. 39.3.2.pr.). Francesco Sitzia considers this interpretation exaggerated. See Bretone 1998: 262; Sitzia 1999: 109–121. Theo Mayer-Maly points out that Labeo’s solution must be related to the influence of Stoicism (Mayer-Maly 1984).

This brings us directly to the matter of risk-bearing capacity. Managing risk is above all attempting to reduce it in order to strengthen the resilience of the group. Yet its tolerance of the risk directly pertains to the benefits it can reap from a hazardous situation. Pliny the Elder perfectly analyses why the Romans accept the flood risk caused by the Tiber, “their blessing and their curse”¹⁰⁵: the river’s numerous tributaries makes it navigable for deep-sea ships, and its tranquil flow, overlooked by innumerable villas, makes it possible to trade produce imported from overseas¹⁰⁶. That is why, whereas it seems that the majority of rich *domus* of Rome were settled on hills, the necessity for commercial activities to access the river dictated their location in lowlands and flood-prone areas¹⁰⁷.

Likewise, exploiting the hill-slopes generates multiple problems like erosion, thinning down of the soil, drought in some place and conversely waterlogging in others. Nonetheless, at the end of the 2nd c. and even more at the start of the 1st c. BC, the increasing need in staples for the Roman market stimulated the expansion of agriculture towards new areas like swamps and hill-sides¹⁰⁸. In that context, the Monti Sabatini, the Alban Hills and even more the Monti Sabini offered the advantage of being well connected to the urban market by a dense network of roads and waterways, offering excellent trade opportunities.

The reason why people would settle in earthquake-prone areas is similarly to be found amongst the benefits they would enjoy from the location. The example of Pompeii is particularly relevant in that respect: the seismic risk and even the experience of the earthquake of 62 did not deter people from inhabiting the area because the expected economic profits greatly overcame the risk¹⁰⁹. The richness of the alluvial Campanian plain was already noted by ancient authors, as well as the fertility of the volcanic soil of Mount Vesuvius. Until the 79 AD eruption, the slopes of the volcano were planted with different varieties of grapes, but also with fruits like quinces, figs or peaches. Yield calculations of different crops, added to the fact that many senators and knights owned agricultural lands in Campania, accordingly point towards a fruitful business oriented agricultural sector¹¹⁰. The expected economic output thus inclined investors to bear the risk.

4. Conclusion: perception and control of the environment

The identification of human activities as a component of risk helps to deal more efficiently with it because social behaviours can be controlled and regulated, which is not the case with the natural event. Our case studies show that this knowledge existed in the Roman world, although diversely depending on the type of risk. This brings us to two main conclusions. The first one is that the answers provided depend on the awareness of the impact of human activities in the increased risk. The reason why seismic resistant construction practices are practically not mentioned in the *Digest* is because jurists found that the technological solutions provided in the construction practices were not reliable enough to

¹⁰⁵ Purcell 1996: 189.

¹⁰⁶ Plin. *HN* 3.4.53-54.

¹⁰⁷ Le Gall 1953: 85; 93–103; Aldrete 2007: 211–217.

¹⁰⁸ Quilici and Quilici-Gigli 2009; Morley 1996: 83–107.

¹⁰⁹ Strabo reaches the same conclusion about the pattern of settlement around the highly seismic but also very fertile territory of the Mysian city of Philadelphia (*Strabo* 13.4.10). See Horden and Purcell 2000: 306, on that text.

¹¹⁰ De Simone 2017.

give ground to legal responsibility and consequently to judicial action. Flood risk was managed by technological solutions too. However, because it was acknowledged that human pursuits might increase the risk, another set of answers was provided to private individuals to allow them to engage the responsibility of their neighbours.

The second conclusion concerns the contribution of the legal texts to the topic. Discussing this particular type of evidence sheds a new light on the distinctive roles played by the public authorities and the private individuals in the natural risk management. It shows very clearly that this management was operated by public decisions, but also thanks to the legal tools at the disposition of private individuals. It is very clear in the case of the interdicts protecting the banks: by protecting their private interests, private individuals were also managing the risk for the benefit of the community¹¹¹.

¹¹¹ A similar view is expressed by Maganzani 2014 and Morley 2015 following Möller 2010.

Bibliographie

Abadie-Reynal, C. 2003: 'La gestion des eaux de ruissellement et des eaux usées à Zeugma à l'époque romaine', in P. Ballet, P. Cordier, and N. Dieudonné-Glad (eds), *La Ville et Ses Déchets Dans Le Monde Romain : Rebutés et Recyclages. Actes Du Colloque de Poitiers (19-21 Septembre 2002)*, Montagnac, 77–86.

Agnati, U. 2000: 'Le Dodici Tavole: il versetto VII, 8 e l'actio aquae pluviae arcendae, Presentazione di F. Sitzia'.

Aldrete, G. S. 2007: *Floods of the Tiber in Ancient Rome*, Baltimore.

Allinne, C., Galve, M. P., and Constante, A. 2012: 'Archéologie du risque d'inondation et gestion des zones humides en milieu urbain : l'exemple de Saragosse (Aragon, Espagne)', in J.-P. Bost (ed.), *L'eau : usages, risques et représentations dans le Sud-Ouest de la Gaule et le Nord de la péninsule Ibérique, de la fin de l'âge du Fer à l'Antiquité tardive, II^e s. a.C.-VI^e s. p.C.*, Bordeaux, 49–84.

Allinne, C., and Leveau, P. 2002: 'Les villes antiques du Rhône et le risque fluvial', in R. Favier (ed.), *Les pouvoirs publics face aux risques naturels dans l'histoire*, Grenoble, 195–218.

Alzon, C. 1963: 'Réflexions sur l'histoire de la "locatio-conductio"', *Revue Historique de Droit Français et Étranger* 41, 553–591.

Babusiaux, U. 2006: *Id quod actum est: zur Ermittlung des Parteiwillens im klassischen römischen Zivilprozess*. Münchener Beiträge zur Papyrusforschung und antiken Rechtsgeschichte. Heft 95, Munich.

Baladié, R. 1980: *Le Péloponnèse de Strabon: étude de géographie historique*. Collection d'études anciennes, Paris.

Bammer, A. 1993: 'Fouilles à l'Artémision d'Éphèse (périodes géométrique et archaïque) : nouvelles données', *Revue Archéologique*, 187–199.

Beck, U. 1986: *Risikogesellschaft: auf dem Weg in eine andere Moderne*, Frankfurt am Main.

Bedini, A. 1997: 'Modi di insediamento e bonifica agraria nel suburbio di Roma', in S. Quilici Gigli (ed.), *Uomo acqua e paesaggio: atti dell'Incontro di studio sul tema*, Rome, 165–184.

Bedon, R. 2005: 'Séismes et éruptions volcaniques: réactions du pouvoir et de la société pendant la période impériale', in R. Bedon and E. Hermon (eds), *Concepts, Pratiques et Enjeux Environnementaux Dans l'Empire Romain. Actes Du Colloque Organisé en 2004 à l'université Laval de Québec*. Caesarodunum 39, Limoges, 353–375.

Blaikie, P. M., Cannon, T., Davis, I., and Wisner, B. 2004: *At Risk: Natural Hazards, People's Vulnerability and Disasters*, 2nd ed., London.

Borsch, J. 2018: *Erschütterte Welt: soziale Bewältigung von Erdbeben im östlichen Mittelmeerraum der Antike*, Tübingen.

Bousquet, B. 2006: 'Les séismes de l'Antiquité, entre nature et société', *Publications de l'Académie des Inscriptions et Belles-Lettres* 17, 33–59.

Bretone, M. 1998: *I fondamenti del diritto romano. Le cose e la natura*. Biblioteca universale Laterza 534, Rome.

Buckland, W. W. 1921: *A Text-Book of Roman Law from Augustus to Justinian*, Cambridge.

Burton, I., Kates, R. W., and White, G. F. 1978: *The Environment as Hazard*, New York.

Campbell, B. 2012: *Rivers and the Power of Ancient Rome*.

Capogrossi Colognesi, L. 1966: *Ricerche sulla struttura delle servitù d'acqua in diritto romano*. Quaderni di 'Studi Senesi', 14, Milan.

Crouch, D. P. 1993: *Water Management in Ancient Greek Cities*, New York.

De Simone, G. F. 2017: 'The Agricultural Economy of Pompeii', in M. Flohr and A. Wilson (eds), *Economy of Pompeii*. Oxford studies on the Roman economy, Oxford, 24–52.

Deeg, P. 2019: 'Der Kaiser und die Katastrophe: Untersuchungen zum politischen Umgang mit Umweltkatastrophen im Prinzipat (31 v. Chr. bis 192 n. Chr.)', Stuttgart.

Dessales, H. 2011: 'Les savoir-faire des maçons romains, entre connaissance technique et disponibilité des matériaux. Le cas pompéien', in N. Monteix and N. Tran (eds), *Les savoirs professionnels des gens de métier : études sur le monde du travail dans les sociétés urbaines de l'empire romain*. Collection du Centre Jean Bérard, 37 ; Archéologie de l'artisanat antique, 5, Naples, 41–63.

– 2012: 'Not built in a day: awareness of vulnerability and construction techniques in Roman times', in R. Carvais, A. Guillerme, V. Nègre, and J. Sakarovitch (eds), *Nuts and Bolts of Construction History: Culture, Technology and Society*, Vol. 3, Paris, 3:471–477.

– 2014: *La Construction Anti-Sismique Dans Le Monde Romain*. Savoir ENS. Séminaire Transferts culturels 2013-2014, Paris. Available from <<http://savoirs.ens.fr//expose.php?id=1582>>. Accessed 30 October 2018.

Du Plessis, P. J. 2004: 'The protection of the contractor in public works contracts in the Roman Republic and Early Empire', *The Journal of Legal History* 25, 287–314.

Fachard, S., Reden, S. von, Ducrey, P., and Derron, P. (eds) 2017: *Économie et Inégalité : Ressources, Échanges et Pouvoir Dans l'Antiquité Classique. Huit Exposés Suivis de Discussions*, Entretiens sur l'Antiquité classique, 63, Vandœuvres.

Festy, M. 1999: 'Introduction', in M. Festy (ed. and transl.), *Pseudo-Aurélius Victor. Abrégé des Césars*, Collection des universités de France, Série latine - Collection Budé 353, Paris.

Fiorentini, M. 2003: *Fiumi e mari nell'esperienza giuridica romana: profili di tutela processuale e di inquadramento sistematico*, Milan.

Frier, B. W. 1980: *Landlords and Tenants in Imperial Rome*, Princeton.

Gerken, J.-F. 1995: 'Exégèse de Paul. D. 39,3 (de aqua et aquae pluviae arcendae), 2,6', *Tijdschrift voor Rechtsgeschiedenis* 63.

Giaro, T. 1975: 'Il limite della responsabilità ex cautione damni infecti: (Contributo allo studio della forza maggiore nel diritto romano classico)', *Bullettino dell'Istituto di Diritto Romano 'Vittorio Scialoja'*, 271–283.

Gros, P. 2010: 'La nouvelle Rome de César : réalité et utopie', in G. Urso (ed.), *Cesare : Precursore o Visionario ? Atti Del Convegno Internazionale Cividale Del Friuli, 17-19 Settembre 2009*, Pise, 265–284.

Guarino, A. 1980: 'La formazione dell'edito perpetuo', *Aufstieg Und Niedergang Der Römischen Welt*, II, 13 II, 62–102.

Harfouche, R. 2005: 'Contradictions et complémentarité des sources à propos de l'arboriculture en terrasses', *Archéologie du Midi médiéval*, 23/1 23, 39–60.

– 2007: *Histoire Des Paysages Méditerranéens Terrassés : Aménagements et Agriculture*, BAR International Series, 1634, Oxford.

Harless, G. C. (ed.) 1829: *Sexti Aurelii Victoris Historia Romana, Ex Ed. T.C. Harlessii Cum Notis et Interpretatione in Usum Delphini Recensita (Vol. 1)*, Londres.

Hettinger, J. 2018: 'Nil mutandum censuerat. Wie aus religiöser Scheu antike Hochwasserprävention wird', in M. Bernhardt, W. Blösel, S. Brakensiek, and B. Scheller (eds), *Möglichkeitshorizonte. Zur Pluralität von Zukunftserwartungen und Handlungsoptionen in der Geschichte*, 91–104.

Horden, P., and Purcell, N. 2000: *The Corrupting Sea: a Study of Mediterranean History*, Oxford.

Jacobs, P. W., and Conlin, D. A. 2014: *Campus Martius: The Field of Mars in the Life of Ancient Rome*, Cambridge.

Jones, C. P. 2014: 'Earthquakes and Emperors', in A. Kolb (ed.), *Infrastruktur und Herrschaftsorganisation im Imperium Romanum: Herrschaftsstrukturen und Herrschungspraxis III : Akten der Tagung in Zürich 19.-20.10.2012*, Berlin, 52–65.

Kaser, M. 1957: 'Periculum locatoris', *Zeitschrift der Savigny-Stiftung für Rechtsgeschichte : Romanistische Abteilung* 74, 155–200.

– 1984: 'Ius honorarium' und 'ius civile', *Zeitschrift Der Savigny-Stiftung Für Rechtsgeschichte. Romanistische Abteilung*, 101, 1–114.

Kaser, M., and Knütel, R. 2008: *Römisches Privatrecht*, 19. überarb. und erw. Aufl. Kurzlehrbücher für das juristische Studium, Munich.

Kingsbury, B. 2018: *An Imperial Disaster: The Bengal Cyclone of 1876*, Oxford.

Kokkinia, C. 2000: *Die Opramoas-Inschrift von Rhodiapolis: Euergetismus und soziale Elite in Lykien*. Antiquitas. Reihe 3; Abhandlungen zur Vor- und Frühgeschichte, zur klassischen und provincial-römischen Archäologie und zur Geschichte des Altertums, Bd. 40, Bonn.

Le Gall, J. 1953: *Le Tibre, fleuve de Rome dans l'antiquité*. Publications de l'Institut d'art et d'archéologie de l'Université de Paris, Paris.

Le Roux, P. 1997: 'Les cités de l'Empire romain de la mort de Commode au Concile de Nicée', in J.-P. Bost and J.-L. Voisin (eds), *Pallas, Hors-série 1997. L'empire romain de 192 à 325*, Toulouse, 31–55.

Lenel, O. 1883: *Das Edictum Perpetuum. Ein Versuch Zu Dessen Wiederherstellung*, Leipzig.

Lonardi, A. 2013: *La cura riparum et alvei Tiberis: storiografia, prosopografia e fonti epigrafiche*. BAR international series ; 2464, Oxford.

MacCormack, G. 1971: 'The Cautio Damni Infecti: Buyer and Seller', *Zeitschrift der Savigny-Stiftung für Rechtsgeschichte: Romanistische Abteilung* 88, 300–321.

– 1979: 'Periculum', *Zeitschrift der Savigny-Stiftung für Rechtsgeschichte : Romanistische Abteilung* 96, 129–172.

Maganzani, L. 2010: 'Ripae fluminis e dissesti idrogeologici a Roma: fra indagine geomorfologica e riflessione giurisprudenziale', *Jus. Rivista Di Scienze Giuridiche* 57, 175–193.

– 2014: 'Le inondazioni fluviali in Roma antica: aspetti storico-giuridici', in M. Galtarossa and L. Genovese (eds), *La Città Liquida, La Città Assetata: Storia Di Un Rapporto Di Lunga Durata*, Rome, 65–80.

Marzano, A. 2007: *Roman Villas in Central Italy: A Social and Economic History*, Leiden.

– 2018: 'Fish and Fishing in the Roman World', *Journal of Maritime Archaeology* 13, 437–447.

Mayer-Maly, T. 1956: *Locatio conductio: eine Untersuchung zum klassischen römischen Recht*. Wiener rechtsgeschichtliche Arbeiten Bd. 4, Wien.

– 1984: 'Aequo animo ferre', in A. Biscardi, J. Modrzejewski, and H. J. Wolff (eds), *Mnēmē : Georgiou A. Petropoulos (1897-1864)*, Athens, 105–115.

Möller, C. 2010: *Die Servituten: Entwicklungsgeschichte, Funktion und Struktur der grundstückvermittelten Privatrechtsverhältnisse im römischen Recht*. Quellen und Forschungen zum Recht und seiner Geschichte, 16, Göttingen.

– C. 2018: 'Römischrechtliche Regelungskonzepte für Regenwasser', in I. Czeguhn, C. Möller, Y. Quesada Morillas, and J. A. Pérez Juan (eds), *Wasser - Wege - Wissen auf der iberischen Halbinsel. Eine interdisziplinäre Annäherung im Verlauf der Geschichte*. Berliner Schriften zur Rechtsgeschichte, 9, Baden-Baden, 9–34.

Morley, N. 1996: *Metropolis and Hinterland: The City of Rome and the Italian Economy, 200 BC-AD 200*, Cambridge.

– 2015: "'The same procedure as last year": Wasserregelung im römischen Reich. Konkurrenz und Konflikt zwischen Ökologie und Recht', in S. von Reden and C. Wieland (eds), *Wasser. Alltagsbedarf, Ingenieurskunst Und Repräsentation Zwischen Antike Und Neuzeit*. Umwelt und Gesellschaft, Band 14, 77–94.

Nakahara, K., Nagase, T., Takahashi, Y., and Hisatoku, T. 2000: 'Earthquake Response Of Ancient Five-Story Pagoda Structure Of Horyu-Ji Temple In Japan', in New Zealand Society for Earthquake Engineering (ed.), *12WCEE 2000: 12th World Conference on Earthquake Engineering, Auckland, New Zealand, Sunday 30 January - Friday 4 February 2000. Vol. 8. Structural Engineering*, Upper Hutt, N.Z., n.p.

Nielsen, I. 2014: 'Creating Imperial Architecture', in R. B. Ulrich and C. K. Quenemoen (eds), *A Companion to Roman Architecture*. Blackwell companions to the ancient world, Oxford ; Malden, MA, 45–62.

Pichlmayr, F. 1911 : 'Einleitung', in F. Pichlmayr (ed. and transl.), *Sexti Aurelii Victoris Liber de Caesaribus. Praecedunt Origo Gentis Romanae, et Liber de Viris Illustribus Urbis Romae, Subsequitur Epitome de Caesaribus*, Bibliotheca Scriptorum Graecorum et Romanorum Teubneriana, Leipzig.

Poehler, E. E. 2012: 'Drainage system at Pompeii: mechanisms, operation and design', *Journal of Roman Archaeology*, 95–120.

Purcell, N. 1987: 'Tomb and Suburb', in H. von Hesberg and P. Zanker (eds), *Römische Gräberstrassen: Selbstdarstellung, Status, Standard : Kolloquium in München vom 28. bis 30. Oktober 1985*. Veröffentlichungen der Kommission zur Erforschung des Antiken Städtewesens, Munich, 25–41.

– 1994: 'The city of Rome and the plebs urbana in the late Republic', in J. A. Crook, A. W. Lintott, and E. Rawson (eds), *The Cambridge Ancient History. Volume 9, The Last Age of the Roman Republic, 146-43 B.C.*, 2nd ed., Cambridge, 644–688.

– 1996: 'Rome and the Management of Water. Environment, Culture and Power', in G. Shipley and Salmon (eds), *Human Landscapes in Classical Antiquity : Environment and Culture*, Londres, 180–212.

– 2017: 'Mountain Margins. Power, Ressources and Environmental Inequality in Antiquity', in S. Fachard, S. von Reden, P. Ducrey, and P. Derron (eds), *Économie et Inégalité : Ressources, Échanges et Pouvoir Dans l'Antiquité Classique. Huit Exposés Suivis de Discussions*, Entretiens sur l'Antiquité classique, 63, Vandœuvres, 75–114.

Quilici Gigli, S. 1995: 'Bonifica agraria e difesa dei territori montani: alcuni interventi nella Bassa Sabina', in L. Quilici and S. Q. Quilici Gigli (eds), *Interventi di bonifica agraria nell'Italia romana*, 129–156.

– 1997: 'L'irregimentazione delle acque nella trasformazione del paesaggio agrario dell'Italia centro-tirrenica', in S. Quilici Gigli (ed.), *Uomo acqua e paesaggio: atti dell'Incontro di studio sul tema*, Rome, 193–212.

Quilici, L., and Quilici-Gigli, S. 2009: 'Segni archeologi nella ricostruzione delle coltivazioni agrarie', in J. Carlsen and E. Lo Cascio (eds), *Agricoltura e scambi nell'Italia tardo-repubblicana*, Bari.

Rainer, J. M. 1992: 'Zur locatio conductio: der Bauvertrag', *Zeitschrift Der Savigny-Stiftung Für Rechtsgeschichte: Romanistische Abteilung* 108, 505–525.

– 1993: 'Servius und Labeo zur cautio damni infecti', in M. J. Schermaier and Z. Végh (eds), *Ars boni et aequi: Festschrift für Wolfgang Waldstein zum 65. Geburtstag*, Stuttgart, 285–302.

– 2019: 'Die Interdikte zum Schutze von Straßen und Wasserwegen im Römischen Recht', in C. Möller and M. Ronin (eds), *Instandhaltung Und Renovierung von Straßen Und Wasserleitungen von Der Zeit Der Römischen Republik Bis Zur Spätantike / Entretien et Restauration Des Infrastructures Routières et Hydrauliques de l'époque Républicaine à l'Antiquité Tardive*. Berliner Schriften zur Rechtsgeschichte, 10, Baden-Baden, 47–54.

Robinson, O. F. 2003: *Ancient Rome: City Planning and Administration*.

Rodger, A. 1970: 'Roman Rain Water', *Revue d'Histoire Du Droit* 38, 417–431.

Romeu, V., Lagomarsino, S., Parodi, S., and Varum, H. 2011: 'Seismic vulnerability and risk assessment: Case study of the historic city centre of Coimbra, Portugal', *Bulletin of Earthquake Engineering* 9, 1067–1096.

Royo, M. 2014: 'Domicilium Orbis Terrarum ou comment Rome devient capitale', *Pallas. Revue d'études antiques*, 53–74.

Sablayrolles, R. 1996: *Libertinus miles. Les cohortes de vigiles*. Publications de l'École française de Rome 224, Rome.

Salerno, F. 2007: "'Suum agrum meliorem facere". Aspetti dell "a.a.p.a." in eta giustiniana', *Studi per Giovanni Nicosia, VII*, Milan, 197–208.

– 2008: 'Opus manu factum, natura agri et l'utilisation de l'eau de pluie dans la jurisprudence romaine', in E. Hermon (ed.), *Vers une gestion intégrée de l'eau dans l'empire romain. Actes du colloque international, Université Laval, octobre 2006*, Rome, 271–276.

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*, Beyrouth.

– 2011: 'Les compétences juridiques de l'architecte d'après Vitruve (*De Architectura* I, 1, 10)', *Cahiers Des Études Anciennes* 48, 211–217.

– 2012: 'Le déroulement du chantier à Rome et dans le monde romain durant la période républicaine et le Haut-Empire : une approche juridique', in S. Camporeale, H. Dessales, and A. Pizzo (eds), *Arqueología de la construcción: la economía de las obras. École Normale Supérieure, Paris, 10-11 de diciembre de 2009*, Anejos del Archivo español de arqueología, 64, Mérida, 15–30.

Sargenti, M. 1940: *L'actio aquae pluviae arcendae. Contributo alla dottrina della responsabilità per danno nel diritto romano*, Pubblicazioni dell'Istituto di diritto romano e dei diritti dell'Oriente mediterraneo, 17, Milan.

Scotti, F. S. 2014: 'Actio aquae pluviae arcendae e fossae agrorum siccandorum causa factae. Per un'esegesi di D. 39.3.2.1,2,4,7 alla luce delle tecniche agronomiche antiche', *Jus. Rivista Di Scienze Giuridiche* 2, 273–308.

Sitzia, F. 1999: *Aqua pluvia e natura agri: dalle XII tavole al pensiero di Labeone*, Cagliari.

Sonnabend, H. 1999: *Naturkatastrophen in der Antike: Wahrnehmung, Deutung, Management*, Stuttgart.

Stewart, I. S., and Piccardi, L. 2017: 'Seismic faults and sacred sanctuaries in Aegean antiquity', *Proceedings of the Geologists' Association* 128, 711–721.

Thély, L. 2020: *Les Grecs face aux catastrophes naturelles. Savoirs, histoire, mémoire, Les Grecs face aux catastrophes naturelles : Savoirs, histoire, mémoire*. Bibliothèque des Écoles françaises d'Athènes et de Rome, Athènes. Available from <<http://books.openedition.org/efa/1536>>. Accessed 14 September 2021.

Thomas, R., and Wilson, A. 1994: 'Water Supply for Roman Farms in Latium and South Etruria', *PBSR* 62, 139–196.

Toner, J. P. 2013: *Roman Disasters*, Cambridge (UK) - Malden (MA, USA).

Veyrac, A. 2006: *Nîmes Romaine et l'eau*, Supplément à Gallia, 57, Paris.

Watson, A. 1968: *The Law of Property in the Later Roman Republic*, Oxford.

– 2001: *The Evolution of Western Private Law*, Baltimore.

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