

The representation of power, water, and engineering in early modern Europe – a comparative view on seventeenth-century Italy and England

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I. Water in the early modern period – and politics

In the 16th and 17th centuries the “elemental” reflections on the nature of the world were largely dominated by the ancient tradition, by the theories on four elements, their hierarchy and their various compositions developed by the pre-socratics and their successors; this pagan school of thought amalgamated with the creation theology of Christianity. The world, if reduced to its basics, consisted of the four elements (fire and water, air and earth), and in order to classify them and to define their internal order of precedence, natural philosophers, mathematicians and engineers employed different categories: of weight (heavy and light), temperature (hot and cold) and substance (dry and humid). As far as the respective “standing” of the single elements was concerned, early modern thinkers were not necessarily in unanimous agreement with each other: The architect, engineer and horticulturalist Salmon de Caus, who had been in the service of the French king before working for the Elector of the Palatinate for whom, on the eve of the Thirty Years War, he designed the famous “Hortus Palatinus”, claimed that fire and air were the superior elements to water and earth mainly because the former resided above the latter, because they tended upwards, whereas water and earth moved downhill, thus equating the concrete physical space with moral (as it were) importance. In his treatise on “movements by force” (“Von gewaltsamen Bewegungen”), which was published in German in 1613, Caus claimed that “fire had the highest position [among the elements] and was to be considered superior to air, and that the air was superior to

earth and water. Consequently, the two former elements, being light, dominated the latter two, being heavy.”¹ Not surprisingly, hydraulic engineers and landscape gardeners, as well as some architects, did not agree with Caus and conveyed the first place among the elements to water. A popular metaphor which was employed in order to underline the importance of water for the functioning of the world was its description in analogy with blood: As blood was transported (or circulated, as William Harvey discovered in the 1620s by comparing hydraulic engineering to human physiology²) via bloodstreams and veins through the human body, so was water via rivers, streams, brooks and water veins through the earth – what the body and blood meant for the individual human being were the earth and water to mankind in general, and whereas physicians took care of the individual, architects could consider themselves doctors of society.

The successful dealing with water in all its manifestations became an increasingly important factor for princes and political authorities in the course of the early modern period. This holds true both for their political actions in the strict sense – water acquired great significance as a theme of political deliberation and as a field of action for early modern “politicians” – and for the symbolic dimension of political power; water became a key element in the ever more elaborate apparatus designed for the representation of princely (and republican) rule, and reflections on water entered the texts of political theorists and the mirror of princes literature. Princes were supposed to protect their subjects from flood and inundation; they prided themselves on ensuring the water supply of their cities; they made the draining of marshes a priority not only to transform the up to now hostile and basically useless regions into fertile ground, but also as a means of ensuring their country’s and subjects’ health, since marshes and moors were considered seedbeds of dangerous germs of all kinds; the disposal of waste water in the cities met the same purpose of cleansing and healing, which shows that not only the architects and engineers, but the princes and political authorities, too, claimed the role of social physicians; engineers, in this sense, were the indispensable nurses to their chief physicians, the monarchs or city governments³. Furthermore, the straightening of rivers in order to make (or keep) them navigable and the construction of canals were regarded a princely duty which contributed to intensified commerce and ensured the country’s enduring and growing wealth.

¹ Salomon de Caus, *Von Gewaltigen Bewegungen. Beschreibung etlicher so wol nützlich als lustigen Machiner neben Unterschiedlichen abrissen etlicher Höllen oder Grotten und Lust Brunnen*, Frankfurt 1613, p. 1.

² Marjorie O’Rourke Boyle, Harvey in the sluice: from hydraulic engineering to human physiology, in *History and Technology* 24 (2008), pp. 1-22.

³ Cf. Rainer Guldin, *Körpermetaphern. Zum Verhältnis von Politik und Medizin*, Würzburg 1999.

At the same time princes – especially in Italy, but also in Spain, France and the Holy Roman Empire – used water in a way which, on the surface, seemed the antipode to the economical and thrifty dealings with water described so far, to the ideology of responsible stewardship: they virtually squandered water in their residences, gardens and parks, water which was tamed and subjugated according to the needs of princely representation and aristocratic relaxation. But this demonstration of power – political and technical – over nature was just the other side of the same medal, as it was an apt instrument to show that princes dominated the elements to whatever end they deemed necessary, and not the other way round⁴.

Water – its interpretation and the dealings with it – was (and, probably, still is) situated at the intersection of two rivalling discourses and, consequently, two rivalling groups of experts: the language of the legal specialists, the bureaucrats, on the one hand, and the “scientific” (or, to be more precise, the natural-philosophical) discourse of mathematicians, architects and engineers on the other hand. In the eyes of the university trained jurists, who came to dominate the early modern administrative institutions, water was primarily an object of property rights, of arguments on questions such as: who owned it, who had the right to use it, who exercised legal authority over it⁵. Lawyers developed a refined set of legal categories in order to be able to allocate appropriate labels to the different manifestations of water: public and private, collective and individual, running and stagnant, subterranean and above the earth, navigable and non-navigable, regal – and less exalted. (Regal rivers and streams are those which are navigable throughout the whole course of the year.) Different kinds of water are subject to different kinds of authority, to different types of owners, and waters themselves mark and constitute boundaries of property, ownership and political influence. Property rights and rights of usage, in premodern times, were closely linked to the whole of the social and political order; and since lawyers were most reluctant to admit to fundamental changes within the society of orders, they were equally reluctant to allow fundamental transfers of property – at least between different classes of proprietors. In this, lawyers were in unison with virtually anyone around them: the early modern period (at least up to the 18th century) was marked by a profound distrust to change, the social and cultural ideal was continuity, and lawyers were probably the most visible and outspoken representatives of this pattern. To state that the early

⁴ Cf. Suzanne B. Butters, Princely Waters: An Elemental Look at the Medici Dukes, in *La civiltà delle acque*, vol. I, 2010, pp. 389 – 411.

⁵ An example for the categorisation of water by a university trained lawyer who tried to “Romanise” the Rhine by adapting the precepts of Bartolus of Sassoferrato to the Holy Roman Empire in general, the Rhine in particular, is: Noe Meurer, Wasser-Recht unnd Gerechtigkeit fürnemlich des Weitberühmbten und Holtreichen Rheinstromes/wie derselbig gleich als ein Richter/ am Gestaden/ jetzt dem einen gebe/ dem anndern nemme/ ..., Frankfurt/Main 1570.

modern culture was “conservative” or “traditional”, and its lawyers even more so, might be judged as banal, but it becomes less of a truism, if one takes into account that nature, too, and especially water, was subjected to this ideal of sameness: Ideally, the lawyers’ water did not change, neither its quantity nor its course nor its boundaries. Obviously, experience told them that, indeed, it did, that especially rivers and brooks were far from keeping the same, exact, definite, and fixed beds, but – in the opinion of the bureaucrats – they should. To ensure that they did, continuous and hard work was necessary, as well as a constant supervision not only of the waters themselves, but still more of the people who lived next to the rivers and whose habits of using – and abusing – them, for water mills, for fishing, for purposes of drainage and irrigation, as an easy means for the disposal of waste water and with their notorious reluctance to keep the river beds and its shores clean, were considered responsible for the often unpredictable, irregular and, most important, unnatural changes of the water. Nature, as the administrative élite preferred it, was tamed, regular and offered no surprises. Lawyers, specialists in the field of continuity, dominated water in so far as it remained basically the same. Technicians and engineers, on the other hand, dominated water that changed – in so far as they possessed the technical skills to subjugate it to massive changes.

II. The place of engineers in the society of orders

In the course of the late Middle Ages and the beginnings of the early modern period (more or less) engineers emerged as a distinctive professional group, a new élite whose claim to importance – social, economic, political and cultural – was based on a combination of theoretical schooling and empirical learning as well as on concrete, practical abilities. Engineers did not consider themselves mere instruments in the hands of their social (and political) superiors: Their knowledge of the secrets of nature in general, of water in particular, and their ability to alter it according to the needs of society, made them not only masters of water, but, at the same time, leading figures in political matters. In his treatise on the “architecture of waters”, published in 1656, engineer Giovanni Battista Baratteri claimed: “Restano maneggiate l’acque in ogni parte, quando segue con termini concessi da quell’arte, e da quella scienza, che l’insegna. L’Architettura è la scienza, & arte soprapstante, maestro à tutte le cose dell’acque; che perciò l’Architetto sarà il disponente le cose dipendenti à quelle.”⁶ Although some experts came to call themselves “engineers” by the end of the 16th century, it is virtually impossible to draw a neat distinction between painters, sculptors, horticulturalists, architects, and military and civil engineers: most of the men whom historians

⁶ Giovanni Battista Baratteri, *Architettura d’Acque*, Divisa in Otto Libri, Piacenza 1656, p. 5.

of technology subsume under the label of “engineer” were engaged in many of the activities mentioned above, they did not necessarily describe themselves as “engineers” and their fields of action, their professional places varied to a considerable degree: They worked as university professors, some in the Faculty of Arts, some in the Faculty of Medicine, they were courtiers, they taught applied mathematics at one of the numerous city schools, or, as land surveyors, they formed part of the urban craftsmanship.

Still, most of them shared a university education in mathematics, either theoretical or applied, and most engineers called themselves “mathematicians”. In spite of this shared academic background, engineers, being a new élite, were confronted with considerable difficulties in the attempt to define their position within the society of the ancien regime. The main reason for this was the traditional hierarchy of subjects and faculties of the academic system of the time: Mathematics, if it was a university subject at all, did not only belong to the Faculty of Arts, the last of the four faculties, but it ranked very low among the subjects taught there – the least prestigious chairs in the least prestigious faculty were those of mathematics. This was partly due to the alleged closeness of mathematics to craftsmanship, partly to its lack of theoretical foundation.

In spite of these inherent difficulties, mathematician-engineers managed to better their academic and social positions in the course of the 16th century – if not all of them, at least many. In order to achieve this, they employed three closely interrelated strategies⁷:

Mathematicians tried to find ways to make their subject more theoretical and less applied, more celestial and less terrestrial. They discovered or rediscovered their ancient predecessors, most notably the Greeks; by underlining their relationship with the heroes of classical antiquity, mathematicians integrated themselves into the humanist context of the Renaissance and made themselves easily acceptable to other humanist scholars. By denying the practical aspects of their profession, mathematicians rose within the hierarchy of the universities; by stressing them, they moved closer to the traditional social élites, the world of the courts, of noble warriors and the aristocracy as a whole. By 1500, the technique of warfare had undergone significant changes: fortifications played an ever increasing role, and therefore officers were forced to acquire at least some knowledge in the basics of mathematics, architecture, and engineering. The former knights, officers of noble origin, were transformed into architects; architects, on the other hand, by contributing to the theoretical and practical

⁷ For the following cf. Mario Biagioli, The Social Status of Italian Mathematicians, 1450 – 1600, in *History of Science* 28 (1989), pp. 41 – 95.

schooling of officers and by constructing fortresses were transformed into warriors, “bellatores” – or, at least, they came closer to them.

At the same time, mathematicians and engineers became part of the court society, of the social environment of the princes who, in Italy, had come to replace many of the formerly independent city republics (most notably in Florence). For the princes, neither the academic hierarchies nor those of the urban societies with their guilds were of vital importance; therefore, courts offered new possibilities to new social and professional groups, and the architects made use of them: they taught the young princes the fundamentals of mathematics and engineering, and they produced the courtly “mirabilia” which contributed much to the princes’ fame throughout Europe. It is true, most mathematicians at court remained invisible, they were merely considered servants and had no access to the upper “familia” of the princely family and aristocratic office holders, but some did – admittedly, mostly those who were of noble origin themselves. Still, in the course of the 16th century engineering had become an acceptable occupation (if not a profession) for some aristocrats, which, in turn, rendered engineers more acceptable to the aristocracy.

Lastly, engineers were in demand for purely civic purposes: city governments as well as the bureaucracies of regional states became more and more interested in surveying, cartographing and registering their territories; in order to “define” the countryside – nature, as it were – according to the needs of administrative purposes, the lawyer élites were dependent upon the expertise of mathematicians who, in Italy, were employed as “idrostatici”. Their work did not only entail the cartographic and statistical representation of the exact state of the country as it was, but engineers were also supposed to develop the technical apparatus necessary for maintaining this status as it should be. Thus, mathematician-architects became indispensable partners for the bureaucrats in order to achieve the ideal of “sameness”; and they were important helpmates for the princes who aimed at transforming the country in order to improve it.

But engineers and architects were not simply passive “instruments” in the hands of their princes: they were themselves agents of politics, or, at least, they possessed the potential of influencing and shaping the process of decision making. In order to achieve this – in order to transform their theoretical and practical knowledge into cultural importance and political power –, mathematicians presented themselves as educated, Roman, and noble – not only in general terms, but also in their professional actions.

III. Hydraulics in 16th - and 17th-century Rome

It seems almost superfluous to state that the city of Rome underwent a process of continuous decline since the early Middle Ages and that it was restored to its former splendour from the Renaissance onwards. The label of “decline” applied to the dark Ages after the invasion of the Goths was, of course, a constituent part of the humanists’ self-image and is, therefore, not an adequate historical description of the state or situation of a given entity at a given period of time; still, if one looks at the water supply of Rome one feels tempted to admit the truth of the decline narrative: Of the numerous aqueducts which had supplied Rome with fresh water from the surrounding Alban hills in antiquity, there was only one left in the 15th century, the “aqua virgo” or “acqua vergine”⁸; most Roman households depended on the Tiber or water carriers for their water supply. When the supreme pontiffs returned to Rome after the century of exile in Avignon they started a vigorous restoration programme which was intensified in the course of the Catholic Reform and the Counterreformation: The “renovatio ecclesiae”, the restitution of the Roman Church to its original glory, when it possessed the uncontested monopoly on the interpretation and teaching of the Christian doctrine (a monopoly it had never really had), was to be achieved through the “renovatio urbis”, the re-establishment of Rome’s architectural grandeur, thus evoking the heritage of the ancient emperors. The popes saw themselves as the lawful successors of all the Caesars and “Augusti” who, undoubtedly, had managed to combine technical knowledge and political power in a very impressive way, and the popes superseded them only in that respect that they did not adhere to paganism but to the one faith. The restructuring of Rome’s architectural beauty, its churches, squares, streets etc. was not just an outward symbol of the newly gained strength of Counter Reformation Catholicism, it was considered a vital instrument for attaining it. Among the measures propagated and realised by the popes of the late Renaissance and early Baroque water infrastructures played a key role; by supplying the capital of Christendom with water, by keeping it clean, habitable and healthy, the popes demonstrated genuinely Christian and princely virtues as they cared for the fundamental needs of their subjects and the Church as a whole, as they transformed Rome into a representation of the Church eternal.

Pope Sixtus V (1585-90) had installed a new aqueduct which brought fresh water from the surroundings of Tivoli to Rome; he called it “Acqua felice”, “happy water”, an allusion to his baptismal name (before his election to the dignity of supreme pontiff he had been Felice

⁸ For the water supply of Rome from the 15th to 17th centuries cf. Katherine Wentworth Rinne, Hydraulic Infrastructure and Urbanism in Early Modern Rome, in *Papers of the British School at Rome* 73 (2005), pp. 191 – 222.

Peretti), and he ordered Leonardo Sormanno to erect a sumptuous fountain at the point where the aqueduct entered the city of Rome. This impressive piece of representative architecture – considered slightly overdone by contemporaries and modern art historians alike – shows, at the top, the papal coat of arms, under which is situated a Latin inscription which gives testimony to the pope's magnificent achievement. At the centre of the fountain stands a gigantic statue of Moses who has just, with God's blessing, made water spring from a barren rock, a source for the people of Israel in the desert. As Moses, by giving water to the chosen people, had manifested his intimate relationship with God and established his position of spiritual and temporal leader, Sixtus V, by building the "Acqua felice", had constituted himself as the uncontested leader not only of Rome and the Romans, but the Church in general. At the same time, by placing the Peretti coat of arms on the top of the fountain, he had found a prominent "lieu" to establish a monument to the memory not only of his own reign but that of his family; since the popes were not succeeded by members of their own "dynasties", they had to employ alternative means to ensure the prosperity, social status and "memoria" of their nephews, and it might be argued that the great quantity of representative fountains in Baroque Rome is largely due to the popes' willingness to mark the eternal city with eternal symbols of their families' prominence.

Popes restored ancient aqueducts or built entirely new ones; they improved Rome's water supply with water pipes and they built numerous fountains; they exercised a sort of invisible power over the city and its inhabitants which resulted in the remodelling and restructuring of the city's appearance. The new water infrastructure was, of course, beneficial to all Romans, but some profited more than others; the new infrastructure led to a new – and visible – hierarchisation of the urban society or, better still, it helped to underline existing hierarchies: nobles, dignitaries of the Church, relatives of the popes, magistrates, artists and engineers were given private water pipes for their homes and gardens. The improved water supply led to new infrastructures, "secondary" infrastructures as it were: Pius V restored the ancient "cloaca maxima"; this work of sewer infrastructure was interpreted as a means of restoring the health of the city and its people; and more and more squares and streets were paved with stone in order to protect the subterranean canals and water pipes, stone pavements being considered a strong symbol of Rome's ancient magnificence.

Engineers played an ambiguous part in this process of "renovatio": they were necessary, and it was vital that their projects did not fail, at least not to a spectacular degree; but they were not just useful instruments in the hands of the papal princes. They did not simply search for

technical ways to realise whatever the popes wanted them to do; they themselves formulated general ideas and drew up concrete schemes for developing Rome's infrastructure and appearance, and by doing so they not only responded to the existing image and ideology of the papal government, but they shaped it and changed it to some extent⁹.

In 1696, Carlo Fontana published a short treatise on the reasons for the continuous inundations of the Tiber and proposed a series of measures to prevent them in future. The "Discorso" was dedicated to Monsignor Lorenzo Corsini, a relative of pope Innocent XII, and it is for that reason that it is not a technical manual, directed at an academic audience or written for the benefit of other engineer-architects, but a carefully composed piece of propaganda, by which the author hoped to make his project acceptable to Rome's leading circles, not only by stressing its fundamental necessity but also by underlining its cultural value¹⁰. It is a vivid example of how an expert of the late 17th century who called himself both "Cavaliere" – knight – and "architetto" claimed his ambitions of belonging to the social and cultural élite by consequently drawing parallels between ancient Rome and his own time.

With view to the Tiber, Fontana repeated the well-known narrative of original greatness, ensuing decline and eventual resurrection: in antiquity, he states, the Tiber was navigable and clean, he did not change his course in a seemingly arbitrary manner, he ran at comparatively high speed and, most important, he did not threat the well being of the city by continuous floods. All this had changed since the invasion of the barbarians from the north, and it was the task of the present spiritual and temporal rulers to restore the Tiber to his original state. The deterioration of the Tiber's condition was not due to a change in nature, but to a change in politics; or, to put it more precisely, the nature of the Tiber had changed because of political – as well as military, social and cultural – ruptures. The fact that under the rule of the Roman emperors – notably the "good" ones, Augustus, Trajan and Hadrian – the Tiber had not only not posed a threat to the urban citizenship, but had been useful as a transport road, was due to the continuous care of the emperors, who delegated the task of supervising the river and its embankments to high ranking senatorial magistrates, the "curatores alvei et riparum Tyberii". Fontana presents his project of "taming" the Tiber and protecting the city of Rome against his waters as a return to antiquity. This implies the renewed application of ancient knowledge and Roman hydraulic techniques – and Fontana had indeed studied all the relevant authors of

⁹ For the cultural strategies of hydraulic engineers in early modern Rome cf. Pamela O. Long, Hydraulic Engineering and the Study of Antiquity: Rome, 1557-70, in *Renaissance Quarterly* 61 (2008), pp. 1098 – 1138.

¹⁰ Carlo Fontana, Discorso sopra le Cause Delle inondationi del Tevere antiche e moderne à danno della Città di Roma ..., Rome 1696.

classical antiquity; but it also means a return to a world, where not only the leading politicians underlined their claims to greatness by taking water and hydraulics seriously, but where those officials who were directly responsible for water were members of the highest order and, indeed, influential politicians themselves. Fontana refers to classical antiquity in a threefold manner: he presents himself as a learned scholar and humanist, thus making engineering a humanist profession; he evokes parallels between the Caesars of old and the popes of his times; and he claims that because the supervision of the waters is a noble task and used to be performed by aristocrats, engineers are noble.

IV. Hydraulic engineering and the art of gardening in 17th-century England

Was the water and were the experts for water in 17th-century England as noble as their Italian contemporaries? In many respects, this seems to have been the case: English authors of books on the art of gardening referred repeatedly to classical sources; and aristocratic dilettantes who proposed miraculous water engines and elaborate irrigation and drainage schemes claimed that an imitation of antique models would render England as powerful as the Roman Empire and make her superior to her rivals France and Spain.

In an anonymously published treatise from 1683, entitled “The Art of Gardening”, the author debates the topic of water at some length: first, he states that water is essential for every garden, that it is “its very soul”¹¹. He continues by discussing the respective merits of different types of water: large and small ones, brooks and rivers, natural and artificial water courses, those that are quite near to the park they are supposed to ornate and those that have to be guided a long way via aqueducts or water pipes. For “J. W.”, as the unknown writer calls himself, it is an unquestioned maxim that a garden in general and its waterworks in particular have to serve one purpose: the pleasure and delight of its master and his friends, and this end is to be achieved not through nature as it is or nature closely resembling “natural nature” but through nature bent and twisted according to the master’s taste. Accordingly, big streams are preferred to small brooks (“For little Brooks and Springs are not so good, Nor please so uch as a more noble Flood”) and canals are judged “more commodious than the natural Current”, because artificial waterways are apt symbols for the owner’s capability to rule – not only the elements, but also society at large. In this, J. W. is in accordance with French authors of the same period who consider aqueducts built at large cost truly regal ornaments for any garden; they are considered superior to other, simpler sorts of water transport not although but because they are more expensive.

¹¹ J. W., *Systema Horticulturae: Or, The Art of Gardening*. In Three Books, London 1683.

But J. W., as much as he is in accordance with his fellow Europeans, is an exception among his countrymen: most English authors who wrote on architecture, horticulture and hydraulic engineering advocated a conspicuously modest use of water; waterways should be as cheap as possible and as close to their original, their “natural” state as possible which was deemed appropriate for an honest country gentleman¹². Instead of evoking the splendours of antiquity and the example of Roman emperors and architects English gentleman authors set a religious context for their doings: their aim was not to transform nature in order to make it resemble a humanistic ideal, but to study it in order to better understand God’s creation, and to return it to its original state in order to make it resemble paradise – and thus to serve the common good¹³.

Engineering in England was, for the most part of the early modern period, a matter for dilettantes without thorough academic or professional schooling; and water and hydraulic engineers were not as triumphant, as refined and as “aristocratic” as their Italian contemporaries – but they were not, for that reason, politically less significant. Their nobility was of another nature, less exalted, and adapted to the needs of a – comparatively – open élite. But they were, nonetheless, noble: the elements in early modern Europe had to strive for excellence.

¹² Cf. e. g. Stephen Blake, *The Compleat Gardeners Practice, Directing the Exact Way of Gardening. In three Parts...*, London 1664.

¹³ Canals in early modern England did not resemble great water avenues like, for example, the Canal du Midi, but they were much more modest enterprises, considerably shorter, and their course adapted to the natural and geographic conditions of the landscapes in which they were situated.