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Managing streams carefully? Thoughts about an emerging paradigm and its contradictions

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Since the last third of the 20th century, managing rivers has experienced a change that is similar to a paradigm shift: what used to be a technicist paradigm—based on a hydraulic valuation turning environments into heavily artificial ones—has been gradually replaced with an environmentalist paradigm advocating protection or restoration of hydro-systems equilibrium.

Supported by national regulatory frameworks and by influential pressure groups, this change of approach is particularly well illustrated by the dams removal, and several countries are trying to implement that policy.

This new paradigm, which focuses on environmental considerations, however, raises resistance from multiple actors. In contrast to the environmentalist vision of free, wild rivers, opponents to the new paradigm support the vision of water streams that have been managed throughout history and appointed by local communities for multiple uses. Could a more integrated management of waterways be likely to reconcile these two opposing views?

Keywords: Careful management, dam removal, environment, paradigms, planning, rivers

1. Introduction

Since ancient time, man has sought to tame waterways, even if that has meant modifying natural components, so as to occupy their natural floodplains, exploit their water, fish and alluvial resources or use their energy potential. Control over waterways has long been not only a guarantee, but a sign of development. Yet, the human impact on streams might well have lead over time to covering them in "concrete" and taking away their natural features. For three decades, driven by environmental groups, scientific thoughts and political inflections have seemed to lead public authorities to embark on a transition in their approach to river management. From the study of the Loire basin, we have hypothesized a transition from one mode of technicist waterways management, which gives priority to controlling them by means of developing large water projects, to a more environmentalist form of management—that strives to articulate development with the preservation of the natural balance of hydro-systems (Rode, 2009, 2010).

We wish to compare this hypothesis to other areas, thus expanding the geographical perspective in order to question what we consider as a genuine paradigm shift in the representation and management of waterways—though it is still fragmented and emerging. If this issue has already been addressed by French or international literature, and therefore is not new, our goal is here to provide a synthesis paper presenting a clear vision of opposing paradigms concerning river management, and of the difficulties met when trying to find a new solution reducing the gap. Which are the emerging characteristics of the relationships between societies and streams, the new ways in which streams are socially perceived and managed?

In order to achieve this goal, we base our study primarily on the case of France (thanks both to our PhD work and to a bibliographic work based on existing scientific works), but we highlight and compare the national situation by resorting to various international examples analyzed in scientific literature (again thanks to a bibliographic work). Confronting many empirical cases will make possible to understand the greater or lesser relevance of the heuristic pattern of "paradigm shift", the complexity of contemporary rivers management and to reach a higher level of generality.

Therefore, the methodology used is both based on a fieldwork about the Loire basin (qualitative investigations with many actors involved in the river management, analysis of the discourses of the different stakeholders) and on a (theoretical and empirical) bibliographic work aiming to confront the hypothesis formulated about the Loire basin to other various situations.

We mobilize the concept of paradigm shift and apply it to the field of river management and development, hence highlighting different social relations towards rivers. We then examine the transition—currently at work, in our view—from one paradigm to another, both thanks to regulatory developments but also concrete careful treatment operations on streams, without overlooking the resistance and disputes arising from such evolutions. Finally, to understand these slow ongoing changes, we discuss the critical role of certain actors, genuine promoters of a new model of river management and the respective weight of the environmental, economic and social stakes.

2. A heuristic pattern: the paradigm shift

2.1. The concept of paradigm and of paradigm shift

Introduced in the history of science by Kuhn (1962), in social science "paradigm" refers to "a set of representations serving as a backdrop to a concept, a piece of work or public action" (Depraz, 2008). The concept of paradigm has been applied in particular, since Hall (1993) and Surel (1995) works, to the analysis of public policies. Spelt out as a coherent thought-system, a mature and dominant view of social reality at any given time, the paradigm "legitimates decision-makers' action for some time [. . .], and it imposes their own vision of the world" (Depraz, 2008). Yet, despite such relative stability, paradigms evolve and succeed each other over time. New social values emerge as dominant, while others are relegated to the background, downgraded somewhat. According to Hall

(1993), a paradigm shift in public action is the result of reassessments of the principles and objectives of public action, themselves related to the valuation of new ways of grasping social problems and the nature of the answers that the State is likely to provide. The transition from one paradigm to another can be likened to the transformation of a society from one mode of governance to another. Thus, in a democratic system, it is based on a method of governance that is open to dialogue.

This heuristic pattern of the paradigm shift is opposed to a naturalistic approach of the problems and relies on a constructivist approach. For this constructivist approach, the problems are seen as the result of a process of narrative and cognitive construction. This process is accompanied by definitional conflicts between different representations of the problem, and by tensions that are not mechanically exhausted when political institutions take care of the problem (Gilbert & Henry, 2009). The paradigm shift results from a complex set of social actors. At one point, stakeholders oppose the social values that underlie and structure the dominant paradigm, and propose to substitute new values and norms of action that will gradually be appropriated by different social actors, to such an extent as to become dominant and form a new paradigm, able to influence public policy substantially. In a dialectical process, public policies both reflect and affect the paradigm content. They reflect the paradigm because they are defined and structured by its guidelines. But public policies also shape the paradigm by contributing to implement and diffuse new practices among many actors. Public policies make thus possible the percolation of the ideas of a new paradigm from a very narrow sphere (the initiated—political or technical—stakeholders) to a larger one (civil society, economic actors, local politicians, etc.).

Such a shift can be measured by the yardstick of some qualitative criteria: the new actors that are supporting the new paradigm and that are now regarded as legitimate, the new discourses that are promoting new values and new visions, the new laws that are implementing and supporting these new values and new visions, the new tools of public action, and also the new way some projects are contested and the fate reserved to them. All these criteria are examined and discussed in the paper. To understand the paradigm shift, it is necessary to study how a question emerges as a problem for society (problem emergence) and how governments support it (agenda setting).

In the area we are interested in—streams management—the paradigm shift proves to be a relevant heuristic model. This is not only a new form of governance taking place, but also a broadening of the areas of interest. Careful management of streams progressively becomes a new public issue, requiring a collective action.

2.2. The first paradigm: hydraulic valuation through planning

Throughout the 20th century, all around the world (from the United States to China, from France to the USSR, from Spain to India), developments meant to control rivers have been rife and have grown in size (Molle, Mollinga, & Wester, 2009). They are perceived as pledges of economic development, progress, and as national symbols of power.

The technicist paradigm, largely hegemonic throughout the 20th century, is based on a scientific ideology that emphasizes the power of technology, thanks to which men will be

able to control nature, hence using it to serve their needs. At the intersection of economic development goals, of political affirmation and of reducing risks, the massive development of streams is deemed as totally legitimate.

Developers (including government departments) have first sought to control the natural element to enslave it to human needs such as transportation (floating and navigation), energy (mills), food (fishing, hunting, water), washing and cleaning . . . but also to fight its excesses (floods) and shortcomings (droughts). In the words of the Corps of Engineers that managed rivers, "we had to discipline nature" (Gunnel, 2009)! Some quotes, and enlightening ones they are, make it possible to take stock of this project: in Spain, J. Costa stated in 1911 that men had to become the "masters of rivers, as they flow in vain, as unruly as beasts, enjoying wild freedom . . . Though men in other countries are content with simply helping nature, here we must do more: we need to create it!" (Quoted by Molle et al., 2010). Similarly, in the United States, President Roosevelt launched the Hoover Dam on the Colorado River, proclaiming: "Proudly, man is reinforcing his conquest of nature" (Stevens, 1988).

This technicist vision—such a Promethean one—of stream development, has resulted in dams being built for hydropower or to store excess water (fighting against floods, preventing low water), to recalibrate waterbeds so as to facilitate water transport or dispose of surpluses, to fell trees or rectify meanders. Developing streams also results from the desire to promote urban development, as is shown by the development of the Cher River when it flows through the city of Tours (Fig. 1).

In the 1960s, a comprehensive scheme was devised to protect the city against the Cher floods and to channel the river by means of hydraulic engineering works. The bed of the Cher was rectified, broadened to become about 200 meters wide, and it was made deeper, along a regular slope. It was also channeled through the construction of watertight dykes over most of its course (the new profile of the Cher is bounded by two 4 to 7-meter high dykes) and dams were built to keep the riverbed constantly deep enough when passing through the city. The bed of the *Vieux Cher* creek was also rectified and the stream of the *Filet* was diverted. Hence, a whole stretch of river has been curbed (Fig. 1). Backfilling work made room for new neighborhoods, namely the *Rives du Cher* district, with its large architectural projects, the Menneton Industrial Area, the *Fontaines* district (Fig. 1) as well as various facilities (exhibition centers, public sports facilities, the *Honoré de Balzac* park) needed to develop the city during its 1960s and early 1970s rapid economic and population growth (Rode, 2009). Even if we today know that these reclaimed lands by backfilling can still be prone to floods, but for less frequent events, at this period backfilling – regarded as an efficient technical solution, and thus representative of the technicist dominant vision – has strongly legitimated urban development in the river floodplains.

Dams, the main symbol of such heavy stream development, have multiplied during the 20th century (the number of large dams[1] rose from 5,000 in 1950 to 45,000 in 2000)

[1] The International Commission on Large Dams (ICOLD) defines a large dam with a height of 15 meters or more from the foundation. Those of a height between 5 and 15 meters and a reservoir having a volume greater than 3 million cubic meters are also classified as large dams. In France, dams are divided into four classes. The most important dams, class A, are with a height of 20 meters or more.

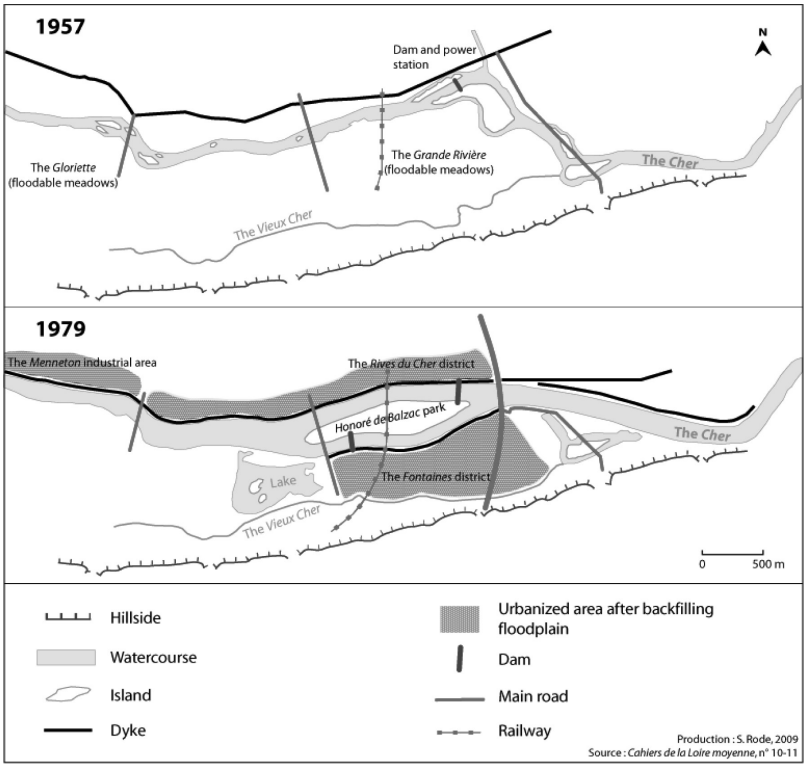

Figure 1. The layout of the Cher waterbed in Tours: a stretch of river brought into line.

and have become increasingly gigantic. Just as dykes, another key tool for controlling the rivers.

Most large French and European rivers (the Rhine, Rhone, Danube, Seine, Meuse, and Elbe) have been developed that way. In 1921, the so-called Rhône development law was passed. It planned to develop river resources in three areas: transport, by developing navigation; industry, thanks to hydropower; agriculture through irrigation.

However, this development program really began in 1934. The *Compagnie Nationale du Rhône* (CNR), founded in 1933, was awarded the French government's general grant for development and exploitation of the river. Nineteen dams were built.

Smaller streams are also involved in this type of heavy development. Thus, at the end of the first quarter of the 19th century, the Oise River (a tributary of the Seine River) was made more regular in its lower course, between *Compiegne* and *Conflans-Sainte-Honorine*, through dams equipped with locks. The point was then to ensure year-round navigation by artificially raising the water line, allowing it during flooding to recover its natural level by opening the dams. Along its middle reaches, between *Compiegne* and *Chauny*, the many convolutions of the river were deemed too restrictive, and a canal was built alongside the Oise on its right bank, in order to make navigation feasible towards

canals in northern France (Bonnard, 2006). No component of the natural environment was really taken into account, except flooding risks: to avoid them, the theory of maximum flow was implemented to drain the water without these new facilities turning out to be a factor of increased flooding.

This paradigm of water-streams management usually ignores the conservation of natural balances. It was not until the second half of the 20th century that this concern was dictated by some legislation, and it took some dozen more years for it to be implemented, under pressure from interest groups, associations and laws.

2.3. A new paradigm: environment friendly valorization through careful management

While water development policies implemented since the late 19th century gave primacy to infrastructures at the expense of aquatic environments (Clarimont, 2009), careful management policies began to focus on their importance, and emphasized preservation or even restoration of the streams. Through this unpublished term that we propose – careful management – we want to identify the new characteristics of the relationships between societies and streams, the new ways in which streams are socially perceived and managed.

Streams are no longer considered as a succession of fixed properties, but are seen as a living whole, to be studied in its entirety and including the complex relationships with societies. This type of approach fits well the goals researchers using systemic analysis target, in accordance with socio-ecological system understanding (Cumming, 2011; Renaud, Sudmeier-Rieux, & Estrella, 2013). A socio-ecological system is indeed composed by natural elements (soil, water, rock, living organisms), products of human activities (food, money, buildings . . .) and also by interactions between humans or between humans and their environment (Mathevet & Bousquet, 2014).

At international level, environmental degradation caused by the heavy development of rivers led, from the 1960s and 1970s, to growing protests, with the emergence of the environmental movement and opposition to building new dams. In many countries, the technocratic paradigm began to be questioned and calls for an "ecological U-turn" on water management (Allan, 2006) became most pressing.

The environmentalist mode of management that followed the first paradigm resulted in part from a desire to "return to nature" owing to growing awareness that nature was in danger, and, secondly, to a reality experienced on a daily basis that man had become too far removed from water-streams while their useful functions had been offset by other technologies (water—by wells and pumps; hydraulic energy—by oil and electricity; fishing—by fish farming and intensive agriculture; and river transport—by road transport).

Consideration of environmental issues in the management of waterways has gradually emerged in France. The PIREN[2] launched by the CNRS as of the mid 1980s on the Rhone, the Garonne, the Seine and the Rhine rivers, in order to improve overall knowledge of hydro-systems were an important step in this regard. The 1992 Water Act is another

[2] Programme Interdisciplinaire de Recherche sur l'Environnement (Interdisciplinary Scheme for Research on the Environment)

milestone, in that a great number of measures promoting softer river management ensued. On the Rhone, it is worth mentioning the 1992 *Action Plan Rhône* (Guilhaudin, 1992) and the 1998 *Programme Décennal de Restauration Hydraulique et Écologique* (Ten-Year Program for Ecological Water Resources and Ecological Restoration). Moreover, in 1994, management committees for migratory fish were created in many basins.

The "*Plan Loire Grandeur Nature*", adopted in 1994, was a turning point both in the Loire basin and at national level: it partially abandoned the logic of heavy structures (thus scrapping the major Basin development project signed in 1986) and focused on flood prevention without resorting to dams, as well as on safeguarding the natural heritage. The Environment Minister at the time, Michel Barnier, intended to make it a symbol of the new willingness for careful management of domestic waterways.

Under this new paradigm, it was a matter of allowing fluvial dynamics to express itself more freely. The way to consider hydrological extremes—floods and low water—has changed, hence the approach to waterways as well. "The principle of accepting hydrological extremes promoted a new scientific and societal framework, typical of the 1990s. [. . .] Erasing extreme, to secure the resource and assets, caused an insidious environmental drift that has proved increasingly costly, both in environmental and economic terms" (Bravard, 2000). Scientific research has shown that floods and low waters play a crucial role in the wealth and maintenance of aquatic and riparian ecosystems. Insisting to remove hydrological extremes at all costs via heavy developments leads to the degradation and depletion of these environments, which we are trying to restore today (Dufour & Piégay, 2009). Public policies no longer emphasize, as before, flood protection by structural measures. On the contrary, they now emphasize prevention (through information, land-use control, adjustment, resilience strategies, etc.). The "space for the river" policies are good examples of this new trend. Policies such as "Room for the river" in the Netherlands or "Making space for Water" in Great-Britain, or, at a local level, floodplains restoration, are thus fully part of a new paradigm of water management (table 1). After the floods that occurred in the 1990s, the dutch government decided to no longer raise the dykes, but to move them back in some places, in order to give more space to the rivers. In this country, dealing with water in a different way has become a national strategy. This is a further illustration of the transition from a technicist to an environmentalist paradigm (table 1).

More generally, a new social perception of streams is gradually emerging. Sociologist Michel Marié, when talking about great hydraulic works, underlines a shift from "the era of development to the era of careful management" (Marié, 1985). Our outlook on rivers is gradually changing: water is no longer seen as just a resource, but as an environment. A real inversion of priorities is therefore operating in the relationship between development and environment. The environment has long been regarded as a mere support to achieving human activities. In this perspective, development aimed at removing natural barriers to the deployment of human activities. The conquest of river floodplains was thus achieved through the safety-based delusion brought about by the construction of protections (dikes and dams). Today it is considered that these are "human activities that must adjust to the demands of the environment and not vice versa" (Dourlens, 2004). This paradigm shift is accompanied by a reformulation process of "fundamental equations" (Jobert & Muller, 1987), as summarized below.

Table 1
Two opposite paradigms

	The technistict paradigm (heavy development)	The environmentalist paradigm (careful management and restoration)
The fundamental equation of waterways management	Waterways = resources to be exploited with care	Waterways = natural environments to be preserved (or restored) and landscapes to be enhanced
The fundamental equation of flood risk management	Structural measures = the right way to get rid of risk and to legitimate urban development in riverbeds Resistance	The efficiency of structural measures = a delusion Non structural measures = a more efficient way to manage flood risk Resilience
The fundamental equation of the development/ environment relationship	Natural environment = a support that can be shaped to foster the development of human activities (the natural environment must yield to the requirements of human activities)	Natural environment = a set of features whose properties must be protected from the negative impact of human activities (human activities must adjust to the requirements of the environment)

3. Stake-holders and public authorities' devices promoting a paradigm that is increasingly asserting itself

3.1. Regulatory mechanisms to initiate and/or approve of the change in approach

Even if the question is whether regulations contribute to the paradigm shift or merely endorse it due to pressure from civil society (the answer is highly variable, depending on the case at hand) the need remains to make a quick review of regulations trying to orchestrate this new form of water management. They are indeed synonymous of an institutional framework within which a new paradigm may stabilize, both from a theoretical (the main structural values) and a practical point of view (technical choices) and may gradually be implemented.

In the United States, the 1972 Clean Water Act changed the restoration and maintenance of the physical, chemical and biological integrity of rivers in the country into a federal policy, thus investing massive efforts to halt the degradation of the quality of water and the trend towards increased artificialization of waterways. The Endangered Species Act passed in 1973, which turned the protection of endangered species due to human activities into a federal policy, is important for water managers, in that about half of all species listed on the federal list of endangered species have been adversely affected by dams and water transfers (Graf, 2003).

In France, the 1964 Water Act recognized the need for basin management and set the goal of improving the quality of water receiving areas, while trying to meet their different uses.

The main principles of water management were established by the 3 January 1992 Water Act, listed in the *Schémas Directeurs d'Aménagement et de Gestion des Eaux*

(SDAGE, Master Plans for the Development and Management of water) in the major watersheds. The principle of "balanced" management of water resources aims to preserve aquatic ecosystems, sites and wetlands, to protect them against pollution and restore water quality, conserving water resources and developing them, while permitting different uses and activities.

The *Directive Cadre sur l'Eau*[3] (DCE, Framework Directive on Water), adopted in 2000, requires EU Member States to try and achieve the "right ecological status" of waters by 2015, particularly through encouraging the re-naturation of watercourses. In France, 80% of rivers do not comply with this directive. The DCE was transposed into French law by the adoption of the 2006 Law on Water and Aquatic Environments (*Loi sur l'Eau et les Milieux Aquatiques*, LEMA). A series of recent texts converge to support scrapping some engineering structures on French territory: a conservation plan for Atlantic salmon (2008), a national plan to restore streams continuity (2009), a national strategy for migratory fish (2010), and a management plan for eels (2010). The *Lois de Grenelle* (First and second Grenelle Laws), adopted in 2009 and 2010, also support this theme, through the *Trames vertes et bleues*[4] (Green and blue corridors) device, which aims to promote or restore the whole ecological continuity.

In Japan also, legislation has gradually moved towards a better integration of environmental stakes in river-management, contributing to the spread of river restoration projects. "The year 1990 was a turning point in river management. The River Bureau (MLIT) launched the initiative "Ta Shizen Gata Kawa Zukuri"—"Nature-oriented River Works." The major aim was to conserve and restore river corridors and their rich biodiversity. [. . .] This trend was enforced by the amendment of the River Law in 1997, when the "Conservation and Improvement of the River Environment" was inserted as the principal goal in Article 1" (Nakamura, Tockner, & Amano, 2006).

3.2. Substantive changes that are well illustrated by the removal of dams

"Growing understanding of the ecological impacts of flow alteration has led to a shift toward an appreciation of the merits of free-flowing rivers" (Poff et al., 1997). River restoration goes through, notably, the removal of barriers and sills[5], as these are major obstacles to ecological continuity and a symbol of the heavy development that has characterized waterways under the technicist paradigm. In the United States, Molly M. Pohl shows that, among different rationales, "environmental removals made a rather dramatic and sudden entry into the dam removal arena in the 1990s" (Pohl, 2002). The removal of dams and sills is thus presented as a tool for an environment-friendly river management,

[3] Directive 2000/60/CE, dated 23 October 2000.

[4] A tool for developing the territory, designed to preserve and restore ecological continuities (both on land and on water) so as to foster biodiversity at all territorial scale.

[5] A sill refers to a work, whether fixed or mobile, that acts as a barrier across all or a part of the river bed and whose height is generally less than 5 meters. A dam is a work that runs across more than the riverbed; its height is generally more than 5 meters.

a tool for achieving a "natural flow regime" (Poff et al., 1997), a kind of "physical and symbolical 'liberation' of the river" (Barraud, 2011).

The practice of "dam removal" was initiated in the United States in the 1960s, when it became quite widespread. According to the National Inventory of Dams, the country has more than 82,000 dams, but in 1998, the rate of dam decommissioning exceeded their construction rate (Gosnel & Kelly, 2010) and, in 2011, the country reached the total number of 1000 dams removed, according to American Rivers[6]. What is important is to promote ecosystem restoration and the recovery of endangered species. Environmental issues therefore weigh heavily in the choice of dismantling dams, even though these stakes are not the only ones. As shown by Pohl, "there is substantial geographic variability in dam removal rationales, with California leading in razing dams for environmental purposes, and Wisconsin leading in economic and safety rationales" (Pohl, 2002). Though most removed dams are small, large dams are sometimes involved in these demolition operations (Elwha and Glines Canyon[7], in Washington State, whose demolition began in September 2011[8]).

In France, Onema[9] recorded more than 60,000 dams and sills[10] on rivers, and found that less than 4% were equipped with fish ladders, while half of them had no proven economic relevance. The negative impact of dams and sills on waterways ecological continuity, added to their economic obsolescence, therefore legitimates the questioning of the very existence of such structures. That is why, a few years ago, the practice of removing dams was launched. Though few of them have actually been dismantled, many more are expected to be demolished over the next few years. Several dams in France are indeed on the spot, and their demolition is being more seriously considered. The Grenelle of the Environment has decided to give priority to the demolition of works that are major obstacles to rivers ecological continuity (Poutès on the Allier river, Vezins and La Roche-Qui-Boit on the Sélune). The removal of the Vezins and La Roche-Qui-Boit dams was officially announced in November 2009 by the Secretary of State for Ecology and, in October 2011, the Minister of ecology officially granted the demolition of the Poutès dam.

In this respect, France has played a pioneering role in Europe. However, removing works is not the only solution: it is also possible to resort to demolishing some works partially, which has the advantage of reducing the hazard posed by these sills, while preserving their possible heritage and landscape value (e.g. mill sills).

Though, in the United States and France, dam removal operations account for only a very small fraction of the works present in streams, they nonetheless embody a major turning point, the passage from one stream management paradigm to another.

[6] http://www.americanrivers.org/newsroom/press-releases/2011/worlds-biggest-dam-removal-9-13-2011.html

[7] The Glines Canyon dam, 64-meters high, will be the biggest dam ever to have been dismantled.

[8] http://www.americanrivers.org/newsroom/press-releases/2011/worlds-biggest-dam-removal-9-13-2011.html

[9] Office national de l'eau et des milieux aquatiques (National Bureau for water and water environments).

[10] Data taken from the national reference frame on obstacles to the free flow of water, available at: www .eaufrance.fr/.

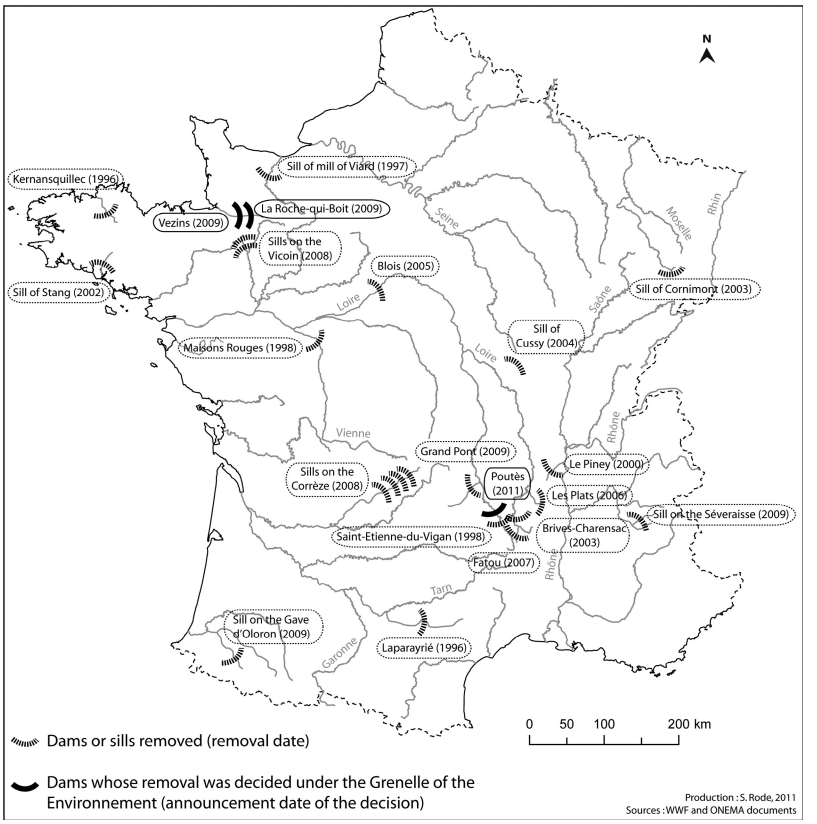

Figure 2. The removal of dams and sills in France.

3.3. More and more pressing environmental considerations and supported by influential actors

Dam removal operations appear as an illustration of that new mode of river management: environmental issues have now become central, so the relevance of great works is being reconsidered in light of this new paradigm. The many negative impacts of dams on river systems are now highlighted (Chien, 1985; Goldsmith & Hildyard, 1984; Petts, 1984; Sear, 1995): changing sediment movement leading to the sinking of riverbeds and increased coastal erosion; barriers to migratory fish that cannot go back to their spawning grounds on the upper basins; transformation of a running water ecosystem into a stagnant water body, resulting in the degradation of water quality (eutrophication), etc. The point of removing dams, therefore, is to restore rivers ecological continuity, while restoring the functioning of the hydro-system and of riparian ecosystems. The return of several species of migratory fish (large Pacific salmon in the American West waterways, Atlantic salmon on the Loire river in France, trout, eels, etc.) and the recovery of macroinvertebrate communities (Hansen & Hayes, 2011) emphasize the benefits of dam removals and act as a

strong motivations for dam demolition. Follow-up studies carried out after the removal of the *Maisons Rouges* dam on the Vienne River show that shad and lamprey in particular are returning, lending credence to the theory of the effectiveness of removing these barriers with a view to getting migratory fish to come back (Cochet, n.d.).

These environmental arguments have long been put forward by environmental NGOs. The newsletter of WWF France, called "Rivières en péril" ("Rivers at Risk") perfectly illustrates the strong stance against the construction of new dams and in favor of dam removals. The current dam projects on French rivers are considered "aberrant", "grotesque"; dam sites are described as "aggression" for rivers and contribute to their "concreting". These projects are also considered "unreasonable" and "expensive" and are presented as witnesses of an "other era" of water management that is now outdated. "Many local elected [. . .] have not yet left the purely quantitative logic in water resources management to move to a qualitative management". So they are calling for a "new water culture", "sustainable management". WWF France also denounce a "Kafkaesque drift of public water policy", the current construction projects of dams being, according to this NGO, in "contradiction [. . .] with all public policy, European and French, in protection of biodiversity, restoration of aquatic environments, saving the resource[11]". Such discourses are not neutral, they contribute to the strong affirmation of an involved viewpoint in the public debate about rivers management. The role of these stakeholders in the advent of a new paradigm of river management and development has proved central. Their activism has been effective, both through public education campaigns on these issues ("Living Rivers" program, orchestrated by the WWF for example, with the events by American Rivers in the United States, etc.) and through strong commitment to local advocacy groups (*Loire Vivante* on the Loire river, "International rivers" on the Klamath , Save the Narmada on the Narmada river). Huyghues Despointes (2009) talk of "a percolation [. . .] with ideas moving around from one sphere to the other (from environmentalists to developers [. . .])." This observation about the Loire River can be generalized: it highlights the crucial mediating role played by environmental associations to advocate more consideration for environmental issues in waterways development. They have goaded a great number of public policies into shifting towards a new direction. By using some works developed in the context of the (constructivist) analysis of public policies, we can show how environmental NGOs have contributed, through their active engagement, to build the soft river management into a public issue. The table below, based on the theoretical framework proposed by Felstiner, Abel and Sarat (1980/1981), highlights the three stages of the publicizing process for a new river management mode: "naming", "blaming" and "claiming".

In France, ecologist political movements are also advocating for dam removals and are fighting against new dams building (like the Sivens dam in Tarn). Environmental NGOs are also helped in their contestation of dams by altermondialist activists, who denounce the primacy given to economic development at the expense of environmental preservation

[11] The quotations in this paragraph are all from "Rivières en péril", the WWF France information bulletin (No. 58 march 2012, 60 may 2012, 63 november 2012 and 65 january 2013).

Table 2
The publicizing process for a careful management of rivers under the influence of environmental NGOs

Stage	General content of stage	Content of stage in regard to river management
Naming	Awareness and designation of the problem	Artificialization and degradation of rivers
Blaming	Responsibility allocation	The technicist vision of stream development
Claiming	Making a request to public authorities	A new model in water and rivers management (careful management)

and of social justice. The contestation of the Sivens dam in Tarn (France), currently strong, well illustrates this coalition of various actors who meet in the struggle against new dam projects and try to defeat them.

4. A controversial paradigm, deemed too limited by opponents

4.1. A new paradigm—and a hard one to implement

However, the practical implementation of these new guidelines is no plain sailing. The new paradigm of river management makes only slow headway. Before becoming dominant and consensual, the values that shape a new paradigm at first generate rejection and reluctance on the part of some stakeholders, who find it hard for a time to give up other theoretical and practical standards. They do not share the new emerging hierarchy of social values. This painstaking and gradual transition between two paradigms results in conflicts between actors' different visions of rivers and of their management.

In the Loire basin in France, a Memorandum of Understanding signed in 1986 provided for an overall development plan of the river and its tributaries to protect against flooding and prevent low waters. In particular, it was to lead to the construction of three large dams (*Serre de la Fare* on the Loire; *Chambonchard* on the Cher and the *Veurdre* on the Allier). Yet, this development program raised strong objections from environmentalists highlighting the need to preserve the ecological integrity of what they present as "the last wild river in Europe". With an effective media strategy, opponents finally managed to get the three planned dams not to be built after all. Though the technicist paradigm prevailed until the 1980s in the Loire basin, focusing on the development of the river and its tributaries, it has gradually given way, after nearly a decade of dispute (1986–1994), to the environmentalist paradigm (Rode, 2010). In the United States, too, numerous conflicts have risen between supporters and opponents of dams: Gosnel and Kelly have studied the emblematic case of the Klamath River (in Oregon and California), where environmental NGOs and Indian activists—who advocated an integrated approach to the river, make room for environmental and social issues alongside economic ones—were for a long time pitted against economic actors (hydroelectric companies, farmers, etc.). An agreement was signed in 2010 that vindicated the environmentalist paradigm and it is hoped that it will bring "peace on the river" (Gosnel & Kelly, 2010).

In the 1990s and 2000s, the Narmada valley, in India, was also the scene of a major campaign against the construction of dams. These dams would indeed have submerged ancient forests and forced the displacement of many village populations, two thirds of them tribal and untouchable caste people. "The scale of ongoing developments, with hundreds of dams of all sizes, some very small, but some more than 100 meters high, turned the Narmada into the workhorse of protesters opposed to dams" (Racine, 2001). The challenge of large hydraulic power-stations (because at the most confrontational one, the Sardar Sarovar dam, a 138 m high wall was to dam the valley) can be read as a manifestation of the emergence of an environmentalist paradigm, challenging the technicist paradigm. It includes the main features of the new river management framework: a criticism of resorting to heavy technology and a willingness to take better account of the environment, but also fostering participatory governance more, including greater attention to local populations affected by hydraulic engineering. But it also worth pointing out that, while NGOs support this new paradigm, major Indian political parties remain favorable to large dams. Their worldview is deeply marked by the technicist paradigm.

In Brazil, in 2007, a proposed hydroelectric complex on the Madeira River[12] was turned down by the Brazilian Institute for the Protection of the Environment (IBAMA), due to its negative impacts on the environment, deemed too serious (500 km² of forest were to be submerged; it would have obstructed the return of a species of migratory catfish). President Lula, for his part, was very keen on achieving these large water development projects and had little regard for environmental issues; therefore, he reorganized the IBAMA to regain control of the development of this tributary of the Amazon. In fact, a few months later, the construction of two dams was launched (Goujon & Prié, 2010). This example speaks volumes about the tensions generated, even within the state apparatus, by the choice of stream management. The IBAMA, which was trying to implement a method of water management that fully integrated environmental issues, faced stiff opposition from President Lula: he was steeped in the technicist paradigm and gave priority to meeting economic challenges and therefore did his utmost to impose that choice.

Indeed, dams building continues to be intensive around the world, especially on rivers in developing countries, which have great expectations as regards the "water revolution". WWF estimates that by 2020, 17 out of 64 major rivers flowing in the world may be equipped with large dams (World Wide Fund for Nature, 2006). The fact that China and India are still on a dam-building spree, especially on rivers in the Himalayas (many of which they share) show that in many places, we are still going ahead with the technicist paradigm. The Salween for example is threatened on its upper reaches by the Chinese project to build 13 hydroelectric dams, while its lower reaches are being imperiled by several Burmese dam projects (World Wide Fund for Nature, 2007). The case of the Sardar Sarovar dam in India, mentioned above, is both symptomatic of the emerging nature of the environmental paradigm (this dam project has been strongly opposed including on behalf

[12] The Madeira is still, for the time being, part of the 64 more than 1000 km long rivers or streams recorded in the world by the WWF as flowing freely, without their course being discontinued by any dam of a great size (WWF, 2006).

of its environmental impacts) but also of its difficulties to be implemented (this dam is actually going to be built!). Not surprisingly, economic issues often continue to take precedence over environmental considerations. But that does not mean that significant changes are not at work.

4.2. Towards a more integrated management of rivers?

However, if environmental and economic issues are not always reconciliable, a more integrated management of rivers is being implemented, trying to take into account both environmental, social and economic issues.

Within this new paradigm of river management, social issues are increasingly taken into account, to the same extent as environmental issues. In many advocacy movements against the construction of new dams (like on the Narmada river in India) or supporting the removal of dams (on the Klamath in the United States), social issues are set up as central concerns. This includes taking into account the impacts of dams on local populations, and consider these as full participants, who must be involved in decisions about the choice of planning and watercourse management. In contrast to the "top-down" decision model, the "bottom-up" model is preferred. However, this is not always the case: dialogue is too often very limited and is more akin to presenting information in a conventional "top-down" approach, with little concern for local communities' representations and uses, though they have appropriated streams and works over time. While proponents of a new mode of rivers management are calling for a more participative governance, they frequently denounce choices that would not be collectively discussed but imposed by a minority ("the consultation of publics, citizens, scientists, various experts [. . .] have been limited to the bare minimum. Their opinion is secondary"; "a handful of elected officials decided that the dam would be done"[13]), and they emphasize the fact that alternative solutions, though less expensive and more sustainable, would not be considered seriously.

Economic stakes are also fundamental to understanding both shifts in favor of a new form of river management and resistance to this paradigm shift. Actually, removing dams is indeed done for already mentioned environmental reasons but also for economic ones: the demolished dams are generally aging infrastructures that would be costly to rehabilitate, while not very profitable anyway. "Since the late 20th century [. . .] complete removal of dams began to be seriously considered, in part because many dams were built 50–100 years ago in the United States, and because they are aging and nearing the end of their life cycle, also partly because they are now subject to more stringent environmental regulations" (Gosnel & Kelly, 2010). The exploitation of the Fatou hydroelectric dam on the Loire, built in 1907, came to an end over fifty years ago. Therefore, it was finally removed in 2007. When the initial economic motivation in favor of dams has become obsolete, removing them may be considered and accepted (although this is not always a sufficient condition, as these works may sometimes fulfill societal functions beyond their original economic purpose). It is only under these conditions that "the environmental values associated with removing

[13] These two quotations are from "Rivières en péril" No. 58, march 2012.

dams and restoring rivers are powerful enough to justify public investment" (Graf, 2003). Furthermore, cost-benefit analyzes emphasize it is more economical to protect the natural dynamics of rivers than developing them endlessly (Gunnel, 2009). So, though this new streams management has undeniable ecological benefits, it could also have economic advantages. Several studies show that there are quantifiable economic benefits of dam removal. Provencher, Sarakinos, and Meyer (2008) and Lewis, Bohlen, and Wilson (2008) show increases in property values and willingness of pay after dam removal. Proponents of removing dams also emphasize the opportunity this provides to (re) create new activities on and alongside the river: reclaiming the land thus released for livestock development and creating footpaths (as on the Léguer, following the removal of the Kernansquillec dam in 1996), improving white water sports (as on the Corrèze, in Tulle), lending new impetus to amateur sport fishing (as on the Orne in Normandy) (Barnetche, 2010).

This is not however a model of integrated management (far from it), articulating the economic, social and environmental dimensions of waterways. In France, a number of operations to restore rivers ecological continuity initiated by the state and its services rely "on incomplete diagnoses in which ecological expertise dominates while customs, and more generally socio-economic dimensions, are neglected" (Germaine & Barraud, 2013). The dismantling of the *Maisons Rouges* dam, for example, was not accompanied with any socio-economic compensation for putting paid to the activities carried out on the water. Concerns in terms of economic activity and employment run therefore high among opponents to the demolition of dams. This is one argument, among others, put forward by the opponents to removing dams, who are keenly attached to a particular representation of the river and who try to defend it.

4.3. Hands off my dam! A socially valid vision of waterways?

As emphasized by Jorgensen and Renöfält (2012), "public opposition is not based on knowledge deficiency, where more information will lead to better ecological decision-making, as is sometimes argued in dam removal science; it is instead a case of different understandings and valuation of the environment and the functions it provides". That is why the vision behind the posture of opposing the dismantling of barriers needs to be taken seriously and considered as betraying a special relationship between local communities and their rivers (table 3). Attention should be paid to the social uses of rivers that this vision involves. Thus, rivers are not reduced to their mere ecological dimension but are considered in a more comprehensive and integrated perspective.

Opponents to dam removal focus on the socio-economic dimensions of these structures and of managed rivers (table 3), highlighting the long history of human impact on rivers while emphasizing, in reaction, the illusory nature of wanting to retrieve fully wild rivers (an aporia vindicated by scientific studies). For the "Friends of dams" association on the Sélune, removing dams involves job destruction and local economic decline. Some economic activities related to dams are threatened with extinction, which would inevitably have a negative impact in terms of jobs and income in the territories concerned. This fear

Table 3
Pro and anti dam removals: contrasted visions

	Dam removals proponents	Dam removals opponents
Representations of the ideal river	- Running water - Free river/Wild river	- Still water - Developed river
Representations of dams	- Negative: a symbol of man-made environmental degradation; an obstacle to the ecological continuity of waterways. - Outdated: the initial economic function has become obsolete; a symbol of a historically dated and old-fashioned approach to waterways management	- Positive: a historical heritage (historical, cultural, industrial) appropriated by local communities, as it is part of their landscape - Modern: a support to economic and societal functions that are still crucial nowadays
Representation of landscape	Natural: going back to how it was centuries ago	Steady-state: Inherent part of the landscape and economic systems

is all the more legitimate in light of what happened when the *Maisons Rouges* dam was dismantled—it was not accompanied by any socio-economic compensation for putting an end to the activities carried out on the water (Germaine & Barraud, 2013). Removing dams is said by opponents to deprive the community of a source of hydroelectric power (whose renewable nature they put forward), of tourism-related jobs linked to presence of bodies of water, and to create problems in terms of drinking water, etc. Opponents to demolishing dams also emphasize the heritage aspect of the river and of the works built on its course (table 3). In fact, some of these inherited facilities have been the subject of a heritage process (mill sills, for example), turning them into a source of local development and giving them value in the eyes of the local community. They highlight the appropriation of rivers for a whole lot of activities: recreational, fishing, swimming, etc., highlighting another form of social utility of dams and sills. Finally they insist a river has aesthetic value, as it enhances, by contrast, the value of calm waters and bodies of water that reflect the light (the dam pond is then characterized as "mirror water", Jorgensen & Renöfält, 2012).

Those are indeed two opposing representations of rivers and dams that necessarily clash—which accounts for the conflicts resulting from dam decommissioning.

5. Conclusion

This paradigm, which we proposed to dub an environmentalist one, is therefore advocating a new form of waterways governance, including both new concerns (mainly environmental, at times social, in addition to the traditionally dominant economic concerns) and new stakeholders, more numerous and endowed with new legitimacy (including the increased importance of civil society). Consideration of environmental issues is the real novelty of this paradigm, and it leads to major consequences in terms of rivers development and management.

Yet, this new paradigm, if it focused solely on environmental issues while neglecting the socio-economic ones as well as the different social uses attached to the development of rivers, would appear simplistic and raise objections. Regarding to rivers management, we would be currently in a situation of "in-between", where heritage of the past and new experiences coexist, where practices and representations of the stakeholders – undergoing in the same time the contradictory influences of two opposite paradigms – combine innovations and resistances.

To overcome this opposition between a technicist paradigm and an environmentalist one, it seems desirable to promote integrated river management (thus coming to terms with the principle of integrated management of water resources, approved internationally at the 1992 Rio Earth Summit, whose objective is to reconcile economic efficiency, social equity and environmental preservation).

A new vision of the environment, a more inclusive one, might well gradually emerge. The transition from one paradigm to another is accompanied by a change in the dominant conceptualizations of the environment. The technicist paradigm as much as the environmentalist one are underpinned by "irreconcilable perspectives on the environment" (Theys, 2010). Environmental movements tended for some time to uphold a bio-centered vision, according to which the environment is reduced to a sort of nature envisioned "regardless of its social utility and according to its intrinsic value, that is to say, as an end in itself" (Depraz, 2008). In contrast, proponents of stream development have tended to think the environment mainly as a resource to be exploited by and for humans (an anthropocentric perspective). But the move towards a more integrated approach to water courses and their management seems to be accompanied with the emergence of a new vision of the environment, neither bio-centered nor anthropocentric but eco-centered. In this perspective, man and nature are no longer opposed, nor separated, but man is envisioned as a part of nature (Depraz, 2008). Once more, such a vision is promoted by works using socio-ecological system, defined by Berkes and Folke (1998) as an assembly of complex systems in which humans are part of nature. In such a perspective, the challenge we are facing is to implement a "good use" of nature (Larrère & Larrère, 1997), a balanced management of watercourses.

Table 4
Integrated management of rivers as a possible synthesis of the two opposing paradigms?

	Technicist Paradigm	Environmentalist paradigm	Integrated management
Priority stake	Economic development	Preservation and restoration of the environment	Combining economic, social and environmental stakes
An ideal vision of the river	Economically managed and exploited river	A free and wild river	A socially appropriated river, economically put to use and with respect to ecological balances
Vision of the environment	An anthropocentric perpective	A bio-centered perspective	An eco-centered perspective

Indeed, implementing the environmentalist paradigm appears complicated, as shown by the case of France. Numerous stakeholders in river management, especially at local level, have indeed the feeling of being passed from one extreme (man being more valued than nature) to another (nature as more precious than man), which is perceived by some as a takeover by environmentalists at the expense of public utility projects. For these persons, environmental stakeholders have a simplistic view of the problems and are not legitimate to participate to river management. As a consequence, many of the new notions which are highlighted and implemented in the environmentalist paradigm (protection of biodiversity, restoration of aquatic environments, ecological continuity, ecosystemic services, etc.) are not yet appropriated by a part of the population and their human benefits are poorly perceived. The usefulness of these new measures regarding to rivers management is even more difficult to perceive that their effects are part of the long time. But the political and economic actors and a part of the population favor short time and want immediate results to identified problems. Another obstacle to the environmental paradigm is that developed rivers and dams are appropriated by local communities, and therefore considered as part of the landscape and as a heritage to protect. The vision of wild rivers, supported by environmental NGOs, is far from unanimous within the population. Lastly, the priorization of economic development—even more in a crisis period—, by many public and private actors, is a powerful brake to the implementation of care management. Dams are still often seen as infrastructures that allow to develop economic activities and therefore wealth. The French state itself promotes infrastructure developments to support jobs and boost consumption.

Similarly, in developing countries, this paradigm shift clashes with the contributions of the "hydraulic revolution" deemed as creating wealth, as a means of struggling against floods and managing water resources to cope with the critical needs of large cities.

A balanced management of watercourses, as much remote from bio-centrism as anthropocentrism, therefore still largely remains a challenge that contemporary societies, both North and South, have to take up.

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