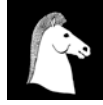




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Charting Environmental Concerns: Reactions to Hydraulic Public Works in Eighteenth-Century France

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ABSTRACT

The optimism characteristic of the Enlightenment multiplied initiatives designed to secure and improve the milieus within which Europeans earned a precarious living, notably through greater control of hydraulic resources. This paper examines the reactions triggered by many such important public works undertaken in Old Regime France. The debates that accompanied most projects did not systematically challenge the positivist assumptions standing behind these improving ambitions, nor did they formulate an alternative vision centred around an appreciation of the intrinsic value of nature. However, they greatly advanced reflections on natural phenomena, drawing attention to their geographical and temporal limits, their internal complexity, as well as crucial socio-cultural frontiers. They mark an important stage toward the conceptualisation of ecosystems and the formation of ecology, and remind us that these forward-looking ventures were, like all human interventions upon the natural environment, hybrid ventures – both conditioned by nature and bound to alter it.

KEYWORDS

Hydraulic public works, environment, eighteenth-century France

Environmental history is tributary to a rich spectrum of disciplines, including the science of ecology. At the heart of ecology stands the concept of ecosystems, centred on the relationships binding all elements of the milieu under consideration. Just as significant although not always explicitly defined and discussed, is the scale of any ecological system, that is, its spatial and temporal dimensions as well as the dimensions at which it is observed. Many defining traits of an ecosystem, including its balance of change and stability, are directly related to

its scale, and multi-scalar studies are now seen as a way to approach the complexity of natural systems. Yet, the seamlessness of nature, the arbitrariness of human frontiers, the brevity of most observation periods, and many cultural factors have long hindered the conceptualisation of areas best suited to environmental inquiries.¹ The following pages argue that the hydraulic public works of Enlightenment Europe greatly advanced reflections on natural phenomena, drawing attention to their geographical and temporal limits, their internal complexity, as well as crucial socio-cultural frontiers. In turn, these reflections regularly informed the plans of their promoters, reminding us that these still modest if forward-looking projects were, like all human interventions upon the natural environment, hybrid ventures – both conditioned by nature and bound to alter it.

Distinguishing a region from another, be it for resource management or for speculations on the links between a society and its environment, evidently predated the definition of ecosystems. However, until the modern age, Christian or even pagan interpretations of natural conditions, as well as more secular but similarly overarching theories, interfered with the recognition of the extent and complexity of environmental phenomena. One may think here of deep-rooted beliefs in the senescence of the earth or lunar influences, ancient associations of mountains with earthly imperfections, a persistent fascination with the abnormal or exceptional, or a common fondness for deterministic associations of land and people. Many early-modern scientific concepts blunted the value of observations. For instance, a belief in underground water circuits frustrated an effective grasp of hydraulic basins, and rival classifications schemes fostered conflicting interpretations of associations of plant and animal life. Even the lack of instruments (notably standardised instruments) hampered assessments of climatic or geographic unity.² Much, in the medieval and early-modern mind, worked to separate the infinite and perpetual order of nature from the punctual and temporary deeds of men. However, the eighteenth century multiplied occasions to assess the overlap between these two spheres, an indispensable step toward understanding our place in the environment.

Over the last two decades, historians have charted key stages in this process, albeit often indirectly or implicitly. Attention has been given most directly to the role of tropical islands in the history of environmental thought, articulating the relation between local and global levels of reflection. A small, isolated, and well-defined setting permitted observations and initiatives not possible in a larger, less bounded environment. Similarly, distinctive natural milieus such as forests and rivers, or conspicuous urban concentrations of problems, resources, and powers afford fruitful vantage points for today's observers, just as they offered a meaningful frame of action to pre-modern administrators. The recognition of a unity of environmental associations within spatial and temporal bounds is also central to the history of landscapes and, even more broadly, the tradition of the *Annales*.³

To further explore the mechanisms that helped shape environmental concerns, this inquiry focuses on hydraulic public works undertaken in France from the second half of the seventeenth century to the Revolution. The period's interest in large-scale hydraulic projects was not unprecedented, as any reference to the Roman and medieval ages will show.⁴ Yet, the seventeenth and, above all, the eighteenth centuries witnessed a proliferation of both projects and reflections on their consequences. They mark an important stage in the growth of European wills to reshape the environment, when the optimism of the Enlightenment sought to lessen the precariousness of material life.⁵ This yearning to master space was particularly strong in France, an ambition best rendered by the difficult to translate expression '*aménagement du territoire*', still a perennial theme in French politics.⁶ At the same time, improving communication and administrative networks enhanced the ability of concerned parties to learn of the impact of their endeavours. A new scientific culture, a rising interest in natural phenomena but also in economic life, and, more generally, the inquisitive disposition of the Enlightenment made this information more relevant than ever.

Great public works proved not only technically, financially, and legally challenging.⁷ The mostly rural people affected by these projects obviously knew the importance of land to their lives, but the approach of promoters, surveyors, and work crews challenged many of the beliefs that made a natural milieu familiar to them. Similarly, the originators of these initiatives learned to incorporate evidence of failure and success into their planning, if often (or mostly) belatedly and reluctantly. The following three sections consider a range of hydraulic projects set in a variety of geographical contexts, seeking illuminating contrasts among distinct patterns of land occupation and degrees of ambitions. First, we examine reactions to massive undertakings, such as canals. They probed the outward dimensions of the affected features of the land at or beyond the scale of a province. Second, we assess less ambitious, more fractured undertakings, when the goals, level, and methods of the project became debatable, exposing key relationships within affected milieus. Finally, we turn to the range of interests and forms of knowledge implicated in these ventures. Like other inquiries into the pre-modern age, this study will not seek an embryonic form of environmentalism. Rather, it sketches an obligatory stage before the conceptualisation of ecosystems, when Europeans learned to locate their interactions with nature within environmentally meaningful boundaries.

GRAND DESIGNS: CHARTING THE EXTENT OF ENVIRONMENTAL DISTURBANCES

The *Canal des deux mers* (later known as *Canal du Midi*) was a momentous achievement, for its length, the land elevation it overcame, and its early date of completion. By linking the river Garonne to the Mediterranean sea, it facilitated

the exchanges of heavy goods between the upper and lower halves of the vast province of Languedoc and brought the Guyenne and the Atlantic coast of France into protected contact with the Mediterranean sea. Undertaken in the 1660s by a local tax-collector, Pierre-Paul Riquet, who added to his financial, technical, and managerial expertise support from the most active of Louis XIV's ministers, Jean-Baptiste Colbert, this 240-kilometre artificial waterway opened in 1683.⁸

Throughout the 1680s, a first wave of complaints exposed the canal's impact on the moisture patterns crucial to the agricultural lands that it traversed. Owners objected to desiccated or waterlogged fields and pastures. Their charges led to a slump in the value of nearby lands, an exception in an otherwise positive regional context further buoyed by the prospects offered by the canal for the commercialisation of crops.⁹ For their part, canal owners came to see water alongside their waterway as a lost resource and a threat. Two lateral by-canals ('*contrecanaux*') were built in the early 1690s to redistribute through a series of culverts the waters seeping from the canal or dammed by its banks. They offered only a partial remedy. Almost a century after the completion of the canal, the inhabitants of Capestang, near Béziers, still denounced infiltrations of water ('*transpirations*') and the attendant fog. In 1833, the mayor of this unlucky town again lamented the loss of 4,000 souls to a '*funeste [...] canal*'!¹⁰

Over time, the number of these complaints did diminish in the neighbourhood of the canal.¹¹ However, the area affected by the canal expanded regularly, as its owners strove to check the flow of sediments and secure more water to accommodate rising traffic and cut summer closures. The number of villages seeking redress rose with the canal's expanding reach and a growing awareness of its effects, for instance along the river Hers-Mort. Concerns over floods on this ninety-kilometre tributary of the Garonne mounted during the 1730s. The authorities first ordered the removal of obstacles lying in its lower bed, such as mill dams, a classic if costly measure (1737–1738). There followed accusations that the Hers-Mort was increasingly swollen by streams diverted from the canal. By 1744, it was decided to fully remodel the course of the river (the French verb '*redresser*' invoking both a straighter and tamer river), a measure that required adjustments to many of its tributaries. Early in the 1760s, many sections of this new bed had to be enlarged or deepened, and man-made obstructions re-designed.¹² To worried villagers, the fate of the Hers-Mort, straightened, widened, contained, and dredged, appeared as '[...] *une suite des rigolles et contrecanaux du canal de communication des mers*'. By 1772, complaints arose further afield on tributaries of this increasingly artificial river.¹³

Over time, two categories of risks in particular mandated the building and maintenance of an increasingly complex system of secondary features, such as over-flow channels, sluices, plantations to stabilise banks, etc.¹⁴ The 'improved' river beds potentially focused flood waters, a dangerous eventuality in a Mediterranean climate prone to fierce storms and flash floods, and any relaxation of maintenance allowed for the alarming pooling of water.¹⁵ Throughout the

eighteenth century, the government responded to the spread of complaints by calling for new inquiries to re-assess the situation and advise remedial work. That of 1772 lasted four months and spawned a thick printed report in which landowners ponder hidden features of watersheds, the nature of soils and crops, the rhythms of their labours and land values. By 1780, attention was turning to the fate of the Orb, a large river marking the eastern reach of the canal.¹⁶ The canal had become central to the management of a large proportion of the Languedoc rivers. When, almost a century later, catastrophic floods devastated this region, a daring mind proposed a 'super' *Canal du Midi*, a gigantic trench dug to sea level, as a definitive solution!¹⁷

The construction of the *Canal du Midi*, like that of other innovative public works, drew on a range of knowledge, combining civil and military engineering skills with local experience. This was a practical partnership, neither formalised nor expounded by those concerned.¹⁸ Similarly, awareness of the canal's implications owed much to local observations and grievances. Slowly, the administration worked this information into official reports, regulations, and, at times, new investments, enlarging its map of the canal's impact upon southern France. Here, the weight of agriculture, the importance of regular flows to early-modern conceptions of health, and the harshness of the climate combined with the extraordinary length of Riquet's canal to lead both its promoters and opponents to consider its impact upon their environment in a widening and increasingly systemic manner. A similar process is evident in a very different context.

Soon after the completion of the *Canal des deux mers*, the project was formed to link it with the Rhône delta, to avoid a disreputable stretch of coastal navigation on the way to Beaucaire and the Rhône valley, Marseille or further East. This entailed the construction of a canal through the string of lagoons punctuating this low-lying coast. Little agricultural land was at risk here, although some fishing rights warranted compensation. The *Canal des étangs* (future *Canal du Rhône à Sète*) was financed by and built under the lead of the Estates of Languedoc from the early years of the century to 1769.¹⁹ It profoundly altered these unique wet-lands.

The great coastal lagunas were shallow (less than one metre deep), separated from the sea by a thin, low beach, itself broken by a few unstable natural channels (called *graus*). They also received several rivers descending from the southern reaches of the Massif Central, great carriers of silt and sand renowned for their dramatic periodic surges. The lagoons were deemed an unstable and unhealthy environment. Initially, concerns about the project focused on the dredging of the new channel. In the minds of many, digging up the mud of centuries would trigger a vast epidemic. Complaints started in the 1720s, when the canal reached Frontignan. By the 1740s, the problem was articulated in broader terms: the canal was accused of depriving the southern areas of fresh water arriving from the north and cutting off the northern parts from the sea. Today's science suggests

that this diagnosis was facilitated by the fact that the salinity, temperature, and oxygen levels of these shallow waters fluctuate widely, with rapid and very visible effects upon the fauna and flora.²⁰

These outcries were taken seriously by the Languedoc Estates. Substantial resources were mobilised and progressively broader solutions adopted. First, isolated pools were filled, before attention turned to the maintenance of channels to the sea. Eventually, it was decided to breach the banks of the canal at regular intervals to allow the flow of water between the two sections of the marshes and the canal itself. Attempts to re-create an environment resembling what existed before the construction of the canal continued. In 1778, a landscaping and plantation program was initiated to stop the sand drifts that hindered water exchanges in a matter of months. Two years later, a dynamic parish priest argued that the strong coastal drift could keep the outlets to the sea open. A dike was built at the mouth of the *Grau de Carnon*, to the desired effect. The same cleric also convinced the Estates to regularly remove the vegetation from all channels.²¹ Soon, concerns expanded to encompass the whole lagoon system and in-flowing rivers. An ambitious drainage scheme was revived that never materialised (see below). In 1783, a young chemist, Jean-Antoine Chaptal, future minister of Napoleon, discussed the region's wind patterns, supply of drinking water, and even economic needs. Thoughts then turned to the deforestation of the rivers' headlands, the Cévennes range almost 100 km to the north.²²

In this marine context, where property values counted for little, public health emerged as the primary concern following the construction of a major canal. However, the parallel between this situation and the one encountered earlier around the *Canal du Midi* is clear. In both cases, a major engineering project cut through complex watersheds. In both cases, remedial efforts called for ever wider interventions, either up the tributaries of rivers affected by the canal, down to the sea, or into the mountain ranges that commanded affected streams, eventually building a complex system needing regular maintenance. Over several decades, entrepreneurs, royal and provincial authorities, and local populations progressively discovered the spatial and temporal impact of what were, at first, sensible projects well suited to a society versed in hydraulics.

Other accounts of early-modern canal building reveal a similar widening of concerns about their impact, although this trend ran contrary to the aspirations of engineers wishing to limit the variables they had to take into account.²³ In the 1760s and 1770s, the mapping of what eventually became the *Canal de Bourgogne* linking the Seine and Saône basins occasioned unprecedented efforts to predict its cost and impact. These discussions are seen as heralding a new age in economic calculations, but they also reveal an awareness of the regional impact of such an enterprise that would have surprised Riquet a century earlier.²⁴ Nevertheless, the completion of each section triggered numerous complaints and the region's Estates were forced to consider further investments.²⁵ In this pastoral region, where three important canals were underway at the end of the century,

landowners bemoaned erratic shifts in soil moisture levels, hedges, ditches and springs (arguably more damaging to pastures than to fields where crops could be adjusted to suit new conditions). These canals, today seemingly well integrated into a rich landscape, had in the words of a recent study, thoroughly re-created rural Burgundy – under the anxious gaze of local populations we may add.²⁶

Canals were ambitious projects conceived in the light of the national interest. Their preference for the straight line and horizontality, their width and depth requirements, and their use of an already taxed resource, water, made them obvious intruders in these landscapes. They sliced their way through a succession of well-used milieus, revealing the reach of the natural systems hidden behind time-honoured choices, practices, and boundaries. The variables at stake were not analysed in terms of a yet-unborn science of ecology, but contemporaries nonetheless discovered that canals reconstructed nature on a scale ignorant of existing partitions. This process had parallels in other areas of Enlightened intellectual life. Since late in the seventeenth century, the mapping of the kingdom had proceeded at many levels, abetting the building of fortifications, roads, etc. These ventures transformed France from a largely unknown and, by European standards, immense space into a *territoire* subject to informed royal attention.²⁷ Increasingly, investigators framed their approaches within significant geographical limits. The new field of medical topography offers many illustrations of this trend toward a ‘parcelling of the landscape’ during the last decades of the eighteenth century, a trend that helped organise knowledge after a long period during which the accumulation of information had taken precedence over structuring efforts. With the Revolution and its call for new administrative units, talks of ‘natural regions’ reached the centre of the political stage.²⁸ Yet, if canals forcefully expanded environmental curiosity, they also remained rare enterprises. The eighteenth century became more familiar with a multitude of smaller, less overarching projects, designed to ‘improve’ a section of a river.

ASSESSING LEVELS OF INTERVENTIONS

Old Regime authorities paid much attention to rivers because they were intensively used and often feared.²⁹ Initiatives ranged from navigational improvements to flood control. The contexts of these enterprises and their smaller stature favoured more diverse and more nuanced opinions than in the case of canals. Not only the size of a project, but also its nature and level of intervention were discussed. In the process, the existing state of affairs became a reference point.

Increasingly, engineers aimed their efforts beyond the protection of a vulnerable low spot, away from urban centres, strategic roads, and bridges toward higher ground. Explanations of torrential excesses were gradually distanced from traditional references to occasional accidents, such as bursting

'water pockets', the sudden emptying of high-altitude lakes, or an extreme melting of snow. More systemic interpretations eventually focused on deforestation, the favourite foe of engineers and foresters in the nineteenth century.³⁰ However, well before this consensus was reached on human causation for such accidents, interested parties were grasping toward the concept of watershed, most no doubt independently of the theoretical formulation given by the geographer Philippe Buache in 1752.³¹

Not surprisingly, many doubted the feasibility of certain projects. Some rivers were deemed 'uncontainable' because of the turbulence of their waters and/or the sediments they carried.³² Perhaps more revealing are recurrent claims that the project was too narrow in scope or that it may be left uncompleted, a common occurrence in an era of unstable budgetary commitments and limited technical means.³³ Contrary to canals whose economic logic largely rested on completion, river improvements were often undertaken in a piecemeal manner, frequently in reaction to a destructive event. Just as commonly, a project was conditioned by the shortcomings of previous efforts and would almost as surely call for further work. The efforts deployed in the 1740s to control the Lauzon, a left bank tributary of the Rhône, are characteristic in this regard. Dredging proved unreliable and dikes were sabotaged by villagers intent on saving homes and fields. A short canal was then envisioned to feed the Lauzon into a neighbouring, presumably safer, river. Ensuing discussions revealed that the excesses of the Lauzon were not natural. Two streams had been diverted towards it a few decades earlier and its outlet had been compromised. The Lauzon emptied into a branch of the Rhône that had itself been cut off from the main channel at its north end in an earlier preventive move. This inactive branch of the Rhône no longer flushed away the sediments brought down by the Lauzon but still permitted high water levels in the Rhône to block its outflow.³⁴

The terms used in these arguments reflect varying degrees of acceptance of human intervention upon the landscape. A first distinction was made between 'passive' and 'active' undertakings (*mesures passives ou actives*). Passive initiatives eased the flow of water by straightening a stream or widening it in sections, clearing its vegetation, dredging shallow stretches, or dismantling man-made barriers.³⁵ Active solutions were more contentious. The erection or renovation of dikes, bulkheads, walls of all sorts frequently led to discussions of the intended level of protection. This was, for instance, the case as the Givors canal advanced along the river Gier. Some landowners argued that dikes and jetties should be strong enough to fully control what was, after all, a small river; others claimed that such instruments should only be tailored to moderate conditions and that they should yield to a major flood.³⁶ The choice between absolute or modulated protection had critical implications for land uses, and could even be said to reflect different environmental philosophies, albeit sharing a common hope to control nature. It was also a matter of discussions in the much more vital context of the great Loire river. Roger Dion has shown how, in this

rich but submersible valley, agricultural practices, commercial interests, the calculations of engineers, as well as political and institutional priorities, combined over seven centuries. Although non-submersible dikes remained the goal until after the disasters of 1846 and 1856, no monolithic belief in their capacity to control France's longest and perhaps most alarming river dominated the thoughts of even royal engineers. Breachable levies, first proposed at the highest level in 1629 (but actually built centuries earlier by local communities), were considered throughout the eighteenth century.³⁷

Not infrequently, a further assessment took place in court. Dikes, dams, and spurs could be termed 'offensive' or 'defensive' and their legality questioned. They were deemed offensive if thought capable of directing dangerous waters toward another vulnerable section of the river. In the Spring of 1756, for example, the Estates of Languedoc were asked to initiate legal proceedings against a large land-owning institution that had 'fortified' the left bank of the Garonne between Toulouse and Castelsarrasin. This threatened the more open right bank where communities failed to coordinate their efforts. Because rivers often marked jurisdictional limits, such disputes could prove lasting.³⁸

Questioning the level of protection offered by a design demanded an implicit or explicit assessment of what could be considered the natural state of a river and its surroundings, the risks it had historically presented (including careful inspections of the existing landscape and local memories for evidence of shifts in river-beds), and the nature and level of human interference that should be allowed to proceed.³⁹ Such discussions accompanied the emergence of an underlying belief that the existing status quo should prevail if assurances as to the success of the operation were lacking. In 1732, the Estates of Burgundy participated in this definition of an existing natural state as a reference point, noting that 'the public's interest demanded that the natural state of the river Arroux be left undisturbed if [the enterprise could guarantee] no substantial benefit'. Two decades earlier, the same assembly had ordered the back-filling of a short but poorly designed canal intended to control the lower section of the Ouche below Dijon. It also called for the re-opening of a 'more natural' channel. Through the following decades, it was duly noted that any remedial work should 'respect the river's natural inclinations'.⁴⁰

In discussing the degree of control planned for a river, in recalling the inadequacies of previous efforts, or in asking surveyors to pay attention to the natural features of a waterway, those concerned by these matters – and they were always many in a densely settled country – were perhaps guided by their immediate interests more than by concerns for the vitality of a natural habitat. Nevertheless, their arguments helped elucidate the degrees to which any intervention would transform an existing milieu, exposing some of the natural relationships characteristic of a regional environment. Here again, studies in the history of geography offer a context for such developments. The eighteenth century was not simply heir to the 'age of exploration'. It also displayed an

unprecedented interest in all the least known parts of Europe, such as high mountain ranges, ‘deserts’ until then avoided by all those who could do so. Forays toward Alpine and Pyrenean summits offered not only a bird’s eye views of hydrographic networks, but also vertical cuts through geological and bioclimatic strata. In exposing habitats, they revealed the diversity of life strategies suited to a range of clearly bounded environments. Moreover, because many of the phenomena that can disturb or transform nature appear in concentrated forms at higher altitudes, their impact could be most readily observed. Where else could one better appreciate the damages of erosion, the implications of brutal temperature changes, or the contrasts between dry and wet, sunny and shaded slopes?⁴¹

Hydraulic public works are only one among many types of early-modern ventures that helped reveal the outward limits as well as the layering of natural milieus. However, they did so to a broader, less specialised, and often more reticent public than contemporary scientific probes. The debates that ensued acquired a political weight that insured their relevance and helped define the social and cultural dimensions of local environments.

PROBING THE SOCIAL AND CULTURAL BORDERS OF REGIONAL ENVIRONMENTS

The economic importance of many types of environments was well understood and regularly articulated. The symbiosis that existed between rivers or marshes and pastures, and between pastures and agricultural productivity – the key equilibrium of pre-industrial economies – sustained arguments against (and sometimes for) many projects.⁴² Similarly, no one could ignore the importance of the mills that cluttered the banks of most rivers nor the risks they posed, and the ability of economic activity to alter natural conditions was acknowledged. For instance, those who opposed the plans of a forge master and wood merchant to float logs down the Morvan river Deheume argued that it would damage its banks, necessitate the creation of many ponds, and modify the forest as distant markets imposed their preferences.⁴³ Such thoughts are not surprising. After all, the Physiocrats who came to dominate many of the economic debates at the end of the Old Regime structured their analyses around the land and its productive potential.⁴⁴ Two equilibria were particularly affected by the enterprises under scrutiny here: the balance of private and public interests and the state of knowledge of the milieu under question – social and cultural markers that are as intrinsic to the definition of an environment as geographical, botanical, or zoological parameters.

Research in the field of environmental risks and environmental justice has suggested that while intentional modifications of the environment are designed to lessen the uncertainties characteristic of a particular milieu, they generally result in an uneven redistribution of risks and a steeper hierarchy of property

values.⁴⁵ Although not expressed in such terms, this redistribution of risks and benefits was what some feared would follow the construction of the Givros canal, briefly considered above. In a public inquiry held before the registration of the royal letters patent granting its promoter the necessary rights, critics asserted that the canal would exacerbate both the crippling low and dangerous high water levels of the river Gier, in effect privatising its profitable waters and leaving the public with re-configured but notable risks. Similarly, the canalisation of the Lez, a small stream linking the city of Montpellier with the sea, was seen as substituting social exclusion for the irregularities of nature: it may free the trade between the *Canal des étangs* and the city from the vagaries of an unreliable river, but at the price of creating a monopoly.⁴⁶ Such discussions were often enlivened by the ambiguities attached to the status of areas that were among the least controlled in a densely settled and highly regulated countryside. River beds and river banks, or the borders of marshes were rare areas of economic opportunities, nominally public but in reality eagerly appropriated by land-hungry peasants. Mediterranean rivers, modest most of the year but set in vast beds suited to the evacuation of spectacular floods, were particularly attractive to this kind of 'squatting'. For their part, communities bordering on larger rivers regularly disregarded regulations to extract whatever income could be had from temporary islands, and newly freed meanders or 'dead arms' of rivers proved just as inviting.⁴⁷ Environmental concerns were inevitably social issues.

The discussions that surrounded most projects also tested contemporary knowledge of the natural phenomena under scrutiny. In many ways, large-scale hydraulic works favoured the emergence and affirmation of 'expert opinions'.⁴⁸ Yet, even these privileged voices could not always overcome all objections. At times, the absence of a minimum consensus with regard to the nature of the problems and the proposed solutions could block all initiatives. A substantial illustration of this process is found in the debates that accompanied an unrealised dream, the reclamation of the main lagunas of the Languedoc coast west of the Rhône delta. A first recorded attempt to drain the shallow waters south of Montpellier took place in the early 1640s. It was followed by a series of initiatives, first by well-connected entrepreneurs and then by the Estates of Languedoc. Eventually, the shipping link between the *Canal des deux mers* and the Rhône was completed, not without difficulties as we have seen, but the great marshes were never reclaimed for agriculture. At each re-activation of this ambitious project, individuals of note, religious institutions, communities, and experts were asked to articulate their position on the nature and value of the existing marshes and their alterations.⁴⁹

The objections raised against the drainage of the lagoons fall into several categories. First come what are best defined as property claims. Many questioned the planned apportioning of the lands to be brought under cultivation. These queries extended to seigneurial and ecclesiastical property rights, and to matters of access to the new lands, canals and fresh water sources. A second

category of worries concerned fishing and hunting rights, both in the hands of individuals or practised by all within customary rules. More complicated topics also emerged. Sheep and cattle grazed the dry areas of the marshes during the summer. Everyone understood the importance of these animals for the manuring of all lands, a need that had led to the selection of a unique breed of cattle suited to local circumstances. However, this highly variable activity could not be assessed properly. Reeds and tamarisks were also widely used, but once again, estimates of the value of these highly variable crops proved elusive. Similarly, the manufacturing of soda from the ashes of a local plant, known as *salicor*, was sufficiently new to preclude an assessment of its potential. The fact that much of the economic value of the marshes was understood as a potential reserve made compensation strategies delicate. Finally, a fourth group of opponents doubted that the draining scheme would solve the health risks associated with wetlands.⁵⁰

Complicated as they were, these issues may not have been responsible for the failure of the project. After all, the Old Regime was well versed in such complicated transactions, even if legal costs would inevitably raise the cost of any settlement. What cast an immovable shadow over these proposals was the nature of the area. Because of the lack of an evident drainage pattern, no firm understanding could be had of the hydraulics of the region. This uncertainty proved fatal on two counts.

First, reclamation plans needed to use local rivers both to supply sediments to raise adjacent lands and to flush out a grid of drainage channels, in a pattern that was never firmly elucidated, because of the overall flatness of the land and its negligible altitude. A second dilemma surrounded the fate of the salt marshes south of Aigues-Mortes, of great value to the French crown because of the fiscal significance of its salt monopoly. It was understood that these *salins* drew at least part of the salt water they needed from the lagoon, directly or through the mysterious agency of '*résurgences*'. This supply was itself seen as conditioned by the flow of fresh water from the Cévennes mountains, by an important evaporation factor, and by unpredictable surges of sea water into the lagoon. No consensus could be reached as to what would happen once the lagoon was reclaimed. Where would sea waters surge when southern winds, storms and tides combined? Where would rivers drain when facing this Mediterranean reflux? And even during quieter periods, who could predict the salinity of waters reaching the precious salt marshes? The lagoon was understood to temper fresh and salt water excesses. However, this balance remained a mystery, precluding any work but never discouraging would-be reclaimers, even after the abolition of the salt tax by the Revolution.⁵¹

The proximal cause of the deadlock over the reclamation of the largest Languedoc lagunas lies in the balance of interests at stake and, notably, the fiscal wealth of the salt works. However, its distal root is located in the area's environmental dynamics. A better grasp of this mix of sea, lagoon, and rivers,

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would have either allowed reclamation or forbidden it altogether. Instead, the salt monopoly highlighted the importance of a natural equilibrium that confounded all experts. Existing channels of consultations were not designed to protect an environment not valued for itself. However, by giving play to a multitude of interests, these discussions probed the limits of expert knowledge, an important border between culture and nature.

CONCLUSION

The many projects intended to improve the natural conditions within which eighteenth-century Europeans earned a precarious living should not be seen as marking simply a new, decisive step toward the affirmation of western wills to recast nature. These undertakings also fostered critical evaluations of both existing natural contexts and proposed interventions. We do not know the exact nature of the discussions that followed each project, and we certainly should not assume that the reactions of those involved were motivated by a belief in the intrinsic value of a natural milieu, the key tenet of a philosophy of environmentalism that would only take its full shape two centuries later. Indeed, few of the areas disturbed by these projects were free of human occupation or at least human influence. However, the records left by these enterprises reveal a growing ability to recognise the size and complexities of the natural phenomena disturbed by human interventions. Large, rigid designs, such as canals, fostered new appreciations of the regional scale of some of environmental processes that were perhaps familiar to many within the confines of their villages. Smaller works favoured comparisons between the goals and means of a proposed venture and the existing state of affairs, exposing the inner articulations of natural and built environments. In all cases, pressing maintenance requirements made clear the lasting effects of human decisions. Finally, these projects illuminated the diversity of interests tied to every milieu and questioned the solidity of the knowledge indispensable to any substantial undertaking. Decision makers as well as many who were only reluctantly implicated in these projects were given a chance to appreciate the spatial and temporal extent of the natural phenomena at stake, their many strata, and some of their key cultural determinants.

Environmental historians tend to structure their analyses around the anti-thetic poles of nature and human designs. The early-modern age, however, is a notoriously ambiguous mix of continuities and ruptures. Eighteenth-century hydraulic public works do reflect an enlightened belief in the perfectability of both nature and human practices, and many show some of the determination and confidence characteristic of future, greater transformations to come. However, the visions of their promoters were relativised and contextualised by the debates that almost inevitably arose, and their limitations quickly highlighted. A project's effectiveness depended on the ability of its authors and managers to acknowl-

edge the impact of their work and the complexities of the natural phenomena they disturbed. Many other environmentally sensitive developments will appear similarly grounded in the imperatives of nature when put in their long-term contexts. The centuries-long struggle to manage the waters of the Low Lands offers a striking parallel on an epic scale, as do the less grandiose but almost as old efforts to contain the river Loire. And even the ‘rash assaults’ of the Victorian era could not ignore the ‘negative feedbacks’ they triggered.⁵²

Such projects are best understood as series of exchanges between engineers and other decision makers and those who, for reasons of their own, were led to draw attention to some of the natural and social variables that formed a territory. In the eighteenth century, this no doubt chaotic, largely empirical and often confrontational dialogue did not revolve around visions of human dominion over the earth, an awareness of the risks of environmental changes, or a nascent consciousness of the fragility of environmental systems. It revolved around the hybrid vision of an improvable but not controllable nature, a concept rooted in a long agricultural past familiar with the interactions of work, reason and natural forces. The early-modern age’s key contribution to environmentalism, the recognition of the interactive nature of our relationship with the environment, is rooted in such pragmatic confrontations as much as in more memorable speculations.

NOTES

¹ Recent ecology textbooks devote an initial chapter to the difficulties associated with the delineation of ecosystems – Robert G. Bailey, *Ecosystem Geography* (New York: Springer, 1996), 20–38; John D. Aber and Jerry M. Melillo, *Terrestrial Ecosystems* (Burlington, Mass.: Harcourt/Academic Press, 2001), 3–11. For illustrations of the value of multi-scalar approaches, see Olivier Planchon, ‘La notion d’échelle en climatologie: l’exemple des climats maritimes et côtiers en Europe’, *Annales de Géographie*, 602 [1998]: 363–80; Jean-Paul Bravard, ‘Le temps et l’espace dans les systèmes fluviaux, deux dimensions spécifiques de l’approche géomorphique’, *Annales de Géographie*, 599 [1998]: 3–15; and Denis Baize, ‘La cartographie des “petites régions naturelles” et des “paysages pédologiques”’: Application dans le département de l’Yonne’, *Annales de Géographie*, 589 [1996]: 319–29. More general considerations in R.V. O’Neill and A.W. King, ‘Homage to St. Michael; or, why are there so many books on scale?’, in *Ecological Scale, Theory and Applications*, ed. David L. Peterson and V. Thomas Parker (New York: Columbia University Press, 1998), 3–15. Thoughts on the scale of natural systems were originally linked to reflections on levels and hierarchies (J.S. Rowe, ‘The Level-of-integration Concept and Ecology’, *Ecology*, 42 [1961]: 420–7), and eventually came to play a key role in the acceptance of the prevalence of instability over the idea of a universal propensity toward equilibrium – a trend with many implications for environmental history (Donald Worster, ‘The Ecology of Order and Chaos’, *Environmental History Review* 14 [1990]: 1–18). For contrasting perspectives on the history of ecology, see Donald Worster, *Nature’s Economy: A History of Ecological Ideas* (Cambridge: Cam-

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bridge University Press, 1994) and Frank B. Golley, *A History of the Ecosystem Concept in Ecology* (New Haven: Yale University Press, 1993).

² Such themes are explored in Yi-Fu Tuan, *The Hydrologic Cycle and the Wisdom of God* (Toronto: University of Toronto Press, 1968); Paul Guichonnet (ed.), *Histoire et civilisation des Alpes*, vol. II, *Destin humain* (Toulouse: Privat, 1980), section 'L'homme devant les Alpes', 169–248; James R. Fleming, *Historical Perspectives on Climate Change* (Oxford: Oxford University Press, 1998), ch. 1; Theodore S. Feldman, 'The Ancient Climate in the Eighteenth and Early Nineteenth Century', in *Science and Nature: Essays in the History of the Environmental Sciences*, ed. Michael Shortland (Oxford: Alden Press, 1993), 23–40; Fabrice Guizard, 'L'homme et la nature au haut Moyen Age: une première approche', *Cahiers d'histoire*, 39, 1 [1994]: 3–17.

³ Richard Grove, *Green Imperialism: Colonial Expansion, Tropical Island Edens, and the Origins of Environmentalism, 1600–1860* (Cambridge: Cambridge University Press, 1995). Forest history is a well-developed field on both sides of the Atlantic. In a French context, numerous works authored or edited by Andrée Corvol stand out (for instance, *L'homme aux bois. Histoire des relations de l'homme et de la forêt, XVIIe–XXe siècle* (Paris: Fayard, 1987)). A broad selection of approaches is found in C. Watkins (ed.), *European Woods and Forests: Studies in Cultural History* (Cambridge: Cambridge University Press, 1998). Most work on pollution and attendant regulations has been done in urban settings, from the medieval context (Ronald Zupko and Robert Laures, *Straws in the Wind: Medieval Urban Environmental Law, The Case of Northern Italy* (Boulder: Westview, 1996)) to more recent times (see references in Jeffrey K. Stine and Joel A. Tarr, 'At the Intersection of Histories. Technology and the Environment', *Technology and Culture*, 39 [1998]: 613–19).

⁴ From a vast corpus devoted to these matters, one may mention: Nicholas Purcell, 'Rome and the management of water: environment, culture and power', in *Human Landscapes in Classical Antiquity: Environment and Culture*, ed. Graham Shipley and John Salmon (London: Routledge, 1996), 180–212; Paolo Squatriti, *Water and Society in Early Medieval Italy, AD 400–1000* (Cambridge: Cambridge University Press, 1998) and Paolo Squatriti (ed.), *Working with Water in Medieval Europe: Technology and Resource-use* (Leiden: Brill, 2000); William Tebrake, *Medieval Frontier: Culture and Ecology in Rijnland* (College Station, Texas: The University of Texas Press, 1985); Salvatore Ciriaco (ed.), *Land Drainage and Irrigation* (Aldershot, UK: Ashgate Publishing, 1998).

⁵ For a concise introduction to the history of water control, see Denis Cosgrove's opening chapter, 'An Elemental Division: Water Control and Engineered Landscape', in *Water, Engineering and Landscape. Water Control and Landscape Transformation in the Modern Period*, ed. Denis Cosgrove and Geoff Petts (London: Belhaven Press, 1990), 1–11. More generally, public works in eighteenth-century Europe have been seen as a factor in industrialisation, a testimony to the ingenuity and abilities of engineers, and a revealing mix of private and public initiatives. Among recent significant contributions related to the context explored here: Rick Szostak, *The Role of Transportation in the Industrial Revolution: A Comparison of 18th Century England and France* (Montreal: McGill-Queen's University Press, 1991); R.G. Geiger, *Planning the French Canals: Bureaucracy, Politics, and Enterprise under the Restoration* (Newark, N. J.: University of Delaware Press, 1994); and Collective work, *Un canal ... des canaux* (Paris: Caisse des monuments historiques et des sites/Picard, 1986).

⁶ Marc Desportes and Antoine Picon, *De l'espace au territoire. L'aménagement en France, XVI–XXe siècle* (Paris: Presses de l'École des ponts et chaussées, 1997). For a short survey of the French experience in public works, see Cecil O. Smith, 'The Longest Run: Public Engineers and Planning in France', *American Historical Review*, 95 [1990]: 657–92. Pierre Dockès noted that early-modern economic thought afforded much attention to space and its organisation, in sharp contrast to the liberal economists who dominated the following century. To the mercantilists' acceptance of concentrations of wealth, the eighteenth century added a focus on movement and exchanges (*L'espace dans la pensée économique du XVIe au XVIIIe siècle* (Paris: Flammarion, 1969)). Chandra Mukerji refers to *mesnagement* tradition standing behind the expression 'aménagement du territoire' (*Territorial Ambitions and the Gardens of Versailles* (Cambridge: Cambridge University Press, 1997), 41–5).

⁷ Jean-Laurent Rosenthal explored the legal and institutional contexts of the period as well as traditional notions of individual and public interests in *The Fruits of Revolution. Property Rights, Litigation, and French Agriculture 1700–1860* (Cambridge: Cambridge University Press, 1992). A more detailed perspective, contrasting in particular the almost utopian nature of some projects and the web of difficulties that defeated them, is found in Anne-Marie Cocula-Vaillières, *Les gens de la rivière de Dordogne, 1750 à 1850 (Doctorat d'Etat, University of Bordeaux III, 1977: notably 529–64)*. For a short survey: Hugh D. Clout, 'Reclamation of Coastal Marshland', in *Themes in Historical Geography of France*, ed. H.D. Clout (London: Academic Press, 1977), 185–213. For a detailed but dated survey, see Dienne, *Histoire du dessèchement des lacs et marais en France avant 1789* (Paris: H. Champion & Guillaumin & cie., 1891). For a list of canal projects never completed: Collective work, *Un canal ...*, 354–8.

⁸ The commercial value of this canal has been minimised by historians, although an era of substantial returns on this heavy investment eventually stretched from the second third of the eighteenth century to the advent of railways, more than a century later. See André Maistre, *Le Canal des Deux Mers. Canal royal du Languedoc, 1666–1810* (Toulouse: Privat, 1968), and Georges Frêche, *Toulouse et la région Midi-Pyrénées au Siècle des Lumières (vers 1670–1789)* (Paris: Cujas, 1974), 579–611.

⁹ The negative impact of the canal upon neighbouring lands was evident in the lack of interest in the 'terres excédentes', lands that were put back on the market once no longer needed for the canal (Henri Blaquière, 'A propos du domaine du canal de Languedoc: la question des "terres excédentes"', *Annales du Midi* 70 [1958]: 415–26). For a general assessment of this agricultural context, see Frêche, *Toulouse ...*, 563–72.

¹⁰ R. Couderc, untitled communication, *Bas-Rhône – Languedoc* 97 (Dec. 1980): 7–10.

¹¹ A visiting member of the Paris *Académie des sciences* argued that sedimentation eventually better contained the waters of the canal, while new drainage patterns became accepted (Le Camus, *Archives nationales*, henceforth AN, H¹ 232, p. xvij; no date).

¹² See Archives Départementales de l'Hérault, henceforth AD Hérault, C 4185 to 4195. Although the Languedoc retained some fiscal and administrative autonomy through its Estates, by the eighteenth century matters concerning roads, rivers, bridges, ports, etc. were managed by the intendant, the local representative of Versailles, in most regions. Unless otherwise specified, all references are to this stream of power, emanating from royal council and reaching provincial levels through the intendants.

¹³ '[...] a continuation of the feeders and collecting trenches of the canal linking the seas' (translation by author; letter from Charlary, dated 8 Apr. 1750, AD Hérault, C 4187). AN, H¹ 748–233, deposition of Vieille-vigne, 22 Jun. 1772. The hybrid nature of much if not

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all of the French environment has become a central feature of French environmentalism (Michael D. Bess, 'Ecology and Artifice: Shifting Perceptions of Nature and High Technology in Postwar France', *Technology and Culture*, 36 [1995]: 830–62). In a North-American context, see Richard White, *The Organic Machine: The Remaking of the Columbia River* (New York: Hill and Wang, 1995).

¹⁴ Alain Bousquet, 'Les plantations du Canal du Midi. De l'origine à la moitié du XXe siècle', in *Le Canal du Midi. Trois siècles de batellerie et de voyages*, ed. Jean-Denis Bergasse (Cessenon, France: private edition, 1983), 335–47. For this and other programs related to canals, see Collective work, *Un canal ...*

¹⁵ See for instance complaints registered in AD Hérault, C 4102 (1782) (as well as several other references in Couderc, untitled). On 13 Jan. 1753, the reservoir at Saint-Ferreol, key to the operation of the canal's central section, was half-filled with sand (AD Hérault, C 4473).

¹⁶ Records exist of inquiries held in 1739, 1753, 1772, and 1780 (respectively AD Hérault, C 4418 and C 4473, AN, H¹ 748 – 233, and AD Hérault, C 4432). The 1739 inquiry led to a royal edict (24 Apr. 1739, AD Hérault, C 4418). The 1772 inquiry was held from 23 Feb. to 30 Jun. 1772, and its report printed in 1774. In 1780, the canal's owners accepted the necessity of a canal-bridge to better manage the Orb.

¹⁷ The success of Ferdinand de Lesseps was evidently not foreign to this proposal (A.-F.-A. Manier, *Projet d'un grand canal maritime du Midi pour prévenir les inondations complément du Canal de Suez* (Paris: E. Dentu, 1876)).

¹⁸ In his essay on the formative years of forestry and geography, Jean-Yves Puyo suggested that the eighteenth century was particularly interested in the potential overlap between popular knowledge and emerging scientific understandings ('La science forestière vue par les géographes français, ou la confrontation de deux sciences "diagonales"', *Annales de Géographie*, 609–10 [1999]: 615–34). See also recent work by Chandra Mukerji on this canal as well as the sea port of Sète ('Cartography, Entrepreneurialism, and Power in the Reign of Louis XIV. The Case of the Canal du Midi', in *Merchants & Marvels. Commerce, Science, and Art in Early Modern Europe*, ed. Pamela H. Smith and Paula Findlen (New York: Routledge, 2002), 248–76), or Ian B. Thompson, 'The Role of Artisan Technology and Indigenous Knowledge Transfer in the Survival of a Classic Cultural Landscape: The *marais salants* of Guérande, Loire-Atlantique, France', *Journal of Historical Geography*, 25 [1999]: 216–34. For a positive assessment of the experience acquired by communities bordering Europe's main rivers, see J. Tricart and Jean-Paul Bravard, 'Le cours périalpin du Rhin, du Rhône et du Danube: aménagement fluvial et dérivés de l'environnement', *Annales de Géographie*, 561–2 [1991]: 668–713. Also Denis Cosgrove, 'Platonism and Practicality: Hydrology, Engineering and Landscape in Sixteenth-century Venice', in Cosgrove and Petts, *Water, Engineering ...*, 35–53

¹⁹ A sum of 30,000 *livres-tournois* (lt) was devoted to this project yearly, including maintenance of completed sections. Relevant information appears in the deliberations of the Estates of Languedoc, notably in AD Hérault, 1 J 6. The Estates, where representatives of the three orders sat, met every second year and managed a still substantial share of revenues, albeit under scrutiny from the intendant in the name of the king. The Crown considered the salt water marshes of the Languedoc coast part of the public domain at least since 1544, and asserted its right to reclaim what amounted to revokable concessions. Nevertheless, the Estates agreed to a number of compensation settlements (see several examples as well as the types of arguments advanced in AD Hérault, C 4518). A 1750 memorandum questioned the link between canal and deteriorating catches, and also noted

that the fisheries themselves had adverse effects upon currents in the lagoons (memorandum by the *Sindic du Languedoc*, AD Hérault, C 4518).

²⁰ For discussions of these matters before the advent of the canal, around the city of Aigues-Mortes, see memorandum dated 18 Oct. 1739, AD Hérault, C 4077. To answer anxieties about dredging (see pleas dated 28 Nov. 1729, AD Hérault, 1 J 6), work crews dried the mud by spreading it atop the banks of the canal. As dredging became a maintenance task, the silt was to be carried to the deepest areas of the marshes or out to sea. If it was used to back fill shallow areas, six inches of 'strong earth' brought from the interior was to be laid on top (AD Hérault 1 J 6, 19 Nov. 1761 and 28 Dec. 1781). For concerns about the interruption of natural water exchanges, see deliberations dated 5 Jan. 1742, 28 Nov. 1744. For today's science, see Martine Ambert, 'Milieu naturel et aménagement de l'étang de Mauguio', in *Le Languedoc, le Roussillon et la mer: des origines à la fin du XXe siècle*, ed. Jean Rieucou and Gérard Cholvy (Paris: L'Harmattan, 1992), 23–35.

²¹ To assess the evolution of complaints, proposed solutions, and chosen initiatives, see (as well as the references mentioned in previous note) deliberations dated 13 Feb. 1759 (first mention of regular breaching of canal levies), 19 Nov. 1761, 23 Dec. 1766, 19 Nov. 1772, 7 Dec. 1778, 16 and 28 Dec. 1779, and 28 Dec. 1782 (all in AD Hérault, 1 J 6). The attention given to water flows benefited from regular observations, such as that made after several great storms in Dec. 1776. They had opened three new channels to the sea and, a year later, lower morbidity rates were recorded in the neighbouring of the 'cleansed' lagoon (7 Dec. 1767). It was generally acknowledged that workers could only help deepening a *grau* opened by the sea. During the 1780s, sums of the order of 10,000 lt were spent yearly on such remedial measures (28–29 Dec. 1782, 16 Dec. 1789). Carnon dike: AD Hérault, 1 J 6, 12 Oct. 1780. The installation of gates controlling the *graus* was also contemplated (AD Hérault, 1 J 6, 28 Dec. 1782). Besides being planted, the banks of the canal were also to be paved (AD Hérault, 1 J 6, 12 Nov. 1778). An enterprising tinkerer went as far as designing a machine to clean the vegetation choking the canal, without success however (AD Hérault, 1 J 6, 4 Feb. 1786, 25 Nov. 1788 and 24 Jan. 1789).

²² Chaptal's *mémoire* in AD Hérault, 1 J 6, 29 Dec. 1783. See Jeff Horn and Margaret C. Jacob, 'Jean-Antoine Chaptal and the Cultural Roots of French Industrialization', *Technology and Culture* 39 [1998]: 671–98. Chaptal's suggestions were perhaps ignored because local vital statistics improved throughout the 1780s (AD Hérault, 1 J 6, 29 Dec. 1783, 4 Feb. 1786, 24 Jan. 1789). Eventually, these rivers (Vidourle, Vistre, etc.) were channelled directly to the sea, with mixed results (Ambert, 'Milieu naturel ...', 23–35). In the nineteenth century, the national forest authority made the Cévennes a model for reforestation (see O. Nougareè, R. Larrère, and D. Poupardin, 'La restauration des terrains de montagne de 1882 à 1913. L'Aigoual et sa légende', in *Protection de la nature: histoire et idéologie. De la nature à l'environnement*, ed. A. Cadoret (Paris: L'Harmattan, 1985), 24–40). For a quick survey of deforestation debates, see Jean-Paul Métaillé, 'Le fleuve ravageur. Risques, catastrophes et aménagement dans les Pyrénées et leur piémont, fin XIIe–XXe siècle', in *Pour une histoire de l'environnement*, ed. C. Beck and R. Delort (Paris: CNRS Editions, 1993), 105–12.

²³ Cosgrove suggests that early-modern Venetian engineers were not ignorant of the need to consider hydraulic works in a broad context, but that this awareness remained second to their attachment to the principle of 'separation' of natural elements, itself both conducive to the use of reason and reflective of its triumph ('Platonism and Practicality ...', 43–5). In their comparative study of the Rhine, Rhône, and Danube, J. Tricart and

Jean-Paul Bravard see little evidence of a global perspective until the nineteenth century ('Le cours périalpin ...').

²⁴ François Etner, *Histoire du calcul économique en France* (Paris: Economica, 1987), 59–64, and Anne Kriegel and Pierre Pinon, 'Les canaux ou l'aménagement du paysage bourguignon', *Monuments historiques* 122 [1982]: 49–56 (notably 51–2). Such calculations were part of a new agenda of reflections on the public good, its relation to private interests, and the role of the state (see Hélène Vérin, *La gloire des ingénieurs. L'intelligence technique du XVIe au XVIIIe siècle* (Paris: A. Michel, 1993), 379–400). Another illustration of this trend is found late in the century, when Condorcet, appointed 'Inspecteur de la navigation', led an investigation of the potential impact of a projected canal in Picardie (Keith Michael Baker, *Condorcet: From Natural Philosophy to Social Mathematics* (Chicago: The University of Chicago Press, 1975), 68–9).

²⁵ *Archives départementales de la Côte-d'Or*, henceforth AD Côte-d'Or, C 3837, deliberations of the Estates of Burgundy, 1 Feb. 1787. The first section of this canal had been authorised in 1783 (AD Côte-d'Or, C 4505). See also the range of secondary works required by the canal de Briare, the first link in the all-important connection between the Loire and the Seine (Abel Poitrineau, 'La construction et le fonctionnement du canal de Briare', *Revue d'Auvergne* 102, 1988: 197–224). For a general overview of the Burgundy canals, see Collective work, *Un canal ...*, 289–299.

²⁶ Kriegel and Pinon, 'Les canaux ou l'aménagement ...', 52–4. Complaints concerning the canal of the Charollais, in AD Côte-d'Or, C 4534 (Oct., Dec. 1785, Jun., Jul. 1786, Aug. 1788, etc.), as well as the very detailed file of the Countess de la Coste (AD Côte-d'Or, C 3835, 11 Feb. 1786).

²⁷ See the arguments made by Desportes and Picon, *De l'espace au territoire ...*, notably pp. 19–32.

²⁸ See for instance Marcel Roncayolo, 'Le paysage du savant', in *Les lieux de mémoire*, ed. Pierre Nora, vol. II, part I, *La nation* (Paris: Gallimard, 1986), 487–528. Related essays in Numa Broc, *Regards sur la géographie française de la Renaissance à nos jours* (Perpignan: Presses Universitaires de Perpignan, 1994). Marie-Vic Ozouf-Marignier, 'Limites naturelles et limites politiques: la division du territoire', in *La nature en révolution 1750–1800*, ed. Andrée Corvol (Paris: L'Harmattan, 1993), 126–33; and Pierre-Henri Derycke, 'La Révolution française et le maillage territorial', in *La pensée économique pendant la Révolution française*, ed. Gilbert Faccarello and Philippe Steiner (Grenoble: Presses Universitaires de Grenoble, 1990), 379–89.

²⁹ The interest manifested in the eighteenth century for better control of rivers came after a long period of growing torrential activity linked to early-modern climatic conditions, notably in southern France. See Jean-Paul Bravard, 'Approches du changement fluvial dans le bassin du Rhône (XIVe–XIXe siècles)', in *Pour une histoire de l'environnement*, ed. Corinne Beck and Robert Delort (Paris: Editions CNRS, 1993), 97–103, and Métaillé, 'Le fleuve ravageur ...'; Jean-Marc Antoine, 'Catastrophes torrentielles et géographie des sources historiques. Le cas de la baronnie de Château-Verdun (Pyrénées Ariégeoises) au XVIIIe siècle', *Sources Travaux historiques* 33 [1993]: 51–68. An even broader context is provided in the case of an Alpine region particularly sensitive to torrential degradations, by François Walter, *Les Suisses et l'environnement. Une histoire du rapport à la nature du 18e siècle à nos jours* (Geneva: Editions Zoe, 1990), notably ch. II. For a more theoretical approach centred around the concept of land erosion, see Piers Blaikie and Harold Brookfield, *Land Degradation and Society* (London: Methuen, 1987), ch. 7.

³⁰ Bertrand Desailly charts this progression in the Roussillon ('Le temps des *aiguats*', in *De l'eau et des hommes en terre Catalane*, ed. Numa Broc, Michel Brunet, Sylvie Caucanas, Bertrand Desailly et Jean-Pierre Vigneau (Perpignan: Llibres del Trabucaire, 1992), 169–217). See also Serge Briffaud and Bertrand Dessailly, 'La poche d'eau. L'interprétation des crues et inondations dans les Pyrénées (XVIIe–XXe siècles)', *Sources travaux historiques* 33 [1993]: 39–49. For a short survey of later developments, see Jean-Paul Métaillé, 'De la géographie des forestiers à la géographie contre les forestiers: la diffusion et l'extinction du concept de dégradation des montagnes, à la fin du XIXe et au début du XXe siècle', in *Autour de Vidal de la Blache. La formation de l'école française de géographie*, ed. Paul Claval (Paris, CNRS Editions, 1993), 101–8. Jean-Antoine Fabre provided an early theorisation of the links between floods and deforestation in 1797 (cited in Jean-Paul Métaillé, 'Lutter contre l'érosion: le reboisement des montagnes', in *Les sources de l'histoire de l'environnement. Le XIXe siècle*, ed. Andrée Corvol (Paris: L'Harmattan, 1999), 97–110). This link was fully publicised in a most influential essay by Alexandre Surell, *Etude sur les torrents des Hautes-Alpes*, 1841. T. Whited sketched some of the debates that accompanied and eventually challenged this interpretation (*Forests and Peasants ...*, 53–67; see p. 9 for a reference to the then prevalent equation between degradation and deforestation upon which the theory rested).

³¹ See also comments by Isabelle Richefort, 'Politiques révolutionnaires de la nature', in *Nature, Environnement et paysage. L'héritage du XVIIIe siècle*, ed. Andrée Corvol and Isabelle Richefort (Paris: L'Harmattan, 1995), 49–57; Desailly, 'Perception ...'; Métaillé, 'De la géographie ...'; Serge Briffaud, 'Le rôle des catastrophes naturelles: cas des Pyrénées centrales', in *La nature en révolution 1750–1800*, ed. A. Corvol (Paris: L'Harmattan, 1993), 134–44. As early as 1728, concerns about floods in the lower Rhône region were linked to deforestation in the Savoie, Dauphiné and Provence (AD Hérault, C 5774, memorandum 1728). Numa Broc argues that Buache's greatest contribution was the linking of the relatively well-developed geography of rivers and hydrographic basins with that, much less advanced, of mountains (N. Broc, *Regards sur la géographie ...*, vol. II, 329–43; Broc et al., *De l'eau et des hommes ...*, 201–4).

³² AD Côte-d'Or, C 4459, river Arroux, depositions given on 28 Oct. 1730, reports dated 15 May 1731 and 25 Aug. 1733). See also *Archives municipales de Lyon*, 14 II 20, Dec. 1771, testimony by B. Deyrieu, and AD Hérault, C 1368, river Gardon, 1767–1768.

³³ AD Hérault, C 1368, 10/3/1767, and C 4190, 5/9/1751; AD Côte-d'Or, C 4459, depositions dated 28 Oct. 1730 and report dated 15 May 1731, and C 4460, failure of the canalisation of the Ouche, early eighteenth century. Early in the 1760s, a small drainage scheme (concerning the Dive, in the Poitou) encountered opposition based on the failure of a 1658 attempt (AN F¹² 1513, letter to Trudaine dated 24 Apr. 1761).

³⁴ This project (1742–1747) was of particular interest to various levels of governments because of the vital traffic on the great north–south axis, but a conflict over jurisdiction involving Papal lands hampered its resolution (AD Hérault, C 4122 and 5769).

³⁵ A report on the Burgundy river Arroux argued that the clearing of a strip of land on each side of the river would ease its flow, safeguard its banks, and allow north winds to quicken its pace, purifying it and neighbouring lands (31 Oct. 1779, based on visits going back to Aug. 1775 and Mar. 1779, in AD Côte-d'Or, C 4459). Examples of similar measures: AD Côte-d'Or, C 4459, river Armançon, 1787, and river Brissotte, 27 Mar. 1768; C 4460, river Yonne, 12 Mar. 1787; AD Hérault, C 1368, river Gardon, 3 May 1745; river Louge, 15 Nov. 1768; C 4276, 4277, 4282, river Peyne; C4122 and 5769, river Lauzon, 1742–1747.

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³⁶ *Archives départementales du Rhône*, henceforth AD Rhône, BP 2577, case dated 22 Nov. 1779, and BP 2585, case dated 22 and 23 Dec. 1783. The Givors canal was conceived in the middle of the eighteenth century as a link between the Loire and the Rhône. Only one section was built, as an outlet for the coal mines of Rive-de-Gier. The outlines of this venture were summarised for a court case late in 1789 (AD Rhône, 1 C 152, 19 pages).

³⁷ Roger Dion, *Histoire des levées de la Loire* (Paris, 1961). For similar discussions around the river Vingeanne in Burgundy, see AD Côte-d'Or, C 4493 (two reports to Estates of Burgundy, 1787). See also Bertrand Desailly, 'Perception et gestion du risque naturel: les ingénieurs et les crues méditerranéennes', in *La nature en révolution 1750–1800*, ed. Andrée Corvol (Paris: L'Harmattan, 1993), 41–5. Intermediary solutions were tried, such as the planting of trees to filter rising waters while checking the formation of devastating currents (AD Côte d'Or, C 4460, river Grosne, 27 Sep. 1787).

³⁸ AD Hérault, C 4148. A smaller, detailed case involving private initiatives is found in AD Rhône, BP 2575 (18 Apr. 1788). The provinces of Languedoc, Dauphiné, Provence, as well as the Papal Comtat and the neighbouring kingdom of Sardinia (Savoie), carefully monitored all initiatives on the Rhône (AD Hérault, C 5769, letter dated 7 Sep. 1746, and report 16 Sep. 1746; C 5771, file 1768; C 5772, letters dated 5 and 26 Jan., and 27 Mar. 1785; C 4122, dispute Caderousse – Laudun, 1756; C 1378; AN, H¹ 165, 1722–1724).

³⁹ A survey of the Arroux noted the presence of several old river beds, recognisable for their distinct soils and crops, and assessed the size and age of sand banks (AD Côte-d'Or, C 4459, report dated 15 May 1731; see also a request from the inhabitants of Bligny, dated 16 Jul. 1736). Alpine rivers were particularly feared in this regard (memorandum on the Guiers, dated Oct. 1723, in AN H¹ 165).

⁴⁰ AD Côte-d'Or, C 4459, 'River Arroux', deliberation dated 3 Dec. 1732 (author's translation). AD Côte-d'Or, C 4460, file 'River Ouche', 1606–1783, calls dated 1709 and reports from the year 1730 (author's translation). Plans for this section of the river went back to 1606 (by Bradley, a celebrated Flemish engineer).

⁴¹ Numa Broc, 'Une découverte "révolutionnaire". La haute montagne alpestre', in *Composer le paysage. Construction et crises de l'espace (1789–1992)*, ed. Odile Marcel (Seyssel, France: Editions Champ Vallon, 1989) 44–59, and Alain Roger, 'Esthétique du paysage au siècle des Lumières', *ibid.*, 60–82; Numa Broc, 'Aspects de la connaissance géographique des Pyrénées au XVIIIe siècle', in *Regards sur la géographie ...*, vol. I, 73–112, and 'Le milieu montagnard: naissance d'un concept', *ibid.*, vol. II, 389–404. The eighteenth-century taste for exotic destinations but also for all regions of France is explored in Bernard Lepetit, 'Voyages en France', *Composer le paysage ...*, 111–130 (followed by 'Dossier du Paysage des Lumières dans huit régions de France', 131–183). See also Numa Broc, 'Voyages et géographie au XVIIIe siècle', *Regards sur la géographie ...*, 133–54.

⁴² AD Côte-d'Or, C 4459, 16 Jul. 1736; C 4493, river Vingeanne, 8 Nov. 1787. Proponents of canals argued that lower number of pack animals would permit the raising of more cattle, hence improving the pastoral/agricultural ratio of the region at hand (AD Rhône, 1 C 152, request dated 10 Jun. 1761).

⁴³ See the legal battles around the mills owned by the influential Toulouse judge Davisard (AD Hérault, C 4192, 1757–1759); Jobert file in AD Côte-d'Or, C 4460, 5 Jan. 1762.

⁴⁴ Elisabeth Fox-Genovese, *The Origins of Physiocracy: Economic Revolution and Social Order in 18th-Century France* (Ithaca: Cornell University Press, 1976); Albert O. Hirschman, *The Passions and the Interests: Political Arguments for Capitalism before its*

Triumph (Princeton: Princeton University Press, 1977); Catherine Larrère, *L'invention de l'économie au XVIIIe siècle* (Paris: Presses Universitaires de France, 1992).

⁴⁵ A particularly relevant study is that by Michel Marié, *Un territoire sans nom* (Paris: Librairie des Méridiens, 1982), notably p. 47. Etner, *Histoire du calcul ...*

⁴⁶ A public inquiry (known as an '*enquête de commodo et incommodo*') was a standard procedure designed to assess the impact of transactions or ventures benefiting from a royal privilege (Pierre Claude Reynard, 'Public Order and Privilege. Eighteenth-Century French Roots of Environmental Regulation', *Technology and Culture*, 43 [2002]: 1–28). The inquiry for the Givors canal was conducted from Mar. to May 1762 (AD Rhône, BP 3604; see also depositions made on 10 Jun. 1761 in 1 C 152). *Lez* file in AD Hérault, C 4313 and 4314.

⁴⁷ In Pézenas, encroachments hindered flood-prevention work (AD Hérault, C 4276 to 4310). Mandated right-of-ways along all but the smallest streams were only maintained if river traffic required it (see the reminders of these regulations regularly issued in AD Hérault, C 4317, memorandum, 1732, or AD Côte-d'Or, C 4493, River Yonne, 12 Mar. 1787). AD Hérault, C 4276, 1729–1731 (Saint-Esprit), 21 Dec. 1774 (Bagnols); in the same file, see also inquiry dated 26 Jun. 1771 and the general ruling re-issued on 30 Apr. 1777. The importance accorded to food production could delay the dredging of gravel banks (AD Côte-d'Or, L 1769, report dated 17 Mar. 1791).

⁴⁸ For a recent illustration: Eric H. Ash, "'A Perfect and an Absolute Work" Expertise, Authority, and the Rebuilding of Dover Harbour, 1579–1583', *Technology and Culture*, 41 [2000]: 239–68. Antoine Picon stressed the tension between mathematical models and experimentation that were at the heart of the training of eighteenth-century engineers. See *L'invention de l'ingénieur moderne: l'École des ponts et chaussées, 1747–1851* (Paris: Presses de l'École nationale des ponts et chaussées, 1992), translated as *French Architects and Engineers in the Age of Enlightenment* (Cambridge: Cambridge University Press, 1992), notably ch. 9.

⁴⁹ The principal attempts took place in the late 1670s, in 1701 (first set of hearings), in 1716, and in 1738. By then, opposition to the project had grown and the first of a long series of *mémoires* were printed. In 1746, the Estates of Languedoc took charge of the project, and work was finally started in 1778, but only on a very modest scale. See AD Hérault, C 4058 and 4059 (1701), 4062 (1717–1718), 4065 (1739), 4073, and 4074 (1746). Outline of these ventures in Dienne, *Histoire du dessèchement ...*, ch. IV. These consultations were shaped along the lines found in Reynard, 'Public Order and Privilege ...'. Here, the word 'community' refers to the notarised record of the statements voiced by assembled, male, tax-paying parishioners. The royal edict dated 8 Nov. 1746, for instance, ordered the posting on all public buildings, as well as the reading at church services, markets and fairs, over three consecutive weeks, of invitations to all those having a claim on the swamps, to register their opposition to the project within six months. Positions could shift over time: the community of Vauvert supported the project in 1701 and 1716 but opposed it by 1728 (AD Hérault, C 4063 and 4094). For expert opinions, see the study commissioned on 30 Jun. 1739 and delivered to the Estates of Languedoc on 21 Dec. 1740 (two more assessments were led by engineers and architects a few years later; AD Hérault, C 4067). As early as 1701, proponents of reclamation knew that the managing of opinions would be crucial to the enterprise (see royal edict, 29 Mar. 1701, and intendant's ordinance, 25 Apr. 1701, AD Hérault, C 4059).

⁵⁰ References in previous note plus Michel Martinez, 'Contribution à l'histoire de la fabrication de la soude végétale à partir des "salicors" dans les communautés maritimes

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de l'Aude, de l'Hérault, etc., au XVIIIe siècle et au début du XIXe siècle', in Collective work, *Les zones palustres et le littoral méditerranéen de Marseille aux Pyrénées* (Montpellier, 1983), 143–53. The principal arguments developed repeatedly over the century, illustrative of both the most voluntarist currents of the *Siècle des Lumières* and the use of local memories and experiences to question their conclusions, are in AD Hérault, C 4077 (memorandum dated 18 Oct. 1739, 11 pages, and 'Reply to a refutation of an earlier *mémoire*', 1742, 28 pages); C 4066 (memorandum by Le Vasseur, 1744, 51 pages; C 4097, deposition dated 7 Apr. 1745).

⁵¹ Two memoranda sustaining these final objections in AD Hérault, 3 F 55. See also Bernard Picon, *L'espace et le temps en Camargue* (Arles: Actes Sud, 1988), 77, note 1, and similar discussions of a short channel that threatened the Balaruc mineral springs near Sète (AD Hérault, C 4509, 15 Apr. 1740). After the abolition of the salt tax, on 1 Dec. 1790, the price of salt fell to one-tenth of its former level. Picon shows a similar pattern of failed initiatives in the Camargue during the nineteenth century, until the will to preserve a regional identity and its natural setting emerged after World War I (Picon, *L'espace et le temps ...*, 47–99). This new philosophy eventually spread to the lagunas west of the Camargue.

⁵² See the essays in a special issue of *Technology and Culture*, 43, 3 [2002], 'Water Technology in the Netherlands'; Dion, *Histoire des levées ...*; and James Winter, *Secure from Rash Assault. Sustaining the Victorian Environment* (Berkeley: University of California Press, 1999).