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## The Water Abstraction License Regime in Italy: A Case for Reform?

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#### Summary

The current Water Abstraction License (WAL) regime in Italy is no longer flexible enough to cope with the challenges posed by human-induced climate and global environmental changes. The cornerstones of the current regime were laid down in the 1930s and have remained essentially unchanged ever since. The sole noteworthy reform of the Italian WAL regime was the decentralization of the regulatory competences from the state to the regional authorities in the late 1990s. In this paper, we review the WAL regimes across the administrative regions comprising the Po River Basin District (PRBD), the largest and economically most important in Italy. PRBD's WAL regime includes a rigid and scattered WAL normative that hinders the performance of bottom-up conflict resolution mechanisms at a basin scale; a water pricing scheme that does not reflect the cost of water conveyance and use, and does not encourage efficient water allocation; and the lack of a central WAL register, which delays and in some cases impedes an environmental impact assessment for issuing new licenses or renewing existing ones, and does not allow prioritizing applications according to their full economic value. We argue these deficiencies may compromise both the integrity of riverine and water dependent ecosystems and the economic uses of water. This paper offers insights that can inform reform of water allocations in the PRBD and elsewhere in Italy and in Europe.

**Keywords:** Water Abstractions License, Water Fee, Water Security, Po River Basin District

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# The Water Abstraction License Regime in Italy: A Case for Reform?

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**Abstract:** The current Water Abstraction License (WAL) regime in Italy is no longer flexible enough to cope with the challenges posed by human-induced climate and global environmental changes. The cornerstones of the current regime were laid down in the 1930s and have remained essentially unchanged ever since. The sole noteworthy reform of the Italian WAL regime was the decentralization of the regulatory competences from the state to the regional authorities in the late 1990s. In this paper, we review the WAL regimes across the administrative regions comprising the Po River Basin District (PRBD), the largest and economically most important in Italy. PRBD's WAL regime includes a rigid and scattered WAL normative that hinders the performance of bottom-up conflict resolution mechanisms at a basin scale; a water pricing scheme that does not reflect the cost of water conveyance and use, and does not encourage efficient water allocation; and the lack of a central WAL register, which delays and in some cases impedes an environmental impact assessment for issuing new licenses or renewing existing ones, and does not allow prioritizing applications according to their full economic value. We argue these deficiencies may compromise both the integrity of riverine and water dependent ecosystems and the economic uses of water. This paper offers insights that can inform reform of water allocations in the PRBD and elsewhere in Italy and in Europe.

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## 1. Introduction

Water scarcity, along with more frequent and severe droughts, are threats that may undo the efforts to achieve the good ecological status of the European water bodies [1], and short-circuit the performance of a wide array of sectors driving economic growth [2]. The financial crisis of the past decade has revealed a high exposure of the EU to economic shocks, including that of extreme weather and climate-related hazards, exacerbated by fiscal and “other macro-economic imbalances” [3]. The European Climate Adaptation Strategy [4] has diagnosed that the risk posed to water security [5] will make up the bulk of the expected climate change environmental and economic impacts. However, the mitigation of water scarcity and droughts is but the last among the aims declared in Article 1 of the Water Framework Directive (WFD) [1], and the least substantiated. The issues of water scarcity and droughts have been further addressed in the EC Communication on water scarcity and droughts [6], which has identified a more efficient water allocation among the seven European concerted actions. Efficient water use is also a cornerstone of the EU Resource Efficiency Flagship initiative, as a part of the Europe 2020 Strategy. The EU Water Policy Review [2,7] has noted some progress, though as yet insufficient, in drought management in Europe, and in the application of economic principles (e.g., cost recovery and water pricing). It has encouraged, cautiously, the use of market mechanisms (e.g., the water right trading scheme) where this represents a value-added increase [2]. Along with this process, the European Parliament (EP) has recommended on several occasions a targeted European policy on water scarcity and droughts [8].

There is reason to believe that, along with the growing demand for water, the effects of the water supply crisis induced by climate change will become particularly pronounced in Southern

Europe [5,9,10], and especially in Italy [11]. It is widely accepted that the most effective and efficient ways of *adapting* to amplified scarcity and droughts are a combination of economic instruments (e.g., insurance, and water pricing and trading) along with legislation and regulation in order to plan more successfully for scarcity and drought spells [2,5,12]. The successful implementation of proactive water management instruments such as those listed above demands flexible, consistent and sustainable Water Abstraction License (WAL) regimes [13–17]. Some EU Member States, most notably Spain and UK, have already started a reform of WAL regimes to address this need.

Water abstraction permits in England and Wales were regulated by the Water Act of 1963 [18]. The permits took into little or no consideration what level of abstraction the water body could actually supply and the allocation system has since proved to be unsustainable. Current abstraction levels are causing significant ecological problems in over 1000 river water bodies [19] and 42% of groundwater bodies are failing [20]. The Water Resources Act of 1991 delegated the task of issuing abstraction licenses to the Environment Agency [21]. The payment of a fixed fee proceeds with the application whose amount is stated in the Abstraction Charges Scheme collected by the Environment Agency (EA). There are three types of licenses: a full license (>20 m<sup>3</sup>/day); a temporary license (<20 m<sup>3</sup>/day over a period of less than 28 days); and a transfer license (trading of full licenses). Only full licenses are charged the fixed fee by the Environment Agency (as of 2015, the minimum annual charge for full licenses is £25.00)[22]. All new abstraction licenses granted after April 2004 are required to include a time limit of typically 12 years. Temporary and permanent water trading for the whole or part of the WAL are possible but typically require the parties involved to apply to the Environment Agency for a new license and to change or cancel (revoke) any existing license. The current WAL regime has proved inadequate in coping with growing challenges. A reform has been recommended in the Cave Report [23] and supported by the analysis of the Water Service Regulation Authority (OFWAT) and the EA. The reform, announced in the Natural Environment White Paper [24] and further substantiated in the Department for Environment Food & Rural Affairs (DEFRA) [25,26], introduces a transition to a new regime by the 2020s. The scope of the reform is to install flexible and sustainable tradable licensing regime capable to respond to current and future challenges.

In Spain, water has been managed within hydrological units ever since the River Basin District Authorities (RBDAs) were instituted back in 1926. The water license holders are granted the right to abstract and use water of specified volumes and for specific purposes. Water is public, and only a fraction of groundwater resources is privately owned [27]. WALs are awarded, supervised and managed by RBDAs, which can limit abstractions either temporarily or permanently, e.g., to meet environmental regulations. Water charges are exerted through a regulation fee (in Spanish: *canon de regulación*, charges for the abstraction and storage costs of surface water), a water use tariff (in Spanish: *tarifa de utilización de agua*, charges for the transportation costs of surface water), sanitation and treatment tariffs, and additional contributions raised by water user boards (e.g., irrigation communities) [27,28]. The 1999 reform of the Water Law allowed for trading of water entitlements [28]. Successive reforms have designated a more flexible WAL regime that is able to channel water abstractions towards economically more efficient uses [27–29]. The RBDA may not authorize the trading deal in the case of conflicts with pre-existing uses, although the rule of positive administrative silence applies [30].

In Italy, the WAL regime is tortuous and substandard, reflecting a Byzantine interplay of water institutions [31]. An abstraction license is required under the Royal Decree (R.D.) n° 1775 of 1933 [32] for the abstraction of surface waters (such as from rivers, streams and canals) and groundwater. Since then the regime has evolved through a process of political decentralization and devolution of environmental protection [33]. As a result, the regional administrations (hereafter regions) Regions have gained full jurisdiction over WAL matters. The transposition of the EU WFD in Italy has prompted a number of legislative and institutional reforms, in which include the 2006 Environmental Code (EnC, in Italian: *Testo Unico Ambiente*, Legislative Decree 152/2006) [34].

According to the EnC, license holders are entitled to abstract a specified quantity of water from a particular source and for a specific purpose. The license award is conditional to conformity with

minimum environmental flows. If the latter are not guaranteed, the regulator may impose revision or revocation of WAL. Temporary limitations may be enacted during prolonged periods of droughts. WAL holders are obliged to pay Water Concession Fees (WCF), a part of which, according to a recent regulation, is earmarked for implementing measures to improve and maintain a proper ecological status of water bodies [34]. The licenses are specified in *absolute* terms and are not transferable. Moreover, the temporal horizons for which the licenses are issued do not take into account the changing availability of water resources in the medium and long-term, as a result of climate change. Nor do they consider changes in the demand for water driven by population growth and economic development. Since human-induced climate change will likely result in a lower average annual water availability and a greater intra- and inter-annual variability [35], the *National Climate Adaptation Strategy* for the Po River Basin District (PRBD) has suggested revising the WAL regimes [36]. From our analysis of the PRBD case study, we propose recommendations on priorities for a national water abstraction reform, in line with international best practices on water abstraction reform [37–39].

## 2. Water Management in the Po River Basin District

The PRBD is the largest single river basin in Italy, spreading over 71,000 km<sup>2</sup> (24% of the state territory) and is home to a growing human population of more than 17 million (+6% since 2001, and expected to increase up to 18–21 million by 2050), most of whom live in small towns and cities with fewer than 25,000 inhabitants. The PRBD extends over several regions: Valle d’Aosta, Piedmont, Lombardy (all three almost entirely included in the basin), Emilia Romagna (about half of whose area is included in the basin), Veneto, Liguria and Tuscany (marginally included in the basin area). The Autonomous province of Trento is also partly covered by the PRBD. The river basin district hosts a dynamic economy that generates around 35% of Italy’s GDP, fuelled by some of the most vibrant industrial hubs in the proximity of the large urban centers of Milan, Turin, Brescia, Modena, Parma, Reggio nell’Emilia, Ferrara, Monza, Bergamo, Novara and Piacenza. The PRBD also offers services of strategic importance, including about 1200 hydroelectric power stations representing 41% of Italy’s hydropower installed capacity, and 1180 thermo-electrical plants that produce around half of the country’s thermoelectric energy. The PRBD also includes Italy’s largest contiguous agricultural land area, nearly 21% of its total agricultural area, 21.5% of its utilized agricultural area, and almost 30% of its agricultural value added [17].

Total water abstractions (consumptive uses) from the Po river account for more than 20.5 billion m<sup>3</sup> per annum (Table 1) most part of which (16.5 billion m<sup>3</sup>) is used in the agricultural sector, 2.5 billion m<sup>3</sup> for drinking water and 1.5 billion m<sup>3</sup> for industrial uses. Abstractions account for 14.5 billion m<sup>3</sup> for surface waters and for 6 billion m<sup>3</sup> for groundwater [40].

**Table 1.** Annual average water uses by sources. Legend (\* energy production excluded) [41].

Uses	Volume (10 <sup>6</sup> m <sup>3</sup> /yr)	Surface water (%)	Groundwater (%)
Potable	2500	20	80
Industrial *	1537	20	80
Irrigation	16,500	83	17
Total	20,537	63	37

Water use in the PRBD has increased over the last decades, and the volume of authorized WAL exceeds average water availability [42]. The problems become more pronounced during the irregular periods of drought spells. During the spring and the summer of 2003, a severe, persistent drought afflicted Southern Europe, including the PRBD. The Po River reached its absolute minimum at the closing section in Pontelagoscuro: −6.99 m or 270 m<sup>3</sup>/s compared to an average of 1400 m<sup>3</sup>/s. In 2006 and 2007, Northern Italy experienced another anomaly in terms of precipitation, and in 2007 river discharges were lower than in 2003. Since 2003, a State of (national) Emergency (SoE) under the law 224/1992 has been declared three times (2003, 2006, and 2007) for a total duration of 21 months [43].

Water restrictions during droughts respect the priorities specified in the EnC [34], e.g., first the household water demand is satisfied, then the irrigation demand and lastly any other miscellaneous

uses. The maintenance of minimum environmental flows was imposed in the late 1980s and later included in the EnC [34]. If shortages worsen to a SoE, the central government appoints a Commissioner Delegate with full powers to manage water bodies. With the aim of limiting welfare losses, the Commissioner Delegate may issue extraordinary water allocation rules that do not necessarily follow the EnC [34] protocol. The contemporary regulatory framework encourages voluntary agreements among users before the SoE is activated [34]. These agreements are managed in the context of the Drought Steering Committee (DSC).

The DSC was initiated and presided over by the Po River Basin Authority (PRBA) in May 2003, amidst a severe water crisis posing a threat to urban water supplies in the lower part of the district, and to irrigation throughout the whole district. The cooperative decision of the DSC was sanctioned by signing a Memorandum of Interest (MoI, in Italian: *Protocollo d'Intesa*), which stipulated the commitments of irrigators to reduce water withdrawal by 25 to 50%, and hydropower operators to release more water from Alpine reservoirs and large regulated lakes. Moreover, the DSC sanctioned a close monitoring of evolving drought conditions. Since 2003, the DSC has been convened whenever persistent drought conditions have threatened to strain Italy's most important economic regions. The DSC also played an important advisory role during the SoE in the 2007 drought, institutionalized through the decree of the Commissioner Delegate for the management of the SoE [44].

Notwithstanding the increased frequency and intensity of droughts and the improved drought knowledge and response in the PRBD, these events are still predominantly managed by resorting to emergency instruments [45]. Proactive drought management instruments being used elsewhere, such as (incremental) water pricing [46], temporary trading of water rights [15,39,47], drought insurance [48] or even drought management plans [49], rely on flexible, consistent and sustainable WAL regimes that are currently non-existent in Italy. A WAL reform is imperative to define the main framework for planning and programming activities with a long-term water security perspective whose aim is to move away from an emergency approach to drought to a proactive and ongoing one.

### 3. Water Abstraction Normative Regimes across the PRBD

In 1933, R.D. 1775/1933 [32] established that nobody, not even a landowner, could withdraw water from natural water bodies without an authorized license. The only exception was water withdrawal for domestic use by landowners or tenants. Domestic use comprises water supply and sanitation, watering of gardens and orchards, and/or water used for livestock. This use is exempt from the obligation to declare withdrawal and hence payment of water concession fees. In both quantitative and qualitative terms, the impact of this exception is marginal. Under the current regimes the abstractions that are exempt from permits and fees are subject to limits that vary across the PRBD regions. In Piedmont, the flow rate must not exceed 2 L/s and 5000 m<sup>3</sup>/year, while in Lombardy it is limited to 1 L/s and 1500 m<sup>3</sup>/year. Veneto allows water withdrawal for domestic use in areas not served by aqueducts and limited to 0.1 L/s. In Emilia-Romagna and Valle d'Aosta, withdrawal limits are not specified.

An *informal* though widespread exception was made for groundwater use, which remained to a large extent outside of the WAL regime until 1994, when groundwater abstractions were converted to formal WALs after Galli Law 36/1994 [50], replaced in turn by the EnC in 2006. [34]. The GL [50] and the EnC [34] also oblige WAL owners to declare their existence and characteristics in order to make an overall census possible, although this objective has so far failed to be fully attained in the PRBD (see Section 5).

The R.D. 1775/1933 [32] distinguished between Small Volume (SV) and Large Volume (LV) WALs (Table 2). For SV permits, R.D. 1775/1933 [32] entrusted WAL management to the Public Works Offices (PWO, in Italian: *Ufficio Regionale del Genio Civile*, is a regional peripheral authority on a provincial basis, which ensures all the functions relating to the execution of public works, while the LVs were controlled by the government. With Legislative Decree (in Italian: *Decreto Legislativo*, D.Lgs.) 112/1998, the WAL authorities were transferred to the regional governments. Where not otherwise specified, the provisions of the R.D. 1775/1933 [32] still apply.

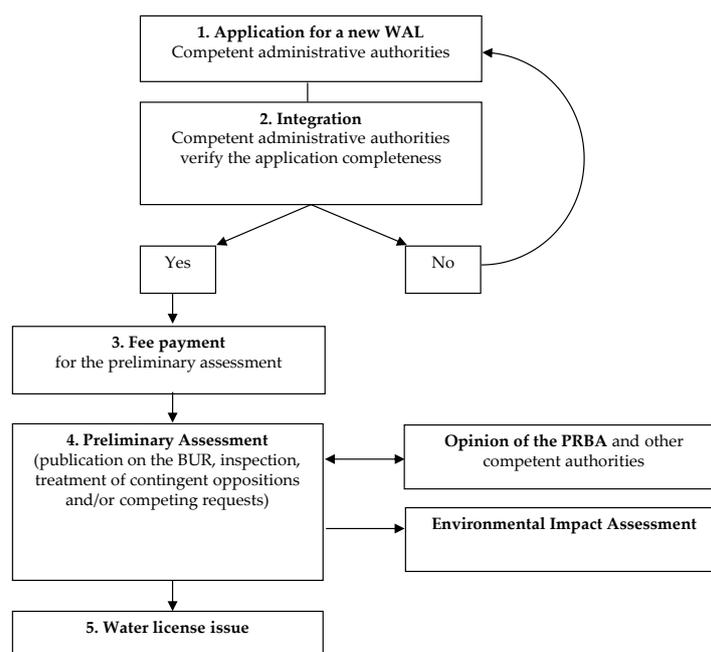
**Table 2.** WAL differentiation by type of use (source: [32]).

Uses	Small volume abstractions	Large volume abstractions
Hydropower [HP] generation	<3000 kW of installed capacity	>3000 kW of installed capacity
Irrigation	<1000 L/s or < 500 ha	>1000 L/s or >500 ha
Others	<100 L/s	>100 L/s

The five regions comprised regions included either entirely or substantially within the PRBD, have introduced to some extent different WAL regimes. Piedmont, Emilia-Romagna and Lombardy have adopted regulations or regional legislations throughout the period 2000–2006: first Emilia Romagna (Regional Regulation 41/2001; a Regional regulation, R.r., is not a law or primary source, but a secondary source that implements and integrates a law) [51], followed by Piedmont (R.r. 10R/2003) [52] and Lombardy (R.r. 02/2006) [53]. Valle d’Aosta, a region enjoying high administrative autonomy, applies a law which dates back to the 1950s (Regional Law 04/1956; in Italian: *Legge regionale*, L.r.) [54]. Veneto governs the WAL through sporadically updated regulations [55]. In the PRBD, regions issue licenses for LV abstractions and specify water concession fees for all types of uses. The regional authorities also have the faculty to enforce additional limits and obligations which the permit holders have to comply with, for safeguarding environmental integrity and quality and for contributing to the objectives of the regional Water Protection Plans (WPP, in Italian: *Piano di tutela delle acque*), which are revised every 6 years. On the other hand, WAL for SV abstractions are issued by lower administrative authorities, which are also in charge of making preliminary assessments of the compatibility of new and existing entitlements (both SV and LV). In Piedmont and Lombardy, the two latter roles are assumed by provincial authorities; in Veneto, by the PWO; and in Emilia-Romagna by Technical River Basin Services (TRBS), entities in charge of water management related issues and existing only in this region [56]. In Valle d’Aosta, given its small extent, the regional public water management office is responsible for both SV and LV abstraction licenses.

The administrative procedures for the concession of SV and LV WAL are rather similar across the PRBD regions (Figure 1). Permits are issued upon a satisfactory preliminary impact assessment. Preliminary assessments include the publication of the water concession application in the official regional bulletin (in Italian: *Bollettino Ufficiale Regionale*, BUR), an inspection (*conferenza dei servizi*) and, finally, the treatment of contingent oppositions and/or competing requests. Applicants are charged a fixed fee for the preliminary assessment, as opposed to the variable water abstraction fee detailed in Section 4. Preliminary assessments may also include the opinion of the PRBA, which unlike the regionally implemented Environmental Impact Assessments (EIA), is not binding. The EIA is based on the water concession flow rate and considers the environmental impacts to protected natural areas, such as Special Protection Areas or Special Areas of Conservation (SACs). Only if the EIA is positive is the water concession application accepted [34].

The only formal WAL that does not follow the administrative process described above is the “draw permit” (in Italian: *atingimento*), a temporary license related to contingent situations that allows the owner to withdraw surface water by means of mobile pumps. A *draw license* is granted for one year and can be renewed a maximum of 5 times. It may be revoked at any time on the basis of public interest, and without compensation for the license owner. In Piedmont, “draw license” also exist for the upper phreatic level. Piedmont and Lombardy have specific withdrawal limits for “draw license” (60 L/s and 40 L/s, respectively, and no more than 300,000 cubic metres per year each). Emilia-Romagna, Veneto and Valle d’Aosta refer to art.56 of R.D. 1775/1933 [32], which states that “draw licenses” are the responsibility of lower institutions (the Technical River Authority, the Public Works Office and the regional public water management office, respectively) as long as: (i) the water withdrawn is less than 100 L/s; (ii) damage to the river bank is avoided; and (iii) there is no modification of river conditions or negative impact on environmental uses.



**Figure 1.** Administrative phases for LV and SV WAL across regions comprised in the PRBD. Source: *Own elaboration*

The main water use categories are defined in the R.D. 1775/1933 [32] as civil, drinkable use; irrigation, energy production, industrial use; and health and sanitation use. The R.D. 1775/1933 [32] specifies a WAL duration of 40 years in the case of irrigation and 30 years for other uses, although regional laws may specify otherwise (Table 3).

**Table 3.** Terms of water uses for regions comprised regions included in the PRBD (source: own elaboration from [51–55]). Legend: \* In the case of water rights allotted prior to 1956, Valle d’Aosta considers “no limitation” for Irrigation and Potable uses and 99 years for other uses.

Uses	Piedmont	Lombardy	Veneto	Emilia-Romagna	Valle d’Aosta *
Irrigation	40	40	40	40	40
Potable	30	30	30	30	30
Civil	30	30	30	30	30
Industrial	15	15	30	30	30
Fish Farming	30	40	30	40	30
Energy	30	30	30	40	30
Sanitation	30	30	30	40	30
Zootecnic	30	30	30	30	30
Others	30	30	30	30	30

The application for the WAL renewal must be submitted before the license expires, after the promulgation of a new regulation that specifies requiring renewal, or in case a substantial variation of water withdrawal is intended. Piedmont and Lombardy specify tighter time constraints for WAL renewal: Piedmont’s regulation states that the renewal application has to be submitted at least one year before the license expires, while Lombardy accepts the application for renewal only if submitted no later than six months before the license expires. Otherwise, the WAL can be revoked in which case a new WAL procedure is necessary (Figure 1). In all regions, WAL renewal may be declined for reasons connected to public interest [51–55].

An existing WAL can be revoked as a result of the following omissions or negligence: (i) the (intended) water use differs from the one granted; (ii) the user does not respect the conditions and requirements associated with the license; (iii) failure to pay the abstraction charge for two consecutive years; (iv) end of term of the concession; (v) sub-licensing to third parties (e.g., trading); (vi) structural allocative inefficiencies that cannot be addressed through temporary or permanent limitations in the WAL; and (vii) an inadequate environmental flow (EF) [51–55]. It is worth noting

that environmental standards for water flows in Italy focus on minimum environmental flows [34] instead of the ecological flows necessary to guarantee a “a hydrological regime consistent with achieving WFD environmental objectives in natural surface water bodies” [57]. The legislations of Piedmont and Lombardy also consider the following cases: (viii) no abstraction for three consecutive years; and (ix) a failure to install flow rate metering devices, mandatory for new WAL [34].

Different norms and procedures across the PRBD have created a fragmented WAL regime, managed by regions and numerous lower administrative authorities. This situation is aggravated by persistent bureaucratic tangles, poor coordination among regions and insufficient supervision. Besides lacking a unifying set of norms, the PRBD also lacks a coordinating entity with powers extending beyond the PRBA’s advisory role. Differing water abstraction fees and the largely uncontrolled overall WAL census reflect this substandard regulatory context.

#### 4. Water concession fees across the PRBD

Water in Italy is charged through water fees and tariffs. Water tariffs are charges imposed on water storage, treatment and/or supply, and contribute to financial cost recovery of these services [58]. Water tariffs include charges levied by *Land Reclamation and Irrigation Boards* (in Italian: *Consorzi di Bonifica e Irrigazione*, public institutions that control land reclamation and about 90% of water distribution in agriculture), and prices domestic users pay for water supply and sanitation services. Water Concession Fees (WCFs) are charges paid by WAL holders typically according to the volume of water withdrawal permitted. WCFs were established by art.35 of R.D. 1775/1933 [32] and at present are fixed and levied by the regions (Bassanini D. Lgs 112/98 [59]). WCFs are detailed in Table 4 (prices are specified in harmonized units). WALs are typically specified in modules for all uses except for unmetered irrigation abstractions, where licenses are issued per ha, and hydropower, where licenses are issued per Kw. For all other uses, modules include the right to withdraw 100 L/s, except for industrial uses, where modules include a flow of 3 L/s in all regions but Lombardy (again 100 L/s) and Piedmont (1 L/s).

**Table 4.** Water abstraction fees (as in 2014) for the major water uses across the PRBD regions. Source: own elaboration from [60–64]. Legend: <sup>1</sup> abstraction with return; <sup>2</sup> abstraction > 3000 L/s; <sup>3</sup> large volume abstraction (>3000 kW); <sup>4</sup> small volume abstraction, installed capacity < 220 kW; <sup>5</sup> small volume abstraction, 220 kW < installed capacity < 3000 kW; <sup>6</sup> surface water; <sup>7</sup> groundwater.

Use	Unit	Lombardy	Piedmont	Emilia-Romagna	Veneto	Valle d’Aosta
Potable	€/L/s	22.51	22..22	20.43	43.06	20.49
Irrigation	Metered, €/L/s	0.53; 0.26 <sup>1</sup>	0.53	0.48	1.01; 0.51 <sup>1</sup>	0.48
	Unmetered, €/ha	0.53	1.16	0.44	0.919	0.45
Industrial	€/L/s	165.30; 333.22 <sup>2</sup>	166.74	142.41	300.42	142.97; 71.49 <sup>1</sup>
Hydropower	€/kW	15.35; 30.91 <sup>3</sup>	28.24	13.93	29.38	18.54 <sup>4</sup> ; 22.66 <sup>5</sup> ; 25.76 <sup>3</sup>
Civil	€/L/s	11.25	11.11	10.33	21.53	10.25
Fish Farming	€/L/s	3.75	3.74	3.41	3.76 <sup>6</sup> ; 7.18 <sup>7</sup>	3.42
Sanitary	€/L/s	11.25	11.11	10.33	21.53	10.25
Zootecnic	€/L/s	11.25	56.72	10.33	21.53	10.25

Where water is abstracted for different uses by the same WAL holder and the volumes abstracted cannot be split to account for different uses, the WCF corresponds to the water use for which the highest fee is due. If metering is available, the WCF is proportional to existing uses. In the particular case where a single water abstraction combines irrigation and hydroelectricity uses (a traditional practice in the PRBD known as *molinare*), the WCF corresponds to the use with the highest fee.

On top of the regular WCF, hydropower operators pay an additional fee to local authorities for grants and exploitation of public waters for producing electricity. There exist two supplementary fees: i) a Supplementary Fee for Riparian Authorities (in Italian: *Sovracanone Enti Rivieraschi*) is paid by plants with an installed capacity above 220 kW and amounts to 5.72 €/kW in case the capacity is below 3000 Kw, and 7.35 €/kW; otherwise, the revenues thus raised are divided among the regions, provinces and riverain municipalities on a predetermined basis. A Supplementary Fee for Mountain Basins (in Italian: *Sovracanone per bacini imbriferi Montani*) is collected by municipalities and paid by operators located in mountainous areas with an installed capacity greater than 220 kW, amounting to 22.88 €/kW in case the capacity is below 3000 Kw, and otherwise 30.40 €/kW.

The rationale behind the WCF is that of charging water users the costs stemming from the private use of a public good (art.35 of R.D. 1775/1933), making this instrument the apparent choice for the recovery of resource and environmental costs of water use [1]. Ministerial Decree 39/2015 developed guidelines for defining resource and environmental costs and identified WCFs as an adequate instrument for reducing (if water is *conserved*) or recovering them. Resource costs are defined as the best use foregone (e.g., opportunity cost); environmental costs are the expenses, interventions or commitments necessary to restore a good ecological status of water bodies or to limit or contain damage stemming from a specific use. Environmental and resource costs should account for both the quantity and quality of water and for seasonal variations [65]. In reality, though, there is insufficient data on the total revenues annually collected by regions through WCFs, and these are generally considered insufficient for the purpose of recovering environmental and opportunity costs [66]. This is aggravated by the WCFs actually declining charges, since the applied projected inflation rate used for updating WCFs falls far below the real inflation rate (initially introduced under the Galli Law 36/1994 [50], then replaced by each regional WAL). In addition, WCFs are calculated on the basis of the potential and not the actual volume of water withdrawn, a method that removes incentives for water saving/conservation. Metering is a prerequisite for any incentive charging policy [2] and its adoption has recently increased in the regions included in the PRBD in the wake of the EnC [34], which made it compulsory to install metering devices for new WALs [34]. However, the adoption of metering devices in agriculture is still insufficient for implementing volumetric charges that address region-wide or basin-wide quantitative challenges [67].

There are also substantial equity issues related to WAL charging. WCF rates appear to be guided more by the user's ability to pay than by the activity's environmental and resource costs. For example in Lombardy, where droughts are becoming an increasingly vital issue, industrial uses represent 5% of the WAL and 63% of the collected fees. WCFs also vary substantially across regions, a situation that cannot be explained solely by differing resource and environmental costs, but also by other economic and policy factors that affect equity among otherwise similar water uses across the basin.

The revenue raised through WCFs in the PRBD is not specifically addressed towards protecting and/or restoring vulnerable water ecosystems, –in contrast to existing regulations (article 119, comma 2-a of the EnC [34]). WCFs are typically incorporated the gross regional budgets instead of remaining a separate line item related to water management. An exception is the region of Piedmont, which allocates part of its WCF funds to specific (though mostly unrelated to water management) line items, namely, a fund for the economic support of mountain communities (30% of the revenues) and water monitoring (5%) in the context of the WPP.

## 5. WAL Census

Physical water balances (or budgets) are essential for a quantitative management of water resources [2,57]. Similarly, a census of abstraction licenses is critically important for understanding water demands within a river basin. Information on the number and characteristics of WALs in Italy is not publicly accessible. For our analysis we have collected disaggregated data from various regional and sub-regional authorities, except for Emilia-Romagna, for which we have only obtained data aggregated at the provincial level. The records are highly heterogeneous. We have reviewed and processed the data and compiled a database that is nearly equivalent to a census. It includes information concerning 70,000 abstraction licenses and contains detailed technical and

administrative information on each of them. Table 4 summarizes water uses in the PRBD. The heterogeneous units of measurement were converted to m<sup>3</sup>/s to make them comparable.

**Table 4.** WAL Census (source: own elaboration based on WAL data collected from regional authorities [68–72]).

Uses	NO. of abstractions	Average water use		Maximum water use	
		% of abstractions with available information	Total (m <sup>3</sup> /s)	% of abstractions with available information	Total (m <sup>3</sup> /s)
Irrigation	21,909	57.8%	1653.6	17.2%	1690.3
Potable	8180	75.5%	342.0	19.5%	79.0
Industrial	6864	76.7%	411.9	22.0%	49.5
Fish Farming	706	75.2%	32.1	21.2%	10.6
Energy	3430	85.4%	6466.1	49.3%	7531.5
Sanitation	8639	82.6%	13.9	8.4%	3.6
Zootecnic	5798	83.4%	6.6	10.8%	113.9
Other uses	6773	56.2%	24.9	26.8%	22.1
Unspecified use	10,190	0.3%	24.1	0.3%	34.9
<b>Total</b>	<b>72,489</b>	<b>59.8%</b>	<b>8975.1</b>	<b>16.4%</b>	<b>9535.4</b>

The recorded characteristics typically include geographical coordinates of the withdrawal point, water source/body, type of permitted water use, status of license (active, expired or under review) and implied conditions, and time limit. The license is specified in absolute terms, either as average or (less frequently) maximum volume of flow that can be withdrawn. Piedmont, Lombardy and Valle d’Aosta specify both values. Where the maximum volume of flow that can be withdrawn is not specified, users have the opportunity to increase abstractions during drought events, precisely when it is a most valuable resource, and reduce its use during water abundant years so as to comply with average water use standards. Only some regions record return flows (Piedmont and Valle d’Aosta).

Withdrawal periods may be limited to irrigation seasons (April–September) but typically extend over the whole year. Some licenses, especially in the case of irrigation, do not define the abstraction volume. Therefore our analysis is partly incomplete. As drought spells are becoming more frequent and intense, gaps in the WAL Census may become a critical issue [37]. In an effort to improve coordination among the different authorities in charge of managing WAL within the boundaries of the PRBD, the Piedmont region recently created an online WAL database called the *Water Resources Information System* (in Italian: *Servizio d’Informazione delle Risorse Idriche (SIRI)*) [73].

## 6. Discussion and conclusion

A more flexible WAL regime in Italy is to be recommended, on account of the observed and expected decline in water availability, amplified climate variability [36], population growth and economic development, and as a means of regulating minimum environmental flows. In this article we look at the case of the of the PRBD, the largest and economically most important river basin district in Italy. We assess the deficiencies of the current WAL regime and we argue these may compromise both the integrity of riverine and water dependent ecosystems and the economic uses of water. The lack of a central WAL register delays and in some cases impedes an environmental impact assessment for issuing new licenses or renewing existing ones, and does not allow prioritizing applications according to their full economic value. It also does not allow taking the edge off the rising conflicts among the different water users during the times of temporary water shortages. The water pricing in place does not reflect the cost of water conveyance and use, and does not encourage efficient water use. The regime is too rigid to permit formal or informal agreements among users, let alone the transfer (temporary or permanent) of existing permits. Finally, the current regime hinders the performance of bottom-up conflict resolution mechanisms such as the Drought Steering Committee. A reform should be inspired by international experience [13–16,74], while

taking into account specific legal, institutional, economic and political conditions, in Italy in general and in the PRBD in particular. Based on our review we formulate the following recommendations that contribute to a greater water security in the district:

*First*, the WAL regime should specify the entitlements as shares of harvestable water resources and entitle shareholders to periodic allocations of water volumes that can be withdrawn for approved, site-specific purposes. Environmental outcomes should be managed by establishing minimum requirements in plans and perhaps by assigning shares to environmental trusts or their equivalents.

*Second*, transparency in governance and allocation arrangements should be granted by means of pre-established rules and procedures out stipulated in the river basin district plans. These rules should be reviewed periodically, say every ten years, and should clarify when, how and how much water will be allocated to each share-holder, and under what conditions unused allocations can be carried forward from one year to the next.

*Third*, the entitlements should check on the rate of return flow, so as to avoid harming the entitlements of downstream users.

*Fourth*, a single register of all water entitlements across the entire river basin district should be introduced and perhaps made publicly accessible.

*Fifth*, the river basin (district) authority should play a major role in controlling the environmental compatibility of the intended withdrawals, particularly for large volume abstractions. The WAL regime should respect the interconnection of and interaction between embedded ground/surface water systems, and between land (management) and the water cycle (run-off, infiltration and evapotranspiration). This, together with the register of entitlements, will favor the development of environmental-economic accounts [34].

*Sixth*, in the absence of or during the transition to genuine WAL trading schemes the water concession fees should be designed as incentives for (more) efficient water use and allocation [58]. The revenues collected by regions should cover operational costs of the WAL regime, including the monitoring, control, surveillance and enforcement costs. It is preferable to design the WCF as consisting of a fixed component and a variable component. Smart water meters should be installed for all abstraction licenses; not only for the new ones, but progressively for all existing abstraction permits.

*Seventh*, the potential efficiency achieved by making water entitlements transferable should be analyzed in depth. Properly designed water markets can both reveal the full economic value of water and facilitate its shift to highest value uses. The ample existing infrastructure favors physical water transfers and trading with licenses. However, in light of the manifested public opposition [75], it is not realistic to introduce a genuine trading scheme any time soon. If tradable permits are developed eventually, statutory plans need to anticipate potential market failures and define rules for determining whose shares and allocations can be traded.

*Eighth*, the length for which the WAL should be issued depends on whether or not introducing tradable permit schemes is envisaged in the long term. If there is an expectation of permission to trade with WAL in the future, then licenses should be released in perpetuity or, at least, with no time limits, in order to favor long-term investments and innovation. If not, licenses should be granted for durations that permit regular “back-end” adaptation to changing patterns of precipitation and river flow. Any changes in license durations should be managed by rules and procedures set forth in river basin district plans and/or regional water conservation plans.

These non-exhaustive principles and the complementary public debate have the potential to overcome the institutional “maze” which characterizes the current WAL regime. Our recommendations respond to allocation inefficiencies we have observed in the PRBD. They may have omitted relevant aspects that such a reform needs to tackle elsewhere. Still, our recommendations draw on EU and Italian policy guidelines [1,2,34,57], and build upon international standards [16] and experiences. We believe that this analysis offers helpful insights for water allocation reform elsewhere in Italy and in Europe, not least in river basin districts with similar characteristics. The new WAL regime should be robust yet flexible, and reliable yet sustainable. It

should balance robustness at the user level with flexibility at the system level, and address trade-offs between efficiency and equity, while guaranteeing environmental sustainability and hydrological integrity.

It is clear that the proposed reform will not be unproblematic. While many recognize that the current license regime fails to allocate water sustainably and efficiently [76,77], there is a considerable divergence of opinions on how the regime should be reorganized [78,79]. It is not conceivable to design, let alone to implement, a reform of a such magnitude without extensive public consultation and scrutiny. Interest groups, even if small, are well-organized and influential, and thus are capable of hampering public policy dialogue and impeding transformative change [80]. A practicable way forward for Italy is a stepwise transition to a (more) resource efficient economy [81,82], an integral part of which is a modern water allocation regime that is consistent with the principles we have outlined.

This research highlights areas in which a concerted policy response is warranted. Although at present there is no plan or intention to embark in a similar policy debate, our contribution has shown that the topic of WAL is important and should be handled with a high priority. Future research should explore how to inform, open and strengthen the policy dialogue that could eventually lead to a new WAL regime and a greater water security in the PRBD and elsewhere in Italy. The analysis and recommendations above represent a first attempt which may help in this regard.

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