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Sharing Water Between Nature and Humans: Environmental Flows and the Politics of Quantification

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ABSTRACT: In 2008 the French government launched its *Quantitative Water Management* policy initiative, as part of which the Rhône-Méditerranée Corse Water Agency undertook studies to ascertain monthly environmental flows at key sub-basin control points and the corresponding 'allowable [water] withdrawals'. Despite simplification, uncertainties, and insufficient data, the studies produced environmental-flow (e-flow) targets endowed with the power of allocating water between humans and nature. We analyse the fluctuation of the e-flow target at Point T6 in the Têt river basin, in the South of France, and show that, rather than an objective, quantitative ecological threshold dictated by science, it can be seen as a boundary number that embodies imaginaries, values, ideologies and interests. Science, but also law, appear to be selectively mobilized, massaged or contested. As a 'slider', the e-flow target reflects the state's political will and/or capacity to impose change and a reduction in water abstraction. Although the e-flow at Point T6 so far failed to play its role as a 'boundary number' and to achieve a settlement, it both exposed the limits of the pre-existing status quo and reshuffled the cards, legitimizing in particular the entry of environmental actors.

KEYWORDS: Quantification, environmental flow, uncertainty, indicator, boundary object, science/policy interface, France

INTRODUCTION

Human use of water is increasingly antagonistic to the conservation of aquatic ecosystems (Flörke et al., 2018). A wide array of scientific disciplines, including biology, ecology, hydrochemistry and hydrology, have stepped up their efforts to understand the relationship between ecosystem health and water regimes. Specifically, a lot of work has been put into establishing minimum flows (or environmental flows, abbreviated as e-flows). These mark the thresholds below which ecosystems may be compromised (Arthington et al., 2023). Due to the complexity of water-ecosystem relationships, the health of the environment is often subsumed within indicators or variables such as the rate of dissolved oxygen (DO), temperature, the presence of invertebrates or river flowrate.

One particular approach, which comes under a family of tools called microhabitat-rating models, consists in examining whether specific stretches of the river offer adequate conditions in terms of substrate granulometry, depth, temperature and flowrate for the reproductive cycle of particular species. With such a tool on hand, it is tempting to envision regulations whereby minimum e-flows would be assigned to specific control points, ensuring that economic and other human uses are compatible with the preservation of aquatic ecosystems. In its simplest form the idea is that science determines the e-flow thresholds and governments enact (and enforce) the relevant legislation restricting water abstraction accordingly.

E-flows have been gradually mainstreamed over the past thirty years and are enshrined in regulation in many countries (Arthington et al., 2023; Tharme, 2002; Wineland et al., 2022; Acreman et al., 2014a,b). For example, they have been enforced in some parts of the US, notably through the Endangered Species Act. In Australia's Murray Darling Basin e-flows are targeted at 'umbrella environmental asset' sites to meet the needs of key ecosystem components (e.g. vegetation, birds and fish) (Swirepik et al., 2016; Bender et al., 2023). In 1995 South Africa announced that it would set a 'social reserve' (a volume of 25 l/day per person for domestic uses) and an 'ecological reserve' (e-flow) to be prioritised over other economic uses, notably irrigation by commercial farming. However, the much-celebrated policy was only partially successful as it ran into methodological, logistical and capacity difficulties, as well as opposition from the agricultural sector (Brown et al., 2020; Mueller et al., 2022; Schreiner, 2013). In Europe, the Water Framework Directive (WFD) – initially more focused on water-quality issues – has not imposed e-flows, but its 'good ecological status' principle has often translated into the establishment of e-flows as river basin management targets (Acreman and Ferguson, 2010). This is the case in southern France, where water shortages and very low river flowrates have impacted existing water uses, water quality and aquatic ecosystems, leading to the gradual imposition of minimum flows.

Implementation, however, remains problematic. Some authors, like Harwood et al. (2018), underline the need for 'enabling factors' (e.g. appropriate legislation, resource and capacity, collaboration and leadership, and adaptive management). Others, meanwhile, identify several significant barriers to the implementation of e-flows. These include siloed or fragmented water governance, a lack of transparency and participation, declining water availability and its increasing variability under climate change, insufficient attention paid to non-biophysical factors, and inadequate will and/or capacity on the part of governments to monitor flows and enforce e-flows on the ground (Arthington et al., 2023; Wineland et al., 2022; Harwood et al., 2018; Alexandra et al., 2023; Horne et al., 2017). This last factor draws attention to the politics of e-flow implementation, which have attracted relatively less scrutiny (Alexandra et al., 2023; Capon and Capon, 2017). The as yet minimal understanding and description of nature mobilized in the determination of e-flows questions the role of science in the definition of environmental targets, but also the choices and values it incorporates. The acceptance of the primacy of environmental objectives over economic ones has also not remained unchallenged, with e-flows being actively opposed by some constituencies.

As such, e-flows can be seen as indicators of ecological health that allow the confrontation and possibly articulation of different worldviews and interests. They find themselves not only at the interface of science and policy but also of science, society and policy. E-flows may both reflect and actively participate in shaping the issues of legitimacy, authority, uncertainty or ontology that pervade these interfaces. In other words, beyond their absolute numerical value, e-flows can be seen as 'boundary objects' that mediate the debates around how water should be shared between humans and nature.

In what follows we examine the implementation of the Quantitative Water Management (QWM) policy in the Têt River Basin, southern France. Endowed with substantial water resources from the Pyrenees supplying 10,000 ha of irrigated land, the basin has however been challenged in recent years by low rainfall, declining snow cover and the implementation of e-flows claiming more water for ecosystems. We start by providing geographical and legislative context, describing the political history of the shifting e-flow value at one controversial point in the basin and noting the resources different actors have used in that debate, in particular the role or place of science in the controversy and the political process behind it. We conclude that, rather than an objective ecological threshold dictated by science, the Têt e-flow can be seen as a boundary number, a 'slider' which reflects the state's political will and/or capacity to impose a change and a reduction in water abstraction.

WATER NUMBERS AS TOOLS OF GOVERNANCE

Critical social studies of science and the sociology of quantification have questioned the origins of conventional metrics and classifications, and which and whose projects they support. They have looked at the social/political role of numbers and how they in turn modify society (Rose, 1991; Porter, 1995; Mennicken and Espeland, 2019; Turnhout, 2018; Star and Bowker, 1999). Much of water science relies heavily on quantification as it is predominantly situated in the realm of biophysical sciences and engineering. This apparently obvious observation is, however, increasingly becoming the focus of critical interrogation, for instance about water accounting (Zwarteveen et al., 2018), modelling (Sanz et al., 2019), remote sensing (Venot et al., 2021) and indicators (Molle and Mollinga, 2003).

Quantitative policy instruments such as a target e-flows "are not axiologically neutral and interchangeable. They are on the contrary value-laden, imbued with a particular interpretation of the social and a specific conception of the mode of regulation envisaged" (Lascoumes and Le Galès, 2004: 13). As Jasanoff (2004) emphasised, reality and the concepts we use to order and act upon the world are coproduced. Ecological indicators are numbers which mediate and transform our relationships with our environment.

Ecological indicators

The development of environmental policies has generated a demand for environmental data and information (Waterton and Wynne, 2004). Based on data, measurements or statistics, such indicators are promoted as a means of replacing judgements based on values or politics with 'objective' and 'neutral' facts. They are also seen to respond to a contemporary demand for openness, accountability and neutrality. While indicators are much in demand as a tool in societies' attempts to 'govern nature', their use and growing hegemony have attracted critics (Muller, 2018; Butt, 2018; Turnhout et al., 2007; Lehtonen, 2015; Molle and Mollinga, 2003). Some criticism revolves around issues of measurement and uncertainty, indicators being too simplistic, too complex or lacking transparency, or the assumed causalities between a given indicator and specific factors. Criticism is also levelled at what the indicators leave out or render invisible, the normative assumptions behind the selection of a desirable 'reference state' for targets, and the worldviews and interests they promote (e.g. the commercialisation of nature), inadvertently or otherwise.

Indicators come in different guises. Some provide seemingly straightforward information about the status of particular environmental objects. They can be based on single variables (e.g. groundwater levels, spring discharge) or a set of variables assembled in different ways. Composite indicators combine descriptors, representing them either as 'doughnuts' or star/spider charts to keep the information conveyed by each, or averaged, possibly with different weights (e.g. the 'water poverty index'). While some indicators lend themselves to direct measurement (CO2 or dissolved oxygen [DO], the counting of invertebrates), others are the result of elaborate calculations (e.g. the 'water footprint': the amount of water used to produce a given good or service). The degree of simplification and distortion, the loss of detail and context, and the erasure of heterogeneity, all depend on the complexity of what is supposed to be quantified.

As descriptors of the state of the environment, indicators can be used to convey information, make comparisons and reveal evolution, but also to denounce environmental degradation, establish causal relationships and apportion blame (Bouleau and Deuffic, 2016). When associated with targets, standards, benchmarks or thresholds that define a 'desirable' value either to be attained (e.g. target population of a given species, or the DO level) or not to be exceeded (e.g. maximum level of pollutant concentration or water abstraction), indicators more distinctly become an instrument of power and government (Bouleau and Deuffic, 2016; Lascoumes and Le Galès, 2004). They promise facilitated compliance, since penalties and changes in behaviours move from being dictated by the state administration to resulting

mechanically from allegedly 'objective' information (Porter, 1995; Merry, 2022). Indicators emerge as a central tool in the 'governing of nature' (Fernandez and Debril, 2016; Bouleau and Deuffic, 2016).

Although the veneer of neutrality makes them attractive, a wide array of studies across domains have shown them to in fact be value laden. Indeed they can embody specific worldviews, be used as tools of governance and serve political goals with the performative potential of reordering society (Turnhout et al., 2007; Fernandez and Debril, 2016). The constructed and political nature of (ecological) indicators can be shown by tracing the particular social circumstances from which they grew (see, for example, Bouleau et al., 2009; Bouleau and Deuffic, 2016; Rametsteiner et al., 2011 or Turnhout, 2009), circumstances which recursively shape these indicators when put to use, as we will see in the case study that follows.

Bouleau and Deuffic (2016) have examined the politics around the construction of ecological indicators and shown how they are negotiated based on their expected implications. In the Murray-Darling Basin, Australia, while the volume of water to sustain wetlands and rivers was estimated in 2009 at 3-7.6 billion m^3/yr, a first 'Sustainable Diversion Limit' of 2.75 billion m^3/yr was later opportunistically reduced to 2.05 billion m^3/yr by a policy promising "to achieve equivalent environmental benefits with less water" (Bender et al., 2023). In the South of France, Fernandez and Debril (2016) and Gaudin and Fernandez (2018) showed how controversies and negotiations around the setting of e-flow thresholds reflect the search for a trade-off between the various agendas of the stakeholders (hydropower, irrigation, environment, etc). New framings, hypotheses or studies are introduced to justify the redefinition of the water deficits and e-flow values, reflecting the shifting priorities assigned to pollution dilution, irrigation or the preservation of the aquatic ecosystem.

Boundary objects

Boundary objects, as initially proposed by Star and Griesemer (1989), are artefacts which allow productive communication and coordination among social worlds. The concept has been put to the test in many fields and disciplines (Trompette and Vinck, 2009). It has been applied to institutions (Barreteau et al., 2011) and organisations (White et al., 2018; Wesselink and Hoppe, 2020), as well as artefacts such as concepts and frameworks (Mollinga, 2008; Abson et al., 2014) and models (van Waas et al., 2015), scenarios (Lebel, 2013) and indicators (Holden, 2013). Much of this work relates to mediations between the scientific and the bureaucratic/policy-maker social worlds – the so-called science-policy interface – and less commonly to the science-policy-society interface.

As Star and Griesemer (1989: 393) put it, “Boundary objects are objects which are both plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites". In the Têt Basin the minimum e-flow (*Débit Minimum Biologique*, hereafter DMB) is endowed with just such an 'interpretive flexibility'. Science-wise its calculation combines elaborate hydrological knowledge with representations of river habitats’ adequacy for particular fish species (see below), conveying the concepts and meanings abetted by river specialists. On the policy side it embodies a desirable and quantified (WFD-compatible) state of the environment that holds the promise of being eventually (after adjustments) compatible with existing uses. For river users it is a measure of the 'efforts' expected from them but also of forthcoming subsidies. For green NGOs and fishing associations it is a prospect of enhanced river health in the step-by-step uphill battle towards the recognition and enforcement of ecological needs.

The DMB, therefore, is tasked with reconciling all these meanings and interests. The enactment of the Quantitative Water Management (QWM) policy at the sub-basin level can be seen as the gradual implementation of a 'negotiated order', "involving bargaining and negotiation between semi-autonomous actors pursuing or protecting their interests" (Barrett, 2004). If "boundary objects [can] act as anchors or bridges, however temporary", as Star and Griesemer put it (1989: 414), the workings around boundary objects "are not simply the imposition of one world’s vision on the rest; if they are, they are sure to fail." For Oswick and Robertson (2009), they might as well be perceived as "barricades

and mazes, reinforcing existing power structures and occupational hierarchies and creating barriers to change". Likewise, Turnhout (2009) found that ecological indicators are unlikely "to serve as a boundary object between social worlds that differ significantly in terms of values and preferences".

Preliminary results from ongoing research by the two authors into the implementation of the QWM policy across the Languedoc-Roussillon Region suggest that in nearly all cases the DMB does its boundary work well and allows a temporary settlement to emerge. As underscored by one of the QWM policy's evaluation reports commissioned by the *Agence de l'eau*, most of the negotiations occur not around the meaning or numerical value of the DMB, however disputed or unintelligible it may be, but around its practical implications in terms of the means, investments and subsidies that will be required to adjust water management in order to meet the target. We investigate why the e-flow at Point T6 in the Têt Basin so far failed to play its boundary role successfully.

GEOGRAPHICAL AND POLICY BACKGROUND

The Quantitative Water Management (QWM) policy

Since the 1960s water policy in France was largely driven by pollution problems. Yet concerns about quantity persisted, often following exceptionally dry years. After a series of droughts and the passing of the 1992 water law, the 16 June 1994 instruction drew up a list of (sub)basins considered to be in deficit (the so-called ZREs, *Zone de Répartition des Eaux*, or Water Allocation Zones) and in need of swift action to restore their quantitative balance. The exceptional drought in the summer of 2003 was the wake-up call that led to the 16 March 2004 *Instruction on the quantitative management of water resources and the assessment of applications for water abstraction authorisations*. This instruction was remarkable for its language advocating tight volumetric control of water extraction. Detailed information, such as on maximum volumes and flow rates, spread over time where possible, etc., would be compulsory in any new declaration or authorisation, while existing withdrawal authorisations would be updated, notably in the ZREs, which came with a set of additional constraints.

The *Agence de l'eau Rhône Méditerranée-Corse* (AERMC, hereafter 'the Agence'), one of France's six water agencies, set out to formalise its "concerted quantitative management of water resources" policy by incorporating it into the Agence's 8th Programme (2003-2006). Subsidies for the quantitative management of water resources became conditional on generating an "environmental benefit [...] concerning both aquatic ecosystems and the balance of the water resources concerned". The *Instruction on the reduction of quantitative water abstraction deficits*, issued on 30 June 2008, was the seminal document marking the roll-out of quantitative management to all basins indicated as being "imbalanced" in the 6-year basin plan (SDAGE). It mandated allowable/permissible withdrawals to be assessed by mid-2009 "at the latest" through studies called EVP (for *Etude de Volumes Prélevables,* i.e. Allowable Withdrawals Studies), financed by the Agence and carried out either by the administration or consultancy firms. Abstraction authorisations granted by state services would have to be revised accordingly and notified by the end of 2014.

In 2009 the Agence drew up guidelines for the EVP studies which would define and prioritise minimum e-flows, then calculate how much water would remain in the river and be potentially abstracted. In a nutshell, the EVP methodology included 1) an assessment of actual water withdrawals and their growth; 2) a hydrologic assessment (and, often, modelling) of the river basin/aquifer in both its natural and altered conditions (i.e. without and with anthropogenic uses); 3) establishment of minimum e-flows (*Débit minimum biologiques*, or DMB) and DOE[1] at key control 'nodes'; and 4) defining allowable withdrawals by subbasin, river stretch or aquifer, and their allocation between sectors and users.

[1] DOE (*débits d'objectif d'étiage*, or Low-flowrate targets) are derived from DMB by adding downstream uses. Because DOE and DMB in T6 are equal, we refer only to DMB in what follows.

Allowable withdrawals would now be computed, for each control point, each month, as the maximum volume that could be provided by the hydrologic regime with a security of four years out of five without cutting into the DMB (which is therefore given priority) and possible downstream requirements.

Although EVP studies have shown that the required hydrological computations were often problematic, we focus here on the definition of the DMB – a step that is more frequently contentious. Over 200 methods have been developed to evaluate the alteration of aquatic ecosystems in relation to stream flows (Tharme, 2003c). Among these, 'habitat rating methods' combine the hydraulic characteristics of a river reach under a varying flowrate with a biological model which quantifies the suitability of the river habitat for specific fish families (*taxa*) and growth stage. In the Rhône Méditerranée-Corse Basin, the Agence promoted the Estimhab microhabitat model (Miguel et al., 2016; Lamouroux, 2002).

Aside from these EVP studies, and the establishment of monthly DMB and allowable withdrawal flowrates, the French legislation also imposes a 'reserve flowrate' (*débit réservé*) for the river. This is often expressed as a percentage of the average annual flow (the so-called '*modulus*') after any river diversion or abstraction point. In 1984 a law on inland fisheries set this percentage at 1/40th but it was raised fourfold in 2009 to 1/10th of the modulus. This *débit réservé*, expressed in actual (instantaneous) flowrate (m^3/s), parallels the ecological norm in the DMB, expressed as an average monthly flowrate.

In the wake of an official legislative report identifying "vigorous antagonism" around the determination of DMB and allowable withdrawals (Martin, 2013), in 2014 the Agence launched its Quantitative Water Management Plans (*Plans de Gestion Quantitative de la Ressource en Eau*), or PGRE. Based on the conclusions and proposals in the EVP study, the PGRE proposes actions towards absorbing the deficits identified. These can include demand-management measures (e.g. enhancing the efficiency of urban networks, raising awareness), water storage or transfers, technical studies or data collection. As a contractual tool (rather than regulatory obligation) it aims to rally all stakeholders around an agreed set of measures to be subsidised (typically at 70-80%) by the Agence or the EU.

A review of the EVP studies[2] on the 11 main river basins of the Languedoc-Roussillon sub-region identified 114 control nodes, around half of which (55) had to reduce their withdrawals for a period of between one and six months (2.4 months on average) (Barrazza and Molle, 2022). Considering each sub-basin's month of greatest water stress, the average reduction in withdrawals required from these 55 control nodes would have come to 56% (ibid). These numbers alone speak of the high demand and stakes of the Rhône Méditerranée-Corse basin's ambitious EVP/Allowable Withdrawal policy. Consequently, it could be expected that the implementation of the policy would not go unchallenged. The most intense and volatile controversy, perhaps, was observed in the Têt River Basin.

The Têt River Basin

The Têt is a coastal river in the Pyrénées-Orientales department[3] (Figure 1), with a catchment area of around 1400 km^2. Approximately 120 km long, the Têt originates at the foot of the Carlit mountain range, at an altitude of almost 2500 m, and flows into the Mediterranean Sea near Perpignan. The basin has two reservoirs that are essential for intra-annual water management. The Bouillouses Reservoir, at the head of the basin, has a capacity of 17.5 million m^3 (Mm^3) and is used to generate electricity downstream and support low-water flows. The Vinça Dam is located around 30 km west of Perpignan, downstream of the city of Prades. Since 1976 its 24.5 Mm^3 capacity has been used both for flood control and to support low-water flows and irrigation.

[2] To date, the Agence has completed 58 EVP studies for surface water resources and 14 for groundwater, while 62 PGREs have been concluded. The Adour-Garonne and Loire Bretagne river basin agencies have designed similar studies and plans.

[3] *Département*, an administrative division. Metropolitan France consists of 101 departments.

Thanks to a relatively abundant rainfall/snow regime in its upper and middle reaches, the annual reconstituted natural flow of the Têt Basin at its outlet is 367-385 Mm^3/yr against an actual flow of 327 Mm^3/yr (the difference being the volume depleted by evapotranspiration). Irrigation, covering around 9700 ha, withdraws a gross volume of 275 Mm^3 which passes through the basin's 101 communal irrigation canals each year (BRLi, 2012). While water resources, regulated by the two dams, had always been by and large sufficient, 2022 and 2023 witnessed low snow packs and dam storage, making emergency restrictions necessary.

The five main irrigation canals branching off the river in the first 8 km downstream of the Vinça Dam account for 53% of the gross annual abstraction of all canals in the basin, with a cumulative gross peak abstraction of 6 m^3/s in July. Together with other, smaller canals downstream, they irrigate around 8000 ha of the Roussillon Plain, two-thirds of which is planted with orchards. Downstream of these five inlets is the key control point known as T6[4], representative of a stretch of about 7 km that is heavily impacted by this combined abstraction, especially in dry years (Figure 1). Historically, river flows at point T6 and in this section could drop to 400-600 l/s in July-August, or even less. Beyond this stretch, the river flow builds up again thanks to small tributaries and the return from the superficial Quaternary Aquifer and wastewater treatment plants. T6 is diversely dubbed "the point in the *département* that crystallises all the tensions and could serve as a yardstick for controversy" (*Users* in www.lagri.fr) and "the black spot of quantitative management in the Rhône-Mediterranean basin" (*Administration*).

Figure 1. Upstream portion of the Vinça Plain with locations of canals and Point T6.

[4] E-flows are defined at key control points with the objective of ensuring overall environmental health. T6 was selected as the point downstream of the five main canals to ensure sufficient flow both in the impacted stretch and between the dam and T6.

The institutional context is also complex. In a nutshell, the French state is represented 1) at the department level by its prefect (*préfet*) and technical services (the DDTM[5]), but also 2) at the higher level of the Occitanie Region (through the DREAL[6]) and 3) the river basin (the Agence and its local branch in Montpellier). Local water users include irrigators, grouped in canal-user associations and represented by the Chamber of Agriculture, and Farmers Unions (mainly the FDSEA), as well as rural and urban dwellers, fishermen (*Fédé66* federation) and tourist activities, notwithstanding NGOs like FNE (*France Nature Environnement*) or Frene66, which campaign for environmental protection. Lastly, water management in the Têt River Basin is entrusted to the SMBVT (*Syndicat mixte du bassin versant de la Têt*), while the Roussillon coastal aquifers fall under the purview of the *Syndicat des nappes du Roussillon*. These syndicates are public entities which combine technical capacity and a governance headed by local elected officials (typically mayors). The SMBVT syndicate leads on several aspects of water management, including river restoration or maintenance, both qualitative and quantitative issues.

Methodology

This study focuses on the Têt River Basin and its control node T6. It is part of wider research that seeks to take stock of 15 years of the QWM's implementation in the Rhône Méditerranée-Corse Basin. Due to COVID and other factors, field work took from 2019 to 2024. It included interviews with a wide range of stakeholders belonging to the Agence (6), syndicates (12), DDTM and DREAL (3), Chamber of Agriculture and farmer associations (6), academia (4), NGOs (3), a fishing federation (2) and consultancies (4). Of these actors 11 were key players in the Têt River Basin controversy with whom 15 semi-structured interviews were conducted (two hours each on average). While the insight offered by this paper is primarily drawn from this subset of interviews, we also borrow from our wider material to further substantiate our analysis. To respect the anonymity requested by most interviewees we used the general categories '*Administration*' (Agence, departmental and regional technical services), '*Users*' (Chamber of Agriculture, irrigation collectives, farmer unions), '*Syndicate*' (river and aquifer syndicates), '*Nature*' (NGOs and Fisherfolks), and added an asterisk (*) when the quote comes from an actor from another department or basin who is also relevant to the overall discussion.

THE POLITICAL LIFE OF POINT T6'S ENVIRONMENTAL FLOW

The river stretch downstream of the Vinça Dam, from which the five main canals branch off upstream of point T6 (Figure 1), offers neighbouring villages several popular bathing spots shaded by imposing trees. In summer the river flowrate varies by location and with dam releases. Canals used to divert water with little concern for what was left to the river, which in some reaches could become crossable by foot. In dry years, such as 2003 or 2016, some river stretches were virtually dry.

In 1984 the minimum flow at point T6, after the last diversion weir, was set at 1/40th of the annual modulus, i.e. around 300 l/s, in line with the standard laid down by the fishery law.[7] But this theoretical minimum flow was little constraining and was ignored in practice. A 2001 study recalculated the river modulus, updating it to 11,700 l/s (Stucky, 2001). As a result, after the minimum flow was raised to 1/10th of the modulus in 2009, the instream flow was set at 1170 l/s.

In 2012 the EVP study carried out by BRLi recalculated the river's modulus at 12,170 l/s and, while acknowledging substantial uncertainties, proposed a DMB value at point T6 in the 1800-2200 l/s range. The study also specified aquatic life-critical flows and indicated that a flowrate of 1000 l/s was only

[5] *Direction Départementale des Territoires et de la Mer.*

[6] *Direction régionale de l'Environnement, de l'Aménagement et du Logement.*

[7] https://www.lagri.fr/reglementation-y-aura-t-il-encore-de-leau-dans-les-canaux

acceptable for a maximum duration of 2 days, beyond which fish mortality would be observed (BRLi, 2012). On 31 July 2013 the minimum flow at point T6 was '*notified*' by the basin prefect[8] to be at the central value of 2000 l/s.

Parcelling the DMB

This 2000 l/s value, however, was anything but consensual. Discussions between the stakeholders continued between 2013 and 2016, and DMB values modulated according to the month of year were negotiated. On 6 September 2017 the prefect signed an order confirming a modulus value of 12,166 l/s at T6 but distinguished between three periods: 606 l/s from 1 July to 31 October, 1217 l/s from 1 March to 30 June and from 1 November to 30 November, and 2030 l/s from 1 December to 28 February.[9] According to the order, defining these periods made it possible to ensure "that the *annual average* of the minimum flow values for each period is not less than one tenth of the modulus referred to in Article I". This system allegedly complied with the conditions stipulated in Article L214-18 of the French Environmental Code, which provides for such flexibility. In the summer the DMB was therefore only 1/20th of the modulus (606 l/s).

Watering down the DMB

It was also at this time that work began on drawing up the Têt Basin PGRE for 2019-2021, led by the SMBVT syndicate under the supervision of the Agence. During negotiations the Chamber of Agriculture and a federation of canal associations[10] continued to oppose the target value (2000 l/s) in favour of a value of 1000 l/s. Faced with this challenge from elected representatives and farmers, the Administration proposed, like for most EVP studies conducted in the region, an 'intermediate [target] value' of 1500 l/s., said to constitute "a level of ambition to engage stakeholders in joint efforts to save water during the implementation of the PGRE. [...] The intermediate value must be established in consultation with and validated by all those involved in the PGRE at each of its iterations, i.e. every 3 years or so" (SMBVT, 2019). The target should therefore be achieved by the end of the plan, i.e. in 2021.

However, the agricultural sector still did not agree to the intermediate target. To break the deadlock the syndicate proposed splitting the difference again, with 1200 l/s finally accepted by the Chamber of Agriculture as a new intermediate value. Although the long-term 'notified' target of 2 m^3/s remained, the final PGRE agreement included an addendum, which stated that

> In view of the operations set out in the action programme, which to date have not enabled this objective to be achieved, and of the consultation carried out with the stakeholders, it is proposed to set an eventual target of 1.5 m^3/s. Given the margins of technical uncertainty, the minimum objective of 1.2 m^3/s is acceptable within the timeframe of this PGRE and could constitute a first step.

While the PGRE's interim objective of 1.2 m^3/s was confirmed as acceptable, the 'long-term objective' (1.5 m^3/s) proposed was again less ambitious than the EVP value (2 m^3/s).

[8] Each of France's six main river basins (each with their own basin agency) is supervised by a special office under the regional prefect where the Agency is located. In the case of the RMC basin, the regional/basin prefect is that of the Rhône-Alpes Region and is based in Lyon. This regional prefect should not be confused with *département*-level prefects, who are closer to local politics and not always aligned with the basin prefect. In what follows 'prefect' should be understood as the departmental prefect, unless otherwise specified.

[9] https://www.pyrenees-orientales.gouv.fr/content/download/20979/160140/file/10-6-9-17-ap-nefiac-millas%20(1).pdf

[10] ACAV: Association of canal collectives located downstream of Vinça dam (*Association des canaux à l'aval de Vinça*).

Legal action

In the face of compromised environmental standards, in a letter dated 9 September 2020 FNE (France's main environmental NGO) requested that the prefect of the Pyrénées-Orientales raised the minimum flows at the canal diversion weirs as per the EVP.[11] Having received no response, in January 2021 it then filed a case in the Montpellier Administrative Court, requesting it to amend the September 2017 orders and set for each canal "a minimum DMB throughout the year at a value of between 1800 (or even 1500) l/s and 2200 l/s, […] as clarified by the results of the study aimed at determining the volumes that can be withdrawn from the Têt".[12] FNE pointed out that the EVP study had shown that such a minimum flow was necessary to permanently "guarantee the life, movement and reproduction of the species living in the water" as stated in article L. 214-18 of the Environment Code. Referring to this article, FNE established that the DMB value indicated by the specific EVP study should take precedence over and replace the floor value of 1/10th of the modulus. In November 2022 the administrative court published its decision to set the DMB at T6 at 1500 l/s.

In January 2023, six days after a major rural protest in Perpignan, the prefect of the Pyrénées-Orientales appealed the decision, arguing that "the court [had] made its decision 5 years after the decrees were issued, even though these had not been challenged within the appeal period", and it was therefore invalid.[13] The appeal is still ongoing.

Derogation of the DMB

At the beginning of April 2023, however, the situation looked catastrophic: with the Bouillouses and Vinça dams not filled and spring rainfall at an all-time low, the annual production, and even the survival, of the fruit trees was under threat. The 2000 l/s released during winter, as per the periodised DMB, proved to have been highly detrimental to inter-seasonal storage, as the snowmelt in spring 2023 was not enough to compensate and fill the dams. In view of these exceptional circumstances, the Chamber of Agriculture alerted the prefect who, in accordance with article 214-18, which allows the enforcement of temporary crisis measures and DMB values, announced 'exceptional' low-water conditions and a derogation of the DMB, lowering its value at Point T6 to 1000 l/s for a period of one month from 5 April.

Unsatisfied with the decreased flow rate, which they still considered too drastic given the drought conditions, the Chamber of Agriculture, together with a canal federation, nine canal associations and 150 individual farmers, requested a provisional judgement (*référé*) suspending the prefectural order of 5 April. But the resumption of discussions between the farmers and the prefect led the latter to formally agree to certain adjustments, leading to the suspension of the procedure and farmers finally agreeing to retain a DMB of 1000 l/s in view of the need to keep enough water in the dam for use by Canadairs (fire-fighting planes).

Nonetheless, in June, as the situation became critical, the prefect published a 22-page drought decree imposing "provisional restrictions on certain uses of water due to the status of groundwater and surface water resources". Various domestic uses were prohibited or limited, and canals had to reduce their abstraction by 25% and establish water turns, while respecting a reduced instream flow of a 1/20th of the modulus (606 l/s). This derogation was valid for one month or would "cease to apply when the volume entering the Vinça dam no longer represents exceptionally low water". Despite this happening in the following days, when significant rainfall filled the two dams in the basin, in July the situation remained critical. On 25 July a new decree extended the order of 13 June (and therefore the flow rate of 606 l/s for

[11] Since the river inflow between the five intakes is negligible, ensuring a minimum flow after the most downstream one (T6) ensures proper flowrates at the other four weirs.

[12] Jugement du n° 2100138 du 29 novembre 2022 Débit réservé sur la Têt

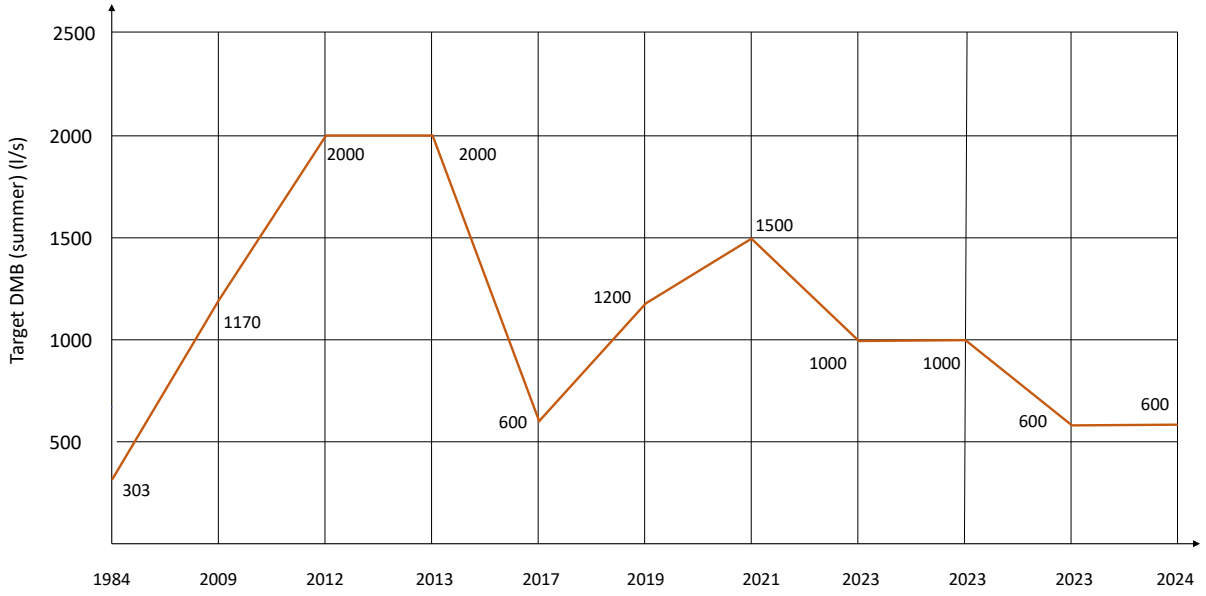
[13] https://madeinperpignan.com/secheresse-pyrenees-orientales-guerre-eau-gestion-nappes-solutions-conflit

T6) until 19 September. Subsequent orders extended it again to 20 October, 30 November and then to 5 April 2024.

Following the late June rainfall, however, FNE expected the measures to be lifted rather than extended over the following months. In July it wrote to the prefect to request the suspension of the decree. With no response, they decided to resort again to the tribunal, challenging the definition of 'exceptional drought' on which the prefect had based the order. The case is now in court, with the state, the Chamber of Agriculture and FNE interacting through their lawyers. Remarkably, and in contrast with the first legal action, the case has not been made public.

The 'T6 saga', summarised in Figure 2, provides a fascinating illustration of a number (here the target e-flow at node T6) acting as a moving boundary object. In what follows, we unpack key dimensions of the debate around this number.

Figure 2. Minimum flow values at Point T6 considered over time (summer).



Note: This diagram could be misleading because it combines regulatory ('notified' EVP, prefectural order, tribunal decision), programmatic (PGRE) and conjunctural (crisis management in 2023) values. This being clarified, the diagram nevertheless has the merit of specifying the reference value being considered *at a given time*. In this sense, it is a good illustration of how the 'slider' shifts over time.

DISCUSSION

The events described above unfolded over the past 15 years in a fast-evolving climatic and institutional environment. Actors' narratives, strategies and bargaining power evolved accordingly, within a main triangle formed by the administration, agricultural users and environmentalists. In this section we highlight their respective narratives, arguments and resources, but also their ambiguities. We thereby illustrate the deeply social and political nature of the DMB's quantitative determination.

Narratives and storylines

The controversy pits three meta-narratives against each other. Environmentalists share the view that the volumes traditionally diverted by irrigation canals have become extravagant in a time of growing hydrological instability, and that in times of drought it is the river – and aquatic life – that invariably bear

the brunt. They denounce the lax enforcement of the law and the administration's complacency. They interpret the drought conditions of the past two years (2022 and 2023) as foreshadowing the future – a future that demands the adaptation of cropping patterns and intensive irrigated agriculture. Yet, they express "their faith in the capacity of the agricultural sector to find solutions". They stand by the law and science ("a serious scientific study, accepted by everyone" [FNE in lagri.fr]), which have determined e-flows and rules that have, however, "been flouted, and since a river is not in a position to defend its rights in court, it is up to us, as approved associations for the protection of nature, to assume this responsibility. [...] What is irresponsible is to have stuck one's head in the sand for so long in order to avoid making the necessary changes to the detriment of nature" (FNE-LR, 2022).

Farmers vehemently oppose the depiction of their irrigation practices as wasteful. They emphasise that they have already massively invested in the modernisation of their irrigation systems (including 6500 ha of drip irrigation) and that the volumes diverted by the canals (which have been reduced in many cases) are part of an intricate circulation of water which recharges the river and the two interconnected aquifers below the plain, which supply most regional cities including the town of Perpignan. With the enforcement of the new DMB values and drought conditions, "It feels like they're trying to send us back to prehistoric times", imposing long water turns which are incompatible with drip-irrigated orchards (which need a little water every day). They argue that with a flowrate of 1200 l/s at T6, or even half of that, there is no observable impact on the river or its fish. Their narrative is illustrated by the Farmers Union newsletter,[14] where FNE is depicted as "waging a guerrilla war" against derogations on e-flows by the prefect. It sees the problem as limited to "a few hundred metres where the tension is high, whereas the rest of the river is less problematic". According to the union's president, fish wellbeing is being prioritised "in defiance of agricultural production and the 1500 farmers who depend on these canals […] and generate sales approaching €200 million. […] They can't keep harping on about the need to strengthen our food sovereignty, particularly in terms of fruit and vegetables, while at the same time preventing us from working".

From the administration's perspective, it is time to enforce environmental regulations to absorb local water deficits as well as to "create resilience" to dampen the effects of climate change. Its main aim is to "raise the issue of water scarcity and quantitative water balances, and to instil a dynamic" [that] tries to move towards restoring the balance [...], and to raise people's awareness of the need to save water" (*Administration*). Irrigation canals are seen as requiring modernisation in order to reduce withdrawals, because "at the end the best is to leave water in the river". QWM policies are also said to be justified by the state's obligation to report the status of water bodies to the EU. "If there is a problem, a dispute with the European Union, regarding the application of the Directive, it is the State that will be called upon first in relation to this".

Actors' resources and strategies

In addition to discursive struggles, these main actors involved in the debate around T6 DMB draw on a number of resources.

The law

While the law can, of course, be a decisive resource, it is not without ambiguity or opportunities for interpretation. It is also selectively employed and enforced. The state can use the floor value of the 1/10th of the modulus to restrict uses, yet it is loath to monitor or sanction users unless a state of emergency has been officially declared.

[14] https://www.lagri.fr/eau-t6-ou-la-borne-de-la-discorde-par-yann-kerveno; lagri.fr is an online/printed journal published by the FDSEA66, the local branch of the national farmers union FNSEA.

A key article of the Environmental Code is L214-18, which states that any structure in the riverbed must leave a "minimum flow guaranteeing at all times the life, movement and reproduction of species living in water". How this guarantee is defined is open to debate, but the state (via the basin prefect) has the power to validate a study that would 'demonstrate' that a given DMB value is both above 1/10th of the modulus and fits the definition. This is the case for EVP values, when and if enacted by prefectural order (*arrêté*), which allowed FNE to bring the case to court. Interviews point to repeated confusions among stakeholders about legal intricacies, such as the difference between DMB values 'notified' or promulgated by an order, or whether the DMB value issued by the court (1500 l/s) overrides that of the EVP (e.g. *Syndicates*).

The Environment Code includes apparent ambiguities that fuel arguments. Article L211-1 states that priority must be given to health and domestic supply issues but that, beyond this, "balanced management […] must allow [other uses] to be satisfied or reconciled", including ensuring biological life, irrigation, fishing, etc. This phrasing has been used by the defending Chamber of Agriculture to claim that irrigation water requirements should be "satisfied" on a par with environmental needs.

Other tricky and ambiguous issues that offer room for manoeuvre (which cannot be addressed here for lack of space) include the relationships between *instantaneous* discharges (*débit réservé*) and the *monthly* DMB values stipulated in the EVP, the updating of withdrawal authorisations (which state services have put on the backburner), or the challenges posed by canals with water rights granted prior to the French Revolution (often in the Middle Ages) and which can go to court to defend their water right.

Public pressure, media

The struggle around T6, exacerbated by the drought conditions, also unfolded in the media and the streets. Farmers demonstrated and even blockaded roads on several occasions.[15] Dramatic banners read, "farmers are suffocated", "the whole life of a region being sacrificed", "our survival is at stake!", "the situation is no longer sustainable!". The local and national media echoed the demonstrations, and processions were made with the statue of Saint Gauderic, the local patron saint called upon to intercede for rain.

According to the regional president of FNE interviewed by a local newspaper, pressure is also exerted directly through "Insulting emails, hostile phone calls from various sources"[16]. Another source recalls that "they carried coffins in front of the prefecture with signs saying "FNE, the gravedigger of rural life"[17] (Figure 3). The fishing federation was similarly threatened, and volunteers studying the use of pesticides reportedly had their car burnt (*Nature*).

Extensive lobbying took place, and the 'agricultural profession', as it is termed, was widely reported as having exerted pressure on the prefect and influencing the local administration. (It is often mentioned in interviews that the agricultural departmental administration and the Chamber of Agriculture long shared the same building.)

[15] See instances at https://www.facebook.com/fdsea.pyreneesorientales

[16] https://www.lindependant.fr/2023/05/16/secheresse-dans-les-pyrenees-orientales-fne-rappelle-quelle-nest-pas-responsable-du-manque-deau-11199601.php

[17] https://madeinperpignan.com/manifestation-agriculteurs-elus-decision-justice-gestion-eau-secheresse-perpignan/

Figure 3. Farmer demonstration in Perpignan (2023).

Note: The banner is held by elected officials, who came in the support of agriculture, and reads: 'S.O.S., the rural world sacrificed'.
Source: © Arnaud Le Vu & Hans Lucas, https://madeinperpignan.com

Bargaining chips

The PGRE mediates the implementation of e-flow values by defining 'efforts' or 'actions' conducive to improved management and/or water savings, and tallying them with budgets. Most actions, such as reducing pipe leakage in cities and canal linings or modernising irrigation systems, incur costs far beyond the capacities of those concerned. Public subsidies, whether allocated directly by the Agence or combined with funding from the department, the region or the EU (FEADER), typically amount to 80% of the total cost, making such projects attractive. Moreover, it is recognised that these subsidies might not be available later on, and that complying now will both improve water availability and relieve the pressure exerted by the state administration.

The Agence acknowledges the power of this mechanism, stating that in discussions with users both regulatory (stick) and financial (carrot) "levers" are in play: "for example, the appropriateness of subsidies (that are conditional upon inclusion in a PGRE) must be weighed against the regulatory need to comply with standards, or the need to negotiate not to be classified as a ZRE in return for a commitment to actions leading to a reduction in water abstraction" (AERMC, 2017). The threat of declaring a ZRE (which comes with a set of constraints), or the question of renewing (and reducing) withdrawal authorisations, lurk in the background, although the first step is to limit use through the DMB. Another state agent elaborates on the 'shadow of hierarchy' argument:

> What works best is not the stick; it's the threat of the stick, but above all the support and the setting of objectives, and giving people the time to organise themselves, helping them to organise themselves to achieve these objectives. And then there are the carrots, i.e. the financial aid, the promise of less 'stuff' [read, administrative burden] on condition that... It's a give and take... (*Administration**).

Using the stick is a double-edged sword, but often, "(…) at the end of the day, we have to [resort to top-down action], because if we don't show the stick, nothing will get done anyway, but we're trying to do it, to use it, in the most intelligent and educational way possible" (*Administration*).

A further indirect incentive for farmers to comply is aid conditionalities. The EU and Agence are increasingly using the legalisation and monitoring of water abstraction as a condition for subsidies. According to one official this has made farmers realise they "must put things in order and legalise use, administratively".

In addition to subsidies for water-saving actions, another key bargaining chip is the funding by the Agence of some of the Chamber of Agriculture's actions through a 'framework agreement', as well as to

syndicates (covering salaries) and FNE. When the syndicate insisted on sticking to a DMB value at T6 below that of the EVP, the Agence reminded it that it was the one funding its staff; the MOU between the Chamber and the Agence was also not renewed.

Mobilising science

The DMB value is the scientific cornerstone of the QWM policy. It is a single number with the power to govern how the resource is shared between nature and human use and hence where to 'allocate' the corresponding 'efforts' and restrictions. As a result, its meaning, definition and determination are the objects of considerable tension and controversy. For the administration, and other actors, the use of science to legitimate the QWM policy poses a catch-22 situation. On the one hand it needs to stand by the soundness of the science that underlies the EVP methodology, but on the other it has to acknowledge its limits, especially when it produces results that are perceived locally to be unrealistic, unacceptable or absurd, at the risk of undermining its policy.

The indisputable authority of the science is therefore essential but must be constantly reasserted in unambiguous language. FNE emphasises that "this minimum [flow] is based on science and is not the prefect's ballpark estimate" (FNE-LR, 2022). It also publicised the "expert report" issued in July 2021 by DREAL Occitanie (the regional technical governmental body),

> which validates both the method and the values of the study of the volumes that can be abstracted and considers that there is no objective evidence at this stage to call into question the relevance of the values established […]. Scientific studies show a number of things that should now be taken for granted (ibid).

Interestingly, even the irrigators feel the need to resort to science, through a counter-study entrusted to a Swiss firm, "necessarily neutral and accurate", they add. A federation of canal associations, the Syndicate and the Chamber of Agriculture commissioned a study to revisit the EVP diagnosis at point T6 and hope to provide up-to-date information that could possibly support the prefect's appeal (currently ongoing) and force a review of the DMB value.

While acknowledging its uncertainties, the Agence's Scientific Council confirmed that the method "proposed for assessing minimum biological flows is currently the best possible approach, given the current state of knowledge, for assessing the quantities of water that need to be maintained in rivers to avoid damaging their ecological status and aquatic communities". When in July 2013 the basin prefect declared a central value of 2000 l/s as the minimum flow at point T6 it was with reference to the EVP study, carried out "using methods validated by the Scientific Council of the Basin Committee and [which] constitutes a "stabilised foundation" on which to base the assessment of the state of the resource, its uses and the needs of the environment". State officials are often unwavering when the rationale of or numbers produced by the EVP are called into question: "it's the best knowledge we have. No other player has been able to offer us studies as advanced, as costly, as sophisticated, and when we cross-check with the local hydrological monitoring, there's no major inconsistency".

On the other hand, there are occasions when holding things together becomes problematic. When settling on a DMB value, the judge – using the administration's arguments – resorted to convoluted language to undo the 2 m^3/s value recommended by the EVP (which had been based on the VCN3 (a statistical hydrological indicator) and "expert opinion") and instead proposed 1.5 m^3/s, based on the VCN10 (another indicator). One state official even admitted, "we can see that we're at the limits of the model, and that in the end, based on expert opinions, it's 2000. Frankly, it's a bit light!". Another acknowledged that, "We know that there are also margins of error in the EVPs [...] we know that, in any case, [they] really have to be taken for what they are, i.e. the best techniques, the best knowledge available on hydrology and abstraction, and we know that this knowledge is not perfect, so we try to be

pragmatic" (*Administration**). Despite some puzzling inconsistencies,[18] recurring phrases depict EVPs as "an initial diagnosis", "the best current knowledge base", or as "better than nothing".

One official acknowledged that canal withdrawals are estimated and not measured, in gross rather than net values (little is known about return flows), and that well abstraction is not monitored. The EVP report underlines that the reconstitution of the 'non-influenced' hydrological series, on which the determination of the allowable withdrawals is based, has a margin of error of "*at least* 20 to 30%" (our emphasis). Hydrological stations once installed for measuring floods are unfit for low-flow measurements. The 2017 evaluation of the QWM policy notes a "point of fragility" concerning uncertainties about methods and/or data, which may "encourage a general disputing of results, without considering their area of validity", while the Agence underscores that "hydrological information is known with varying degrees of accuracy, which it is important to determine and make explicit" (Secrétariat technique du SDAGE RMC, 2013). In practice this is rarely done and rarely even possible. The promise that greater transparency would make it easier for users to support the project has not materialised. Indeed, in the case of T6, the DMB number was produced primarily by the state, via consultants. Uncertainties were minimised or glossed over rather than highlighted for discussion. The contradiction between science cloaked as a neutral number-maker and the pervasive uncertainties it contains were not dealt with.

The legitimacy of participation

Along with the supposed neutrality and authority of science, the administration points to the inclusive nature of the EVP/PGRE process. In its proposed methodology for the evaluation of DMB (EVP studies), the Agence (AERMC, 2008) includes an "adaptation/negotiation loop" through which recommended DMB values are to be screened

> in terms of both technical feasibility and socioeconomic impact [...] The minimum flows – and objectives for managing hydrological regimes more generally – that are ultimately set are [thus] realistic and can be translated into operational terms by the stakeholders, users and services concerned.

The administration banks on local cooperation in discussing and contextualising the target e-flows and believes that "a great deal of subsidiarity is still being given to the local level". While studies may spark debates about numbers such as e-flow values, "in the end, when the diagnosis is that the basin is very unbalanced, there is agreement". It is emphasised that the "policy has had the virtue of bringing everyone to the table and getting them to agree on a common view [of the status of the resource]" (*Administration*). It is claimed that, "the idea behind the QWM approach and the PGRE is to be based on consultation; the DOEs, the management flows, it's a consultative approach" (*Administration**).

But this view does not appear to be shared by the stakeholders concerned. PGREs are indeed participatory in nature, since they aim to reach agreements on the actions to be taken, yet the EVP study has tended to be top-down in practice and steered by the Agence. While the farming sector has been duly invited to meetings, "At no time in the organisation of these studies was there any question of negotiation, consultation or anything else that would allow us to say: 'this figure is also our objective'" (*Users*). This is corroborated by a state official who admits that "there wasn't really any consultation. In any case, officially, yes, there were meetings, there were files sent out, but the comments were not really taken into account, […] in any case, these meant: 'This isn't going to work'".

[18] For example, the modulus calculated at Point T6 in natural ('non-influenced') conditions is higher than at Point 7, further downstream. Since the habitat parameters of the *barbeau méridional* was not available in Estimhab, consultants used that of the *barbeau* from northern Europe – a different fish.

The T6 e-flow as a boundary object: Negotiations and the political process

Having reviewed the narratives and resources deployed by the various parties in the T6 controversy, we now go back to Figure 2 and unpack the underlying negotiation and bargaining process around the DMB number, described by one protagonist as "arm wrestling". The DMB, with its shifting value, can be typified as a boundary object at the centre of the arena.

The four years following the EVP were characterised by the farmers' wholesale rejection of the T6 DMB value notified by the basin prefect in 2013. The period also saw intense debate between the prefect and state services (DDTM, DREAL, the Agence), the syndicate and the Chamber of Agriculture. Farmers were fixated on 600 l/s (1/20th of the modulus) and adamant in rejecting a value of 1200 in summer. The modulation option with three different periods and values (including 600 l/s in summer) was presented to the Departmental Commission for Energy and Health and Technological Risks (CoDERST) for general advice to boost support.

State representatives agreed to the proposed periodised DMB and it looked like they had yielded to farmers. As one official recalls, "In fact, the PGRE was blocked; the DMB were blocked; so, in the end nothing was happening. So, we said to ourselves: OK, that's the objective [...] at least it will unblock things and we'll see whether the judge follows us or not. It's true that the judge didn't follow us, but that's no surprise" (*Administration*). Indeed, while agreeing to the farmers' proposal, the state services a) allowed the preparation of the PGRE to start, b) imposed metering devices on the main canals, c) insisted that the DMB be enshrined in a prefectural order (*arrêté*), thereby opening the door to legal contestation.

But this settlement was to be derailed by the ensuing negotiations on the PGRE. As detailed in Part 4, the tensions revolved around 1) the intermediary e-flow value targeted in the plan and its subsidised 'actions'; 2) whether the long-term target DMB would remain at 2000 l/s, as per the EVP, or be reduced to 1500, as per the farmers. In 2009, facing stiff resistance from farmers and elected representatives, the basin prefect stated that the proposed targets were not ambitious enough.[19] Having declared the area to be a ZRE, following an outcry from farmers this was rescinded. To rally support the Chamber of Agriculture raised the issue with the Commission supervising the coastal aquifers masterplan,[20] which voted unanimously in agreement, except the Agence and DREAL. In this charged atmosphere, the PGRE ended up endorsing the EVP's DMB values for all points except T6, which came with a modest intermediary target of 1200 l/s and an addendum – wearily accepted by stakeholders and "reviewed 40 times, including every comma" (*Syndicats*) – which made the position of the farming sector explicit with regard to considering a long-term target of 1500 l/s. The Chamber also got the assurance that half of the water savings made could be reallocated to expansion projects and referenced four new irrigation projects of vineyards in the PGRE.

With farmers pulling the DMB value down, FNE sensed that the environment was being sacrificed in the growing water crunch. Echoing FNE's claim that "the OFB [water police] had been instructed for years not to monitor the canals", an official acknowledged that "it has to be said that we are extremely accommodating, in terms of monitoring, because we don't actually carry out any formal check". Just as in the earlier case of the Céret Canal, in the neighbouring Tech Basin, FNE resorted to the court, with the argument that the EVP studies had assessed a DMB value that explicitly corresponded to the definition given in the law. A farmer representative reacted that indeed "This was stated in the terms of reference [of the EVP], the minimum biological flows are to be imposed by the law; this study wields incredible power. We were slow to realise that" (*Users*). In a Byzantine decision, the judge agreed with FNE's argument and juggled with the ambiguity shrouding the various hydrological parameters evoked to

[19] https://www.lagri.fr/reglementation-y-aura-t-il-encore-de-leau-dans-les-canaux

[20] The masterplan, or SAGE (*Schéma d'aménagement et de gestion des eaux*), is a management plan devised and monitored by a commission (the CLE) formed of state representatives, elected officials and user representatives. The coastal aquifers, which overlap with the lower Têt basin, are governed by such a SAGE and its CLE.

define the DMB. "In the end, the judge opted for this intermediate value, the VCN3 at 1500, not to say 'This is the average', but to say 'This is acceptable'" (*Administration*) – a value that FNE had indicated to the judge to be acceptable to them (*Nature*).

As the target e-flow value continues its chequered political trajectory, one even forgets that "we are arguing about a few litres/s, but we are in fact unable to track the actual flowrate. T6 is a poorly monitored point" (*Users*). One informant (*Users*) goes as far as stating that the T6 e-flow is actually hostage to the arm wrestling initiated by the administration, saying "no one is really interested in what actually flows in the Têt at point T6"… If there is some truth to this statement, it is perhaps reflected in the juxtaposition of a science that oscillates between 'authoritative numbers' and a wide 'acceptable' range from 1200 to 2000 l/s, with a political process in which the DMB 'slider' moves in accordance with the shifting bargaining power of the various parties set against prevailing climatic/weather conditions.

With an 'exceptional' drought motivating the prefect to enact a temporary (but lasting) DMB at 600 l/s, an appeal still under way and a second court case is challenging how this 'exceptionality' is defined, and new hydrological and ecological studies being completed, the push and pull around the DMB value is still in full swing. At face value, the struggle pits those who endeavour to protect the environment against the mechanisms by which abstraction inexorably grows, with insufficient state ability or willingness to check that trend. Beyond specific interests, the interviews also revealed a number of idiosyncratic factors, such as the personality of the key actors involved, deep-seated beliefs and cognitive rigidities which cannot be fully factored in or exposed, in part for reasons of confidentiality.

Finally, we must return to the question of why T6 has been and continues to be such a controversial point. It sits in notable contrast with the more common case where, rather than questioning the value set, stakeholders focus on negotiating funding and projects (AERMC, 2017). Were deep antagonisms to blame? Did uncompromising positions lead to a missed opportunity? FNE claims that it could actually have accepted a DMB of 1200 l/s if 'they' had been willing to talk – a value that farmers would have also been willing to accept, according to one representative (*Users*). Meanwhile, many actors underlined that FNE's decision to go to court created animosity and foreclosed a negotiation process. Others pointed to a longstanding tug-of-war between the Agence and farmers in the Têt Basin (perceived as refractory and change-adverse). As a boundary object, the DMB failed to bridge "social worlds that differ [too] significantly in terms of values and preferences" (Turnhout, 2009).[21] Ultimately, the deadlock might also reflect the fact that especially under drought conditions, the 2000 l/s DMB threatens 6500 ha of farmland and is barely tenable without a systemic change of water distribution. This requires funding, sophisticated technical thinking and further studies – and hence time – to avoid disrupting the intricate circulation of water with (un)anticipated consequences on groundwater and water supply.[22] Through the EVP, the state might have supported an overly high or unrealistic target[23] in a bid to exert authority and instil change, inadvertently foreclosing a settlement.

Despite this apparent failure of the DMB, the introduction of the e-flow disrupted the status quo whereby the state counted on irrigation modernization to save water, but without taking steps such as measuring flowrates and revising withdrawal authorizations to realise those savings. It allowed the reopening of the debate, exposed the inconsistency of state policy, challenged the priority given to agriculture, and legitimized the entry of new stakeholders defending the environment. The irrupting

[21] A divide perhaps illustrated by either/or alternative headings in the Farmers Union's journal: "Support FNE *or* the farmers of our department" (our emphasis); the prefect has "to choose between the life of people and ecological protection". www.lagri.fr/soutenir-france-nature-environnement-ou-les-paysans-de-notre-departement-par-jean-paul-pelras

[22] Many farmers source water from the quaternary aquifer recharged primarily from irrigation canals. If this recharge is reduced 'to save water' they might be led to tap the deeper – strategic – Pliocene aquifer, with much more serious consequences from seawater intrusion. Several urban areas will also be affected, potentially leading them to look for other resources.

[23] One official acknowledged that the 2 m^3/s value may seem high, in retrospect, but that at the time there was hardly any knowledge on actual canal withdrawals, making the assessment of the room for manoeuvre difficult (*Administration*).

exceptional drought heightened the stakes and laid bare the vulnerability of the basin to climate change. Our account calls for a science that fully considers the strategies, interests, beliefs and power relations behind quantification and the production of neat numbers.

CONCLUSION

The implementation of an ambitious Quantitative Water Management policy in the Rhône Méditerranée-Corse River basin is facing a predictable number of difficulties that have arisen elsewhere. However seductive it may be, the idea of using science and quantification to justify one of the most politically charged decisions – reallocating water away from human use to nature – cannot elude politics. Relying too heavily on the extraordinary simplification of the EVP methodology and its target DMBs, as Jackson (2006) aptly put it, is tantamount to doing "hard politics with soft numbers". The attempt to 'govern by numbers' by commensurating fish species, habitats, river morphology, water flows and sediments, as well as human uses, all subsumed in one a single figure to redefine a 'healthy' or 'protected' aquatic environment, is likely to backfire when that target e-flow value is seen to be unrealistic or unachievable. Since the target DMB has the power to reallocate water, the "trust in (the DMB) number" (Porter, 1995) must constantly be validated by every means, whether the authority of science or law, the sword of Damocles of the EU Water Framework Directive, or the democratic gloss of participation.

In documenting the chequered political trajectory of the target DMB we have shown that this pivotal value could be conceived of as a boundary number rather than the embodiment of authoritative science. Doing 'boundary work', the DMB seeks to commensurate ecological values, policy objectives, livelihoods, droughts, dams and subsidies, as well as antagonistic social worlds. We have elucidated how it both reorders relationships between society and the environment and, in return, reflects these shifts. In general, as Bowker and Star (1999) emphasise, "Boundary objects do not claim to represent universal, transcendent truth; they are pragmatic constructions that do the job required". Once a settlement is within reach, inconvenient truth (e.g. the wobbliness of science) and convenient untruth (e.g. the alleged effectiveness of water-saving measures) are glossed over in favour of a trade-off deemed acceptable by all (Laurenceau and Molle, 2023), with negotiations focusing on implementing (mostly) capital-intensive solutions funded by public money.

At point T6, however, a host of idiosyncratic factors, antagonistic social worlds, complex water circulations and uncooperative, weakening water regimes have so far undermined a settlement. Together, updated scientific assessments, the enhanced bargaining power of the agricultural or environmental sectors at the national level, legal cases and appeals and further climate vagaries all point to a bumpy road ahead on the DMB's quantitative-cum-political trajectory.

LIST OF ACRONYMS

ACAV: *Association des canaux à l'aval de Vinça*, Association of canal collectives located downstream of Vinça dam

AERMC: *Agence de l'eau Rhône Méditerranée-Corse*, the water agency

DDTM: *Direction Départementale des Territoires et de la Mer*, the department-level technical services

DMB: *Débit minimum biologique*, or minimum e-flow

DOE: *Débit d'objectif d'étiage*, or low-flowrate target

DREAL: *Direction régionale de l'Environnement, de l'Aménagement et du Logement*, the regional technical services

EVP: *Etude de Volumes Prélevables*, Allowable withdrawals studies

FDSEA: *Fédération Départementale des syndicats d'exploitants agricoles*, the main farmers union

FNE: *France Nature Environnement*, France's main environmental NGO

PGRE: *Plans de gestion quantitative de la ressource en eau*, Quantitative Water Management Plans

QWM: *Quantitative Water Management (QWM) policy*, gestion quantitative de l'eau

SDAGE: *Schémas Directeurs d'Aménagement et de Gestion des Eaux*, river basin masterplan

SMBVT: *Syndicat mixte du bassin versant de la Têt*, the Têt River Syndicate

ZRE: *Zone de Répartition des Eaux*, or Water Allocation Zones

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