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KEY WORDS: Roman science; land-surveying; imperialism; ancient mathematics; Frontinus; ancient technology

ABSTRACT: This paper aims to cast new light on one of our main sources for ancient science, Sextus Julius Frontinus; to cast new light on the science of the Greco-Roman period; and to contribute ancient materials to present discussions on the relations between power and knowledge, and/or science and empire.

## DIVIDE AND RULE: FRONTINUS AND ROMAN LAND-SURVEYING

Serafina Cuomo\*

Imperialism [...] is an act of geographical violence  
through which virtually any space in the world  
is explored, charted, and finally brought under control.<sup>1</sup>

This article has three main aims: to cast new light on one of our main sources for ancient science, Sextus Julius Frontinus; to cast new light on the science of the Greco-Roman period; and to contribute ancient materials to present discussions on the relations between power and knowledge, and/or science and empire.

Probably a *homo novus*, whose family may have been from Gallia Narbonensis, Frontinus rose to become, according to a younger contemporary, one of “the most respected citizens of his time”<sup>2</sup>. His public career was long and varied: he may have been procurator in Spain in AD 68 and was at the head of an army in Gaul by AD 70. He also fought in Britain, where he was governor ca. 76, before handing the command over to Agricola. During this time he defeated the tribe of the Silures of North-East Wales and started to build a road through their territory. It also seems that he led an

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army in Germany around AD 83. In between military expeditions, he had been nominated praetor and then prefect of the city of Rome and, perhaps in 73, consul for the first time. He was proconsul of Asia ca. AD 86 and consul in 98 and again in 100 (both times his partner in the consulship was the Emperor Trajan). We also know that he was appointed supervisor of the aqueducts (probably in AD 97); that he was augur until Pliny the Younger took over from him in 103, and that at some point he was elected to sit on a senatorial committee in charge of reducing public expenditure. Frontinus' death can be placed in AD 103, given that augurs were usually appointed for life<sup>3</sup>.

Frontinus is often described as the quintessential Roman public officer: a sober, pragmatic, no-nonsense kind of man, the embodiment of 'typical' Roman pragmatism, which valued practical applications of science over pure speculations and led him to praise Rome's water supply system thus:

With so many necessary buildings carrying so many waters  
compare, if you like, the idle pyramids or the other works of the  
Greeks, inane but celebrated by fame<sup>4</sup>.

The remark above is contained in Frontinus' most famous work, about the aqueducts of the city of Rome (*De aquis urbis Romae*). He also wrote a book on military tactics (the *Stratagemata*), and one on land-surveying (*De arte mensoria*)<sup>5</sup>. It is on this latter that my article will concentrate.

Several studies have already been published on Roman land-surveying, so we need not repeat the basics here: historians have examined how centuriation

(the division of land according to a uniform square pattern) was actually carried out in the field; what were the procedures and instruments involved; and what the mathematical knowledge of the *agrimensores* amounted to. They have speculated on the land-surveyors' training, and on the influence of Greek mathematics on their treatises. There are accounts, based on literary, legal and epigraphical evidence, of how the role of the *agrimensores* changed over time, and of their social composition<sup>6</sup>.

Finally, more recent essays have underlined the political significance of land-surveying as an instrument of Empire, sometimes by reference to particular regions<sup>7</sup>. Centuriation has been described as

a spectacular display of the conqueror's power. Although some environments are more tractable than others for centuriation, the amenability of the terrain does not determine this response [...]

Much more important is the wish to punish and repress.<sup>8</sup>

While land-surveying is being recognized as a fundamental part of the processes of 'Romanization', or, more generally, of administration of the Empire, I think one important factor is being left out of the picture. Centuriation did not simply happen - the acts of geographical violence were carried out by people, i.e. the *agrimensores*. In a more or less official capacity, they dealt with the business of dividing up the land, assigning it in ways that could be recognized as equitable and acting as experts in disputes about boundaries, ownership or rights of way.

Most of the studies to which I have referred talk about the *agrimensores* as if they were more or less impersonal or uncomplicated elements in an activity which in a sense overrides them as individuals: the evidence from the *Corpus Agrimensorum Romanorum* (a collection which is our main literary source on land-surveying) is generally used as if the manifest differences in the time, aims and social circumstances of its authors could be ignored. It is true that cross-references, commenting and excerpting are common practice in the *Corpus*; and it is also true that the land-surveyors saw themselves, to some extent, as a group - but to *what* extent is not clear. Indeed, in my view, we still know very little about how the *agrimensores* saw themselves, their job, the kind of knowledge it required, the ethical and political connotations it carried. Frontinus is one of the few authors in the *Corpus* on whom we have separate evidence, he belonged to the ruling elite, so he looks like the ideal case-study. Back to his treatise on land-surveying<sup>9</sup>, it is traditionally divided into four parts, the first of which describes three types of terrain: parcelled out and assigned ("divisus et adsignatus"); measured by its boundaries ("mensura per extremitatem comprehensus") and not measured ("qui nulla mensura continetur" or *arcifinius*). Different types corresponded to different administrative and fiscal status: for instance, the first type, as Frontinus indicates, was typical of Roman settlements, called *coloniae*, whose land was distributed, for instance, to war veterans, while the third type of field was originally frontier territory. The second part of Frontinus' text testifies to the legal role of land-surveyors: fifteen types of controversies are presented upon

which the practitioner may be called to express his professional opinion, either directly or as the advisor of a judge. These included disputes about boundaries, ownership, public pastures, flood water, rights of way and so on. A short history of land-division and a discussion of various units of measure are taken up in the third part. Frontinus follows the first-century BC author Varro in attributing the origin of the surveying art to the Etruscan *haruspices*, a group of official diviners who not only read omens, but decided the best sites for the foundation of temples and cities. A *haruspex* would orientate the sides of a temple in the direction of the four cardinal points. This practice, Frontinus claims, is at the origin of the laying out by the land-surveyor of the two main lines of orientation for a centuriation grid, *decumanus* and *cardo*.

The fourth part of Frontinus' treatise, which goes by the title *On the art of measuring*, deals with the land-surveyor's task in general. It starts thus:

The basis of the art of measuring lies in the experience of the agent. It is in fact impossible to express the truth of the places or of the size without calculable lines, because the wavy and uneven edge of any piece of land is enclosed by a boundary which, because of the great quantity of unequal angles, can be contracted or expanded, even when their number [of the angles] remains the same. Indeed pieces of land which are not finally demarcated have a fluctuating space and an uncertain determination of *iugera*. But, in order that for each border its type is established and the size of what is enclosed within is determined, we will divide the piece of

land, to the extent allowed by the position of the place, with straight lines. [...] We also calculate the area enclosed within the lines using the method of the right angles. [...] Having assigned boundaries to its space, we restore the place's own truth. The multifarious nature of places does not let this occur in the same way everywhere, since in some places there are mountains on one side, elsewhere a river, or banks or some gorge with steep ground, with many uneven and rough places, also often there are cultivations, because of which it is necessary to make the most of the richness of the art. For any smallest part of the land which is to be in the power of the measurer must be bound with the method of the right angles, according to what he requires.<sup>10</sup>

This text is remarkable for many aspects, but let me just single out two of them: the idea that there is a 'truth' of the place, and the references to straight lines and right angles.

The two things are connected, in that Frontinus is saying that expressing the 'truth' of a place depends on its being enclosed by a network of straight lines intersecting at right angles. What Frontinus also seems to be saying is that there is a sense in which a territory like the field of the type "divisus et adsignatus" described in the first part of the treatise is true, while a field which is "arcifinius" is not, and the criterion for truth is that the "divisus et adsignatus" territory is described in a specific way - a *geometric* way.

If we think that the straight lines in question were not just ideal lines, but concretely roads, ditches or hedges, this is geometrization in a strong sense: the land-surveyor transforms the landscape, the territory becomes a different kind of object from what it was before. Geometrization has obviously the advantage of making the piece of land amenable to measurement and calculation: the land-surveyor is now able officially to express its size. The operation in question, called “renuntiatio modi”, is often mentioned in our legal and epigraphical sources<sup>11</sup>.

The two operations of mapping out the territory and calculating its size - of measuring and counting, of *mathematizing* the territory - are made to equate truth, or, in other words, are seen as amounting to an expression of the real nature of the territory. In this sense, centuriation is also a knowledge act. In Frontinus' passage, the identification between mathematization and knowledgeability is reinforced by a language of grasping, surrounding and enclosing. These words denote both the physical, material act of setting boundaries and drawing lines around plots of land, and the knowledge act of the surveyor, who, by mapping out the plot of land and expressing its size with a number, apprehends it.

The act of centuriation, which is, at a basic level, a ‘practical’ or ‘technical’ act, is thus inextricably intertwined with knowledge acts and, to the extent to which ‘grasping’ a territory means establishing control over it, is also a deeply political act. Thus, the fields whose borders are not conclusively demarcated (literally, they are ‘open-ended’, *soluti*) can arbitrarily grow and diminish in

size: non-measured equals confusion, uncertainty, instability. The opposition between surveyed and non-surveyed territory in Frontinus is presented as one between straight (lines) and right (angles) on the one side and sinuous, wavy or oblique (lines) on the other. These terms are not just descriptive - in ancient Latin and Greek usage, and still in many languages today, they usually carried positive or negative connotations. We still say that someone is crooked or that something is straightforward<sup>12</sup>.

To sum up, Frontinus' account of the business of land-surveying conveys the idea that the mathematization of an object (a field in this case) makes it into the object of reliable knowledge, the idea that this operation brings control over the object and the idea that it has positive political and, by extension, ethical significance.

Now, if we look at Frontinus' treatise on the aqueducts, the same ideas are conveyed, often employing similar terminology. One of the points that *De aquis* makes more forcibly is the state of chaos and mismanagement with which Frontinus was faced when he took up his job as supervisor for the water supply in Rome. A great number of private citizens tapped illegally into public reservoirs or conduits; they often used nozzles or pipes larger than they had been permitted to use; they used water for improper purposes, such as sewage disposal. The problems faced by Frontinus are not due to adverse physical conditions - the enemy to subdue is not so much hostile nature (as was at least partly the case with land-surveying) as much as irresponsible and corrupt members of the body politic. That said, Frontinus' task was not much

unlike that of having to bring a wild territory under rule and square, so to speak, and the way he went about it presents some parallels to what he prescribes for the land-surveyor.

First of all, he says, he had a map made of the aqueducts, to see where the conduits lay, and get a better idea about their maintenance and repair. Map-making was of course one of the *agrimensores*' primary tasks, and there have been many studies on the administrative and political role of maps. Indeed, it is extremely likely that the same people, probably *apparitores* whose technical competences extended from architecture to land-surveying, produced both maps like the one Frontinus required for his aqueducts, and cadaster maps like the one found at Orange or larger-scale items like the *Forma Urbis* itself<sup>13</sup>.

Secondly, Frontinus streamlined his administrative domain. Each aqueduct is systematically described in the text first in terms of its history and then in terms of numbers: figures are given for its length, the distance between its source and the city, and finally its output, assessed on the basis of the diameter of the pipes<sup>14</sup>. Thanks to his measurements, he claims, Frontinus was able to detect frauds and abuses, because he noticed the discrepancy between input at source and output once inside the city. The emphasis put on measurement and the overall mathematical outlook provide Frontinus with a rhetoric of objectivity and accuracy in which to embed his presentation of himself as an honest and competent administrator<sup>15</sup>.

Finally, Frontinus chose one particular type of pipe, the *quinaria*, as the standard type and ruled that authorized standard pipes and nozzles had to be

stamped with an official mark, and no unstamped pipes or nozzles could be used. Imposing a standard is clearly at the same time a pragmatic administrative choice - uniformity facilitates repairs and control of misappropriations - and a political one - the fact itself that someone has the authority to set a standard unequivocally signals where the power lies.

Now, it is often assumed that Roman land-surveying used a standard measure unit of twenty by twenty *actus* for centuriation. Much as that would help my argument, I think that further careful review of the evidence is necessary before such a strong claim can be sustained. Yet, a weaker claim can certainly be made that centuriation in general was a type of standardization, the imposition of uniformity on a territory and therefore also an indication of authority, as well as a form of unification and amalgamation of different social, juridical and geographical realities and a way for centralized power to exert control over the peripheries<sup>16</sup>.

It is to be noted that the term (in itself rather unusual, at least in this context) that Frontinus uses to denote non-standardized nozzles is again *soluti*, 'open-ended', and indeed, like the non-centuriated fields, non-standardized nozzles could be enlarged and diminished in an uncontrolled way by dishonest people. Then again, when Frontinus talks about the size of the pipes, or the amount of water they deliver, the word he uses is *modus*, the same term employed by him and in a general land-surveying context to indicate the size of a field. The role of the public officer is in either case a form of control, management and distribution to the body politic of an essential means of

living (water or land), according to modalities and in quantities which are monitored by the administrative powers. The *modus* is an expression of the way in which the distribution and control of those essential means of living were conceptualized.

Analogously to the land-surveying treatise, the treatise on aqueducts teems with quite explicit ethical overtones: a lack of stable measurements brings about abuse and fraud, while

everything that is bounded by measure must be certain,  
unchanged and equal to itself.<sup>17</sup>

The imposition of a standard is a way of avoiding arbitrariness and an act of justice, just as parcelling out land in equal lots grants equality of distribution. Also, measuring land is made to amount to restoring something that essentially belonged to the place, its truth.

The emerging picture is, then, one where the administrative tasks of land-surveyor and aqueduct-surveyor have got something in common. Were the people involved in land-surveying the same as those involved in aqueduct-surveying? The question is basically a question about the audience of Frontinus' treatises, and, in the case of *De aquis*, it has received some satisfactory (at least in my view) answers. Frontinus' account, written around AD 98, has been seen as the expression of the Senate's claims to a more prominent deliberative role in the administration. After Domitian's death in 96 and Nerva's brief principate, a year followed when Trajan, the new

Emperor elect, was away from Rome. The Senate apparently took this opportunity to reinstate some decisional power and hail the return of old privileges. With his celebration of the perfect administrator of senatorial rank (an ideal embodied by himself, whose exemplary *cursus honorum* duly included governorships and military experience), Frontinus was thus expressing ideas about running the state which were shared by his fellow senators<sup>18</sup>.

Arguably, that can be said of his ideas about land-surveying, too. To borrow Purcell's phrase again, I am of the opinion that these ideas were intimately connected with the structures of power and with the whole range of ways in which those who managed the Roman state conceived of their imperium in the world<sup>19</sup>.

Interpreting *De arte mensoria* presents the additional problem that, unlike *De aquis* and *Stratagemata*, it does not seem to be immediately connected with any of Frontinus' public appointments.

First of all, the links between land-surveying and military surveyors and road-builders on the one hand, and augurship and omen-taking on the other are well attested. Thus, we can assume that once again Frontinus' works did stem in some way from his public roles. But I do not think that Frontinus actually was a land-surveyor, and I think it is important to underline this, because it distinguishes him from several authors in the *Corpus*, some of them

probably younger contemporaries of his, who mention their first-hand experiences in the field or refer to land-surveying as “our profession”<sup>20</sup>. Frontinus' treatises on land-surveying, again unlike the others in the *Corpus*, contain little in the way of actual mensuration procedures or techniques. He does not come across as a technical expert in land-surveying; nor is he an expert on aqueducts: in the latter case, he actually declares his wish to familiarize himself with the job<sup>21</sup>. At the same time, he is aware of the power that expertise can command, and wants to make sure that the leadership remains firmly in his own hands, rather than being delegated to others who possess the ‘know-how’ he lacks. He says in *De aquis*:

There is nothing as dishonourable for a decent man as to conduct an office entrusted to him on the basis of the prescriptions of his assistants, which it is necessary to do, every time that the ignorance of the person in charge has recourse to the experience of those who, even though they are parts necessary to the task, should still be like some sort of hand and instrument of the agent.<sup>22</sup>

I think that passages like the one quoted above throw some light on the contentious question of professionalism in the Roman imperial administration<sup>23</sup>. Although career advancement, as is well known, was mainly a function of social status, connections and, at most, service in the army, it is also true that issues such as the importance of competence or expertise did

arise. Especially in cases where some specialized knowledge was required for the task at hand (for instance, architects or indeed land-surveyors), there was potential for clashes between leadership by prestige, so to speak, and the potential for leadership given by experience, know-how and a different network of connections built over the years. Think of the *aquarii* themselves, who clearly were more powerful with respect to the average citizen than Frontinus himself, who was 'in charge' fleetingly and probably without much expectation of real involvement<sup>24</sup>.

If indeed Frontinus was making a stance for senatorial entitlement to key administrative tasks, his technical treatises would have provided the edge required, in that they informed about some technical matters (enough to prove one's authority) while at the same time stressing the political, ethical and intellectual values involved, so that leadership could reassuringly not be limited to expertise, but be presented as depending on a number of qualities that public officers like himself embodied at their best.

Most of the land-surveying activity in the period that goes from Vespasian to Trajan seems to have been concerned less with the centuriation of new settlements<sup>25</sup> than with the administration of old ones. We have numerous inscriptions from various parts of the Empire which document mainly two kinds of activity: resolution of boundary disputes and restitution of *ager publicus* (public land) to public ownership<sup>26</sup>. The Orange cadaster dates from this period; it was accompanied by a large inscription, dated AD 77, with

which the emperor Vespasian announced the restitution of public land and some other revisions of land administration in the area.

The intervention on the part of the government in local territorial situations, denoted by the inscriptions relative to land-surveying, was often unpopular. For instance, restitution of public land in most cases meant that the Emperor could then lease the land to private individuals and use the money to fill up the state coffers, which under Vespasian's predecessor had reached an all-time low. Some of these operations provoked such negative reactions that reversing them could be a good means to acquire some favour: Domitian for instance, effectively nullifying Vespasian's and Titus' decisions, returned some land to those land owners who had had the usufruct of it for more than a certain period<sup>27</sup>.

Or again, in a group of inscriptions, dating ca. AD 114, Caius Avidius Nigrinus, pro-praetorian legate to Achaea during the principate of Trajan, documented the settlement of several disputes between Delphi and neighbouring cities. After listening to the parties in question, personally inspecting the boundary areas and examining the evidence, in the form both of previous decrees and of testimonies, Nigrinus declared in one inscription:

After devoting quite a lot of time to this business and having scrutinized for several days anything that could be gathered from knowledge of individuals or from extant documents, I have included in this decision what seemed to agree the most with the judgement of the memory-men; a decision on the basis of which,

even if it does not quite fulfil the hopes of each party, at least in the future they will be able to see what their actual possessions are, thanks to the goodness of the emperor, and this will happen without dispute<sup>28</sup>.

The inscriptions from Delphi give a glimpse into the difficulty of managing factors such as conflicting authorities and claims to competence, the importance of old traditions and the role of local officers as opposed to 'imported' ones.

Indeed, discord ripples the surface of Frontinus' accounts, both *De aquis* and *De arte mensoria* (and let us not forget that the third treatise is on war stratagems, including various chapters on how to avoid rebellion among the soldiers, and when to profit from treachery on the enemy's part). The territory which the land-surveyor has to bring under control presents all sorts of hostile features: gorges, valleys, mountains, and discord was internal to the administrative machine itself: official figures, such as the watermen (*aquarii*), are represented as unmitigatedly corrupt. In both cases, the administrator is faced with chaos and wilderness, both physical and moral, and it is his duty to regulate and harness them. The other presence haunting Frontinus' accounts is the people to be administered, the customers, so to speak; the beneficiaries of land and water. In this case too control was not easy: the hostile reactions with which Vespasian met, or the complex negotiations going on in Delphi, are just examples.

Control was not easy - this gives an extra spin to Frontinus' idea of mathematization as imposing order on a territory. The imposition of order is a dialectic, dynamic process through which a model of administrative control is applied to the specific nature of a place. This dynamic implies a negotiation of various factors, and I think that the role played by mathematics and by mathematical imagery in this negotiation is fundamental. On the one hand, mathematics guaranteed the possibility and reliability of calculations, and made cataloguing and recording easier, so it was 'directly' useful. On the other hand, it was the values associated with mathematics - fairness, accountability, order, stability, justice - that bolstered the propaganda or, if you like, that mediated the relationship between land-surveyor and land and occupiers, between supervisor of the aqueducts and water supply and people using the water, between administrators and the administered<sup>29</sup>.

The kind of rhetoric, or of imagery, whereby justice and fairness were associated with mathematics had been in place for some time, in fact, since early Greek civilization, and it was often deployed in the context of administration and sometimes of land division itself<sup>30</sup>. Greek colonies were supposedly instituted on the assumption that all the people would receive equal plots of land; geometry itself, according to several authors, had originated from the need for equitable land administration. A first-century AD Greek geometer, Hero of Alexandria, claimed:

The distribution of land according to proportion, equal land to equals and more land to those who deserve it, is universally

judged convenient and necessary. Indeed the entire earth is also divided by nature itself according to merit; correspondingly a great people is assigned a large region, while sometime a small region to a small people, on the same basis. Analogously cities are divided only according to merit: to the leaders and to those who are capable of governing is given more and, according to proportion, to those who are not at all capable of governing one leaves over the small places [...] Yet, if one wants to divide [...] according to a given ratio, so that not even a grain of millet, as it were, of the proportion exceeds or falls short of the given ratio, it takes geometry alone. In this latter, in fact, there is impartial accord, justice, by means of the proportion, and the demonstration of these things is indisputable, which none of the other arts or sciences guarantees<sup>31</sup>.

We can also add that some Latin literature, earlier than Frontinus but still widely read around Frontinus' time, had associated land-surveying and injustice. Apart from Cicero, a number of poets between the end of the first century BC and the beginning of the first century AD created a sort of literary *topos* whereby land division was one of the distinctive signs that the golden age was well and truly over.

This all goes the better to understand, I think, the background to Frontinus' rhetorical strategies. When he presents mathematization as a guarantee of

reliability and, indirectly, of justice in land administration, he does so the more strongly as there were positions to the contrary. The point is not whether mathematics was actually used, but that it fulfilled a rhetorical function, especially in the presence of opposing views.

Let us turn to some conclusions. There is often, I think, an assumption that forms of knowledge with a practical edge, and especially the mathematics which is directly concerned with measuring and calculating, are ‘simple’. They are not the object of reflection, they do not carry ethical or political values - they are not *used* as carriers of values, they are not an essential part of the culture that produced them but are pushed to the margins. Yet, if one looks hard enough at our evidence, one sees that it is not like that, at least not completely. Frontinus was not at the margins of society. The ‘simple’ operation of dividing up the land was a very complex negotiation.

Frontinus' case can also be instructive in reconsidering some still widely-held notions of ‘theory’, ‘practice’, their distinction and their prevalence in Roman *vis-à-vis* Greek science. Centuriation, as a form of control, is both theoretical, ideological, the display of power, and practical, concrete, violent, the actual enforcement of power, or rather it is neither theoretical nor practical, because those categories, which are never used by Frontinus anyway, are not useful here. Far from taking at face value sound-bites such as Cicero's much-quoted

With [the Greeks] geometry was held in utmost honour, so that nothing was considered more prestigious than mathematicians,

but we [the Romans] have restricted the form of this art to the utility of measuring and reckoning<sup>32</sup>

or Frontinus' 'appreciation' of pyramids, we should go behind the surface, see these statements in their context and finally start taking Roman science seriously.

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<sup>1</sup> Said (1993), 271.

<sup>2</sup> Pliny Jr., *Epistulae* 5.1.

<sup>3</sup> On Frontinus' life, see e.g. Ward-Perkins (1937); Eck (1970) and review by Jones (1973); Birley (1981), 69 ff.; Baldwin (1994). Cf. also Head & Poole (1892), nos. 133-135 for the coins from his appointment in Asia.

<sup>4</sup> Frontinus, *De aquis* 16. The reference to pyramids could be considered a *topos* since it can already be found in that other representative of Roman-ness, Pliny the Elder (died AD 79) - he had commented that pyramids were "the idle and stupid ostentation of the wealth of kings", *Historia Naturalis* 36.17.81.

<sup>5</sup> On the *Stratagems*, see Campbell (1987). Among the most recent studies on *De aquis* are Bruun (1991); Evans (1994); DeLaine (1996).

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<sup>6</sup> For instance, Dilke (1971); Hinrichs (1974); *Misurare la terra* (1984-); the papers collected in Behrends & Capogrossi Colognesi (1992); Chouquer & Favery (1992).

<sup>7</sup> For instance, Clavel-Lévêque (1988); Campbell (1995) and (1996); Castillo Pascual (1993) and (1996).

<sup>8</sup> Purcell (1990), 16 and (1996).

<sup>9</sup> I have used K. Thulin's edition of the text (Leipzig: Teubner 1913) whenever possible. As far as Frontinus is concerned, the principal difference with the other main edition (by F. Blume, K. Lachmann, A. Rudorff, Berlin: Reimer 1848-52) seems to be in the handling of Agennius Urbicus, a later author who wrote commentaries on Frontinus, as a source for Frontinus himself. Lachmann & *alii* were more optimistic than Thulin in thinking that some parts of Urbicus' text can be ascribed to Frontinus' with some degree of certainty. The text of Frontinus in Thulin's edition is thus a 'minimalist' version.

<sup>10</sup> "Principium artis mensoriae in agentis positum est experimento. Exprimi enim locorum aut modi veritas sine rationabilibus lineis non potest, quoniam omnium agrorum extremitas flexuosa et inaequalis cluditur finitione [Hinrichs reads flexuosa et inaequalis as adjectives of *extremitas*, *finitione* in relation to the following relative sentence], quae propter angulorum dissimilium multitudinem numeris suis manentibus et cohiberi potest et extendi. Nam soluti mobile habent spatium et incertam iugerum enuntiationem. Sed ut omnibus extremitatibus species sua constet et intra

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clusi modus enuntietur, agrum, quo usque loci positio permittet, rectis lineis dimetiemur. [...] Modum autem intra lineas clusum rectorum angulorum ratione subducimus. [...] adscriptis spatio suo finibus ipsam loci reddimus veritatem. Haec ubique una ratione fieri multiplex locorum natura non patitur, oppositis ex alia parte montibus, alia flumine aut ripis aut quadam iacentis soli voragine, cum pluribus fragosorum locorum iniquitatibus, saepe et cultura, propter quae maxime ad artis copiam est recurrendum. Debet enim minima quaeque pars agri, quae in potestate mensoris est abitura, rectorum angulorum ratione sua postulatione constringi". Text in Hinrichs (1992).

<sup>11</sup> Cf. e.g. Hinrichs (1974), 80 ff. *Renuntiatio* was used to refer to assessing the results of elections in the Roman republic and early Empire, see Hinrichs (1974), 85.

<sup>12</sup> Early examples are e.g. the contrast between 'straight' and 'crooked' in Hesiod, *Works and Days*, or the poem by Simonides where the perfect man is described as being "square without fault" (*tetragwnon a[neu yovgou*), in *Fragmenta* 542 (*apud* Plato, *Protagoras* 339a-346d). For later usage check Liddell-Scott *sub vocibus*.

<sup>13</sup> Cf. e.g. Piganiol (1962); Sherk (1974); Salviat (1977); Conticello de'Spagnolis (1984) and review in Rodriguez Almeida (1988); Nicolet (1988) and review in Millar (1988); Taub (1993). On *apparatores* see Purcell (1983).

<sup>14</sup> On problems connected with measuring the water output see Landels (1978); Rodgers (1986); Hodge (1993).

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<sup>15</sup> Cf. Bruun (1991). While I agree that the function of the numbers in *De aquis* is to some extent “a rhetorical device” and serves the end of “confirming power”, I do not think, *contra* DeLaine, that the rhetoric at work is along the lines of “[manufacturing] an air of mystery around the subject” or “generating wonder”, see (1996), 128 and 139, respectively. In my opinion, a different kind of rhetoric is at work here.

<sup>16</sup> Standardization was of course not unfamiliar in other parts of the Roman world, e.g. brick or *amphorae* production, evidence quoted in Bruun (1991), 56.

<sup>17</sup> *De aquis* 34.

<sup>18</sup> One of the most recent supporters of this view is DeLaine (1996), who quotes previous bibliography.

<sup>19</sup> Purcell (1990), 15.

<sup>20</sup> E.g. Balbus, an army-trained land-surveyor who fought with Trajan or perhaps with Domitian in the Dacian wars (or perhaps against the Germanic tribes, for the uncertainties of interpretation, see Dilke (1971), 42) *Ad Celsum expositio et ratio omnium formarum* 93.14 (Blume edition); Siculus Flaccus, who, according to Dilke (1971), 44, dates from the third century AD, *De condicionibus agrorum* 98.9.

<sup>21</sup> *De aquis* 1.

<sup>22</sup> *De aquis* 2. The ‘agent’ is the main character in the passage I quoted from *De arte mensoria* as well.

<sup>23</sup> On the issues of careers in the administration, see e.g. Saller (1982).

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<sup>24</sup> See also Cicero's unmitigatedly negative images of land-surveyors, who are portrayed as social climbers who use their task to gain wealth and power: *De lege agraria* e.g. 2.17.45; 2.20.53; *Philippicae* 11.5.12; 14.4.10.

<sup>25</sup> New centuriations were carried out in Pannonia during Trajan's principate, cf. Moatti (1993), 94.

<sup>26</sup> The evidence collected in Hinrichs (1974); Moatti (1983). Cf. also Watkins (1988-89).

<sup>27</sup> Agennius Urbicus, *De controversiis agrorum* 41.16 ff. Blume's edition attributed this passage to Frontinus himself.

<sup>28</sup> In Plassart (1970), 294-295.

<sup>29</sup> In this light, I would say that the numbers in *De aquis* belong not to the rhetoric of 'mystery' but to that of 'accountability' - they are there for everybody to see and check for themselves, if they want and are able to do so. Once again, this use of numbers had a long tradition e.g. in the Athenian city-state.

<sup>30</sup> Cf. e.g. Harvey (1965); Boyd & Jameson (1981); Burford (1993); Cartledge (1996); *contra* Asheri (1975).

<sup>31</sup> Hero, *Metrica* 140.5-142.2. It has been convincingly argued that some of the authors in the *Corpus* knew Hero's work: cf. Clavel-Lévêque (1992); Folkerts (1992); Guillaumin (1992).

<sup>32</sup> *Tusculanae disputationes* 1.2.5.