Hydrol. Earth Syst. Sci. Discuss., 4, 1697–1727, 2007
www.hydrol-earth-syst-sci-discuss.net/4/1697/2007/

Hydrology and Earth System Sciences Discussions

Papers published in *Hydrology and Earth System Sciences Discussions* are under open-access review for the journal *Hydrology and Earth System Sciences*

Rivers we can't bring ourselves to clean – historical insights into the pollution of the Moselle River (France), 1850–2000

R. J. Garcier

École normale supérieure, département de géographie, 48 boulevard Jourdan, 75014 Paris, France

Received: 10 May 2007 – Accepted: 23 May 2007 – Published: 15 June 2007

Correspondence to: R. J. Garcier (romain.garcier@normalesup.org)

Abstract

As products of both natural and social systems, rivers are highly complex historical objects. We show in this paper that historical analysis works on two different levels: one level, which we call "structural", shows the materiality of the riverine environment as the spatial-temporal product of natural factors and human impacts (bed and course alterations, pollution, etc.). On a second level – "semiotic" – we show that river systems are also social constructs and the subjects of ancient and diverse management practices. The quality of a river will be a function of the dialectical interaction between both levels. Historical analysis can uncover the inherited constraints that bear upon current management practices. To help substantiate this analytical framework, we analyse the case of the Moselle river in eastern France by using archival sources and statistical data. Severely impaired by industrial discharges from iron, coal and salt industries between the 1875s and the early 1980s, the waters of the Moselle became the subject of a social consensus between stakeholders that prevented the implementation of efficient pollution management policies until the 1990s. The example urges caution on the pervasiveness of participatory approaches to river management: social consensus does not necessarily benefit the environment.

1 Introduction

The contemporary scientific literature on river systems calls for a better understanding of the relationships between rivers and society (Meybeck, 2002). This testifies to the powerful social dynamics that shape natural objects. At all time and space scales, the impact of human action on natural objects and environments has been getting harder to neglect. The floristic composition of forests, the strength of soil erosion in ancient times, the circulation of exogenous species, the presence of lead in Arctic ice all advocate a reassessment of how we theorize, analyze and quantify human interaction with the "natural" world. This is a complicated debate because it develops at the borders of

HESSD

4, 1697–1727, 2007

Historical pollution

R. J. Garcier

EGU

disciplinary fields. It is sometimes difficult to reconcile the concerns and methods of the natural scientists with those of the historians, the philosophers and the sociologists. True interdisciplinarity in the environmental field is needed but hard to achieve.

Rivers are good objects on which to build interdisciplinary research, as the existing literature shows (Petts et al., 1989; Meybeck et al., 1998). History plays a great role in those research initiatives. One reason is that, in the Western world, there is generally a wealth of historical data available on rivers. Very early, the significance of water for human settlements transformed the watercourses in legal objects. Roman law developed a large corpus on water rights. Even in those countries where the legal system does not derive from Roman law, the question of water property was never left unspecified. It was of considerable importance to know who was entitled to withdraw water from a watercourse or a water table; who had the right to modify the course of a river to create mills or irrigation works; who was responsible for maintaining the dykes and dams erected to protect the land against floods, etc. As a consequence, public and private archives alike are rich with ancient information about the representations, transformations and management of rivers[1]. Specifics about water abstraction and channel geometry modifications appeared as early as the Middle Ages. Data regarding water quality appeared later, with the development of analytical methods (end of the eigteenth century). In France, the development of spas from the 1830s gave a decisive impetus to the chemical analysis of water and the subsequent development of adduction and sanitation networks made necessary frequent water quality analyses which have been kept in the archives. The expansion of water quality analyses has been very great since the 1960s, when they were extended to all waters (and not only those used for human consumption). Other sources of data can be mobilized to study the historical evolution of rivers: e.g. field observations, aerial photography, sediment sampling (Meybeck et al., 2007). However, for contemporary river managers and river scientists, the recourse to history may appear like a nice but somewhat superfluous

[1] For information about contemporary historical sources for environmental history in France see Corvol (1999, 2003).

addition to their core business and concerns. In this paper, we would like to argue that a systematic exploration of river history can shed light on many aspects of current river dynamics and politics, especially for those rivers that have been most transformed by human action.

This belief is grounded in a case study that was conducted over five years in Eastern France, on the river Moselle (Garcier, 2005). Over the course of thirty years at the end of the nineteenth century, the Moselle underwent brutal changes. It became the axis of a powerful industrial region, saw its channel considerably remodelled and the quality of its waters progressively degraded. We used archival sources – among others – to reconstruct this transformation and provide some quantitative elements about it. But we also tried to make sense of it: how could a river experience such massive changes without much debate? How come that the local population and administration quickly saw industrial pollution as normal? What kind of management policies were applied to remedy the problem and with what success? And ultimately, can contemporary river management gain some insight from this retrospective assessment?

We will first provide a theoretical overview on rivers as historical objects and products of socio-natural systems. We will then present the case of the Moselle. We will finally introduce some conclusive comments on the use of historical information to aid contemporary decision-making on river management.

2 Rivers as socio-natural systems

In the twentieth century, historiography has undergone important changes that have affected the methods and the objects of historical enquiry. The main reformers of historical practice are the members of the so-called “Annales School”, among them M. Bloch, L. Febvre, and later, F. Braudel. Their approach promoted the use of adjunct sciences to advance historical research. They were not hostile to scientific inputs from anthropology, sociology and geography and they favoured the use of a variety of information sources. Most importantly, their scientific stance departed from the tradi-

HESSD

4, 1697–1727, 2007

tional emphasis on events. As one prominent member of the school puts it, this new approach “relegated the sensational to the sidelines and was reluctant to give a simple accounting of events, but strived on the contrary to pose and solve problems and, neglecting surface disturbances, to observe the long and medium-term evolution of economy, society and civilisation.” (Duby, 1990).

Observing the “long and medium-term evolution” requires studying historical “structures”. The notion of structure is widely used in the social sciences and humanities, though its meaning varies. Here, by historical structure, we mean a lasting mode of repartition and organization of social objects and practices. In this historical model, events are a manifestation of structures: no event can happen independently of the structures uncovered by historical scrutiny. As a consequence, no event is “random”, completely foreign to the way societies are organized materially but also, culturally. It is another contribution of the Annales school to have specified that structures are not only material but mental as well. Each region and time period has specific ways of thinking that filter experience and steer action or inaction. Accordingly, an idea cannot spontaneously spring in any social structure: it is always dependent on a certain context.

The influence of the Annales school on environmental history has been very great, because environmental change, until recently, has been a “long and medium-term evolution”. The new approach opened up the possibility to investigate the historicity (i.e. historical character) of the environment itself by using historical data. Emmanuel Le Roy Ladurie’s *Histoire du climat depuis l’an mil* was the first attempt to use textual data (e.g. the dates of wine harvests in the south of France) to document natural climate variations over historical periods (LeRoy-Ladurie, 1988). The research done by the Lyons group on river systems shares the same theoretical basis: by using a variety of data sources (geomorphologic field observations, textual and cartographic archives, etc.), it is possible to reconstruct the natural evolution of a watercourse over many centuries if not millenia (Roux, 1982; Bravard, 1989; Girel, 1996; Bravard and Magny, 2002). Environmental change modifies the whole fluvial system. Rivers respond by reshaping their beds. Depending on water conditions and the availability of sediments, a river will cut its bed or expand it by aggradation.

Other research stances take up a slightly different approach; they insist on the impact of social structures and economic development on the environment – see for example Cronon (1992) and Williams (1992). The river "biographies"' that have been published in the last fifteen years share the same line of thought. In those works, the river system and basin are not considered as the setting of historical events nor are they considered as purely "natural" entities. Indeed, the main driving force of change is human action, and especially, industrialization and urbanization (Barca, 2007). Steinberg has shown how the pristine waters of New England were "incorporated" into the cotton mills built by Bostonian capitalists in the early 1830s (Steinberg, 2001). Cioc studied the case of the Rhine and the continuous stream of alterations and modifications applied to the river channel and flow by human action (Cioc, 2002). In an equally severe case but different context, Gumprecht has analysed how the city of Los Angeles has slowly preyed upon the Los Angeles River, diverting its waters and finally casting it into a casement of concrete to prevent flood damage (Gumprecht, 2001). In all cases, historians have shown that some rivers in the Western world have been severely impacted by human action. Their evolution is driven by socio-economic factors as much as by natural ones.

This has been theorized by the sociologist Ulrich Beck in his famous book *Risk Society* (Beck, 1992). Written in the wake of the Chernobyl accident, Beck's book was mainly concerned with nuclear risk. However, Beck has shown more generally that industrialization has brought, or "integrated", natural objects into the social world. Natural objects have become technical elements within the industrial system: they are one of the industrial production factors. This seminal idea works extremely well when applied to rivers. With industrialization, the technical means to harness nature, the variety of water uses, the quantity of water, the corrections applied to channel geometry and of course water pollution have reached levels never seen before. As a consequence, it has been increasingly difficult to separate rivers from the social and geographical context in which they are enshrined because many aspects of contemporary rivers, even some of their “natural” dynamics, are driven by social demands and uses. This is especially true on those rivers most transformed by human action.

For such objects, it is irrelevant to speak of “natural” objects impacted by society. There is a complete interpenetration of the fluvial system and socio-economic system that gives birth to another object that is neither natural nor social. On a more general stance, to account for environmental impacts in rivers, it is rational to discard the Nature/society dialectics that has been under heavy criticism for conceptual reasons[2] and move forward towards a more integrative framework. This framework would first of all concern itself with all the material aspects of rivers. If archival data is rich enough, historical analysis can provide many insights on the material and spatial configuration of such socio-natural river systems and on the flows of water and matter that transit through them. This is where the concept of “anthroposystem” is useful. An anthroposystem, according to M. A. Santos, “is an orderly combination or arrangement of physical and biological environments for the purpose of maintaining human civilization.” (Santos and Filho, 2005, p. 80). The concept of anthroposystem describes the

[2]Sociologist Bruno Latour has shown that even in the Western world, this divide was never as perfect and definitive as we like to think it was (Latour, 1993, 2004). He argues that there have been permanent and often unsuccessful efforts to insulate natural objects and scientific facts and practices from the “contamination” of social values. In his view, scientific practices that have reinforced the Cartesian distinction between Nature and society from the sixteenth century onwards have never been free from social interference. Accordingly, we cannot claim to have an absolute knowledge of Nature, simply because Nature is socially constructed through scientific practices that categorize arbitrarily objects and situations as “natural” or “social”. In another strand of criticism, anthropologist Philippe Descola has shown that the relationship between people and natural objects (e.g. wild animals) is negotiated in different ways in different societies (Descola, 2001, 2005). Some societies do not draw a sharp distinction between what belongs to the human and social world and what belongs to the natural world. Even non-animated objects (river, trees) can have the same social standing as individuals. In other words, the distinction between Nature and society is not anthropologically invariant across cultures but is historically and socially constructed.

metabolism of the river in a way that makes sense to the hydrologist, the geochemist, the historian and the geographer. The concepts of "anthroposystem" and "historical structures" have a strong affinity because reasoning historically in terms of "structures" opens up the possibility of modelling and quantification since a material structure can be rendered by a system [3]. This affinity is obvious in the studies that analyse the past metabolism of cities (Barles, 2002, 2007; Laakkonen and Lehtonen, 1999).

However, beyond this "material" level of historical analysis, another level has to be taken into consideration. Some younger members of the Annales School have argued that historical structures do not only reside in material elements. Some cultural elements are shared among people and constitute mental structures – sets of values, of automatic thought reflexes, of legitimate practices. In short, mental structures, or "mentalités", control what people collectively think and collectively accept. A person is not always conscious of the mental structures that categorize his or her thoughts. On a personal level, however, a person can rebel against them. On a more general scale, it is not the case and the ways of thinking that are recurrent and dominant can be outlined by historical analysis. Sharing some mental structures does not mean that all social actors agree nor have the same interests but they have an identical way of analysing a situation or responding to a problem. Mental structures encompass struggle between interest groups: they provide a background and the lines along which issues are debated. In other words, mental structures frame social debate about issues, policies or objects. They will endow some objects with certain sets of values and rivers are no exception to the rule. This is why the anthroposystem concept does not capture all the complexity of the social representations of rivers. Rivers are not only material objects; they are also cultural entities which interact with the social system. The Rhine, for example, has always been a strong symbol of German unity – and the German Moselle itself benefited from the Third Reich Law protecting landscapes meaningful for national identity, the *Landschaftsschutzgesetz* of 1935 (Chaney, 1996). These representations – the "images" people have of rivers – have an impact on river use and management.

[3]This idea was put forward by R. Boudon as early as 1968 (Boudon, 1968).

The image of a river can be invoked to dispel any change or use deemed illegitimate and incompatible with it. In the 1990s, all plans to further dam the Loire river in France were dropped in front of the fierce opposition from local populations and environmental activists putting forward the need to protect the unique character of "the last wild river in Europe". We would call this level of historical analysis "semiotic" because rivers are treated as signs conveying meanings or values. The meaning presently controls what can be done on or with the watercourse. Accordingly, river management is not only a matter of conscious decisions and objective rationality: it also depends on the mental structures and the image of the river stakeholders have. When we judge that a river has been badly managed, the explanation is not necessarily scientific ignorance or the incompetence of river managers. It may be that the conditions of possibility of a good management could not be met because of an inadequate legal framework, of specific power relations inside the river basin or because of incompatible mental structures. Political decision-making is not a simple, linear process and in the long run river management is the dialectical product of a combination of material processes, socio-economic factors and mental structures.

3 Applying the conceptual model: the example of water quality of the Moselle

These general considerations can be readily translated into concrete research practices. The case of the pollution of the Moselle is an interesting real-life example because the socio-economic specialization in the drainage basin changed dramatically in the second part of the nineteenth century. Very heavy industrial activities developed that changed the image of the Lorraine region itself and induced massive changes in the regional metabolism, most notably with respect to water flows. The quality of surface waters in the basin was of course adversely affected by these developments. We tried to quantify this negative impact and identify the material and mental structures that made it possible or gave birth to it. Finally, we tried to link the material data ("how much pollution?") with the political reaction and management initiatives that were taken

HESSD

4, 1697–1727, 2007

Historical pollution

R. J. Garcier

EGU

at the time. To summarize, the objective was threefold:

- Understand the impact of past activities and spatial configurations on river quality,
- Explain the context in which past management policies were implemented,
- Contrast current management practices with those of the past and point to potential problems already encountered in historical times and still remaining because of the inertia of historical structures.

3.1 A conceptual model of pollution level

To this purpose, we used a model proposed by M. Meybeck et al. that links pollution discharge, economic development and political reaction (Fig. 2). Two categories of variables influence pollution level. On the one side, aggravating factors such as population and economic growth (and especially, industrial growth); on the other, limiting factors such as the presence of sewage plants or the implementation of efficient control strategies (pollution taxation, for example). This conceptual model assumes some kind of link between the pollution level and the political reaction since inflexion points appear at certain moments in time and give birth to various scenarios. However, it does not specify the nature of this link: how does the pollution level influence the decision process that leads to management initiatives? In turn, what is the impact of management strategies on pollution levels? And more generally, would historical hindsight back up the model assumptions?

The data sources used to specify the model are diverse. France has a tradition of public administration of natural objects. This derives from Gallic legal idiosyncrasies, most notably the eminent role of the centralised State as a landowner. Moreover, through law, the State – and not the judge – is the primary socio-spatial regulator. The State is the rightful owner of all rivers deemed "floatable and navigable‘" (for an overview of history of the French water law, see Gazzaniga et al., 1998). It does not own the water, which in French law has always been "res communis" – the property of all – but it owns the banks and the bed. For smaller rivers that can be privately appropriated, the State still has a right to validate the use owners make of water because it should guarantee the mutual compatibility between all the water uses of a river. Accordingly, vast amounts of technical and management data on rivers can be found in the public archives kept in every "département". The continuity of the State from the early monarchies to contemporary day through the Revolutionary period enables one to have spectacular historical depth. To reconstruct the modifications applied to river beds in the Moselle basin, we primarily used reports from the civil engineers' bodies in charge of the management of rivers. These reports sometimes provide more general overviews on water uses in a "département" or on a river and sometimes include statistical data.

Other public technical bodies have been in charge of the overview of industrial activities. Since 1810, France has had a legal framework that categorizes industrial activities according to their level of nuisance. Three categories have been created and for the first two, public authorization is necessary to create a plant. An order of the prefect (the representative of the State in every "département") allows an industrialist to proceed with the construction of the plant but specifies by what norms the plant operation should abide. The demands of the industrialists, the technical documentation they provided, the answers of the technical bodies and the prefect can all be found in the public archives, where they are classified on a communal basis. They provide a very interesting source of information on industrial discharges. Moreover, the technical bodies in charge of the industrial sector were responsible for the compilation of production statistics. Production statistics are also available for publicly owned companies – most notably *Charbonnages de France*, the coal production monopoly created by the nationalisation and merger of independent mining companies after World War II (HBL, 1993; Haby, 1965).

Finally, since World War II, France has devised numerous national and regional development strategies to compensate for territorial inequality and especially for the weight of the region of Paris. These strategies were translated into policies at the regional level. In face of vigorous industrial and urban growth, water was becoming a limiting factor of regional development in the 1950s. To forestall that ominous prospect, public authorities devised the 1964 Water Law that created basin agencies and water taxes based on polluter-pay principles. The Rhin-Meuse basin agency has been, since its debuts, a huge provider of data on water and watercourses. They have been in charge of the equipment of the basin with sewage treatment plants and large amounts of documentation are available in their archives.

3.2 Historical evolution of pollution level in the Moselle basin

The Moselle is the main tributary to the Rhine. Its river basin has a surface of 28 280 sq. km and is shared between three countries. France has slightly more than 50% of the basin, and most of the headwaters. Luxembourg has 15% of the basin, through sovereignty over most of the river Sûre (Sauer)[4]. Germany has the lower course of the river, down to the confluence with the Rhine, at the *Deutsches Eck* ("German Corner") in the city of Koblenz (Fig. 1).

Historically speaking, the Moselle has been documented by text archives since Roman times. It was then an important axis of circulation between the North and the South of Europe and the city of Trier, in contemporary Germany, was the capital of the province of Belgium. A long poem by Ausonius (fourth century) dedicated to the river provides the first known mention of water mills in Europe, an indication of the ancientness of human action on the river itself (Bloch, 1935). The Moselle, however, was never modified significantly before industrial times, because of hydro-geomorphological constraints and historical circumstances. The river carried a large amount of bed-load that proved to be a severe obstacle to fluvial navigation and human settlement. The river was constantly changing its course on its flood plain, acquiring a reputation of "treachery" and making itself extremely difficult to control. Navigation was further impeded

[4]In this paper, we generally use the French names of the rivers. However, we will also provide the German names when appropriate.

by the political segmentation of the river after the demise of the Carolingian Empire (ninth century). All local authorities levied large tolls on navigation, providing a strong disincentive to the development of commercial flows and making any project of course rectification irrelevant. As a consequence, before the 1850s, most rivers in the Moselle basin, including the Moselle itself, were in a pristine state[5]. Fish was plentiful and renowned and the riparian landscapes were celebrated – specifically in the German part of the basin, where the Moselle meanders in vine-covered gorges. The only exception in the basin was the Saar river in Germany. In the Saar region, coal mining was an ancient activity that received a new impetus under the leadership of the Counts of Nassau-Saarbrücken (mid-eighteenth century). In the 1820s, after the merger of all mines into a single organisation overseen by the Prussian state, production reached an industrial scale. The introduction of steam engines in mines allowed for the creation of new mine pits and the expansion of existing ones through the pumping out of underground waters. The spatial and quantitative expansion of mining activities had a strong impact on the regional environment. The first reported consequences were soil subsidence and the disappearance of springs, which forced the local authorities to encourage a centralised water distribution system (Kraemer, 1999). Later, in the 1850s, induced activities such as iron production began to impact adversely the quality of the Saar in Germany (Duelmen and Labouvie, 1992).

In the French part of the basin, industrial development came later than in the Saar but with amazing strength and rapidity (Bour, 1995). Industrial growth was based on the three valuable ores that can be found in Lorraine (see Fig. 3): coal, iron and salt. The coal seam in France is in the continuity of that of the Saar and was mined industrially from the 1840s. In the east of the region can be found massive amounts of low-content iron deposits. The local pig-iron industry, located in the mining areas, transformed

[5]Some exceptions are documented in the grievances books requested by the Revolutionary power in 1789. For examples, some stakeholders of the Orne river complained about the impact of mining and proto-industrial activities of the Wendel ironworks, but these complaints remained extremely local.

itself into a very powerful steel industry after the technical process to eliminate the phosphorus contained in the local ore fell into the public domain in 1893. Finally, the geological salt deposits found in the region served as raw material for various chemical industries, the most notable being the soda plants using the Solvay process (founded between 1871 and 1910). Other industries had developed earlier, and locally, their impacts were significant. At the head of the basin, the Vosges mountains provided good conditions for the textile industry. After the annexation of Alsace and the northern part of Lorraine by Germany in 1871, this industry received technical, human and financial support from the Alsatian industrialists who had decided to leave Alsace to remain in France.

From a hydrological point of view, industrial growth had two major consequences. First, a large majority of plants favoured locations close to the rivers or the canals because they needed the proximity of water. At that time, water played different roles. It served as a mean of transportation, as an input in some industrial processes (steam production for example) and also, as the receptacle of industrial effluents. Sometimes, the rivers were even modified to suit the needs of the industry. The Moselle, for example, was thoroughly modified in the downstream industrial section. In 1932, a canal was built by private interests to bring in coke imported from the Ruhr and export iron products to the Belgian and Dutch ports through the Rhine system. Later, the canalization went further and in 1964, Rhine-type barges could navigate upstream up to Nancy. All these aspects illustrate the material integration of the river and its tributaries into the industrial system.

The rapid growth of local population through immigration was a second significant impact of industrialization. Some cities in the most industrial parts of the basin experienced spectacular growth. The region lacked unskilled workers and the industrialists and mines had to organize immigration networks to bring workers from Poland, Belgium and Italy first and from Northern Africa after World War II. This called for a complete upheaval of urban water provision, since the traditional modes of water provision and evacuation were quickly outpaced by the rhythm of urban expansion. Water was essential for urban growth. In the mushroom cities created by industrial activities, it became standard to have access to large amounts of flowing water for domestic and urban uses. Waste waters were then rejected without treatment into the natural environment through the sewer systems that were extensively built in the region between 1870 and 1950. In 1946, a study counted only three existing urban waste water treatment plants in the whole Moselle basin, two of which had been out of order for at least six years. Quite predictably given the experience of other cities in France, England or Germany, the development of urban hygiene in the cities of the Moselle basin resulted in severe degradation of the watercourses by organic pollution of domestic origin. Figure 4 illustrates the changes brought about to the existing spatial structure of population in the basin between the 1851 and the 1946 census. The main axis of the river system, the large cities and the industrial basins concentrated most of the population growth. The more rural areas in the centre and in the west of the basin experienced depopulation. The net result was a changing geography of pollution, with increased urban pressure on watercourses in those areas where industrial pressures were already very high.

Figure 5 provides a summary of organic pollution discharges in the Moselle basin since 1850. A few provisos have to be made. The unit of measure is the population-equivalent (Pe), which is an aggregated index widely used in sanitation projects[6]. The great advantage of using this index is that it enables one to compare domestic and industrial pollution. Domestic pollution was obtained by collecting census data. We considered that before 1965 all waste waters were rejected in the environment without treatment. After 1965, the construction of some large treatment plants began, remov-

[6]The definition of the population-equivalent is variable across countries and time periods. Here we follow the French practice of the 1980s and consider that one population-equivalent is the equivalent of a daily discharge of 180 litres of wastewater containing: 57 grammes of BDO5, 135 g of CDO, 9.9 g of nitrogen and 3.5 g of phosphorus. Article 2 of the European Council Directive 91/271/EEC of 21 May 1991 “concerning urban waste-water treatment” simplifies the definition by considering that one population-equivalent is worth a daily discharge of 60 g of BDO5.

ing an increasing proportion of pollution by direct discharge. To evaluate industrial pollution, we used production statistics found in the archives for the most polluting industrial sectors: iron industry and coal mining. The equivalency ratios between actual industrial pollution and its measurement in population-equivalent were drawn from a document published by the basin agency in 1965. The dotted lines indicate a tendency when the data is too sparse to provide robust values. The plain line indicates values given by the basin agency itself in published documentation. Mineral and toxic pollution are not included in the chart[7].

The pollution curve has two modes. A high point was reached just before World War I, when industrial development in the basin was buoyant. World War I brought things to a halt since the northern part of the basin was very close to the combat zones and industrial infrastructures were destroyed during the conflict. Recovery was impeded by the economic crises of the 1920s and 1930s then by World War II. Between 1919 and 1945, the economy did not substantially grow and the pollution level was accordingly fairly stable. It did not reach its 1913 mark before the beginning of the 1950s. After that date, strong economic and industrial growth induced a sharp increase of pollution.

The highest level of organic pollution in the basin was reached at the beginning of the 1960s. After that date, the decline of pollution owes to the reduction of domestic effluents (all the more remarkable because population numbers were still going up at the time). Organic pollution of industrial origin was abated more slowly until 1990. At that date, the rythm of pollution reduction increased. Today, organic pollution levels are probably lower than they were in the 1860s. To explain this evolution it is necessary to

[7]Mineral pollution in the basin originates in the calcium chloride discharges in the Meurthe by the soda making plants located south of Nancy in Dombasle. Toxic pollution is impossible to chart, because no consistent data has been collected before the mid-1980s. This absence is surprising. The production of toxical compounds (phenols, cyanides) by the iron and coke industries has been documented since the end of nineteenth century and their periodical massive release in the watercourses was detrimental to the fish and fed the wrath of fishermen.

explore the impact that river management policies have had on pollution levels.

3.3 Management issues

Indeed, such transformations of the river could not go unseen and we have been able to identify four management strategies that have been applied to control pollution since the 1870s. It is misleading to believe that what we call today environmental policies were born in the 1960s with environmental awareness. Pollution control strategies were in place as early as the 1870s. However, pollution was not seen specifically as an environmental problem. Pollution was linked to other scientific, social and economic issues. The concept's position in the scientific and social fields was not the same as it is now. In other words, pollution fit differently in the mental structures prevalent at the time and its mode of "construction" has evolved since its reintroduction in French.

An old French word indeed, "pollution" was reintroduced in French from the English in 1874 by the water scientist Gérardin to describe the state of the river Seine after its flowing through Paris[8]. The concept described only the alteration of water (and not air or soil). The archives show that the river managers were using the word pollution in Eastern France as soon as 1878. At the time, the concept was still marked by its scientific origin and pollution was a technical word used only by a fraction of scientists, policy makers or civil servants. The degradation of rivers was seen as a technical problem that science and technology would solve. As a consequence, the policy options were limited, for the problem was not seen as a political one. The faith in the capacity of science and technology to remove pollution was very strong, especially for those industrial sectors that incorporated a lot of science and research (e.g. steel making and mineral chemistry). Medical and technical publications mention various experiments to recover industrial waste. There was a widespread alchemistic belief that some monetary value resided into industrial waste, much as faecal matter could be transformed into fertilizer or tar into aniline with a profit.

[8]Britain had created in 1865 a *Royal commission on River pollution*.

HESSD

4, 1697–1727, 2007

Moreover, the discovery of microbes in the 1860s shifted the emphasis from pollution to hygiene. For the medical profession, the battle against infectious disease was more important than industrial discharges in the watercourses. To clean cities, hygienists and urban planners were the most fervent promoters of unified sewage systems which conveyed concentrated organic pollution to the rivers. The city of Nancy, for example, decided to completely remodel its water and sanitation system in the 1880s. It turned to remote and pristine water sources while creating a sewer system that massively polluted the river Meurthe. The only source of hostility in the basin came from rural stakeholders, whose uses of water resources were being challenged by increased pollution. However, in face of the increased prosperity brought by industrial development, dissident voices went silent. The primacy of rural activities was slowly pushed back by the new social forms linked to industrialization. The whole region adapted materially to the artificialization of the river network and the degradation of surface water quality, for example by shifting its sources of drinkable water.

Ultimately, the process of adapting to pollution created a form of consensus between most stakeholders in the basin. People would not complain anymore and consider pollution as the legitimate by-side of prosperity. The consensus was reinforced by the symbolic standing acquired by the industry itself (especially the steel industry). It became very difficult to criticize an industry that had brought prosperity to a poor region and that was a cornerstone of French military security, scientific progress and national pride. The iron used to build the Eiffel Tower in 1889 came from the Pompey plant, right by the Moselle. Lorraine, more generally, served as a display of all the attributes of French modernity in front of the perceived menace of Germany. This consensus reinforced the social position of the industrialists and provided the industry with a very powerful symbolic protection against complaints.

Around 1910, it was becoming clear that scientific progress was unable to stem pollution progression. Some rivers had already become fish-less and the removal of pollution from the watercourses seemed more and more remote. The technical difficulties, the cost, the extreme variety of industrial by-products were as many hurdles

HESSD

4, 1697–1727, 2007

Historical pollution

R. J. Garcier

EGU

on the way to success. The confidence in the ability of science to remedy the problem gave way to the conviction that pollution was a criminal behaviour.

This was the foundation on which a second management strategy was built. There is no strict succession order here and river managers applied this “legal” mode of pollution regulation and river management from the 1870s onwards. It was grounded on the belief that pollution was essentially a discrete process and that most damage and nuisance came from sudden discharges. In the river managers view, a well-maintained plant had minor effects on surface waters whereas sudden and uncontrolled discharges were highly nefarious. The most spectacular symptoms and displays of pollution – massive fish poisonings – hid the consequences of chronic pollution. This position gave birth to a very minute and very inefficient “command and control” policy. From 1906, very detailed indications on waste water discharge were included in the authorization order signed by the prefect, who could withdraw its authorization and close the plant if it did not observe the discharge norms (this extreme provision was never used). At the same time, some fishermen associations were suing individual polluters for fish poisoning. The result was a schizophrenic situation where chronic pollution was endorsed by the administration and catastrophic pollution punished by law. Since the administration did not recognize that water pollution was a structural consequence of industrial activity, it found itself in an impossible situation. This legal aporia explains the further degradation of water quality in the basin. In the 1920s, the creation of new coking facilities approved by the administration had a dramatic impact on the aquatic fauna. Some rivers or river sections became entirely devoid of life. The situation was endorsed by the managers and the industrialists, which made theirs the German concept of *Opferstrecke* (“sacrificed section”) originally developed in the Ruhr region (Buschenfeld, 1997). The concept legitimated the devolution of river portions to industrial pollution when no other economically sensible solution was available to preserve industrial prosperity.

The situation did not evolve significantly before the end of the 1940s because the pollution problem was less acute due to economic difficulties and the war. At the beginning of the 1950s, some civil engineers started to worry about water provision in the region. Consumption was rapidly increasing due to economic and population growth and the refurbishment of distribution networks. In the foreseeable future, some shortages were to be feared. That fuelled a demand for water expertise and between 1949 and 1954 the States technical bodies conducted studies on the regional water budget. They showed that pollution was a factor of shortage because it impeded the use of some water resources. Pollution was rapidly growing and could not be seen as a criminal – i.e. deviant – behaviour anymore: pollution was the norm and a structural element of the water budget. Controlling chronic pollution was a precondition of the water provision strategy. A third pollution management strategy was devised which hinged on strategic planning of sectoral water uses. The Moselle was strictly viewed as a source of water and the managers' aim was to insure mutual compatibility between all water uses within the basin.

The Water Law of 1964 provided the legal framework required to enforce this new strategy. It created the basin agencies. The basin agencies produce five-year strategic plans which lay out all the investments and policy initiatives programmed in the basin. The plans are financed by pollution and water abstraction taxes nominally paid by all water users in the basin except farmers. The level of the taxes is voted by a basin committee which includes representatives of the State, of water users and of basin stakeholders (environmentalists, for example). Even if the polluter-pay principle has been invoked from the start as the conceptual basis for taxation, the level of the taxes has never been high enough to become a true incentive. Until the 1990s, tax revenue was dimensioned to provide exactly the amount necessary to finance the wastewater plant equipment plan: pollution control was based on the mutualisation of the financing of pollution abatement equipment and not on cost internalisation incentives through taxation.

Two other points are worth noting. First, and despite all claims to the contrary from the river managers, it was not environmental concerns that gave birth to the basin agencies and the new tax-based policy instruments but the need to make sure that water shortages would not undermine the growth of the urban-industrial system in France. Second, the basin agency had to take into account the industrial consensus existing in the Moselle basin. In the beginning the agency's legitimacy was very low and it met wide ranging opposition from a variety of basin stakeholders (industrialists and mayors in particular). In the basin committee, environmentalists and individual consumers were underrepresented. The basin committee and the basin agency management were very sensitive to the pressures exerted by the most powerful polluters in favour of the existing industrial consensus. In the 1970s, in the wake of the industrial crisis that undermined the economic base, the industrialists were able to negotiate only modest increases and spatial modulation of pollution taxes. As a consequence, until 1990, the overall decrease in organic pollution in the basin came from domestic pollution abatement (see Fig. 5).

The lasting presence of the industrial consensus began to crumble when a series of factors took momentum. The first one was the industrial crisis which challenged the industry's primacy as an economic sector. The crisis was dissociating the interests of the industrialists from the interests of the workers. If industry was not able to provide jobs any longer, why put up with its nefarious effects on the environment? Second, the pollution of the Moselle had become so severe in the 1960s that the downstream States had begun to take exception to the situation. In 1963, France, Germany and Luxembourg founded International Commissions for the Protection of the Moselle and the Sarre against pollution. Even if the commissions' action was curtailed by their intergovernmental nature (until 1990, they were only a forum of discussion between governments), they were a symptom of the political magnitude reached by the pollution problem of the Moselle and a channel through which downstream States (and co-members of the European Economic Community) exerted pressure on France. In the 1960s, the main issue was organic pollution. However, in the 1970s, the priorities changed and the question of salt discharges in the Meurthe came to the forefront. That was linked to the heated debate surrounding the salt content of the Rhine. In the 1970s, the Moselle system contributed 27% to the French share of chloride discharge in the Rhine (the remaining 73% came from the potash mines in Alsace). The local administration was extremely reluctant to take action against pollution and the industrial consensus prevented pressures from the French diplomacy to trickle down to either the prefect or the basin agency. Overall, the situation was stalled and the sectoral management principles inherited from the "planning" strategy proved inadequate to deal with emerging pollution problems (e.g. diffuse pollution).

The main factor leading to a strategic turnaround in water pollution management was the Sandoz accident in Basel (Switzerland) on 1 November 1986. The water the firemen used to put the fire out flowed to the Rhine, loaded with chemicals. Fish in the river was eradicated, drawing large media coverage and public attention. Marco Verweij has related the circumstances surrounding the endorsement of the Rhine Action Program by all riparian States in 1987 (Verweij, 1999, 2000). For the Moselle basin, the accident led to the adoption of a new "international and environmental" strategy that had two main consequences. The Rhine Action Program was translated into regional objectives laid out by the basin agency (1990). Pollution taxes rates were increased by roughly 60% over a period of eight years. The pollution discharges, already severely curtailed by the industrial crisis, were further reduced (see Fig. 5). In the new strategy (and in the new action program for the basin), the environment was given some consideration. It was a consequence of the influence of the German and the Dutch examples and the logical outcome of a national debate on the functions of natural ecosystems (1990). Its conclusions were that some tasks were better carried out and at a lesser cost by functional ecosystems (e.g. wetlands) than by artificial means. Environmental protection was not a matter of principles: it was based on sound accounting.

4 Conclusions

In the second book of *The Orator*, Cicero extols the virtues of history, "magistra vitae" (teacher of life). He probably did not think of river management at the time but with a distance, his expression is a good summary – mutatis mutandis – of our argument.

HESSD
4, 1697–1727, 2007
Historical pollution
R. J. Garcier

There is more to history than a mere remembrance of things past. An understanding of the forces that have shaped the materiality and the images of river systems is necessary to grasp river management in the past but also in the present because historical structures have strong inertia. For the Moselle, the lesson to be learnt is that some mental structures and power relations (what we termed "industrial consensus") have prevented the conception and implementation of successful pollution management strategies. In the Moselle basin, local public outcry over pollution issues was non-existent for decades and the main driving force to remedy the pollution problem in an integrated manner came from outside the French borders. The creation of formally democratic and open forums (such as the basin committee) did not bring by itself an improvement of water quality in the basin. It means that policy initiatives cannot ignore structural conditions that shape river basins functioning, image and management. The case of the Moselle shows that stakeholders participation will not necessarily produce an environmentally optimal outcome and that consensus over management principles is no indication of the desirability of the principles themselves from an environmental point of view. Caution is required in front of the calls for "integrated management" and "stakeholder participation" in a drainage basin when they ignore the reality of power relations and the weight of historical structures.

Acknowledgements. Figure 4 was made using PhilCarto, a free statistical cartography software: (http://perso.club-internet.fr/philgeo).

References

Barca, S.: Enclosing the River: Industrialisation and the "Property Rights" Discourse in the Liri Valley (South of Italy), 1806–1916, Environment and History, 13, 3–23, 2007. 1702

Barles, S.: L'Invention des eaux usées: l'assainissement de Paris, de la fin de l'Ancien Régime la seconde guerre mondiale, in: Le démon moderne: la pollution dans les sociétés urbaines et industrielles d'Europe, XIX^{e} – XX^{e} siècles, in: Bernhardt and Massard-Guilbaud, Presses universitaires Blaise Pascal, Clermont-Ferrand, 129–156, 2002. 1704

Barles, S.: Feeding the city: Food consumption and flow of nitrogen, Paris, 1801–1914, Sci. Tot. Environ., 375, 48–58, 2007. 1704

Beck, U.: Rosk Society: Towards a New Modernity, Sage, London, (First German edition: 1986), 1992. 1702

Bloch, M.: Avènement et conquêtes du moulin à eau, Annales d'histoire économique et sociale, 10, 538–563, 1935. 1708

Boudon, R.: À quoi sert la notion de structure? Essai sur la signification de la notion de structure dans les sciences humaines, Gallimard, Paris, 244pp., 1968. 1704

Bour, R. (Ed.): L'Épopée industrielle, Encyclopédie illustrée de la Lorraine: Histoire des sciences et techniques, Éditions Serpenoise – Presses Universitaires de Nancy, Metz–Nancy, 238pp., 1995. 1709

Bravard, J.-P.: La métamorphose des rivières des Alpes françaises de la fin du Moyen-Âge à l'époque moderne, Bulletin de la Société géographique de Liège, 25, 145–157, 1989. 1701

Bravard, J.-P. and Magny, M. (Eds.): Les Fleuves ont une histoire: Paléo-environnement des rivières et des lacs français depuis 15 000 ans, Archéologie d'aujourd'hui, Errance, Paris, 312pp., 2002. 1701

Büschenfeld, J.: Fluesse und Kloaken: Umweltfragen im Zeitalter der Industrialisierung (1870–1918), Klett-Cotta, Stuttgart, 454pp., 1997. 1715

Chaney, S. L.: Visions and Revisions of Nature. From the Protection of Nature to the Invention of the Environment in the Federal Republic of Germany, 1945–1975, Phd in History, University of North Carolina, Chapel Hill, 1996. 1704

Cioc, M.: The Rhine: an Eco-biography, 1815–2000, University of Washington Press, Seattle, 263pp., 2002. 1702

Corvol, A. (Ed.): Les Sources de l'histoire de l'environnement: le XIX^{e} siècle, L'Harmattan, Paris, 502pp., 1999. 1699

Corvol, A. (Ed.): Les Sources de l'histoire de l'environnement: le XX^{e} siècle, L'Harmattan / Direction des Archives de France, Paris, 750pp., 2003. 1699

Cronon, W.: Nature's Metropolis: Chicago and the Great West, Norton, W. W., New York, 530pp., 1992. 1702

Descola, P.: Leçon inaugurale faite le 29 mars 2001, Collège de France, Paris, 623pp., 2001. 1703

Descola, P.: Par-delà nature et culture, Gallimard, Paris, 2005. 1703

Duby, G.: The Legend of Bouvines: War, Religion, and Culture in the Middle Ages, University

of California Press, Berkeley, 234pp., 1990. 1701
Duelmen, R. V. and Labouvie, E. (Eds.): Die Saar: Geschichte eines Flusses, Rohrig Verlag, St. Ingbert, 400pp., 1992. 1709
Garcier, R. J.: La pollution industrielle de la Moselle française: naissance, développement et gestion d'un problème environnemental, 1850–2000, Phd in geography, Université Lumière – Lyon 2, 2005. 1700
Gazzaniga, J.-L., Ourliac, J.-P., and Larrouy-Castera, X.: L'Eau: usages et gestion, Litec, Paris, 316pp., 1998. 1706
Girel, J.: La prise en compte de l'histoire dans la gestion des corridors fluviaux: les enseignements des aménagements anciens, Revue de Géographie de Lyon, 71/4, 341–352, 1996. 1701
Gumprecht, B.: The Los Angeles River: Its Life, Death and Possible Rebirth, Johns Hopkins University Press, Baltimore, 369pp., 2001. 1702
Haby, R. (Ed.): Les Houillères lorraines et leur région, Éditions SABRI, Paris, 1965. 1707
HBL: Du Charbon et des hommes: histoire des houillères du bassin de Lorraine, Éditions Serpenoise, Metz, 311pp., 1993. 1707
Kraemer, H.-H.: Von Dorfbrunnen zum Wasserwerk – Geschichte der Trinkwasserversorgung an der Saar, Saarland Bibliothek, Gollenstein Verlag, Blieskastel, 276pp., 1999. 1709
Laakkonen, S. and Lehtonen, P.: A quantitative analysis of discharges into the Helsinki urban sea area in 1850–1995, European Water Management, 2, 30–39, 1999. 1704
Latour, B.: We Have Never Been Modern, Harvard University Press, Cambridge, (First French edition: 1991), 176pp., 1993. 1703
Latour, B.: Politics of Nature: How to Bring the Sciences into Democracy, Harvard University Press, Cambridge, (First French edition: 1999), 307pp., 2004. 1703
LeRoy-Ladurie, E. (Ed.): Times of Feast, Times of Famine: A History of Climate Since the Year 1000, Farrar, Straus and Giroux, New York, (First French edition: 1967), 438pp., 1988. 1701
Meybeck, M.: Riverine quality at the Anthropocene: Propositions for global space and time analysis, illustrated by the Seine River, Aquatic Sciences, 64, 376–393, 2002. 1698
Meybeck, M., Chapman, D., and Helmer, R. (Eds.): Global Freshwater Report: a First Assessment, Blackwell, Oxford, 306pp., 1989. 1724
Meybeck, M., de Marsilly, G., and Fustec, E. (Eds.): La Seine en son bassin: Fonctionnement écologique d'un système fluvial anthropisé, Elsevier, Paris, 749pp., 1998. 1699
Meybeck, M., Lestel, L., Bonté, P., Moillerond, R., Coline, J.-L., Rousselot, O., Hervé, D.,

de Pontevès, C., Grosbois, C., and Thévenot, D. R.: Historical perspective of heavy metals contamination (Cd, Cr, Cu, Hg, Pb, Zn) in the Seine River basin (France) following a DPSIR approach (1950–2005), Sci. Tot. Environ., 375, 204–231, 2007. 1699

Petts, G., Roux, A.-L., and Moeller, H. (Eds.): Historical Change of Large Alluvial Rivers: Western Europe, Wiley, Chichester, 355pp., 1989. 1699

Roux, A.-L. (Ed.): Cartographie polythématique appliquée à la gestion écologique des eaux. Étude d'un hydrosystème fluvial: le Haut-Rhône français, Éditions du CNRS, Lyon, 113pp., 1982. 1701

Santos, M. A. and Filho, W. L.: An analysis of the relationship between sustainable development and the anthroposystem concept, International Journal of Environment and Sustainable Development, 4, 78–87, 2005. 1703

Steinberg, T.: Nature Incorporated: Industrialization and the Waters of New England, Cambridge University Press, Cambridge, 1st edition 1992, 284pp., 2001. 1702

Verweij, M.: A Watershed on the Rhine: changing approaches to international environmental cooperation, Geojournal, 47, 453–461, 1999. 1718

Verweij, M.: Transboundary Environmental Problems and Cultural Theory: the Protection of the Rhine and the Great Lakes, Palgrave, New York, 260pp., 2000. 1718

Williams, M.: Americans and their Forests: a Historical Geography, Cambridge University Press, Cambridge, 599pp., 1992. 1702

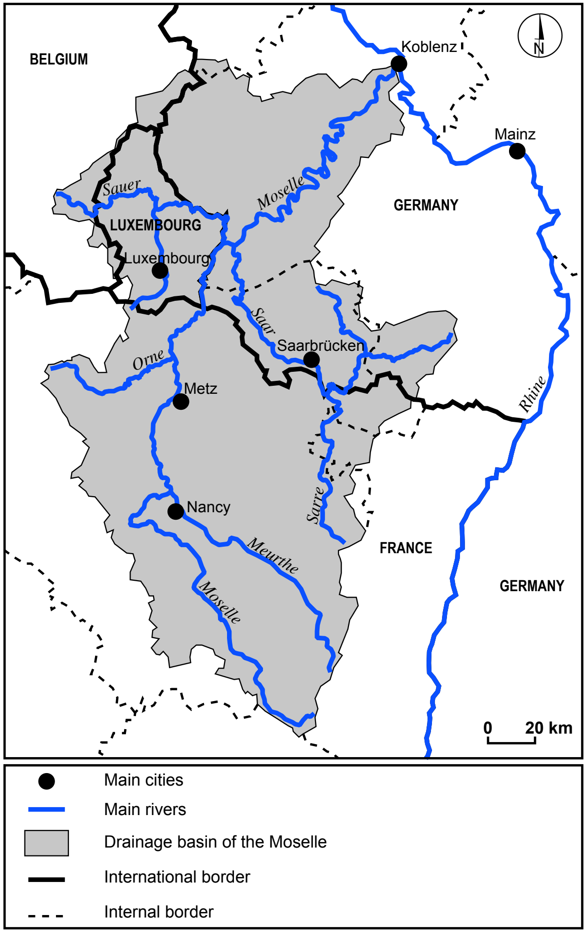

Fig. 1. The drainage basin of the Moselle.

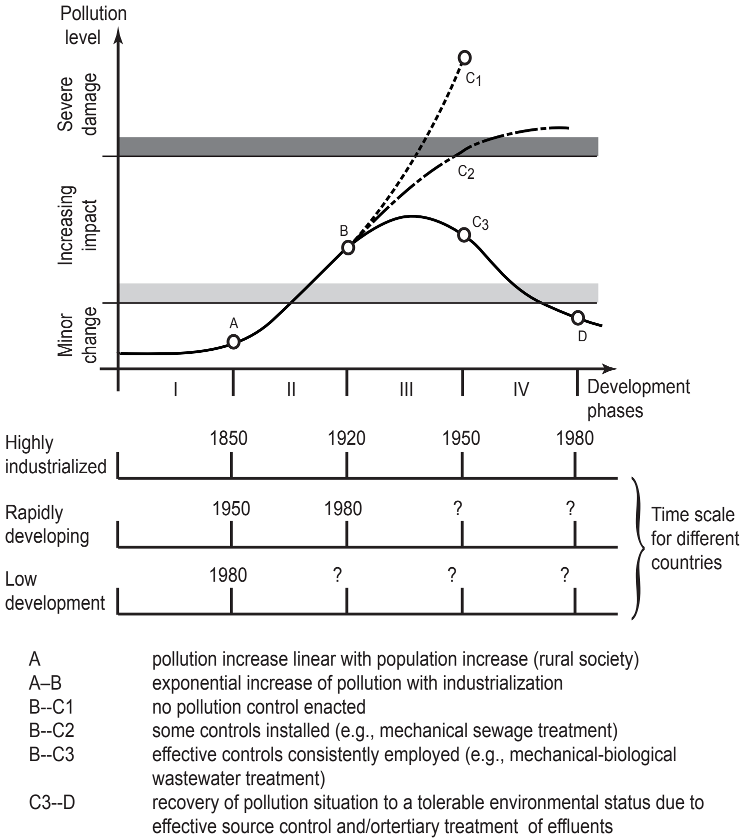

Fig. 2. Conceptual model of pollution occurence and control taking organic pollution in Europe as an example. Source: after Meybeck et al. (1989).

HESSD
4, 1697–1727, 2007

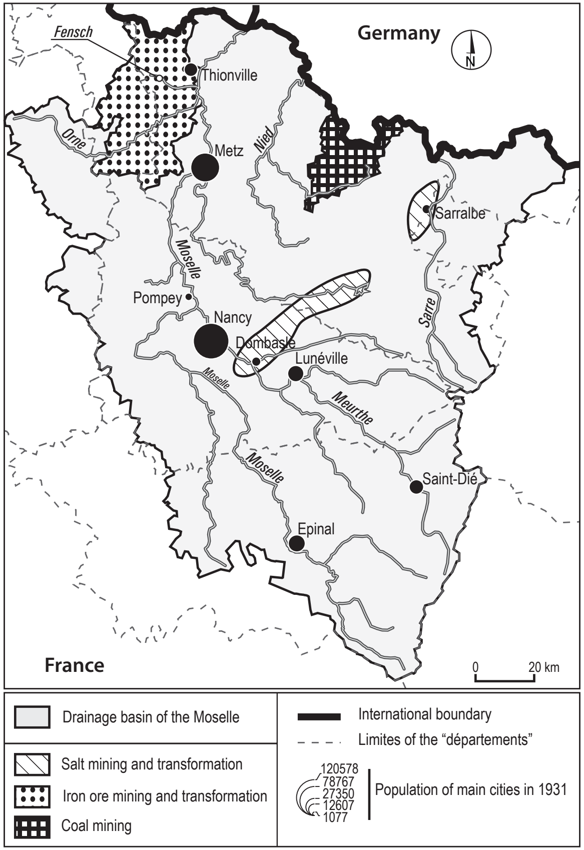

Fig. 3. Spatial specialization of industrial development in the basin of the Moselle.

HESSD

4, 1697–1727, 2007

Historical pollution

R. J. Garcier

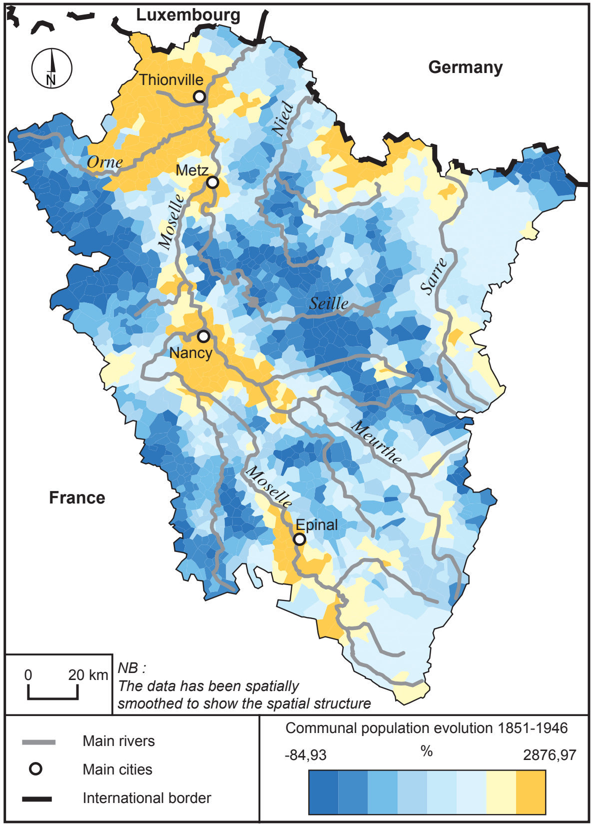

Fig. 4. Evolution of the communal population in the Moselle basin in France between 1851 and 1946.

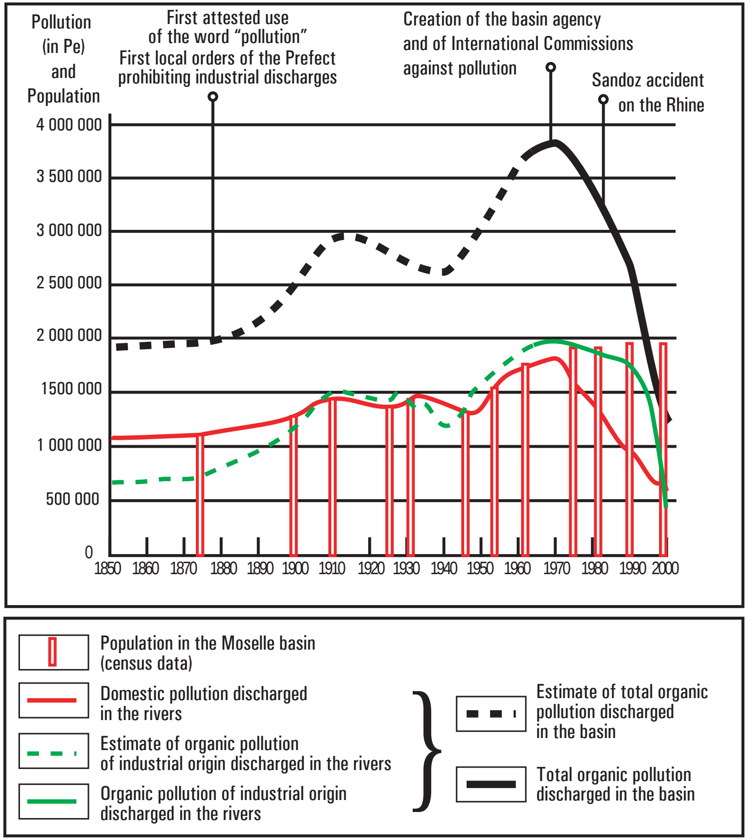

Fig. 5. Estimation of organic pollution discharge from domestic and industrial sources in the basin, 1850–2000.