GOVAQUA policy matrix Part B – Review of national eflows policies in six European countries

GOVAQUA Deliverable 2.1

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1.3	29.07.2024	Eleftheria Kampa	Revisions made based on the internal reviewers' comments and suggestions.

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List of Abbreviations

Abbreviation	Explanation
ASB	Abstraction Sensitivity Band
CAMS	Catchment Abstraction Management Strategy
CAP	Common Agricultural Policy
CIS	Common Implementation Strategy
DGA	Dirección General del Agua (Spain)
DMB	Débit minimum biologique (Minimum Biological Flow) (France)
DMP	Drought Management Plan
DOE	Débit d'Objectif d'étiage (low flow target) (France)
EA	Environment Agency
EC	European Commission
EFI	Environmental Flow Indicator
ETC	European Topic Centre
EU	European Union
IPH	Hydrological Planning Instruction (Spain)
IUCN	International Union for Conservation of Nature
MS	Member States
NGO	Non-Governmental Organization
QMNA5	Five-year low water flow
RBDs	River Basin Districts
RBMP	River Basin Management Plan
RPH	Hydrological Planning Regulation (Spain)
SDG	Sustainable Development Goals
WFD	Water Framework Directive

Introduction

Policy background on eflows

Human activities and interventions, such as direct water abstractions from rivers and aquifers and the construction of dams have greatly modified the natural flow regimes of many rivers in Europe. At the same time, the flow regime is of central importance in sustaining the ecological integrity of freshwater systems, and its modification leads to environmental degradation. The concept of environmental flows (eflows) was historically developed as a response to the degradation of aquatic ecosystems caused by the overuse of water (Tharme, 2002; Acreman et al., 2014; Sanchez Navarro, 2021).

Eflows aim at allocating sufficient water to ecosystems to maintain a certain level of ecological integrity based on an appropriate management vision. Moreover, eflows can support the integration of river management into the broader scope of ecological sustainability by making a delicate balance between the water needed for ecosystems and water needed for socioeconomic systems (Poff and Matthews, 2013; Gebreegziabher et al, 2023). The concept of eflow continues to evolve and is shifting from the traditional view of minimum water amounts to a more comprehensive and holistic understanding, taking into account all aspects of a flowing water system (e.g. floodplains, groundwater aquifers, wetlands), different elements of the flow regime (quantity, frequency, duration, timing, and rate of change), the dynamic nature of rivers and water quality aspects (Alexandra et al. 2023; Acreman et al., 2014; Sanchez Navarro, 2021).

Ecological flow (which is also abbreviated as eflows and is a similar term to environmental flows) is the amount of water required for the aquatic ecosystem to continue to thrive and provide the services we rely upon (Tharme, 2002). It is a key element of sustainable water use in river basins along with water balances and water allocation mechanisms. Defining an ecological flow and taking measures to maintain it is important for restoring and managing river ecosystems, to preserve the communities of biota as well as support the delivery of other ecosystem services. At the same time, the need to maintain an ecological flow in river ecosystems may lead to conflicts with other water users of the same river ecosystems because of the need to limit existing and future abstractions (Alexandra et al. 2023, Kampa & Schmidt 2023).

In the EU water policy framework, the Water Framework Directive (WFD) explicitly acknowledges the importance of the flow regime for the status of aquatic ecosystems and includes it as one of the key elements supporting biological elements in the classification of the ecological status (Acreman and Ferguson, 2010). Although the WFD does not prescribe the establishment of ecological flows, it acknowledges the critical role of water quantity and dynamics in supporting the quality of aquatic ecosystems and the achievement of environmental objectives, and thus requires taking adequate response measures, such as Article 11(3)e “controls over the abstraction”. The flow regime is explicitly included as a hydromorphological supporting quality element in the WFD definition of ecological status.

A 2012 report on the review of the European Water Scarcity and Droughts Policy pointed to the “essential” need to establish and enforce ecological flows in order to deal with water scarcity and drought challenges, reach good ecological status in line with the WFD, while providing a number of associated co-benefits (EC, 2012). The establishment and enforcement of adequate ecological flows for all water bodies in Europe is essential for dealing efficiently with water scarcity and drought issues and for achieving good ecological status as required by the WFD, as well as securing significant co-benefits for energy savings, climate change mitigation and adaptation, nature and biodiversity. It requires the adaptation of current water allocation to consider the ecological needs of water-dependent ecosystems (EC, 2012).

The implementation of ecological flows in EU countries has been under way after the publication of a WFD common implementation strategy (CIS) guidance document on ecological flows in 2015 (EC, 2015). The guidance emerged in response to the assessment of the first river basin management plans under the WFD, which highlighted the need to better address over-abstraction and other alterations to the hydromorphology of surface water bodies such as hydropower dam operations. This guidance recommends all Member States to "develop effective national frameworks on eflows" and works towards a common understanding of ecological flows and their implementation in the river basin management plans (RBMPs). These national frameworks should provide a clear basis for regulating water use, allocations, water rights and permits; in all cases, eflows should be included in RBMPs. The development of scientifically credible eflows national frameworks, taking into account their regional and local specificities, will be a major contribution to the resolution of conflicts over water uses and to ensure of achieving EU ecological objectives. The Integrated Assessment of the 2nd RBMPs (EC, 2019) pointed to improved methods for defining ecological flows "e.g. linking observations of river flows with biological quality elements" but notes that actual enforcement of ecological flows through permitting regulation is lagging behind.

Eight years after the publication of the 2015 CIS guidance document, the integration of eflows assessments in the RBMPs has steadily increased from the first to the third WFD planning cycle. However, also several challenges are still faced by water management institutions in implementing eflows in EU Member States (Kampa & Schmidt 2023).

In addition to the WFD and the EU policy framework for water scarcity & droughts, the EU Biodiversity Strategy 2030 reinforced the WFD's targets with relevance to quantitative water issues, setting the objective for EU Member States to "review water abstraction and impoundment permits to implement ecological flows in order to achieve good status or potential of all surface water and good status of all groundwater by 2027."

In the global environmental policy context, water flows are notably relevant to achieve Sustainable Development Goal 6 (Ensure access to water and sanitation for all), which includes targets to protect and restore water-related ecosystems including rivers, wetlands, aquifers, and lakes (SDG 6.6, SDG 15.1). Environmental water requirements are explicitly referenced and defined in SDG indicators 6.4.2 (Level of water stress) and 6.6.1 (Change in the extent of water-related ecosystems over time). Ecological flows contribute to improvements in the production of freshwater and estuarine foods such as fisheries (SDG 14.2), thereby contributing indirectly to other SDGs (Arthington et al., 2018).

Table 1 summarises the key EU and global policy objectives related to eflows.

Even though the concept of environmental flows has existed for over 60 years, there is still no unified definition for it; however, there is a clear tendency to differentiate environmental flows and ecological flows (Sanchez Navarro, 2021). In this report, we use the abbreviation "eflows" to cover both terms of ecological flows and environmental flows (see Text box 1), although in EU countries eflows usually refer to ecological flows following WFD principles. However, as the analysis of legal frameworks of eflows shows in the following sections, different terms for eflows are used in the national policy frameworks.

Text box 1. Ecological flows and environmental flows (both abbreviated as eflows)

The 2015 WFD CIS guidance no. 31 (CIS 2015) introduced the definition of the term "**ecological flow**" as "a hydrological regime consistent with the achievement of the environmental objectives of the WFD in natural surface water bodies as mentioned in Article 4(1)". These environmental objectives refer to:

- non deterioration of the existing status
- achievement of good ecological status in a natural surface water body,
- compliance with standards and objectives for protected areas, including the ones designated for the protection of habitats and species where the maintenance or improvement of the status of water is an important factor for their protection, including relevant Natura 2000 sites designated under the Birds and Habitats Directives.

The term "**environmental flow**" describes the quantity, timing, and quality of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these ecosystems (from Brisbane Declaration, International River Foundation 2007). The 2018 Brisbane

Declaration re-defined eflows to accommodate human cultures and economies as: 'eflows is the quantity, timing, and quality of freshwater flows and levels necessary to sustain aquatic ecosystems (including rivers, streams, springs, riparian, floodplain and other wetlands, lakes, coastal waterbodies, including lagoons and estuaries, and groundwater-dependent ecosystems) which, in turn, support human cultures, economies, sustainable livelihoods, and well-being' (Arthington et al. 2018).

Ecological flows can be considered a component of the overall environmental flow and are established to provide for the ecological values attributed to a particular water body. Thus, environmental flow is a broader term than ecological flows, which can also be used for mitigation measures on flows aimed to reach any environmental objective under the WFD (Kampa & Schmidt 2023).

Table 1 Key EU and global policy objectives related to eflows.

EU and global policy	Policy objectives and targets linked to eflows	Target year
Water Framework Directive (EC 2000)	To achieve good status or potential of surface water bodies and good quantitative status of groundwater bodies Establish and implement eflows in the River Basin Management Plans (based on CIS Guidance 2015)	2015/ Latest by 2027
Biodiversity Strategy 2030 (EC 2021)	Member State authorities should review water abstraction and impoundment permits to implement ecological flows in order to achieve good status or potential of all surface waters and good status of all groundwater by 2027 at the latest, as required by the Water Framework Directive.	2027
Water scarcity and drought communication and policy review (EC, 2007, 2012)	To address the challenge of water scarcity and droughts in the EU Resilience building; from crisis management to risk management Seven policy options: putting the right price tag on water; allocating water and water-related funding more efficiently; improving drought risk management; considering additional water supply infrastructure; fostering water-efficient technologies and practices; fostering a water-saving culture in Europe; improving knowledge and data collection.	NA
Sustainable Development Goals	Water flows are relevant to achieve SDG 6 (Ensure access to water and sanitation for all), which includes targets to protect and restore water-related ecosystems including rivers, wetlands, aquifers, and lakes (SDG6.6, SDG15.1). Environmental water requirements are explicitly referenced and defined in SDG indicators 6.4.2 (Level of water stress) and 6.6.1 (Change in the extent of water-related ecosystems over time). Ecological flows contribute to improvements in the production of freshwater and estuarine foods such as fisheries (SDG14.2), thereby contributing indirectly to other SDGs. (Arthington et al., 2018)	

Objective and outline of the report

The present report focuses on characterizing and analysing eflows policies and strategies at national levels. The report contributes to an improved understanding of national legal frameworks and practices of eflows in European countries, to support further research on the development and effective implementation of eflows policies. Its specific objectives are:

- To provide insights into how eflows regulatory frameworks are designed and implemented in selected European countries
- To discuss current challenges with the implementation of eflows regulatory frameworks
- To identify opportunities for innovative solutions to implement eflows in Europe

The analysis focuses on the six countries of the Living Labs of GOVAQUA, including five EU countries (Spain, France, Romania, Finland, Sweden) and England. Although England is not part of the EU, water policy and management remains highly structured around the WFD.

The report is structured into seven chapters. At first, the methodology for analysing national eflows legal and regulatory frameworks is outlined. The report then examines how eflows are considered in national water policy frameworks in the six studied countries. This is followed by a chapter on eflows implementation mechanisms linked to the system of permits and water rights and eflows revisions under droughts. The following chapters address the governance structure for eflows in the six countries, in terms of organizational responsibilities and stakeholder engagement. Mechanisms for eflows compliance and enforcement are finally examined. The discussion chapter highlights key challenges in implementing eflows in the six countries. The report concludes with proposals for further research on potential good practice case studies on legal/regulatory instruments, approaches or arrangements for eflows; these good practices aim to provide innovative ideas for national and basin level water managers and other decision makers in water governance.

This report is one of three parts composing Deliverable 2.1 of the GOVAQUA project. Part A addresses in more detail the legal and regulatory approaches for water allocation and Part C focuses on the regulation of value chains to support sustainable water management.

Methodology

For the characterisation and analysis of eflows regulatory frameworks in the six countries of GOVAQUA Living Labs, a structured template was developed to collect and examine information on the key elements of eflows national policies. For the development of the template, a review of international literature on eflows was carried out, in particular journal articles, book publications and consultancy reports on eflows policies and their implementation. In addition, we reviewed findings of a previous study (Kampa & Schmidt, 2023) on challenges faced by EU Member States on the design and implementation of eflows. Subsequently, key elements of eflows policies were derived, which were used to structure the characterization and analysis of the policy and regulatory frameworks on eflows in the six countries.

Based on the key policy elements derived, a template for collecting data at national level was developed (**Annex I**). This template was filled in by national experts of the GOVAQUA project through desk-based review of documentation. Interviews with national experts from governmental bodies and agencies were carried out to complement the data collected through desk research (**Annex II**). Interviewees were selected based on their work profile and expertise on the topic of eflows establishment and implementation in their respective countries. The interviews lasted between one and two hours and were carried out by video conference or in person. Interview questions were tailored to each national context.

The sections below present the review of eflows implementation challenges and the key elements of eflows legal and regulatory frameworks selected for detailed analysis.

Eflows implementation challenges

The requirements for effectively providing environmental flows depend significantly on the political, environmental, and water resource development context. Despite these variations, several central elements are likely to be essential in most efforts. These elements include having appropriate political and institutional enabling conditions, conducting necessary assessments and planning to understand the required flows for meeting environmental needs, and implementing mechanisms to achieve those flows.

Implementation of eflows is a critical part of sustainable water management and in the last two decades many countries have incorporated environmental flow provisions as they have updated water policy. Nevertheless, despite widespread recognition of the benefits and need to establish eflows, implementation has been slow, with limited examples of broad, systematic success (Wineland et al., 2022). A number of review studies exist on critical factors and challenges related to the implementation of eflows mainly drawing from experience gained in case studies outside Europe (US, Mexico, Australia, Asia).

Harwood et al. (2018) identified the following enabling factors that support successful eflows implementation: Legislation & regulation, collaboration & leadership, resources & capacity and monitoring & adaptive management. Harwood et al. conclude that the fundamental enabling factor that underpins most, if not all, cases of successful eflows implementation is the existence of conducive legislation and regulation. The type of legislation and regulation behind the implementation of eflows varies greatly; however, long-term protection or restoration of flows for the environment is dependent on there being a legislated framework within which to act. Jurisdictions that have eflows written into their laws and regulations have demonstrated at least some consideration of the ecosystem services and values that rivers provide. Although fundamental, legislation alone is rarely sufficient, and needs to be supported by additional policy measures. The precise mechanisms set out in legal frameworks need to be defined according to local context and in light of the nature of eflows implementation challenges.

Wineland et al. (2022) provided a review of the following main barriers to eflows implementation: Lack of authority to implement eflows in water governance structures, complex water governance structures, declining water availability and increasing hydrologic variability under climate change, and complex socio-environmental trade-offs resulting from water reallocation or redistribution.

Sanchez Navarro (2021) also identifies a number of challenges to the implementation of eflows policies across the world, in particular lack of political will and stakeholder support, insufficient resources and capacity, in water management and allocation institutions generally, and for the delivery of those functions tasked with assessing and enforcing environmental requirements, institutional barriers and conflicts of interest. Inadequate will and/or capacity on the part of governments to monitor flows and enforce eflows on the ground draws attention to the politics of eflows implementation, which have attracted relatively less scrutiny (Alexandra et al. 2023, Capon and Capon 2017, Horne et al. 2017).

In the EU, the main implementation constraints and challenges concerning eflows, based on a self-assessment of EU national water authorities and river basin authorities, were recently analysed and described by Kampa & Schmidt (2023), with following key conclusions:

- There is mixed progress of EU Member States in terms of institutional, legal and governance measures and mechanisms to establish and support eflows.
    - Most countries have already established (or are in the process of establishing) abstraction permit systems that respect eflows, as well as processes for reviewing water rights to introduce eflows requirements.

- At the same time, important challenges remain in terms of taking account of cumulative impacts and of impacts of climate change on water availability.
    - Implementing eflows for heavily modified water bodies needs to be further developed.
    - Several countries are still facing challenges in terms of the legal and policy basis, which needs to be further elaborated for implementing eflows. Countries are also facing challenges in terms of stakeholder involvement in eflows definition and implementation. Further challenges include the lack of evaluations of ecological benefits of eflows and mechanisms to deal with opposition to implementation from affected major water users.
- Enforcement and compliance with eflows remain a challenge for many Member States, in particular related to monitoring gaps and to systems of administrative fines when limits of permits are not respected.
- Large uncertainties in both hydrological and biological regimes make it difficult to establish direct connections between the need to implement eflows and changes in ecological status and pose a challenge to an adaptive approach for eflows implementation.
- Jurisprudence regarding implementation of eflows does not seem to be a major challenge in most countries. In some countries, specific training of lawyers and judges is organised by environmental authorities, though in other countries, this potential issue has not been detected yet because of the lack of legal cases on eflows to this date.

Key elements of eflows legal and regulatory frameworks for country analysis

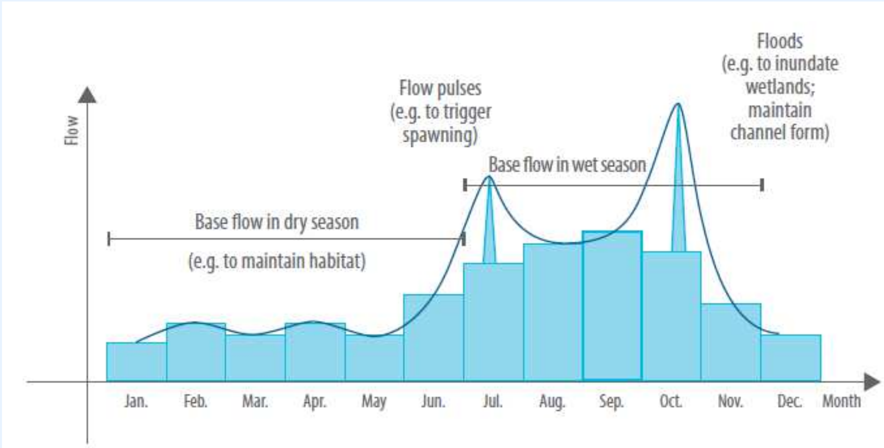
The main types of challenges for setting up and implementing eflows (reviewed in the previous section) concern the type of legal and regulatory instruments used, mechanisms for collaboration and stakeholder support, governance structures, resources and capacity, monitoring provisions, enforcement, a changing hydrological environment, and socio-environmental trade-offs. Drawing on the main challenges in setting up and implementing eflows, the following are the key elements of eflows legal and regulatory frameworks that have been selected for the country analysis in this report.

- **Legal and policy provisions** with focus on national legislation or other type of policy that build the main regulatory framework for eflows definition and implementation.
- **Eflows definitions** in legislation or policy documents. This aims to provide the detailed definitions of eflows developed in national legislation or other type of relevant policy. Among others, this also reflects the extent to which different flow regime components are considered.

Text box 2. Flow regime components

Flow regimes encompass the complete flow pattern (Speed et al., 2013), including flow magnitude, timing, frequency, duration, seasonality, and year-to-year variability, which play a crucial role in maintaining the health of rivers. While ecological flows focus on surface waters, also groundwater is a critical element, supporting ecological flows during dry periods as base flows as well as various water dependent freshwater and terrestrial ecosystems such as wetlands and peatlands. Low groundwater levels can worsen low flows in dry period. Groundwater recharge is therefore important. Groundwater recharge occurs through infiltration of rainfall and infiltration during high and flood flows. Maintaining a natural flow regime, including of flood flows, is therefore crucial in many instances to enhance floodplain groundwater recharge and support base flows during the dry season.

Figure 1 Different components of an annual flow regime relevant for freshwater ecosystems dependent on surface water

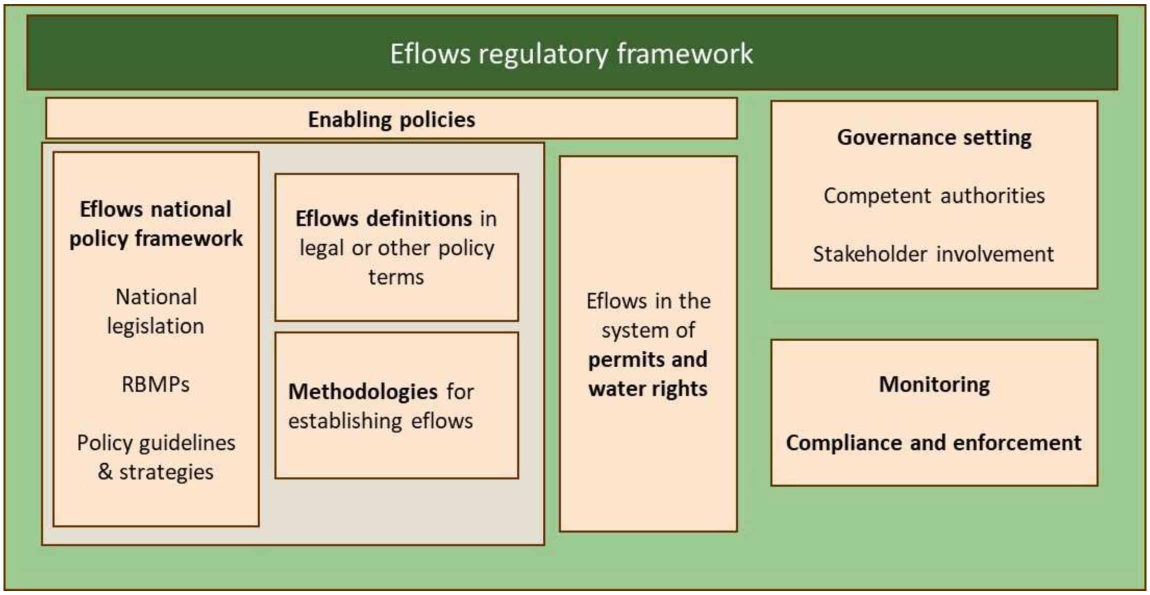


Source: Speed et al., 2013

- **Links of eflows to other elements in the water policy framework**, in particular to groundwater, biological quality elements or species, hydromorphology, and climate change.
- **Methodologies for eflows** in the policy framework. This concerns methodologies for establishing eflows broadly distinguished into hydrological, hydraulic, habitat simulation or holistic methods.
- **Eflows in the system of water rights and permits.** This examines provisions and ongoing processes to revise water rights and abstraction permits as a regulatory mechanism for implementing eflows.
- **Eflows changes under droughts.** This aims to examine whether eflows regulatory frameworks consider the particular ecological conditions under natural droughts and whether revisions of eflows under drought conditions are allowed.
- **Governance of eflows regulation** with focus on competent authorities and the involvement of stakeholders.
- **Eflows compliance and enforcement** with focus on monitoring and reporting provisions, use of penalties and fines.

These key elements of eflows legal and regulatory frameworks build the structure for the review and analysis of national policies presented in this report (see also Figure 2).

Figure 2 Key elements for the analysis of eflows national legal and regulatory frameworks



Eflows in national policy frameworks

Legal and policy provisions

In France, Spain, and Romania, policy requirements for eflows are anchored in national acts and definitions of eflows are included in the legal framework. In England and Finland, eflows are based on the river basin management plans and permit requirements, without specific legal provisions in national legislation. In England, there is a well-defined eflows indicator used for application in RBMPs by competent agencies. In Sweden, river basin environmental quality standards, which are established on the basis of the Environmental Code, refer to "sufficient flow".

Error! Reference source not found. summarises the key laws and other policy instruments relevant to eflows in the six countries studied, and **Error! Reference source not found.** presents the main eflows definitions in the national legal and regulatory frameworks.

Figure 3 Key legislative and other policy instruments for eflows in the six countries examined

France
- Environmental Code L214-18
- Circular of 30 June 2008 on reduction of quantitative water abstraction deficits and collective management of irrigation abstractions
- Water Law 1992
- Law on Water and Aquatic Environments (LEMA) 2006
- RBMPs

Spain
- Water Act 1985 and Royal Legislative Decree 1/2001 on revised Water Act
- National Hydrological Plan (Law 10/2001)
- Hydrological Planning Regulation (RPH) (Royal Decree 907/2007)
- Hydrological Planning Instruction (IPH) (Orden ARM/2656/2008)
- RBMPs, Drought Protocol

England
- Water Resources Act 1991
- RBMPs, Environmental Flow Indicator

Sweden
- Environmental Code 1998
- RBMPs
- National Plan for Modern Environmental Conditions for Hydropower 2020

Finland
- RBMPs
- National Strategy for Fish Passages 2012
- Watershed visions
- NOUSU Programme for hydropower facility owners

Romania
- Ecological Flow Act of 2020 (HG 148/2020)
- Water Law 107/1996
- RBMPs

Table 2 Eflows definition in national legal and regulatory frameworks

Country	Definitions	Law
France	**Minimum biological flow ("Débit minimum biologique", DMB):** minimum flow guaranteeing permanently the life, reproduction and circulation of aquatic species **Minimum flow ("Débit plancher"):** intangible minimum flow, corresponding to the 1/10th or 1/20th of the average interannual natural flow **Reserved flows ("Débit réservé"):** minimum flow that must be maintained at any time downstream an infrastructure	Environmental Code Article L.214-18 Circular of 30 June 2008 relevant to the reduction of quantitative water

Country	Definitions	Law
	affecting the river bed. It must correspond to the highest value between the minimum biological flow and the minimum flow **Low flow target ("Débit d'Objectif d'étiage", DOE)**: the reference flow allowing good water status to be achieved and above which all uses are satisfied on average 8 years out of 10 **Drought management thresholds**: 'alert' and 'crisis' flows below which restrictions on water abstractions and uses apply so that essential water uses and the environment are prioritised in the event of droughts	abstraction deficits and collective management of irrigation abstractions Environmental Code Article L. 211-3 II 1°
Spain	**Ecological flow**: Flow that maintains, as a minimum, fish life that would naturally live in the river, as well as the riparian vegetation. Eflows shall be established in such a way as to sustainably maintain the functionality and structure of aquatic ecosystems and associated terrestrial ecosystems, contributing to achieving good status or ecological potential in rivers or transitional waters.	Spanish Water Act Hydrological Planning Regulation (RPH) (R.D. 907/2007)
England	The **Environmental Flow** Indicator (EFI) is used to make sure a water body meets good ecological status, and indicates the proportion of natural flows that are required to support the environment in any given water body. Depending on the sensitivity of the water body it typically indicates that somewhere between 80% and 90% of natural low flows are protected.	Defined in official Environment Agency guidance
Sweden	No eflows definition in legislation. Environmental quality standards set at river basin level refer to a **sufficient flow** (tillräckligt flöde) to maintain basic ecological functions in the natural stream or other relevant parts of the water body and to enable upstream and downstream migration for migratory species	n/a
Finland	No definition in legislation or official guidance	n/a
Romania	**Ecological flow**: the flow necessary for the protection of aquatic ecosystems, both quantitatively and in terms of its dynamics, in order to achieve the environmental objectives for surface water bodies provided for in art. 2.1 of the Water Law 107/1996. **Servitude flow**: the minimum flow required to be permanently left on a watercourse downstream of a dam work, consisting of the ecological flow and the minimum flow required for downstream users	Ecological Flow Act HG148/2020

France

The regulatory ecological flow in France is the **reserved flow ("débit réservé")**, as defined in Article L.214-18 of the Environmental Code which requires the setting of **minimum biological flows ("débit minimum biologique", DMB)** guaranteeing the life, reproduction and circulation of aquatic species downstream of every diversion infrastructure affecting river flow. Appendix 2 of the circular of July 5, 2011 relating to the application of article L214-18 presents the methods to help determine the reserved flow value (RF, 2011). Minimum biological flows are established based on studies focused on local hydrological statistics and considering the linkages between hydraulic and ecological conditions. In all cases, reserved flows cannot be set below a **minimum flow ("debit plancher")** representing 1/10th of the average natural annual flow, or 1/20th for rivers with an average natural annual flow above 80 m3/s. The 1/20th also applies as a minimum servitude for infrastructure used to produce peak-time electricity. The average flow rate should be based on all the years for which data are available, with a strict minimum of 5 years, and should recreate an estimated natural flow removing the impact of abstraction, discharges and water transfers. If the flow upstream of an infrastructure is below the reserved flow, the infrastructure owner is obliged to stop the operation, emphasizing the importance of maintaining flow levels (Interview French experts, 2024). In the absence of a specific study, the reserved flow is set at 1/10th of the yearly average river flow.

Other flow targets which are in place for quantitative management purposes include low flow targets (DOE) and drought management thresholds.

The **low flow target (Débit d'Objectif d'étiage, DOE**) is defined in circular of 30 June 2008 relevant to the reduction of quantitative water abstraction deficits and collective management of irrigation abstractions, defined as "*the reference flow allowing good water status to be achieved and above which all uses are satisfied on average 8 years out of 10*" (RF, 2008). Although not defined in the regulatory framework as the *ecological flow*, the DOE is a key quantitative water management target. It contributes to meet "good status" under the WFD and the requirement of Article L.211-1 of the Environment Code that aims towards a "balanced and sustainable management of water resources", which must make it possible to satisfy "the requirements of biological life in the receiving environment, especially fish and shellfish fauna".

Operationally, the DOE starts from minimum biological flow (DMB) established by Article L.214-18 of the Environment Code and adds it to the flows needed for downstream uses. They take the form of a monthly average flow value at nodal points (key management points in river basins and catchments) above which, it is considered that downstream of the nodal point, all uses (activities, withdrawals, discharges, etc.) are in balance with the proper functioning of the aquatic environment. Hence, minimum biological flows used for DOEs are estimated for strategic points of the catchment and river basin, unlike minimum biological flows used to establish "reserved flows", which only apply immediately downstream of storage, abstraction and derivation infrastructures.

The low flow target (DOE) is set in the catchment and river basin management plans (the SDAGE, SAGE and equivalent documents), and takes into account the development of uses over a certain horizon (10 years for the SDAGE). It can be assigned a margin of tolerance and modulated throughout the year depending on the regime (seasonality). The DOE objective is achieved by controlling upstream abstraction authorizations, by mobilizing new resources and water saving programs upstream and also by better functioning of the hydrosystem. Low flow targets are set in a nested manner, at the most downstream point of each hydrological sub-unit of the river basin, that is individual catchments, sub-catchments and other management units. The low flow targets (DOE) include both a minimum flow to maintain good ecological status and flows to maintain downstream human uses.

Target groundwater piezometric levels (or maximum abstraction volumes) are also set for aquifers connected to surface water bodies, to avoid a drop in aquifer levels impairing the achievement of minimum biological flows. The flow targets are considered achieved if it is observed, a posteriori, that the lowest 10-days average flow (or aquifer level) was maintained above 80% of its value. Flow targets must be met on average 8 years out of every 10. These low flow targets are used to calculate the sustainable abstraction cap (for more information on the sustainable abstraction cap, see part A on water allocation of this deliverable).

Drought management thresholds are used in drought management and the regulatory framework for setting these thresholds is provided in the Environmental Code Article L. 211-3 II 1° based on the 1992 Water Law (RF, 1992) and the 2006 Law on Water and Aquatic Environments (LEMA) (RF, 2006). 'Alert' and 'crisis' flows (i.e. Débit d'Alerte and Débit de Crise) are used, below which restrictions on water abstractions and uses apply so that essential water uses and the environment are prioritised in the event of droughts:

- 'Alert' level is the average daily flow that indicates that water demand for all water uses downstream may not be met without impacting the aquatic environment. First restrictions on non-priority uses apply.
- 'Crisis' low flow is the average daily flow below which top-priority uses (e.g. essential drinking water provision for humans and animals, and good functioning of freshwater species) are endangered. Non-priority uses are not allowed for the abstraction of water.
- A 'vigilance' level is also set before the 'alert' level and a 'reinforced alert' level is set before the 'crisis' level in order to smooth the implementation of the alert level (some restrictions) to a crisis situation (full restrictions).
- Specific restrictions on water uses apply at each level. An equivalent system based on groundwater levels applies to unconfined aquifers. These targets are set considering the interaction between surface and groundwater, based on studies conducted during the planning process (SDAGE or SAGE).

Overall, different types of flow targets are used in water management in France. The concept of "minimum biological flows" established in Article L214-18 of the Environmental Code is nearest to the concept of Ecological Flows as defined at European level. Under the current regulatory regime, minimum biological flows are specifically required downstream of storage, abstraction and diversion infrastructure. At river basin level, they must be estimated and integrated when establishing low flow targets (DOE). In theory, low flow management targets in France do not necessarily focus on the summer low flows, but may vary throughout the year to recognize the varying flow conditions across seasons, and to ensure that the filling of reservoirs takes into account the natural variability of river flows.

Spain

Water scarcity faced in many Spanish river basins led to an early recognition in the 1985 Water Act (SG, 1985) of the need to establish and implement ecological flows as a restriction in water management. Since 2001, Spanish legislation requires the establishment of eflows as part of the elaboration of the River Basin Management Plans (RBMPs) (Law 10/2001 on the National Hydrological Plan, Royal Legislative Decree 1/2001 on the revised Water Act) (SG, 2001a; SG, 2001b). The Spanish Water Act established the ecological river flows as the flow that maintains, as a minimum, fish life that would naturally live in the river, as well as the riparian vegetation. The establishment of the environmental flow regime, as established in the Water Act, is compulsory content which must be included in the RBMPs.

Operationally, **ecological flows** are defined by Royal Decree 907/2007 "Reglamento de Planificación Hidrológica (RPH)" aligning with the requirements of the WFD. According to Royal Decree 907/2007 Art. 18, ecological flows shall be established in such a way as to sustainably maintain the functionality and structure of aquatic and associated terrestrial ecosystems, contributing to achieving good ecological status or potential in rivers or transitional waters (SG, 2007). The hydrological plan shall determine the regime of ecological flows in the rivers and transitional waters defined in the river basin, including the water needs of lakes and wetlands. For its establishment, the basin organizations will carry out specific studies in each section of the river. The latest amendment of the RPH is from December 2022, updating the requirements and procedures that are taken into account in the 3rd river basin plans and the special drought plans.

During the first cycle of the WFD planning process (RBMP 2009-2015), detailed guidelines for eflows determination within hydrological plans were deemed necessary. These guidelines were outlined in the "Hydrological Planning Instruction (IPH)" (Orden ARM/2656/2008), providing clear directives for calculating and establishing eflows (SG, 2008). The IPH explicitly established that eflows are not a use but a restriction prior to water use (Sanchis-Ibor et al 2022). According to the IPH, ecological flows definition includes the following variables for selected river control gauges (which are defined in each hydrological plan):

- Minimum flow that must be exceeded to maintain the spatial diversity of the habitat and its connectivity, ensuring habitat control mechanisms over the biological communities, in a way that favors the maintenance of the native communities. This is defined monthly for the selected control gauges at hourly/daily/monthly level.
- Maximum flow that must not be exceeded in the ordinary management of infrastructures, to limit circulating flows and thus protect the native species most vulnerable to these flows, especially in heavily regulated sections.
- Temporal distribution of the above minimum and maximum flows, with the objective of establishing a temporal variability of the flow regime that is compatible with the requirements of the different vital stages of the main species of native fauna and flora species present in the water body.
- Channel maintenance discharges (i.e., bank-full discharges), which are flood flows downstream of regulation infrastructures, especially hydropower plants, to control the presence and abundance of the different species, maintain the physico-chemical conditions of the water and sediment, improve habitat conditions and availability through geomorphological dynamics and favour the hydrological processes that control the connection of the transitional waters with the river, the sea and the associated aquifers.
- Maximum rate of change downstream of regulatory infrastructures, to avoid negative effects of a sudden variation in flow rates, such as the entrainment of aquatic organisms during upstream movement and their isolation in the downstream phase. Likewise, it must contribute to maintaining favorable conditions for the regeneration of aquatic and riparian plant species.

Eflows are defined for river control points and rivers highly regulated with dams or reservoirs. In the regulated rivers, which are the majority in Spain, reservoirs are controlled by the River Basin Authority that opens/closes the gates according to the ‘exploitation plan’ approved previously in the ‘Drought Protocol’. The reservoirs release water specifically to maintain eflows in the critical months (summer) as the rest of the year (autumn to spring) abstractions are reduced (irrigation is minimal outside late spring / summer).

In the 2nd cycle RBMPs, efforts were specially focused on the establishment of minimum flows, both for standard hydrological scenarios and drought scenarios. Minimum flows were established in 73% of the river water bodies, whereas the rest of the variables, i.e., maximum flows, change rates and bank-full discharges had been defined in less than 8% of the river water bodies (Mezger et al., 2019), and implemented mainly in selected pilot locations.

England

The Water Resources Act 1991 includes a section on “minimum acceptable flows” which however does not refer to environmental needs but makes provisions for the minimum flow needed for safeguarding public health and for meeting the needs of existing lawful uses of inland waters, namely agriculture, industry, water supply or other purposes (UK Parliament, 1991).

There is no clear reference to ecological or environmental flows in the national legislation. Targets of good ecological status are set for WFD water bodies unless an alternative objective can be justified through the RBMP process. The flow must be sufficient to support the river biology. A nationally consistent method is used by the Environment Agency to analyse what abstraction recovery would be needed to meet environmental flows (**Environmental Flow Indicator**: EFI). The Environment Agency uses the EFI to make sure a water body meets good ecological status. The EFI is part of the procedure that informs decisions on abstraction licensing. The EFI is not defined in national law but is part of the assessments carried out for the river basin management plans, that provide the framework for managing water bodies in the river basin districts in England (Environment Agency, 2021).

The EFI is used to indicate where abstraction pressures may start to cause undesirable effect on river habitats and species. It indicates the proportion of natural flows that are required to support the environment in any given water body. Depending on the sensitivity of the water body it typically indicates that somewhere between 80% and 90% of natural low flows are protected (Environment Agency, 2020). The EFI has translated for England the UKTAG river flow standards which vary by river type and flow, with stricter standards at lower flows and for water body types considered more sensitive to abstraction (Environment Agency, 2021).

Sweden

Eflows are not defined in national legislation; however, the Environmental Code includes a Chapter on environmental quality standards that are established on the basis of scientific criteria and that need to be complied with when granting a permit to a water activity (Swedish Parliament, 1998a, Chapter 5, Sections 3-5; SEPA, 2017, p. 18-19). On the national level, the surface water-related environmental quality standards are decided by the Swedish Agency for Marine and Water Management (SWaM) and the groundwater-related environmental quality standards are decided by the Geological Survey of Sweden (Swedish Parliament, 2004, Chapter 4, Sections 8-8b; Söderasp, 2018, p. 80). The environmental quality standards transpose the WFD's environmental objectives into the Swedish system; however, they do not specifically mention or define eflows (SwAM, 2019a). Nonetheless, these objectives form the basis for the river basin authorities' work when they develop ecological environmental quality standards for individual water bodies as part of the RBMPs (Michanek and Zetterberg, 2021, p. 203-204). The river basin environmental quality standards are decided on the basis of the Ordinance on Water Management (Swedish Parliament, 2004). They aim at ensuring the existence of a **sufficient flow** (tillräckligt flöde) to maintain basic ecological functions in the natural stream or other relevant parts of the water body and to enable upstream and downstream migration for migratory species (see e.g. County Administrative Board of Norrbotten, 2021; County Administrative Board of Västernorrland, 2021; County Administrative Board of Västmanland, 2021). Eflows are thus regulated through the environmental quality standards, which are covered in the RBMPs.

In 2017, SWaM defined eflows as the proportion of the natural flow of water that needs to be ensured in a watercourse in order not to risk negative ecological consequences. According to a model for determining ecological flow, 30% of the annual mean water flow (MQ) is recommended to maintain good living conditions for most aquatic organisms. When the flow after a water withdrawal is less than 10% of the annual average water flow during the summer season, fish and benthic fauna have been shown to decrease in number and production. An ecological flow needs to be ensured in the watercourse all year round, every day, and even at low tide. Water abstraction may have to be stopped when the water flow falls below the ecological flow. If water abstraction is still allowed below this level, the physical and chemical conditions of the water need to be investigated more closely and the water abstraction possibly limited/compensated. Appropriate flow regulations with regard to ecological flows need to be adapted for different geographical areas and ecosystems (SwAM, 2017). SwAM has also sought to increase awareness on ecological flows in watercourses used for hydroelectric power generation by publishing guiding material on the matter (e.g. Malm Renöfält and Ahonen, 2013).

Overall, policy discussions on eflows so far have focused on hydropower, and other sectors have received less attention (Interview Swedish civil servant, 2024). New legislation for the permit system of hydropower initiated in 2018 (amendment of the Environmental Code) may have further implications for the establishment of eflows in relation to the hydropower sector over the next 20 years (National Plan for Modern Environmental Conditions for Hydropower (Swedish Government, 2020)). Further details on the ongoing revision of hydropower permits to introduce more modern environmental conditions are given in the report section on "Changes to permits and water rights".

Finland

There is no clear reference to ecological or environmental flows in the Finnish legislation. However, permit regulations for projects that affect the water level or water flow in the water body “shall also, if necessary, include regulations on the maximum and minimum water level and arrangements for the discharge of water” (Finnish Parliament, 2011, Chapter 3, Section 10, Subsection 2). This in theory applies to all water bodies. In literature, this has been interpreted to mean the determination of water levels and their fluctuation in all times (Hollo, 2014, p. 149). This provision applies to permits granted for new projects. It does not discuss different seasons or flows (although discussing those is not specifically excluded, either).

Although eflows are not referenced in legislation, they are discussed in the RBMPs, highlighting that the development of the practices for the regulation of water bodies (river flows and lake water levels) will be essential in improving the ecological status of water bodies. The RBMPs interpret eflows as the adequate flow to ensure the functioning of the river ecosystem and to achieve good ecological status of the water body (e.g. Mäntykoski *et al.*, 2022, p. 166). Eflows are most often discussed in the context of returning the water flow to those parts of the watercourse that lost their waterflow as a result of water regulation (e.g. Räinä *et al.*, 2022, p. 91; Centre for Economic Development, Transport and the Environment of Lapland *et al.*, 2020, p. 54). For instance, the plan for the Vuoksi river basin proposes that one should aim at guaranteeing eflows, if the lack of flow prevents achieving good ecological status, and that methodologies for establishing eflows should be further developed (Kotanen, Manninen and Roiha, 2022, p. 109, 113).

In addition, most of the RBMPs highlight that the development of the water regulation practices should aim at restoring the environmental flow of dry, meaning old riverbeds. They use eflows as a term to describe the returning of adequate water flow to secure the river ecosystem and to restore to its natural status (or as close as possible). Defining eflows and investigating the possibilities of use are proposed for all riverbeds that are dry or left with little water due to hydropower operation (see e.g. Räinä *et al.*, 2022, p. 105). Yet, such measures only exist in the RBMPs on a very general level (Puharinen, Belinskij and Soininen 2024, p. 182). None of the current RBMPs includes a clear plan on the achievement of eflows. Thus, the development of water regulation practices and methods to assess eflows and to apply them in all RBDs is considered a priority policy proposal for eflows (Mäntykoski *et al.*, 2022, p. 125; Westberg *et al.*, 2022, p. 136, 140).

Further developments of advisory or planning nature which are relevant to the development of eflows in Finland are described below:

- Ecological flow is mentioned as a measure to be developed in the 2012 National Strategy for Fish Passages, drafted by the Ministry of Agriculture and Forestry (Finnish Government, 2012a, 2012b). The Government’s decision concerning the National Strategy for Fish Passages recognizes that changes in legislation need to be discussed to implement eflows in the Finnish system (Finnish Government, 2012a, p. 12). The 2012 National Fish Passage Strategy indicates that measures to promote the migration and reproduction of migratory fish in those water bodies that hold potential for the protection and revitalization of nationally and locally notable fish stocks should be prioritized. Such measures include e.g. orienting the management of fish stocks towards supporting the natural life cycle of fish and developing fisheries regulation to safeguard fish passage (Finnish Government, 2012a, p. 6). However, the National Fish Passage Strategy has no basis in the legislation (no act/decree requires that such strategy is drafted and/or updated or specifies the responsible unit).
- Eflows can be discussed in the watershed vision (vesistövisio), which is a strategic planning document prepared in collaboration of all actors in a river basin and includes a vision for the future of the basin and the steps to achieve it. Typically, watershed visions aim at coordinating between the various water uses, good ecological status, and biodiversity, while not forgetting the anticipation of conflicts between actors and various uses and their improved management (see e.g. Peltonen *et al*., 2022). The watershed vision for the River Oulujoki, for instance, highlights the role

of eflows in improving the status of migratory fish populations. As part of its development, various assessments of the impacts of eflows to the hydropower plants were made. The report also recognizes the need for legislative improvements in the area (Marttunen *et al.*, 2023, p. 63-66, 140).

- The current 'NOUSU Programme', a voluntary programme for hydropower facility owners funded by the government, focuses on removing barriers to fish migrations (Ministry of Agriculture and Forestry of Finland, [no year available]).The programme has "succeeded in removing several dams and in funding measures to create bypass channels and enhance ecological flows. Among other things, the NOUSU Programme provides leverage funding for collaborative processes that aim to remove small hydropower dams. The programme is voluntary for hydropower facility owners. It makes use of a specific, science-based hydropower value assessment tool to establish the present net value of the facility" (Puharinen, Beliskij and Soininen, 2024, p. 183-184, footnotes omitted).

Overall, the most promising measures to improve eflows in the Finnish system are based on voluntary contributions and voluntary participation in their implementation, in particular the NOUSU Programme and the watershed visions. These voluntary processes are often driven by the government or regional authorities and have a participatory character. Nevertheless, these processes also clearly operate in the shadow of the law, since the current permit conditions, the possibilities and limitations of permit reviews provided in the law and the legal weight of the water management objectives may influence their results (Puharinen, Belinskij and Soininen, 2024, p. 184-185 footnotes omitted).

Romania

In Romania, eflows are defined and implemented through national legislation, the Ecological Flow Act of HG148/2020 (RG, 2020), which also outlines the method to determine and calculate eflows. The eflows must be ensured downstream of dams or water intake works located on water courses, it applies both to natural and to (heavily) modified water bodies, while the Act uses the natural flow regime as a reference base (RG, 2020). In cases when ensuring the eflows is deemed not feasible due to technical reasons or disproportional costs, this needs to be justified through specific technical-economic studies: the holders of the water management permit are responsible to conduct these studies within the timeframe and conditions established by law.

The Ecological Flow Act HG148/2020 (RG, 2020) defines **ecological flow and servitude flow** (minimum flow) according to the Water Law 107/1996 (RG, 1996), namely:

- ecological flow, as the flow necessary for the protection of aquatic ecosystems, both quantitatively and in terms of its dynamics, in order to achieve the environmental objectives for surface water bodies provided for in art. 2.1 of the Water Law 107/1996.
- servitude flow (in English translation), as the minimum flow as the flow required to be permanently left on a watercourse downstream of a dam work, consisting of the ecological flow and thenimum flow required for downstream users.

Further, the Ecological Flow Act of 2020 outlines the requirements and principles associated with eflows in Romania. The principles defining ecological flows state that they should be able to:

a) provide a full range of natural variability in the hydrological regime to protect the aquatic ecosystem;
b) be dynamic, variable in time and space, and have multiple values;
c) support the achievement and maintenance of environmental objectives in water bodies according to national legislation;
d) support ecological water requirements of for habitats and species in protected zones;
e) support the achievement of environmental objectives for groundwater bodies;
f) provide suitable habitats for aquatic fauna and integrate the needs of other types of biological organisms such as benthic invertebrates, phytobenthos, phytoplankton and macrophytes.

Eflows links to other elements in water policy framework

The following discusses the extent to which the legal and regulatory requirements for eflows in the analysed national frameworks address links to other key elements indicative of a more holistic approach to eflows. More holistic approaches to eflows take into account all aspects of a flowing water system including both surface and groundwater, the needs of ecosystems and species, the dynamic nature of rivers including their morphology as well as uncertainty in the light of climate change.

Eflows and groundwater levels

This concerns whether groundwater is acknowledged as key factor in supporting eflows and groundwater-dependent ecosystems. This linkage is addressed in the eflows policy frameworks in France, Spain, England and Romania.

Consideration of surface-groundwater connectivity is seldom addressed in environmental flow development due to a lack of methodologies that account for groundwater contributions to instream flow. Under changing climate conditions where extreme hydrologic conditions such as floods and droughts are increasing, water management frameworks that explicitly integrate groundwater and surface water conditions are needed to meet ecological flow needs and determine environmental flows that will support functioning river ecosystems and the aquatic community, improve river health, and sustain key ecosystem services (Yarnell et al. 2022).

- **France.** Management targets for groundwater linked to surface water bodies in the form of groundwater levels are defined, usually in catchment management plans, as well as in the drought thresholds.
- **Spain.** Primarily, the legislative definition of eflows pertains to surface water; however, groundwater is also impacted, particularly in cases involving groundwater-dependent water bodies (e.g., the Doñana wetlands, where groundwater abstractions are regulated to maintain wetland status). The connection between eflows and groundwater is addressed in the IPH, which stipulates that the ecological flow rate calculated according to specified criteria (as outlined in Article 18 paragraphs) should serve as a reference when determining the average interannual flow necessary for computing available groundwater resources.
- **England**. The calculation of the EFI involves the assessment of water availability at water body scale that uses among others also data on groundwater abstractions (natural flow data surface, water abstractions, groundwater abstractions, discharges and influences from reservoirs).
- **Romania.** The principles on which the determination of the ecological flow is based on according to the Ecological Flow Act 2020 include that the ecological flow must ensure that the environmental objectives for bodies of groundwater are achieved and maintained.

Eflows and biological quality elements or species

This concerns whether eflows requirements and definitions are linked to the good status of specific biological quality elements under the WFD or the survival of certain species. This linkage is addressed in the eflows policy frameworks in France, Spain, England, and Romania.

The Water Framework Directive, as well as the Birds and Habitats Directives, set binding objectives on protection and conservation of water-dependent ecosystems. These objectives can only be reached if supporting flow regimes are guaranteed. The establishment and maintenance of ecological flows is therefore an essential element in meeting those objectives. National frameworks for ecological flows should refer clearly to the necessity to link the eflows definition to biological requirements according to the objectives of WFD and the Birds and Habitats Directives (Sanchez Navarro, 2021).

- **France.** The regulatory framework requires the setting of reserved flows downstream of hydraulic infrastructures "*guaranteeing the life, reproduction and circulation of water species downstream of* *infrastructures affecting river flow*." In addition, when defining the DOE, the setting of minimum flows for the environment requires flows that allow achieving good ecological status. In both cases (reserved flows and minimum flows), studies are usually carried out to assess the adequate flow targets. In recent years, there has been a more frequent, if not increasingly systematic, use of assessments of the impacts on habitats and species. In particular, studies setting low flow targets involves estimating a naturalised reference flow regime combined with the use of habitat and species modelling methods and complemented by site specific assessments.

- **Spain.** The link of eflows in particular to the survival of fish life is included in the Spanish Water Act. The Spanish Water Act establishes the environmental river flows as those sufficient to maintain at least fish life that would or could live under natural conditions and its riverbank vegetation. The IPH explicitly links eflows to spatial diversity of habitat and its connectivity, biological and native communities.
- **England.** When setting the Abstraction Sensitivity Bands under the EFI methodology, three criteria are considered. These are: the physical habitat of the river, fish monitoring, and invertebrate monitoring. With these elements in mind, the EA is able to categorise water bodies' sensitivity and allocate them to a specific Abstraction Sensitivity Band (ASB) to determine flow requirements (Interview English experts, 2024).
- **Romania.** The principles on which the determination of the ecological flow is based on according to the Ecological Flow Act 2020 include that the ecological flow shall support the ecological water requirements of communities/habitats and species in the protected zones, and that the ecological flows must be able to provide wintering, feeding and breeding habitats for aquatic fauna, integrating the needs of other categories of biological organisms: benthic invertebrates, phytobenthos, phytoplankton and aquatic macrophytes. However, the Act does not provide indications that specific biological aspects or indicators have been taken into account for the calculation of ecological flows.

Eflows, hydromorphology and sediment

This concerns whether eflows requirements and definitions are linked to the hydromorphological structure of water bodies including sediment. This link is addressed in the policy frameworks of France, Spain and England.

The CIS guidance on ecological flows (CIS, 2015) recommended to consider sediment dynamics and river morphology together with hydrology and hydraulics in order to determine eflows. Groundwater is the main factor supporting eflows in streams during low flow conditions in dry seasons. Groundwater will play a crucial role in maintaining the resilience of the water system and aquatic environment during projected increasingly dry periods in the future and more ecosystems will become groundwater-dependent (Kampa & Buijse, 2015).

- **France.** The link of eflows to hydromorphology and sediment is not set in the regulatory framework but studies establishing reserved flows below hydraulic infrastructures and low flow targets (DOE) should include consideration of habitats including hydromorphological conditions and sediments.
- **Spain.** The IPH explicitly links eflows to spatial diversity of habitats, habitat conditions, connectivity, sediment, and geomorphological dynamics.
- **England.** The criteria used to set the Abstraction Sensitivity Bands under the EFI methodology include the physical habitat of the river (in addition to fish monitoring, and invertebrate monitoring mentioned above).

Eflows and climate change

This concerns whether eflows requirements and definitions are linked to climate change. This link is addressed in the policy frameworks of Spain and, to some extent, France and England.

Eflows implementation under changing climatic conditions is a challenge. Generally, eflows strategies set out objectives based on the assumption of climate stationarity. However, if climate change is neglected in eflows planning, then strategies based on annual water availability will fail to deliver the intended long-term flow regime, and particularly the frequency of higher flow events (John et al. 2021). Despite the high uncertainties involved in modeling climate change, there is a need to test current eflows management practices, adapt policy settings, and assess how they perform under different climate regimes to sustain eflows objectives (Poff et al. 2016).

- **France**. The link between eflows and climate change is not recognized in the regulatory framework, but in the guidance provided by river basin authorities when carrying out studies to establish DOE. During interviews, it was highlighted that there was ongoing debate on how to consider, when setting reserved flows and DOE, a change from a perennial to a temporary river regime ('rivière intermittente') due to changes in rainfall with climate change (i.e. as shown by a naturalized flow regime). On the one hand, it may be assumed that the change in flow regime is driven by climate change and not the uses. Hence reference conditions of intermittent rivers should apply. On the other hand, it could be assumed that the change due to climate change is driven by human pressures. Hence flows should be set to maintain the perennial nature of the river to enhance its resilience. Albeit these questions, there remain knowledge gaps on adequate reference conditions for intermittent rivers (Interview French experts, 2024).
- **Spain**. The link between eflows and climate change is recognised in the IPH in the provisions for monitoring the flow regime. Among others, the monitoring of the flow regime should incorporate into the process forecasts of the effect of climate change on aquatic ecosystems.
- **England**. The link between eflows and climate change is recognized in the National Framework scenarios developed to update the determination of water stress areas in England and explore longer term changes to protect the environment. The National framework scenarios are for planning purposes only, and more detailed local and regional analysis is required to inform decision making (Environment Agency, 2021b).

Table 3 Eflows links to other elements in water policy framework

Eflows requirements address following links	**France**	**England**	**Sweden**	**Finland**	**Spain**	**Romania**
Eflows and **groundwater**	Yes	Yes	No	No	Yes	Yes
Eflows and **status of specific biological quality elements or certain species**	Yes	Yes	No	No	Yes	Yes
Eflows, **hydromorphology and sediment**	Yes	Yes (physical habitat)	No	No	Yes	No (no explicit link)
Eflows and **climate change**	Unclear	Unclear	No	No	Yes	Unclear

Methodologies for establishing eflows in the policy framework

Although the techniques for establishing eflows can be categorized in a variety of ways, four basic groups of methodologies are widely recognised; hydrological methods, hydraulic methods, habitat simulation methods and holistic methodologies.

- Hydrological methods are based on the natural flow regime as a key variable in the structure and functioning of aquatic ecosystems, and usually rely on historical flow data in natural conditions.
- Hydraulic methods relate various parameters, from stream geometry to discharge rate, and the hydraulic parameter is used as a surrogate for habitat factors that are limiting for riverine biota.
- Habitat methods establish flow requirements on the basis of the hydraulic conditions needed to meet specific habitat requirements for biota. Habitat methods are based on hydraulic models that predict how water depths and velocities change with discharge, and these models are based on each species' range of preferences regarding habitat parameters.
- Finally, holistic methods aim to assess the flow requirements of the many interacting components (abiotic and biotic) of aquatic systems. The full spectrum of flows, and their temporal and spatial variability, constitutes the flows to be managed (Sanchez Navarro, 2021).

In France, Spain, England and Romania, there is one or more methodologies for establishing eflows anchored in the policy framework (see overview on types of methodologies used in Table 1Table 4). This is not the case for Sweden and Finland where no eflows methodology is specified yet in legislation or other policies.

Table 4 Methodologies for establishing eflows in case study countries

Methods	Hydrological method	Hydraulic method	Habitat method	Other approach
France	Yes	Yes	Yes	
Spain	Yes		Yes	
England				Yes
Romania	Yes			

France. Three approaches are typically used to establish eflows, depending on the available data and conditions of the catchment.

- The "hydrological" approach is based on the reconstruction of the "natural hydrology" of the watercourse, that is to say in the absence of uses (without withdrawals and replenishment). The principle is to base the DOE value on this so-called "natural" reference to ensure a minimum level of disturbance.
- The "hydraulic" approach is based on the modeling of hydraulic characteristics (water speed, water height, etc.) as a function of flow.
- The results from the hydraulic approach can then be coupled with species preference models by life stages or by groups of species for these characteristics. The species preference models are referred to as the "micro-habitat" method (e.g. ESTIMHAB). These models are not available for all species or all river types.

The hydraulic and micro-habitats methods make it possible to quantify the evolution of physical habitats for the species considered. They can also be used to simulate and compare management scenarios. They are by far the most commonly implemented.

Spain. The establishment of eflows regimes is based on the use of various technical tools including water resources assessment models, modelling of habitats and simulation models of management systems. The IPH, approved by Order ARM/2656/2008 (SG, 2008), of September 10, collects and develops the articles of the Planning Regulation Hydrology (RPH) (SG, 2007) and the Consolidated Text of the Water Law (SG, 1985). The IPH in section 3.4 broadly covers the issue of environmental flows, developing both its objectives and the phases in which it should be implemented and the methodologies to follow for this. The IPH proposes the definition of minimum flow by integrating the flow computed by hydrological simulation to the ecosystem habitat.

The hydrological series is built based on SIMPA model (Sistema Integrado de Precipitación Aportación) that gives the monthly flows for significant water bodies (river segments). Based on this national database, each Basin Agency makes detailed analysis of base flow at daily basis and adapts the hydrological model to define the natural regime for a 20-year series. From this basis, an estimation of habitat is done, and the methodology is adapted to each river basin considering type of geological substrate (granitic, karst, etc.), location (upper, medium, lower basin) and other specific characteristics (location) (CEDEX, 2010).

The IPH also proposed the application of habitat modelling methods in representative sections based on hydraulic simulation, coupled with the use of habitat preference curves for some target species, allowing curves to be obtained that relate the potential useful habitat to the flow (Sanchis-Ibor et al 2022).

The simulation models of management systems serve to gauge the effect of eflows regimes on the availability of water for economic activities and are essential to feed the consultation process and to design an appropriate implementation strategy. In Spain, the Aquatool-DMA tool has been used as a general support to the planning process. It is used to evaluate the impact on water uses of different alternatives for the implementation of minimum flows in rivers (MITECO, n.d).

England. The Environmental Flow Indicator is part of the overall methodology of the Environment Agency to calculate water availability on a water body scale and develop scenarios that inform decisions on changes to water abstraction to protect the environment. To calculate water availability, a database is used that looks at the balance between the flow in the river, the quantity needed to support the ecology and the water that can be licensed for abstraction. For each water body, the starting point is the natural flow that would be in the river in the absence of any artificial influence. Data used include natural flow data (what flows would be under natural conditions) and artificial influence data including surface water abstractions, groundwater abstractions, discharges and influences from reservoirs. Further, an Abstraction Sensitivity Band (ASB) of high, medium or low sensitivity to abstraction is assigned to each water body based on a combination of physical, macroinvertebrate and fish typology. The ASB defines the EFI (Environmental Flow Indicator), which indicates the quantity of water that should be maintained in the river to protect the ecology and subsequently the amount of water that can be allowed for abstraction (Environment Agency, 2020).

The Environment Agency screens all river waterbodies (except those in flow regulated rivers) to show where abstraction impacts may be causing flows to fall below EFIs when the flow is low. A water body is compliant with EFI when recent actual flows are above the EFI at low flows. Non-compliance with the EFI is divided into 3 categories depending on how far below the EFI recent actual flows are: 1) recent actual flows are up to 25% below the EFI at low flows; 2) recent actual flows are up to 25-50% below the EFI at low flows; and 3) recent actual flows are greater than 50% below the EFI at low flows (Environment Agency, 2022).

Finland. Even though eflows are not defined in legislation, there have been pilots to develop methodologies for assessing them. There is no consensus over the methodology that should be used and the absence of a standardised methodology is identified as a key barrier to eflows implementation. Overall, if the legislation is not modified, further developing eflows will be challenging (Interview Finnish civil servant, 2024).

In 2023, a report was published by the Finnish Environment Institute on the implementation of environmental flows and criteria and prioritization method based on the assessment of ecological benefits (Turunen *et al.*, 2023). This report refers to environmental flows (not ecological flows) and seeks to respond to the need to "systematically assess where environmental flow could yield the largest ecological benefits and where further work on the implementation should be conducted” (Turunen *et al.*, 2023, p. 5). The study presents environmental criteria and develops “a prioritization method that can be used as a guidance to assess where implementation of environmental flow might yield the best ecological benefits. The selected criteria emphasize the benefits for migratory fish species, which are typically the target species in environmental flow applications. Prioritization was done for 219 hydroelectric powerplants in Finland. This report is not a guidance document that for instance the permit authorities would be required to follow when they assess/reassess permit proposals; rather, it seeks to propose an assessment method and way of identifying the instances in which the eflows implementation would have the biggest ecological impacts (Turunen *et al.* 2023, p. 6).

Romania. The eflows methodology defined in Romania in the Ecological Flow Act of 2020 is a primarily hydrological approach (method RoEflow). It consists of a variable flow of three values, depending on the hydrological regime and forecast. The hydrological approach is (simplistically) correlated with critical periods of fish species, though does not update ichtyofauna studies or consider hydromorphological or hydraulic elements (Ilinca & Anghel, 2023). The hydrological studies necessary for determining the ecological flows are carried out by public or private institutions certified by the central authority in the field of water.

The Act provides explicitly the condition to update the method pending on new evidence and available technology. There are proposals developed to update the primarily hydrological approach (method RoEflow) and incorporate linkages between hydrological regime and aquatic habitat (Gălie et al, 2021). An important issue of contention regarding eflows concerns the impact of the hydropower uses, particularly the impact of capacities smaller than 10MW. The alignment of the river classification and evaluation of hydromorphology to the European standard EN 14614:2004 and updating the methodology would help align the hydromorphological assessments, and there are methods developed to support that goal (Stanca et al, 2023).

Eflows implementation

The implementation of environmental flows involves various regulatory mechanisms, typically carried out through water abstraction licenses or permits, reservoir operation licenses, water allocation plans, and annual water allocation rules (Speed et al., 2013). Details on how water is allocated and can be re-allocated for different water uses, including the environment, are provided in part A of this report which focuses on water allocation regimes. In the following, we focus on mechanisms which are in place in the countries studied to revise permits, licenses, authorisations and water rights, in order to set flow conditions according to eflows requirements. Subsequently, we review if and how the regulatory framework of the countries address eflows implementation under drought conditions.

Changes to permits and water rights

France. Reserved flows are gradually adopted as they apply to new authorisations, renewal of existing authorisations, or of existing authorisations upon request of the State. Article L. 214-18 of the Environmental Code establishes that the minimum biological flows (DMB) apply also to existing works and should be integrated at the date of renewal of their title, and no later than January 1, 2014. However, in practice, this date proved to be unrealistic. In particular, the minimum flows set under the DOE procedure and the definition of a Sustainable Extraction Limit (SEL, see water allocation part A for details) have not led yet to systematic review of existing permits. A partial exception are permits for agricultural irrigation in priority basins for quantitative water management, where individual permits have been cancelled and integrated into a collective permit held by Agricultural User Associations. These collective permits must in theory match the requirements of the SEL, although permits have so far usually included a transition period.

Spain. The 1985 Water Act (SG, 1985) declares all water (surface and groundwater) as public property. However, it allows for the preservation of pre-existing water rights established under the former Water Law (of 1879) under the condition of 'use it or lose it'. Each River Basin Authority maintains a Catalogue of Private Waters, listing water uses classified as private under the Water Law of 1879. Owners of these rights could choose to maintain them under this regime by declaring their existence to the basin organization within a specified period (but not after). The volume of water under this regime is relatively small compared to post-1985 water rights, although exact figures are not available.

In principle, ecological flows in Spain take precedence over water use rights, making water use rights subsidiary to ecological flows. Thus, eflows have the status of a 'priority-constraint' and water users must respect them (majority of users with post-1985 public water rights and the minority registered in the catalogue of private waters under the 1879 Law). As most water rights are public, the Government may reduce their annual or seasonal volume in order to guarantee the eflows. Exceptions may apply during drought periods. Although there are no detailed figures, old water rights are usually groundwater abstractions and they can be subject to constraints in case of aquifer over-abstraction or drought management.

England. While legislation in 2003 enabled new licenses to be time-limited, it did not provide a mechanism for the systematic revision of existing licenses that impact eflows. Progress toward re-allocating water from existing uses to the environment is driven primarily by legal imperatives of the EU Habitats Directive and has been slow to date. There is currently a shift towards Environmental Permitting Regulations, which will require licenses to be reviewed every six years. A small surcharge on water license charges provides limited financing for re-allocation. Powers to revoke and time-limit existing licenses are currently being considered by the UK government, alongside market-based mechanisms to encourage reductions in unsustainable abstraction (Interview English experts, 2024).

Sweden. Most Sweden's hydropower plants were built prior to modern environmental legislation, which resulted in 90% of the country's plants being granted unlimited legal concessions to operate. This also meant that there were few fish passes and that the statutory minimum water flow requirements were often insufficient to ensure good ecological status (Lindstöm and Ruud, 2017). Sweden went through a major renewal of the permit system for hydropower in 2018. The 2018 amendment to the Environmental Code establishes a general obligation on hydropower operators to ensure that their operation is consistent with 'modern environmental conditions', also meaning that a facility's permit conditions relating to the protection of human health or the environment are not older than 40 years (Swedish Parliament, 1998a, Chapter 11, Section 27(1); Puharinen, Belinskij and Soininen, 2024, p. 174-175). Modern environmental conditions must apply to water activities to produce hydropower that require a permit (water regulation, water diversion, water transfer or other influence on the flow of water). This also includes the existing water activities (Michanek and Zetterberg, 2021, p. 356-357). If the permit conditions are older than 40 years, the operator needs to apply for a permit review by 2037 (Swedish Government, 2020). All existing hydropower licenses will be reviewed over the next 15 years. Unlimited concessions will no longer be granted, with a maximum for new concessions of 40 years. Additionally, a greater focus will be placed on environmental goals, including minimum environmental flows (SwAM, 2019b). According to Michanek and Zetterberg (2021), this national hydropower plan is only indicative for individual operators, as their environmental conditions are determined by applying the rules of the Environmental Code (p. 358). The affected hydropower companies may apply for compensation from the Hydropower Environmental Fund (Swedish Government, 2020).

Finland. In Finland, water allocation takes place through the permit procedure, but the established priority of water uses does not refer to eflows (Finnish Parliament, 2011, Chapter 4, Section 5, Subsection 2). Further, the lack of a clear timeline in the regulatory framework to review old water rights and existing permits is one of the key problems in the Finnish regulatory system for the introduction of eflows (see e.g. Puharinen, Belinskij and Soininen, 2024). Given the permanence of permits, old permits that grant the right to abstract water exist. The Water Act includes transitional provisions for water regulation permits (Finnish Parliament, 2011, Chapter 19, Section 7), according to which "if a regulation project for which a permit was issued before 1 May 1991 has considerable detrimental impacts on the aquatic environment and its use, the competent state supervisory authority shall investigate the possibilities to reduce the detrimental impacts of the regulation". After this investigation, "the state supervisory authority, the fisheries authority or the municipality may apply for a review of the permit regulations or impose new regulations, if the detrimental impacts cannot otherwise be reduced to a sufficient extent". However, Section 7(3) of the Water Act limits the applicability of this provision by spelling out that the benefit to be gained from the review must be significant in the view of the circumstances. This is to be analysed from the perspective of public interest. In addition, the review cannot "considerably reduce the overall benefit gained from regulation nor fundamentally change the original purpose of regulation, unless such a purpose has already lost its significance". Section 7(4) also includes provisions on compensation.

For eflows in specific, the regional administration's expertise and knowledge has been central in advancing eflows implementation even though the permitting system and legislation have not required it. As a result, there have already been some instances where permit holders (private or the Finnish State) have applied for a permit modification to ensure eflows (Interview Finnish civil servant, 2024).

Romania. LAW 122 of 2020, which amended and supplemented the Water Law 107/1996, defines that the servitude flows (consisting of the ecological flow and the minimum flow required downstream of a dam or water intake work), which are mandatory in riverbeds, are calculated in hydrological studies developed by public or private entities, are certified by the central water management authority and are provided for in the water management permit or authorization. The Law does not specify whether the provisions apply only to new authorizations or also to amendment of existing authorizations to introduce eflows. The Ecological Flow Act of 2020 (Article 5) states that the operating regulations related to dams or water intake works are to be revised in order to ensure downstream ecological flows but makes no further reference to the system of permits and authorizations or a timeline.

Eflows changes under droughts

Prolonged droughts can prevent the achievement or the maintenance of ecological flows. As drought is part of the natural hydrological variability which is a key element in the functioning and the natural dynamics of aquatic ecosystems, some countries take account of the ecological conditions of natural droughts in the definition and implementation of ecological flows. In France and in Spain, provisions for eflows in legislation and regulations consider natural droughts. Further, in these countries, the regulatory framework allows for reduction of eflows under drought conditions. The aspect of droughts is not specified yet in the regulatory framework for eflows in Sweden, Finland, England, and Romania.

In France, studies defining reserved flows and low flow management targets recreate the natural hydrology of the river. Targets usually consider the QMNA5 (flow characteristics during dry years).[1] Specific provisions are included in the legislative framework, recognizing the temporary nature of some rivers or their natural drying out during the dry season.

Article L. 214-18 of the Environmental Code allows the administrative authority to exceptionally and temporarily set reserved flow rates lower than their nominal minimum value, when a watercourse is subject to exceptional natural low flow. According to 2011 Circular on the implementation of Article L.214-18, these exceptional conditions must be understood as having a return period less than ten years. In such situations, if the flow immediately upstream of the structure is lower than the temporary reserved flow set by the authority, no abstraction is possible and the entire incoming flow must be passed downstream. It is appropriate to avoid the repeated implementation of these exceptional provisions which could have

[1] Five-year low water flow (or QMNA 5) is a monthly flow that is exceeded on average four years out of five. The QMNA 5 is the reference low water flow for the implementation of the water policy. https://glossaire.eauetbiodiversite.fr/en/taxonomy/term/2?page=19

significant consequences for the aquatic ecosystem and its capacity for regeneration. For example, rivers in regions characterized by pronounced natural low water levels will not be able to justify regular application of this provision. Further, the regulatory framework in France restricts, and may even prohibit, both surface and groundwater abstractions at low flows in dry periods.

In Spain, according to Article 18 of the Spanish Hydrological Planning Regulation (RPH), a prolonged drought situation allows the justified reduction of the eflows of water bodies as established in the RBMPs (SG, 2007). A less demanding flow rate regime may be applied provided that the conditions laid down in the RPH on the temporary deterioration of water body status are met. When a drought is declared including risk of shortages to domestic supply, the Drought Management Protocol (DMP) applies, which is revised according to the 6-year WFD planning cycle, and the eflows are reduced according to the drought declaration. The Real Decreto 1159/2021, de 28 de diciembre, revised the Drought Management Protocol including indicators for droughts and scarcity which declare the status of emergency/alert/normality. When emergency status is declared, eflows are reduced and water rights (both surface and groundwater rights) are limited (SG, 2021).

In England, the regulatory framework can limit or prohibit both surface and groundwater abstractions in dry periods. Restrictions on abstraction are first based on 'hands-off flows', which are usually added as a condition on a license to allow a certain amount of abstraction. For example, the hands-off flow at Q95 means that 10% can be abstracted ("take"). During more severe droughts, drought orders may be issued to establish stricter restrictions during which only drought permits – usually reserved for essential uses such as drinking water – are allowed to abstract (Interview English experts, 2024). In the dry summer of 2022, the Environment Agency was supporting river flows via its water transfer schemes (moving water around locally to support environmental flows and abstraction for water users), releasing water from reservoirs and by taking water from groundwater sources (Environment Agency, 2022b).

In the catchment abstraction management strategy (CAMS), which translates the RBMPs and the water abstraction plan into the licensing policy, all river water bodies are screened (except those in flow regulated rivers) to show where existing abstraction impacts cause flows to fall below EFIs when the flow is low (Environment Agency, 2021).

For Sweden, Chapter 2, Section 10 of the Act (1998:812) Containing Special Provisions concerning Water Operations stipulates that in the event of a serious water shortage, the entity responsible for the water operation and the person/entity that has access to the water resource must withhold the water that is unavoidably necessary for the public water supply or for any other public need, if the water shortage is caused by drought or any other comparable circumstance (Swedish Parliament, 1998b). This provision aims at securing the public water supply or other general causes, such as threatened crop failures. It applies in times of disaster-like events, such as droughts and severe winters. There is no specific mention to the needs of the environment in this regulatory context.

In Finland, in case there is a long-term drought or another similar reason that causes a considerable decrease in the supply of water, the quantity of water abstracted by a water abstraction facility may be restricted for a fixed period. The aim is to secure the water for ordinary household use or for community water supply (this is to be prioritized even in normal conditions). The restriction comes from the permit authority which decides the matter based on an application filed by the entity that needs water. If the restriction causes unreasonable loss of benefit to the owner of the water facility, the permit authority may, upon application, order the applicant requesting the restriction and others gaining an essential benefit from the restriction to compensate for the loss of benefit (Finnish Parliament, 2011, Chapter 4, Section 10; also Finnish Government, 2009, p. 85-86). However, there is no specific mention to the needs of the environment in this regulatory context.

Responsibilities and involvement of stakeholders

Competent authorities for eflows

The governance system on eflows in the six studied countries consists of authorities with competence in overall eflows policy design, eflows definition and implementation in the RBMPs, competence in the permit system and in monitoring and compliance checking. In most countries, eflows policy design is in the hands of Ministries or Agencies working at national level. The definition and implementation of eflows in the RBMPs is carried out by river basin authorities or other authorities with equivalent competence for the RBMPs e.g. the County Administrative Boards in Sweden, the Centres for economic development, transport and the environment in Finland and the Environment Agency in England. For details on permit authorities and authorities with competence on monitoring, see detailed descriptions for each country below.

France. The Environment Ministry in the form of its decentralised services at the level of the départements (DDT(M)) is the competent authority on eflows established by the 1992 Water Law (RF, 1992) and the 2006 Law on Water and Aquatic Environments (LEMA) (RF, 2006). The following authorities share competences on eflows:

- Lead on eflows policy: Environment Ministry and its services in the DDT(M). They ensure that reserved flows are included in the conditions of permits for infrastructure affecting the hydrology of rivers.
- Eflows definition in RBMPs: River basin authorities establish the target flows (management targets including minimum biological flows in addition to flows needed for specific uses) under the control of the River Basin Management Council[2].
- Issuing and revising permits that respect eflows: Environment Ministry in the form of the decentralized services in each Département (DDT(M))
- Monitoring, enforcement and compliance with eflows: The water police in France is in charge of enforcement. The water police is mainly under the responsibility of the Environment Ministry and consists of officials in the decentralized state technical services at the Department level (DDT(M)). The national Office for Biodiversity also has a supporting role.

Spain. The main competent authorities for eflows implementation are the River Basin Water Agencies (one Agency per river basin). The Directorate-General for Water at the Ministry for Ecological Transition, with the support of CEDEX and various scientific and academic experts played a key role in the first phase of discussion and definition of eflows methodologies. The establishment of eflows regimes, their monitoring and implementation is the responsibility of the River Basin Agencies, following the governance framework that is primarily set out in the Hydrological Planning Regulation (RPH) and Public Hydraulic Domain Regulation (RDPH). The following authorities share competences on eflows:

- Lead on eflows policy: Ministry for Ecological Transition and Demographic Challenge, Directorate General for Water (DGA), and the River Basin Water Agencies.
- Eflows definition in RBMPs: River Basin Water Agencies
- Issuing and revising permits that respect eflows: River Basin Water Agencies
- Monitoring, enforcement and compliance with eflows: River Basin Water Agencies

England. The Environment Agency is the regulatory body responsible for managing water resources in England. The Environment Agency controls how much water is taken in the permitting system, it regulates existing licenses and grants new ones. The Environment Agency has all relevant competence on eflows

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[2] See water allocation report for the composition of this multi-stakeholder organisation; the State is one stakeholder amongst others in this decision making body, but has a major influence in the definition of these targets.

policy; eflows definition in RBMPs; issuing and revising permits that respect eflows; monitoring, enforcement and compliance with eflows.

Sweden. The County Administrative Boards (CABs) are responsible for implementing the RBMPs, which spell out any eflows requirements. The following authorities share competences on eflows:

- Lead on eflows policy: SwAM (supporting and coordinating role and provides national guidance on water management).
- Eflows definition in RBMPs: Eflows definition is not visible in the current RBMPs; however, the County Administrative Boards decide the environmental quality standards for their water district (Swedish Government, 2020, Chapter 4, Section 1).
- Issuing and revising permits that respect eflows: The Land and Environmental Court examines permit applications concerning water activities.
- Monitoring, enforcement and compliance with eflows: The County Administrative Board supervises the vast majority of water operations.

Finland. The RBMPs name the Ministry of the Environment and the Ministry of Agriculture and Forestry in Finland as the two responsible units for developing eflows practices. They should act in cooperation with the Centres for economic development, transport and the environment,[3] the operators of hydropower facilities, and research institutions (e.g. Kotanen, Manninen and Roiha, 2022). The following authorities share competences on eflows:

- Lead on eflows policy: Ministry of the Environment and Ministry of Agriculture and Forestry (both are responsible for developing policies on eflows and their measurement).
- Eflows definition in RBMPs: Centres for economic development, transport and the environment (responsible for preparing RBMPs) (Finnish Parliament, 2004, Section 5).
- Issuing and revising permits that respect eflows: Regional state administrative agencies as the permit authorities according to the Water Act.
- Monitoring, enforcement and compliance with eflows: Centres for economic development, transport and the environment; they are responsible for overseeing the Water Act and the permits. Operators (permit holders) take care of monitoring.

Romania. The relevant authorities with competence on eflows are the Ministry of Environment, Water and Forests, and the National Administration "Romanian Waters”. The latter bears the core responsibility for the development and implementation of all the strategies and policies regarding water management, including eflows. The National Administration „Romanian Waters” or its subdivisions, namely the River Basin Administrations, are responsible for issuing water permits. The Ministry of the Environment, Waters and Forests drafts and enforces regulations and supervises the National Administration "Romanian Waters”.

Involvement of stakeholders

Participation schemes for stakeholders and water users who may be impacted by relevant measures are particularly crucial for the achievement of eflows. Success will ultimately depend upon effective interaction with stakeholders, from politicians to local users, and the ability to communicate the need for ecological flows among those whose interests are affected (Sanchez Navarro, 2021). The following examines how

[3] The centres for economic development, transport and the environment prepare the RBMPs in Finland (Act on the Organisation of River Basin Management and the Marine Strategy, Section 5). There are seven RBDs in Finland (Åland is not included in this count) and fifteen centres for economic development, transport and the environment. A river basin may thus overlap with the jurisdiction of multiple centres.

stakeholders are involved in the implementation of the policy framework for eflows in the six studied countries.

France. Implementation of management targets in RBMPs and catchment management plans are the shared responsibility of users, organized in three “colleges”[4] and supported by the River Basin Authority (in relation to RBMPs) and specialized technical river syndicates in charge of developing and implementing the catchment management plans for the catchment management councils. Overall, the determination of eflows, whether through dedicated studies or EVPs (Studies of allowable withdrawals that define allowable entitlements at the sub-basin/aquifer levels, as well as eflows values), is a technical study largely remote from the user concerned. Stakeholder involvement is stronger in catchment management planning as well as drought planning. Molle and Collard (2024), for example, have shown how the political process of defining and enforcing eflows could be contested.

Spain. The Hydrological Planning Regulatin (RPH) determined that the process of implementing the ecological flow regime is to be developed in accordance with a consultation process that will take into account existing uses and demands and the regime of concessions, as well as good practices. The Hydrological Planning Regulation IPH (ARM 2656/2008) defines three stages in eflows planning process (SG, 2008). First: technical studies and composing of draft proposal; Second: public participation process; Third: definition and implementation. Stakeholders (urban utilities, irrigators, citizens, etc.) are involved in RBMP design in general which includes consultations and negotiation process (at least in strategic surface water bodies) with the aim of making water use rights compatible with the eflows regime (see Annex on case study of Spain in Kampa & Schmidt (2023)). Water users can express opposition during the RBMP development. However, once the RBMP is approved by Government (Royal Decree), it has a legal status and must be respected. Monitoring is done in a public and transparent way (public online access) and the Water Agency is responsible for implementation and enforcement.

Sweden. Stakeholders, such as government agencies, municipalities, interest organisations and the industry, participated in preparing the plan for the modern environmental conditions of hydropower introduced in the 2018 update to the Environmental Code (Swedish Parliament, 1998c, Section 29-31). The plan describes the procedure and the involvement of stakeholders in its making: for instance, there were a number of opportunities to submit views, including through specific collaboration issues on the timetable and review groups. Dialogue meetings were held with authorities and industry and stakeholder organisations to obtain additional views. During the consultation, five regional consultation meetings were held where all stakeholders had the opportunity to participate. In order to provide the conditions for a well-established plan, special collaboration has taken place with the County Administrative Boards and water authorities. The Swedish Environmental Protection Agency, Kammarkollegiet and the Swedish National Heritage Board have also participated in the work, and the Swedish National Courts Administration has had the opportunity to submit views on the timetable so that the courts are given the conditions for appropriate planning (Swedish Government, 2020, p. 2; 6-7).

Finland. The preparation of the RBMPs is governed by the Act on the Organisation of River Basin Management and the Marine Strategy (Finnish Parliament, 2004). Section 15 of the Act concerns stakeholder participation in the RBMP *preparation* process. For managing the preparation process, each Centre for economic development, transport and the environment needs to arrange sufficient cooperation and interaction with the different authorities and other parties in its operating area by establishing a cooperation group (Finnish Parliament, 2004, Section 14). The government proposal explains that such a group should involve authorities and other stakeholders (Finnish Government, 2004, p. 45-46). The RBMPs

[4] First college: 40% representatives of general and regional councils and, mainly, representatives of municipalities or their groups competent in the field of water
Second college: 40% representatives of water users and aquatic environments, socio-professional organizations, approved environmental protection and consumer defense associations, fishing representative bodies and qualified people
Third college: 20% of representatives of the State or its public establishments concerned

then indicate the parties relevant to the implementation of each aim set in the plans; however, stakeholders other than the owners of the hydropower facilities tend not to be listed.

Further, the voluntary processes in the NOUSU programme on dam removals and watershed visions, which are at present the most promising measures to improve eflows in the Finnish system, can be described as collaborative, bottom-up processes. They are voluntary and participatory and their governance objectives are decided in a collective decision-making process instead of being set out in the law (Puharinen, Belinskij and Soininen, 2024).

England. Stakeholders are not consulted with regards to determining flow requirements for catchments. This process takes place at the national level and is coordinated between the Environment Agency and the UK Technical Advisory Group (UKTAG). Stakeholder consultations occur every six years through the river basin planning process, but this consultation is not oriented on eflows (Interview English experts, 2024).

Romania. The Ecological Flow Act of 2020 does not foresee any specifications for public consultation on the setting of eflows values (RG, 2020). Overall public consultation on water management issues is carried out in the context of river basin management planning. Romania has a national RBMP which consists of a synthesis of the eleven RBMPs and has been updated for the period 2022-2027. The public consultation in the elaboration of the second generation of the RBMPs consisted of two steps: first, providing the relevant information online and, second, organizing consultations with water users in River Basin Committees for the preparation of the RBMPs and of the plans for drought restrictions (Ioana- Toroimac et al, 2018).

Eflows compliance and enforcement

Compliance and enforcement of eflows requirements is closely linked to the presence of appropriate monitoring and reporting systems as well as provisions for penalties and fines in the regulatory framework.

Monitoring and reporting

Monitoring programmes should be adapted to provide an improved picture of hydrological alterations and their impact on habitat/morphology and biology and to effectively support the achievement of ecological flows. The development of operational hydrological monitoring should relate to the surface and groundwater hydrological pressures and be prioritised where action is likely to be needed. The integrated monitoring of hydrological, morphological and biological quality elements will enable the estimation of the effectiveness of flow restoration actions (Sanchez Navarro, 2021).

The following examines to what extent national regulatory frameworks in the studied countries include legal obligations to monitor eflows at large infrastructures/major water intakes as well as at other parts of the river network affected by smaller abstractions and intakes. Specific requirements for monitoring of eflows are in place in France, Spain and England. The policy frameworks of Sweden, Finland and Romania do not include specific provisions for eflows monitoring, although water flows may be monitored as part of general obligations to monitor activities related to abstractions.

France. Article L. 214-18 of the Environmental Code foresees that for works to be built and existing works for which authorization or concession is renewed, the administrative authority will impose the establishment of a control/monitoring system at the expense of the petitioner. The administrative authority should propose the establishment of appropriate monitoring methods allowing for a rapid and easy recording, reporting and control of the water use. In addition, the services responsible for water policing will have to establish a water control plan to monitor the “reserved flows” of the infrastructures.

This control plan will primarily target existing works for which the water regulations or specifications do not impose a control device.

When the administrative authority sets a reserved flow, it may impose monitoring to assess the impact of the new minimum flow on the environment in order to readjust it later if necessary. This prescription must be motivated by the ecological issues linked to the watercourse and the impact of the dam. This monitoring may include physicochemical analyses, biological (macro-invertebrates, fish, etc.), and hydromorphological monitoring. Follow-ups must be proportionate to the present ecological issues and the impacts of the work on the watercourse. This monitoring can integrate data from pre-existing monitoring (WFD monitoring, other legislation) if the location of monitoring stations proves relevant for monitoring the impact of the new reserved flow. However, in practice, the State does not have the capacity to do much of such monitoring.

For low flow targets (DOE), there is a surveillance programme managed by the water agencies at river basin levels and by water managers of catchment management plans. A surveillance programme of Low Flows (ONDE) is managed by the State (Office Francais pour la Biodiversité).

Enforcement is tasked to the water police (officials from the state technical services at the Department level or belonging to the national Office for Biodiversity). They may control river flows downstream of abstraction points to check conformity with the reserved flows or DOE. However, the water police has been weakened by reductions in staff and pressure from agricultural lobbies. It may even sometimes be instructed by the Department-level state representative (the prefect) to turn a blind eye to unlawful abstraction. The water police is mainly activated in cases of gross violation or in times of severe restrictions.

Spain. The River Basin Management Plans (RBMPs) mandate the monitoring of eflows at critical gauges along surface waterways, such as rivers. This legal requirement applies specifically to gauges identified with defined eflows parameters in the RBMP. All river basin authorities have in place a public accessed 'on-line' tool to monitor the eflows status (on-line-automatic-real time monitoring).[5] This is a transparent tool which is available on each river basin authority website and is a capture of 'real time' gauges that have a defined eflow in the RBMP. This automatic monitoring system alerts when flows are at risk of falling short of minimum level.

Drought conditions imply more proactive control and monitoring and management of water reservoirs (releasing water stored to maintain eflows). In practice though, in the 2nd RBMPs, compliance with eflows was monitored in only 11% of the river water bodies where they had been defined (Mezger et al., 2019). An additional shortcoming is that the relationships between eflows implementation and ecological response are not being assessed (Mezger et al., 2019). Recently, there are specific targeted studies being carried out by research institutions on this topic but there are no results available yet (Interview Spanish expert, 2024).

England. Flows are not monitored in every water body. There are gauging stations along water bodies which are used in conjunction with sophisticated hydrological models to interpret flows at various points. These models can provide an overview of an entire catchment, allowing the EA to determine where eflows are not being met. Groundwater levels are monitored similarly. The EA is in the process of launching an approach for operators called the "local flow constraint" – which would allow operators to do their own monitoring and modeling and present it to the EA. This can be used to request a different level of fee, and possibly greater access to water in the catchment, in the case where environmental obligations are still met.

Sweden. There are no specific legal requirements that apply specifically to monitoring eflows. However, the operators are under a general obligation to monitor their activities. The quality of monitoring carried out by

[5] For example, the Automatic Hydrological Information System of the Guadalquivir Basin can be accessed here: https://www.chguadalquivir.es/saih/

the authorities varies between regions. The authorities have different monitoring resources which affects their ability to carry out monitoring (Interview Swedish judge, 2024).

Finland. Permit regulations must include an obligation to monitor the impacts of the project (Finnish Parliament, 2011, Chapter 3, Section 11). Such monitoring obligations cover both the water flow and the water level (Finnish Government, 2009, p. 68; Hollo, 2014, p. 150). The obligation is the same for all abstraction projects despite the size provided that the water management project requires a permit. The Water Act though does not specifically mention eflows in this context. There are also no provisions in the Water Act to publish reports on the level of compliance with eflows (Finnish Parliament, 2011, Chapter 14).

Romania. The Ecological Flow Act of 2020 includes requirements to make available the values of the servitude flows (not specifically of the ecological flows) discharged downstream of a dam or water intake on the website of the permit holder and to submit these monthly to the water management authority that issued the water management permit. Information could not be found on the extent to which this is practiced and applied by the permit holders.

Penalties

Only scarce information is available on penalties and fines that may be applied to permit holders if eflows are not respected. In **Spain,** sanctions in case of non-compliance with defined eflows are generally economic penalties but there can also be penal consequences if non-compliance is considered an environmental crime (criminal offence against natural resources and the environment under the Criminal Code). Decision-making on penalties is an ad-hoc process and the judges decide based on technical reports of legal experts (peritos judiciales) (Interview Spanish expert, 2024). In **Sweden and Finland,** there are no specific penalty rules on eflows. Also in **Romania**, no provisions could be identified for penalties in case eflows are not respected.

Expertise in the legal system

Information is also scarce on the extent to which technical and scientific advisors are used for legal cases on water rights disputes that involve eflows. **In Spain,** there are experts that can be called in by litigating parties. **In Finland,** the permit authority employs legal, scientific and technical advisors. In water issues, the composition of the court in the Vaasa administrative court (the first appeal instance in water issues) and the Supreme Administrative Court includes technical and scientific experts (Finnish Parliament, 1999; Finnish Parliament, 2006). In **France**, trainings for professionals in water management are primarily aimed at a mixed audience, including consulting firms, instructive services, small and medium-sized enterprises, and enforcement agents. Judges and magistrates are not the target audience for these technical trainings, but there have been efforts by the Ministry to distribute documents and raise awareness among magistrates on minimum flow rates and related issues (Interview French experts, 2024).

Discussion of challenges for eflows legal and regulatory frameworks

In this section, we discuss main challenges for the implementation of eflows regulatory frameworks in the six European countries studied in this report. The main challenges identified relate to the following main aspects: development of the legal and regulatory framework; water rights and permits; knowledge and science; water availability and climate change; policy incoherence; enforcement and compliance.

Development of legal and regulatory framework and translation into practice

The existence of **well-developed legislation and regulation** is considered a fundamental enabling condition that underpins most, if not all, cases of successful eflows implementation (Harwood et al. 2018). In several EU countries, the legal and policy basis for implementing eflows (national legislation, policy documents) is still not sufficiently elaborated (Kampa & Schmidt 2023). This may entail the lack of provisions for eflows under national water acts, and/or RBMPs. Further, even if relevant regulations exist, they may not be sufficiently coherent and detailed, leading to the lack of consistent application within the same country.

The six European countries examined in this report are at different stages of policy development on eflows. The most advanced legal and regulatory frameworks on eflows are in place in Spain, France, and England. In Finland, eflows are not defined yet in national policy, and this is considered the most important barrier for making progress on eflows implementation in the country. Also, the methodologies for calculating eflows have not yet been standardised in Finland and completing this process could have a positive impact on eflows implementation (Interview Finnish civil servant, 2024; Interview Finnish judge, 2024). Similarly in Sweden, there is no specific and detailed definition of eflows in national legislation yet. In Romania, eflows have been relatively recently introduced in 2020 in the national legal framework and the methodology for assessing and monitoring of eflows is under development. Therefore, there is still limited evidence regarding eflows implementation (Ramos et al, 2017; Ilinca and Anghel, 2023).

Also, in countries with more advanced frameworks for eflows such as Spain and France, there are challenges when **translating the legal provisions into practice.** In Spain, although the regulatory eflows definition requires different flow regime variables to be met, in practice focus has mainly been so far in defining and implementing minimum flows. The 2017 River Basin Plans monitoring report indicated that although 76.9% of the rivers had established minimum flows, only 9% had set maximum flows, 8.7% channel maintenance discharges and 11.4% change rates downstream of regulatory infrastructures (Sanchis-Ibor et al 2022).

In France, eflows are mainly understood as minimum ecological flows (reserved flows), and in the local context, they usually follow the minimum regulatory requirements such as the 1/10th of the average naturalised flow. Catchment-specific and monthly eflows have been systematically introduced in (roughly) the southern half of France, on around 500 control points. This unique effort to cap withdrawals based on priority minimum ecological flows will face growing tension as available flows are reassessed after considering climate-change induced reductions.

Further, the limits of the current approach of quantitative water management in France, which focuses on low flows, start to be acknowledged as well as the need to adapt methods also to high water (floods). It is now seen as necessary to broaden the low flow targets framework, in order to take into account the needs of the environment over the entire hydrological cycle (e.g. maintenance of floods for the impoundment of spawning grounds or of wetlands). However, eflows methods adapted to high water (floods) are currently limited to specific basins and there are no regulations that promote high flow rates during seasons when they naturally occur. At the same time, despite not being mandatory, rules start to be established on the timing and rate of water releases from water storage schemes to prevent sudden and sharp changes in flow rates that could harm aquatic life or downstream infrastructure. Overall, the regulatory framework on these types of flows still needs to be clarified and further developed (Interview French experts, 2024).

Water rights and permits

A further challenge in national regulatory frameworks lies in existing **water rights and permits** and the extent and timeframe in which these can be reviewed to introduce eflows. This has been confirmed as a key challenge in at least three of the six studied countries, namely in Sweden, Finland and France. In France, the State can change permits in theory at any time without compensation, but in practice, this proves challenging to implement. This is an unpalatable administrative move that is seen as antagonistic by users. In practice, the State prefers to cap water use by imposing eflows rather than through *a priori* maximum withdrawals. In Finland, the review of old permits is extremely difficult in case the permit holder is not interested. Thus, advancing the implementation of eflows currently builds on voluntary contributions of permit holders (Interview Finnish civil servant, 2024; Interview Finnish judge, 2024). In Sweden, a system for reviewing hydropower permits is in place since 2018. However, it will take time for the full effect of this legislation to materialise. The 2018 Environmental Code amendment to review the permit system of hydropower may have implications for the establishment of eflows linked to hydropower over the next 20 years, but the 15–20 year implementation phase is rather long and speaks against swift eflows implementation in the country. Further, the largest hydropower plants have permits that protect the plant owners against permit changes without compensations (Interview Swedish judge, 2024).

Knowledge and science

Gaps in the scientific basis for eflows setting is considered an important barrier to eflows implementation in Spain, France and England, which already have a regulatory framework for eflows in place.

In Spain, despite having one of the most comprehensive eflows legal frameworks in the EU, there are scientific knowledge gaps on the interrelation of surface and groundwater abstractions with eflows, and on the link between eflows and their impacts on ecology. The relationships between eflows implementation and ecological response are not being yet systematically assessed in Spain (Mezger et al., 2019). Recently, specific targeted studies are being carried out by research institutions on this topic but there are no final results available yet (Interview Spanish expert, 2024).

In France, studies in specific catchments have demonstrated the difficulty in obtaining biological evidence on the effectiveness of flow rate regulations, as this requires significant long-term data collection and statistical analysis. Significant changes in flow rates are necessary to observe biological responses in a 10-20 years' time span, and even then, it can be challenging to attribute biological changes solely to flow rate regulations. Natural variability and non-flow related stressors can lead to difficulties in attributing observed changes solely to flow rate regulations. At the same time, the potential risks associated with decreased flow rates, such as reduced water quality and biodiversity loss, need to be carefully considered (Interview French experts, 2024). Overall, targeted and regular monitoring is key for assessing the impacts of implemented eflows on ecosystem condition to prove the ecological benefits of increased flow rates and to adapt eflows, where needed.

Also the science linking flow regimes with ecological status, species and habitats status is still embryonic in France. There are specific models available in the country, which are applicable to various contexts, but they need to be complemented by additional site studies for more robust results (Interview French experts, 2024).

Water availability and climate change

The **declining water availability and increasing variability of the flow regime under climate change** pose further challenges to the implementation of eflows in Europe. This is a key implementation challenge acknowledged in France and in Spain among the studied countries. In both France and Spain, countries where several basins are affected by water scarcity and droughts in recent decades, the definition of eflows in legislation and regulations already considers situations of natural droughts. In France, increased frequency of droughts and reduction in mean river flows have been observed widely, especially in the western and southern regions, which poses great challenge in defining a baseline for eflows. If the available resource is reduced while the eflow is not, allowable withdrawals will be squeezed. The aspects of droughts and climate change are not specified so far in the regulatory framework for eflows in Sweden, Finland, England, and Romania.

Policy incoherence

Among key implementation challenges in several EU countries is **opposition to eflows implementation from major water users** (Kampa & Schmidt 2023, Alexandra et al. 2023, Molle and Collard 2024). In Finland, eflows enforcement is hindered by opposition from hydropower, the key question being the compensation to water users. The situation is similar in Sweden, where there is pressure from the hydropower sector and the government to interpret the regulatory framework in favour of using exemptions under the WFD, prioritising water availability for energy production, rather than what good ecological status would require (Interview Swedish civil servant, 2024; Interview Swedish judge, 2024). Also, compensation of users is a very relevant issue; if hydropower plant owners are compensated for plant removal, many owners (of especially smaller plants) are more willing to apply (Interview Swedish judge, 2024). In France, there is opposition from the energy sector and agricultural users who are most affected by eflows. Although some processes are in place to address this (e.g. binding nature of RBMPs and catchment management plans for all stakeholders and planning decisions), eflows are not directly considered in sectoral investment decisions and eflows policies are not well coordinated with planning processes of these key sectors. Indirectly, water resources availability and eflows are increasingly considered in such assessments.

Enforcement and compliance

A key challenge in enforcing eflows relates to **non-compliance which cannot be detected due to monitoring gaps and lack of resources**. The **lack of resources and capacity** of competent authorities on eflows is considered as a key challenge in most of the countries examined (France, Spain, Sweden, Finland, England). In France, the water police (officials from the state technical services at the Department level or belonging to the national Office for Biodiversity) faces staffing issues to ensure abstraction points comply with permits and drought orders. In Spain, a monitoring system is in place but according to Mezger et al. (2019) compliance with eflows was monitored in only 11% of the river water bodies where eflows had been defined in the 2nd RBMPs. Also in Sweden, resources of the relevant authorities for monitoring are not adequate; therefore, many cases and complaints are only initiated after an environmental organisation takes action (Interview Swedish judge, 2024). Further, the permit conditions for establishing connectivity between various parts of the river are based on assessments which are produced by the applicant and evaluating the quality of such assessments is challenging for Swedish permit authorities (Interview Swedish judge, 2024).

In some countries, there are also difficulties in controlling illegal abstractions which can have a significant impact on eflows. This is an implementation barrier to eflows in both Spain and France among the studied countries. In France, illegal abstraction, especially agricultural groundwater abstraction, is a key problem. No clear overview is available, but undeclared abstraction points and tampering with metering have been described as common in some areas.

Conclusions

The present report has described and analysed the legal and regulatory frameworks for eflows in six European countries, contributing to an improved understanding of national policies and challenges for eflows set-up and implementation in Europe. The six studied countries face different challenges for eflows implementation, related to their varying degrees of policy development on this topic. Policy requirements for eflows are already anchored in national legislation in France, Spain, and Romania. However, only France and Spain have a longer record of developing and implementing eflows in practice, while the Romanian eflows policy framework was only very recently developed. In England, eflows are not defined in national law but there is a well-defined eflows indicator used for application in RBMPs by competent agencies. In Finland and Sweden, there is no specific definition of eflows and eflows methodologies in national legislation yet.

In European countries with less advanced legal frameworks on eflows, the development of conducive legislation with clear eflows methodologies as well as regulatory instruments to include eflows in water permits are key to making progress on eflows implementation. On the other hand, European countries with more advanced legal frameworks on eflows face scientific knowledge gaps to improve eflows implementation, the need to adapt their regulations and methods for more holistic approaches e.g. to consider high water (floods) and increasing hydrologic variability due to climate change. Also, resources and legal provisions for monitoring and enforcement of eflows need to be strengthened. Common challenges across countries remain the opposition of eflows implementation from key water users, options for compensation and better coordination of eflows with sectoral planning processes.

The description and analysis of national regulatory frameworks for eflows in this report can be used as starting point for further research on the development and effective implementation of eflows policies in European countries. The following research questions may guide a more in-depth analysis of regulatory instruments for the design and implementation of eflows in the GOVAQUA good practice inventory. For each question, indications are made below for sources of potential good practice case studies and lessons that can be drawn from the countries examined in this report.

What are the main characteristics of the most advanced legal and policy frameworks for eflows? How are these integrated with water allocation regimes?

- Good practices and remaining challenges can be drawn from the regulatory frameworks of Spain and France that have among the most advanced eflows frameworks in the EU.
- In both Spain and France, achieving eflows in over-abstracted river basins remains a challenge, and further research can examine the linkages between eflows regulations and the regimes for allocating and reallocating water in specific catchments/regions in these countries.

What kind of provisions can be used to make the legal and policy basis for eflows adaptive to impacts of climate change and droughts on water availability?

- Concerning eflows under droughts, lessons learned can be drawn from France and Spain that have gathered some experience on the implementation of relevant provisions. Concerning adaptiveness of eflows regimes to climate change, there is limited experience in the regulatory frameworks of the countries examined. However, in France, there are efforts to develop regulatory provisions for eflows related to high flows (floods) and their effects on eflows and ecosystem condition.

What regulatory mechanisms can be used to manage trade-offs between eflows implementation and affected water users (e.g. hydropower, agriculture) and reduce conflicts when water availability is decreased? What other types of instruments (e.g. economic instruments, participatory planning) can complement these in managing trade-offs and how?

- In particular for the hydropower sector, some early lessons can be learned from Sweden's recent national plan for hydropower that foresees review of hydropower permits in a specific timeframe and a funding mechanism for mitigation measures. The system of permit revisions for hydropower until 2037 includes revision of environmental conditions that can allow for introduction of eflows among other requirements.
- In France, individual permits for agricultural irrigation in priority basins for quantitative water management have been cancelled and integrated into a collective permit held by Agricultural User Associations.

What arrangements support more effective enforcement and compliance with eflows implementation? What role does monitoring play in improving effectiveness of enforcement and compliance?

- Spain can serve as source of good practice for its system of automatic monitoring of eflows. All river basin authorities have a public accessed 'on-line' tool to monitor the eflows status. This is a capture of 'real time' gauges that have defined eflows in the RBMPs. In some catchments, the 'on-line' eflows monitoring tool is used to inform irrigators and taken into account in irrigation planning.
- In France, the introduction and long-term scientific research on eflows in the Rhone River may also be a source of good practice of how science informs the implementation of eflows on basin level. Before 2014, the Rhône was not subject to water regulations, and there were no minimum flow requirements. After the regulations were implemented, there were substantial increases in minimum flow rates, sometimes by a factor of ten. This allowed for extensive scientific research with many years of data, including before and after comparisons, experience feedback, prediction tests, and effects analysis. The scientific effort associated with the flow changes demonstrated that altering minimum flow rates can lead to predictable changes, though not entirely. The study provided valuable insights into the effects of flow rate changes on biological communities, although it doesn't explain all observed changes due to various other factors at play (Interview French experts, 2024).

Further work in WP2 of GOVAQUA will explore, document and assess selected good practice approaches on legal and regulatory instruments for eflows.

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Annex I – Expert interviews

The following lists the interviews carried out with nine national experts to complement the data collection for Deliverable 2.1 concerning water allocation, eflows and water value chains regulatory regimes. The interviews that provided material for this report on eflows are cited directly in the text.

1. Sweden, interview 1, civil servant, Ministry
2. Sweden, interview 2, judge, Land and Environment Court
3. Finland, interview 1, civil servant, Ministry
4. Finland, interview 2, judge, administrative branch
5. Spain, interview, national expert on water regulation and management
6. France, interview, one national expert on eflows & one civil servant at environmental agency
7. England, interview, two national civil servants on water regulation and eflows
8. Romania interview 1 civil servant, water administration
9. Romania, interview 2, NGO

Annex II – Analysis template (Regulating eflows)

Enabling policies and institutions

Question 1 – How are key requirements set for eflows in your country? *Multiple options are possible* *Depending on the type of response chosen, provide detailed information on the requirements set. E.g. in case of specific national legislation, please provide law number, articles on eflows, and content of requirements.* *Provide key references of relevant documents.*
☐ In national legislation (clearly explain if it is national water law/water act; or a decree; or a regulation; or a specific regulation on dam operation) ☐ In regional legislation ☐ In national guidelines or non-binding standards ☐ In regional guidelines or non-binding standards ☐ In sector-specific guidelines (e.g. eflows guidelines for hydropower) ☐ Case-by-case permit requirements (with or without underlying legislation) ☐ No requirements for eflows ☐ Requirements in development Please explain:
Question 2 – Which key EU policies does the eflows policy framework link to in your country? *Multiple options are possible*
☐ Water Framework Directive ☐ Habitats & Birds Directives (conservation/restoration of habitats and species) ☐ Floods Directive ☐ Environmental Impact Assessment ☐ Other Please specify if different pieces of legislation address eflows for these different policies:
Question 3 – Are there any other strategies or plans which address eflows explicitly? This could include river basin management plans, drought management plans, climate adaptation strategy or plan, sectoral plans (e.g. hydropower national or regional master plans)

Question 4 – Does legislation define one or more competent authorities for eflows implementation at different scales (e.g. ministries, independent agencies, river basin organisations, etc)? **If not by legislation, are the competent authorities defined in another context?**
Question 5 – Explain the role of each competent authority, i.e.
a) Who is the lead authority on eflows policy? Explain: b) Who is responsible for defining eflows in the river basin management planning (RBMP) planning process? Explain: c) Who is responsible for issuing and revising permits that respect eflows? Explain: d) Who is responsible for monitoring, enforcement and compliance with eflows? Explain:
Question 6 – Which stakeholders are involved in the implementation of the overarching policy framework for eflows at more local level? How are decisions taken?

Legal definition & scope of eflows

Question 7 – How does legislation define eflows? Please provide the specific wording.
Question 8 – Do legal and regulatory requirements and methodologies only consider minimum flows? Or do they consider different flows (high flows, flood flows, base flows, etc) in different seasons?
Question 9 – Are the particular ecological conditions of natural droughts included in the definition of eflows in the legal and regulatory framework?
Question 10 – Does the eflows policy framework specify a methodology for establishing eflows? *Choose one option*

☐ Yes, one methodology specified

☐ Yes, more than one methodological option

☐ No methodology specified

☐ Methodology in development

If **yes**, is it a hydrology-based methodology with a focus on minimum flows? Or is it a methodology based on habitat models? Or something else?

Please explain:

Question 11 – Do legal and regulatory requirements apply in theory to any water body or is there a focus on specific waters only, e.g. waters with protected species?

Question 12 – Which specific legal and regulatory requirements for eflows are defined, regarding flow magnitude, timing, frequency, duration, different seasons in the year, and year-to-year variability?

Question 13 – Do legal and regulatory requirements for eflows refer to:

… **the role of eflows for meeting WFD and other policy requirements for good water quality, particularly at low flow conditions (e.g. link of eflows implementation to bathing or recreational waters standards, to regulations for sewage treatment plant discharges, for industrial discharges, for application of fertilisers/pesticides)?** ☐ Yes ☐ No ☐ Unclear

Please explain:

… the link between groundwater levels and eflows (groundwater acknowledged as key factor in supporting eflows and groundwater-dependent ecosystems)? ☐ Yes ☐ No ☐ Unclear

Please explain:

… the link between eflows and the status of specific biological quality elements (e.g. fish) under WFD? ☐ Yes ☐ No ☐ Unclear

Please explain:

… the link between eflows and the survival of certain species? ☐ Yes ☐ No ☐ Unclear

Please explain:

… the link between eflows and keeping healthy ecosystems to provide key ecosystem services? ☐ Yes ☐ No ☐ Unclear

Please explain:

… the link between eflows, hydromorphology and sediment? ☐ Yes ☐ No ☐ Unclear

Please explain:

… the link between eflows and climate change? ☐ Yes ☐ No ☐ Unclear Please explain:
Question 14 – How are the eflows requirements from the overarching policy framework translated into requirements at more local level? *Multiple options are possible*
☐ Eflows for specific water bodies determined in River Basin Management Plans and Programmes of Measures of WFD ☐ Eflows established for specific hydraulic infrastructure (e.g. dams) based on national/regional regulations ☐ Other Please explain:

Eflows in the water allocation regime

Question 15 – How are eflows addressed in water allocation in your country? *Multiple options are possible*
☐ A cap on total water abstractions (surface and groundwater) is imposed to protect and preserve eflows (cap imposed before water becomes over-allocated and eflows cannot be met) (prior restriction approach) ☐ Reallocation or reduction of abstraction rights of water users (e.g. hydropower, irrigation) to ensure eflows are protected (eflows are considered as "another water use") ☐ A legal right to water for the environment is established (water license held by an entity on behalf of the environment). This involves granting entitlements to the environment (non-consumptive use), similar to consumptive entitlements. ☐ Other Please explain:
Question 16 – Does the regulatory framework allow for reduction of eflows under drought conditions?

Eflows and the system of permits and water rights*

*(*in addition to questions asked under "permitting regime" in water allocation section of questionnaire)*

Question 17 – Is there a clear regulatory framework to limit or prohibit abstractions at low flows in dry periods? **If yes, does this apply to both surface and groundwater abstractions?**
Question 18 – Are there old water rights? Define year (year of legislation) before which water rights are defined as "old"
Question 19 – Is there a clear timeline set in the legal and regulatory framework to review old water rights and existing abstraction permits? Does the legal and regulatory framework make specific reference to the introduction of eflows in this context?

Enforcement and compliance

Question 20 – Is there a legal obligation to monitor eflows at large infrastructures and major water intakes (e.g. dams)?
Question 21 – Is there a legal obligation to monitor eflows at other parts of the river network affected by smaller abstractions and intakes?
Question 22 – Are there regular reports published by competent authorities on the level of compliance with eflows in different river basins and water bodies (based on monitoring)?
Question 23 – Does the legal and regulatory framework foresee penalties for permit holders if eflows are not respected? If yes, what type of penalties is foreseen? Is this limited to permit holders for large infrastructures and major water intakes (e.g. dams)?
Question 24 – Are the impacts of implemented eflows on ecosystem condition regularly assessed based on monitoring and, if needed, eflows adapted? (i.e. adaptive management)
Question 25 – Are there trainings offered by competent authorities to lawyers and judges on eflows, to be prepared for legal cases on water rights disputes involving eflows implementation?
Question 26 – Are technical and scientific advisors called in, if there are legal cases on water rights disputes involving eflows implementation?

Barriers

Question 27 – Which of these barriers do you think apply most to the implementation of eflows in your country? *Multiple options possible. Barriers may vary between different places in the country. We ask for an overall judgement, but please explain in what ways your judgement should be qualified below.*
On a scale of 1 (very important), 2 (important), 3 (less important) to 4 (not important)

Eflows **definition and implementation mechanisms** set out in legal framework are **not sufficiently precise and detailed** and so implementation can differ across the country. Explain possible reasons (use examples/mention specific cases, if applicable): …	
Uncertainties on the definition of eflows and lack of clear methodologies in the legal framework for establishing eflows. Explain possible reasons (use examples/mention specific cases, if applicable): …	
Eflows **definition and implementation mechanisms** set out in legal framework for eflows are **not properly translated in local context**. Explain possible reasons (use examples/mention specific cases, if applicable): …	
Declining water availability and increasing variability of flow regime under climate change. Explain possible reasons (use examples/mention specific cases, if applicable): …	
Scientific barriers e.g. lack of scientific knowledge on interrelation of surface and groundwater abstractions with eflows, lack of appropriate data and models on flow regimes. Explain possible reasons (use examples/mention specific cases, if applicable): …	
Eflows implementation hindered by not controlling **illegal groundwater and surface water abstractions.** Explain possible reasons (use examples/mention specific cases, if applicable):	
Old water rights cannot be reviewed (or difficult to review) to introduce eflows requirements. Explain possible reasons (use examples/mention specific cases, if applicable): …	
Eflows implementation hindered by **lack of information exchange and collaboration between different policy institutions** relevant to water use, e.g national authorities for environment, energy, flood protection, regional and local authorities implementing water management measures. Explain possible reasons (use examples/mention specific cases, if applicable):	

Eflows enforcement hindered by **opposition of water users (e.g. hydropower, irrigation) because of reduction of economic benefits** when eflows are introduced. Explain possible reasons (use examples/mention specific cases, if applicable), explain which water users: …	
Eflows policies are not considered in planning processes and policies of key sectors that are major water users and may thus impact eflows implementation (in particular, hydropower plans; CAP and rural development programmes for agriculture; water utility strategic plans; industrial water use policies and planning) Explain possible reasons (use examples/mention specific cases, if applicable):	
Eflows implementation and enforcement hindered by **lack of involvement of stakeholders** other than authorities. Explain possible reasons (use examples/mention specific cases, if applicable): …	
Eflows implementation hindered by **lack of communication to convince citizens** on the importance of water in the river Explain possible reasons (use examples/mention specific cases, if applicable): …	
Eflows implementation hindered by **lack of resources and capacity** of competent authorities for this issue. Explain possible reasons (use examples/mention specific cases, if applicable): …	
Compliance check of eflows implementation hindered by **unsuitable monitoring** framework for this purpose Explain possible reasons (use examples/mention specific cases, if applicable): …	
Enforcement of eflows hindered by **insufficient penalties** to permit holders when eflows are not respected Explain possible reasons (use examples/mention specific cases, if applicable): …	
Other Please explain: …	

Question 28 – Are there any steps planned to develop the existing legal and regulatory framework for eflows definition and eflows implementation?

Good practice

Question 29 – please report any good practice / front runners in implementing successfully eflows that you have come across during your research for this questionnaire *Compiling such examples will be useful for Task 2.2 on innovative governance mechanisms*