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PARIS INSTITUTE OF TECHNOLOGY FOR LIFE, FOOD AND ENVIRONMENTAL SCIENCES

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Office national de l'eau
et des milieux aquatiques

TECHNICAL SYNTHESIS

Protection of public health and water in good status : Similarities and incompatibilities of 4 European directives

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Mars 2010

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Summary

This synthesis throws light on the challenges to achieve the “good status” of water in conjunction with those of Public Health. This issue is clearly illustrated in the comparison of : on the one hand Public Health management directives concerning water, notably those linked with drinking water, raw water, and water suitable for bathing and on the other hand the water framework directive (WFD). The comparison proves that there are synergies but also differences between the directives.
A synergy between these directives lies in the implementation of action plans in the catch basin (the battle against diffuse pollutions) which is going to complete the protection perimeters of the catchment (the battle against punctual pollutions) already set up for the drinkable water supply. On the other hand there are some differences between them: in particular, they are not generally interested in the same parameters and on certain common parameters such as pesticides, polycyclic aromatic hydrocarbons (PAHs) or heavy metals, water can be in “good status” without respecting the standards of potabilisation or of drinkability. Finally this synthesis highlights that there is confusion between the directives but no contradiction.

Key words : Bathing, Drinking water, Health, Raw water, Water Framework Directive

Résumé

Cette synthèse met en perspective les enjeux liés à l’atteinte du « bon état » face à ceux de la santé publique. Ainsi, la comparaison de la directive cadre sur l’eau (DCE) avec les directives « eau potable », « eaux brutes » et « baignade », trois directives usages liées à la santé publique, nous indiquent qu’il existe des synergies, mais aussi des différences entre elles. Une synergie entre ces directives réside dans la mise en place de programmes d’action dans les aires d’alimentation de captage (lutte contre les pollutions diffuses) qui va compléter les périmètres de protection des captages (lutte contre les pollutions ponctuelles) déjà mis en place pour l’alimentation en eau potable. En revanche il existe quelques différences entre elles : notamment, elles ne s’intéressent pas en général aux mêmes paramètres. Et, sur certains paramètres communs à au moins trois directives sur les quatre : tels que les pesticides, les hydrocarbures aromatiques polycycliques (HAP) ou les métaux, l’eau peut être classée au bon état selon les critères normatifs de la DCE tout en étant non conforme selon les normes de potabilisation (directive « eaux brutes ») ou de potabilité (directive « eau potable »). Enfin cette synthèse ne met à jour aucune contradiction majeure entre ces directives, seulement des confusions.

Mots clés : Baignade, Directive Cadre, Eaux brutes, Eau potable, Milieux aquatiques, Santé

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INTRODUCTION

The subject raises the problem of the interactions between water and health policies. It is a question of analysing the contents of the various directives relating to water and\or to health and of highlighting the points of convergence and, the incompatibilities. This technical synthesis will attempt to identify the points of agreement and divergence of the European directives on public health and on water regarding :

- Issues and objectives of these policies,
- normative criteria used in the implementation of the directives at the French level.

Even if the Water Framework Directive (WFD) of 2000 imposed the implementation of management plans and programs of measures at the scale of river basin district for the winning back of water **good status**, water management remains regulated by various sector-based policies such as those regarding energy, agriculture, urban planning and **public health.**

The consumption of a poor water quality can lead to a potential danger to human health usually named " hydric risk ". Indeed the exposure to certain bacteria or to abiotic substances (nitrates, pesticides, heavy metals) can be a health risk (Poux et al., 2008).
The World Health Organization (WHO) asserts regularly that the microbiological quality of the water remains the first concern of public health at the world level. And according to the Institut National de Veille Sanitaire (INVS) most of the pathologies associated with chemical pollutants in water distribution today are essentially cancers due to chronic exposures (more than 10 years and until 40 years) (INVS, 2008).

The various uses of the water which can lead to a direct sanitary risk are the consumption of water - risk due to ingestion of water - and bathing - risk due to direct contact with the water (Poux et al., 2008). Therefore in the years 70-80 an European regulations on water intended for human consumption and for bathing were elaborated. To protect public health and guarantee drinking water and bathing, these directives established parameters to monitor and thresholds.

In this context we shall compare throughout this bibliographical synthesis the WFD with three "use" directives (the "bathing" directive, the " raw waters " directive and the "drinking water" directive) and update their synergies and their incompatibilities. Indeed we wish to put in perspective the issues regarding the infringement of the **good status** prior to those of **public health**.

COMPARISON OF THE FOUR DIRECTIVES

0 THE DIRECTIVES AND THEIR FRENCH APPLICATION

Presentation of the 4 directives

We are going to examine four directives concerning the domain of water :
- the " raw waters " directive of 1975
- the "bathing" directive of 1976 (revised in 2006)
- the "drinking water" directive of 1980 (revised in 1998 and in revision nowadays)
- the water framework directive of 2000.

The first one, named " **raw waters** " directive (75/440/EEC) of **1975**, establishes standards for waters intended for the abstraction of drinking water . It determines three quality levels according to the treatment necessary for potabilisation.

The second directive taken into account is the "**bathing**" directive of **1976**[1], repealed and replaced in **2006** (2006 /7/EC), it establishes the quality criteria which bathing water has to respect.

[1] Bathing directive of 1976 : 76/160/EC

The third is the "**drinking water**" directive (98/83/EC) of **1998**[2]**,** which establishes the quality criteria of water intended for human consumption. This directive is now being revised. We shall discuss briefly also new concepts introduced into the new "drinking water" directive which is in preparation and which should be published by 2012.[3]

The most recent is the " **water framework directive** " of **2000** (2000/60/EC) which establishes objectives for results on the status of the aquatic environment. It strongly modified the statutory scope by establishing a regulatory framework for member states in the field of water management. The WFD was completed by two daughter directives :
- the "groundwater" directive (2006/118/EC) which establishes the criteria for "good status" of groundwater,
- and the " environmental quality standards" (EQS) directive (2008/105 /EC) which establishes the EQS to 41 chemical substances for water surfaces.

The contribution of WFD in water regulation

According to Gabrielle Bouleau (CEMAGREF[4]), water was one of the first subjects treated by the European regulations on the environment (Bouleau, 2008). Nevertheless the various directives before the WFD were sector-based, they concerned waters defined by **their uses** (drinking water, bathing) or on particular pollutants (nitrates). The WFD aims to group together in a coherent set all the regulations on the water.
The living gradually entered the institutional panorama via the WFD which for the first time asks for the achievement of the good ecological status of streams. Now etymologically, the ecology, term created in 1866 by the German scientist Ernst Haeckel, means, science of the housing environment and indicates the study of the " interrelations of the human beings with their environment " (Guérin, 2005). The WFD is thus the first European directive for which the environment is situated in the center of the concerns (Barraqué, 2002). WFD leads a break with the anthropocentric vision of the 3 usage directives.

An adjustment of the deadline of the bathing directive with those of the WFD

The revision of the bathing directive allowed to adjust some of its deadline on those of the WFD. All the bathing waters have to be at least at a **sufficient quality** for 2015 what also corresponds to the first deadline of the WFD after having implemented the SDAGE[5] and the first programs of measures. The majority of waters have to be in the **good status** before 2015[6].
On the other hand the bathing directive asks for the determination of the bathing water profile[7] at the latest for 2011 which corresponds to no deadline of the WFD.

Their french transcription

The " **raw waters** " directive was transcribed in French law by the decree of 19/12/1991. Although the " raw waters " directive was repealed in 2007 by the WFD, it is included in the scope of the study. Indeed, some articles of the public health French code are still refer to this directive (Gatel, 2009). The "**drinking water**" directive of 1998 is transposed via the decree n°2001-1220 and is repealed by the " raw waters " directive in the "arrêté" of January 11th, 2007. Finally, the "**bathing**" directive is transcribed via the decree 2008-990 concerning the management of the quality of bathing waters and swimming pools.
The **WFD** was transposed into French law via the law of April 21st, 2004, and is applied via the publication of diverse circulars and guides, the most recent of which date March, 2009, fixing temporary values to the good status of superficial fresh water (MEEDDAT, 2009a).

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2 This directive repealed the drinking water directive of 1980 : 80/778/EEC.
3 The disclosure of the project should intervene in May, 2010.(Gatel, 2009)
4 CEntre national du Machinisme Agricole du Génie Rural des Eaux et des Forêts.
5 Schéma directeur d'aménagement et de gestion des eaux.
6 Others have for terms 2021 or last deadline 2027.
7 Profile including in particular a description of the concerned zone, the sources of pollution possible and the location of the monitoring points.

The water and the aquatic environment law of December 30th, 2006 usually called "LEMA" completes these regulations by stating clearly the conditions to reach the objectives fixed by the WFD. An important point to underline regarding the WFD is that even if the normative criteria are defined at the European level, the French implementation works by definition of thresholds.

0 COMPARISON OF THE OBJECTIVES AND THE FOUNDATIONS

A common objective of the " raw waters ", "the drinking water" and "the bathing" directives lies in the protection of human health. Indeed the “bathing” and the “drinking water” directives aim to guarantee **public health** through usage (bathing or ingestion of water). So, the bathing directive main objective is to improve the sanitary standards and to protect swimmers from microbiological contagions (gastroenteritis risks, otorinolaryngologic risks) (Harvey, 2002). Also, the “raw waters” directive fixes the minimal quality which is needed to guarantee the supply of drinking water. And the drinking water directive fixes the minimal quality for safe consumption of the water .

The WFD also wish to protect human health but it gives priority to **environmental protection**. So it asks environmental quality standard (EQS) to be fixed which are defined as " the concentration of a particular pollutant or a group of pollutants in water, sediment or biota which should not be exceeded, to **protect human health** and environment " (Cf. WFD article 2 definition 35).
With the WFD, the environmental protection passes from an objective of means, directed to the use, to an objective of results, with a deadline (on 2015 except argued dispensation) (Miquel, 2001). The central objective is thus the aquatic environment. It is a conception radically new as regard to the objectives of 3 other directives.

0 COMPARISON OF THE APPLICATION FIELDS

The following table indicates in which environment are interested the directives

Superficial fresh water used or intended to be used for the abstraction of drinking water	Waters intended for human consumption, except natural mineral waters and medicinal waters.	Surface waters, groundwater, transitional[8] and coastal water	Surface waters susceptible to be bathing places, except swimming pools and spa pools, confined waters subject to treatment or used for therapeutic purposes as well as artificially created confined waters separated from surface water and groundwater.

Table 1 : Comparison of the application fields of the four directives

We can notice that these four major directives have sometimes the same field of application. Indeed surface fresh water is concerned by these four directives (Cf. tabl. 1). On the other hand, logically, the bathing directive does not apply to groundwaters (Cf. tabl. 2). We can notice that even if in the " raw waters " directive groundwaters are not included in its fields of application, in French law (in particular in the “arrêté” of January 11th, 2007) there are standards for raw groundwater (Cf. tabl. 2).

8 Water in the vicinity of river mouths which are partly saline in character as a result of their proximity to coastal waters but which are substantially influenced by freshwater flows.

	Raw waters dir.	Drinking water dir.	WFD	Bathing dir.
Superficial water	X	X	X	X
Greoundwater	X	X	X	
Transitional water	X	X	X	X
Costal water	X	X	X	X

Table 2 : Application fields of the directives transcribed in French law

0 DIFFERENCES BETWEEN THESE DIRECTIVES

Differences in waters typology

The "drinking water" and the "raw waters " directives do not make any typology of waters while the WFD and the "bathing" directive make one. According to the type of water the WFD and the bathing directive apply different indicators railings to better qualify the quality of the water. So the "bathing" directive uses two thresholds different for indicators: one for internal waters and the other one for coastal and transitional waters.

The WFD goes farther to the typology of waters than the bathing directive. It divides them into water bodies[9] (WB) (river or coastal) which can be natural (NWB), heavily modified (HMWB) as a result of physical changes due to human activity or artificial (AWB) (Cf. fig 1). Then for each type of water body, thresholds of indicators which qualify the water quality are different.

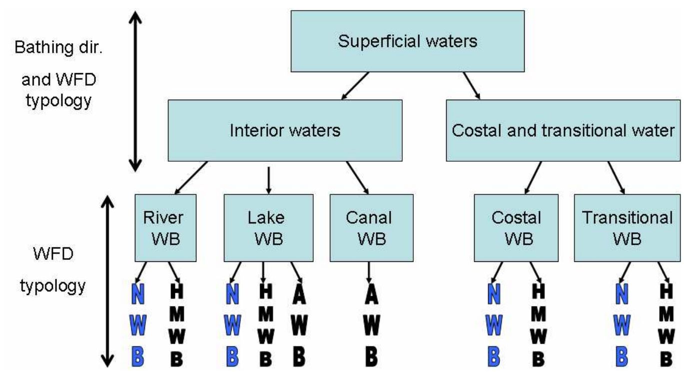

Figure 1. Superficial water typology from the WFD and the "bathing" directive

Differences in the terms used to characterize waters

	"Raw water" dir.	"Drinking water" dir.	WFD	"Bathing" dir.
Terms employed	Meet the min requirements/ Do not meet the min requirements	Meet the min requirement/ Do not meet the min requirement	Ecological status : High/good/moderate/poor /bad Chemical status : Good/ bad	Excellent/ good sufficient/ insufficient

Table 3 : Terms used by each directive to characterize water quality

The terms used by each directive to characterize water quality are very different. For example to qualify the ecological status of superficial natural waters, the WFD recommends a ranking system with 5 classes (see tabl. 3) while the bathing directive recommends only 4 and the " raw waters " and "the drinking water" directives use only 2 classes (meet the minimum requirements or do not meet them).

According to the WFD classification, a bathing zone can be in good (or bad) ecological status (natural lake) or have the "good and more" (or the bad) ecological potential (dam lake) which do not correspond to the same WFD thresholds. Moreover the same bathing zone can be in excellent

9 Zone where the aquatic environment is homogeneous.

quality or not according to the bathing directive. We can wonder then how the stakeholders and the users manage to understand the classifications. According to Mrs Paoletti (Suez-environment), the administrators lean nowadays on the label[10] " bathing water " which enables the qualitative water status to be easily communicated to the users (Paoletti, 2009).

In summary the WFD contrasts with the 3 other directives in particular by its **main objective** being the quality of the aquatic environment and by the fact that it makes water typology more important. Furthermore these directives do not use the **same terms** to characterize water qualitative status which can complicate the work of the administrators. We are now going to reduce the field of the analysis to what is comparable. That is we are going to examine the normative criteria of these directives and to try to analyze if it exists a direct link between a water in " good status " according to the WFD and a water "good" for the health according to the " raw waters ", "the drinking water" and "the bathing" directives.

ANALYSIS OF THE NORMATIVE CRITERIA WHICH CHARACTERIZE THE WATERS STATUS

Reminder of the definition of the good status in the WFD sense

The notion of good status differs according to the type of water. For example for natural superficial waters, the " good status " is determined at the same time by the " good ecological status " and by the " good chemical status " (Cf. tabl. 4).

Table 4 : Criteria of the good status by type of water bodies (Devaux, 2008)

Good status (cumulative criteria)		Good ecological potential	Good ecological status	Good quantitative status	Good chemical status
Superficial waters	NWB		X		X
	HMWB	X			X
	AWB	X			X
Groundwaters				X	X

The ecological status is the appreciation of the structure and the functioning of the aquatic ecosystems. It depends on criteria of biological or physico-chemical nature. The good ecological status is characterized by a distance in the conditions of reference which are the representative conditions of superficial water not, or barely, influenced by human activity (Devaux, 2008).

0 THE EVOLUTION OF THE SYSTEMS OF TALE-TELLING OF WATER QUALITY

In France there were various historic approaches to water quality evaluation (Barbe, 2009). At the beginning of the XX[th] century to estimate the water quality, only about ten parameters centred on the drinkable water supply were used, without statutory bases. These appeared only in 1958.

After the creation of the water agencies, from 1971 untill 1990, we used the first "ranking system" of water quality which integrated oxidizible organic matters.
From 1990 till 2005, the quality of streams and water plans was estimated via the SEQ (**Systems of Evaluation of water Quality**). There is then the water grid, the biological grid and the physical "grid".
According to Mr Barbe (DREAL Languedoc-Roussillon), the SEQ was only taking back the statutory prescriptions of the drinking water supply or bathing water in its rankings. For example, 50 mg / L of nitrate constituted the limit of correspondence for drinking water but also the orange / red limit of the SEQ, that is when all use is forbidden. Simarly the bacteriological thresholds and all the parameters governed by usage texts: the imperative levels according to the directives were within the orange / red limit.

10 Repository certification in August 2008, aimed at improving the quality of bathing water (Melquiot, 2008)

The WFD implementation implied a revision of this system by creating gradually the **system of evaluation of the ecological status** (SEES).
The SEES will be similar to the SEQ. The available physico-chemical ranking in the " good status " guide of March, 2009 which prefigures the SEEE is not very different from the SEQ water ranking. Only 50 mg / L of nitrate "downgraded" by two classes into the green / yellow limit (good / moderate threshold). Consequently a superficial water not potabilisable is not in the good status. There is thus no incoherence between the drinking water directive and the WFD even if this "downgrading" can be criticized[11]..
According to Mr Barbe there is no contradiction between the drinking water supply, bathing water and the water-based recreation uses as far as the standards which are fixed by the directives, then reduced in French regulations. Furthermore he thinks that the SEES will give coherent thresholds between these various directives (WFD, bathing, drinking water and raw waters) or will prescribe nothing and will refer back to the other directives (bathing, drinking water and raw waters).

0 PARAMETERS ANALYZED IN THE DIRECTIVES

The 4 directives do not recommend analyzing the same parameters. The "bathing", "the drinking water" and the "raw water" directives aim to guarantee public health through a usage. So the "bathing" directive is interested in the bacteriological quality via 2 types of bacteria. It also asks to monitor macroseaweeds and phytoplankton, as well as waste like tarry residues, and plastic … Besides, and because there will be in fine ingestion of the water: the " raw waters " and "the drinking water" directives go farther and advise to look for besides bacteria, from 22 to 48 chemical parameters (pesticides, heavy metals, nitrates) (Cf. tabl. 5).
In parallel, the number of parameters to be watched according to the WFD differ according to the type of water. For example, for a natural superficial water, it asks to focus on 41 priority substances and other pollutants (pesticides, metals, PAH[12]), 14 general physico-chemical parameters (nitrogenous and phosphorous parameters, balance assessment of oxygen), 9 specific pollutants (metals) and three in four bio-indicators (fishes, diatomees, invertebrates and phytoplankton). The WFD, contrary to the three other directives, is not interested in the microbiological quality. We can also notice that the quantitative parameters such as the flow appear only in support of biological parameters in the WFD (Cf. tabl. 5).

Parameters	"Raw water" dir.	"Drinking water" dir.	WFD River	WFD Lake	"Bathing" dir.
Microbiological	2	4	0	0	2
Biological	0	0	3	4	0
Chemical	22	48	14 + 9 + 41	14 + 9 + 41	0
Including pesticides	*All*	*All*	*15*	*15*	*0*
Organoleptical	1	4	0	0	0
Quantitative	no	no	support biology	support biology	no
Total number	25	56	67	68	2

Table 5 : Comparison of the number of parameters to be examined according to the directives (and their applications in French law)

So, we notice that only some parameters (chemical and microbiological) divide the field into at least 3 directives. The following paragraphs present the comparison of thresholds of these common parameters in at least 3 directives out of 4.

11 It can be criticized because a water with no human intervention has a nitrate rate between 0,5 - 15 mg / L and not of 50 mg / L.
12 Polycyclic aromatic hydrocarbon

The thresholds of the nitrogenous parameters

Nitrates in the water were identified for a long time as facilitating a blood disease at children, the methaemoglobinaenia (WHO, 2009a). So let us analyze closer the standards on this parameter in these 4 directives. **In streams** the threshold of water drinkability for nitrates (50 mg /L) corresponds to the good/moderate ecological status limit while for nitrites (0,5 mg/L) it corresponds to the passage in the moderate/ poor ecological status (Cf. fig. 2). Consequently a river in good status, from the point of view of the nitrogenous parameters, is drinkable and potabilisable.

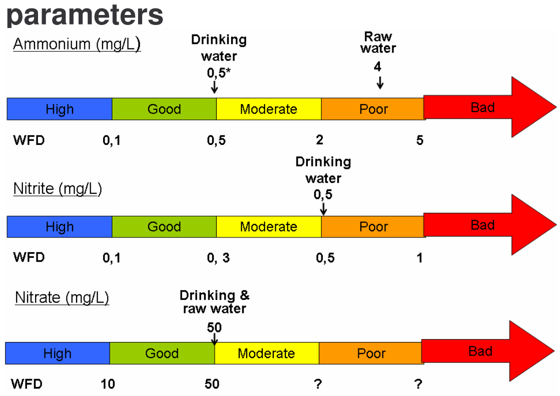

Figure 2. Comparison of nitrogenous parameters thresholds **for rivers**

mg /L	**Raw dir.** Threshold	**Drinking water Dir.** Threshold	**WFD** Thresholds High /good/moderate/ poor/bad	**Bathing dir.**
N mineral maximal (NO3- + NH4+)	50 + 4	50 + 0,5*	0,2 - 0 ,4 - 1 - 2	-

* control threshold

Table 6 : Comparison of nitrogenous parameters thresholds **for lakes**

This is even more true for the **natural lakes** because the maximal mineral nitrogen must be lower than 0,4 mg/L to be in the good ecological status. A Much lower standard than the threshold of drinkability (Cf. table 6).

mg /L	**Raw dir.** Threshold	**Drinking water dir.** Threshold	**WFD** Thresholds Good/bad	**Bathing dir.**
Nitrate	100	50	50	-

Table 7 : Comparison of nitrogenous parameters thresholds **for groundwaters**

Similarly the good / bad chemical status threshold for **groundwater** is included in the threshold of the "drinking water" directive to 50 mg / L. So if the groundwater is in good status, there is no need to treat drinking water for nitrates.

Thus, regarding nitrogen parameters : water of all types in good status is drinkable or ready to be treated, it is not considered harmful to human health. This seems logical since, as explained above the nitrogen parameters thresholds for environments (SEQ, SEES...) were modeled on those of the public health (drinking water...) which are the oldest.
If the WFD were respected on the nitrogen parameters, consequently the water would meet the standards of the "raw water" and "drinking water" directives. There would also no longer vulnerable

areas[13] as understood by the "nitrates" directive. So here we find consistency between these directives.

The thresholds of microbiological parameters

The following table shows the levels of microbiological parameters of the 4 directives according to two types of bacteria[14]. In fact, the bacteria can cause several diseases such as typhoid fever and paratyphoid fever (WHO, 2009 b).

	"Drinking water" dir.	Bathing dir. Thresholds excellent/good/sufficient/insufficient		"Raw water" dir.	WFD
	(for 250 mL)	Interior water (UFC/100mL)	Costal and transitional water (UFC/100mL)	(for 100 mL)	
Enterocoques	0	200-400*-330**	100-200*-185**	10 000	-
Escherichia Coli	0	500-1000*-900**	250-500*-500**	20 000	-

*95[eme] percentile, ** 90[eme] percentile

Table 8 : Comparison of threshold of microbiological parameters

Table 8 indicates an escalation between standards of "bathing", " drinking water" and "raw water" directives. Thus, the more exposure, the lower the threshold is. Indeed drinking water should be free from these bacteria, while there can be some in bathing water, but less than in raw water that will undergo treatment (see tabl. 8).
It should be noted that the WFD does not include bacteriological parameters, so it is a parameter specific to the protection of public health. Thus, characterization of water in "good status" gives no indication in any case of its bacteriological quality. It may even provide quantities of microorganisms very important and therefore be detrimental to human health (Harvey, 2002). Therefore water in good status is not potabilisable and much less suitable for swimming or drinking according to these parameters.
Standards of "bathing", " drinking water" and "raw water" directives here are **additional criteria** to the WFD (Robischon, 2006).

The thresholds of some chemical parameters

<u>The levels of pesticides and PAHs</u>

Pesticides and their metabolites, polycyclic aromatic hydrocarbons (PAHs) are recognized as potentially carcinogenic, causing endocrine or nervous disorders or causing reprotoxic risk ie addressing human fertility (WHO, 2009).

µg/L	Raw dir. Threshold	Drinking water dir. Threshold	WFD Thresholds Good/bad	Bathing dir.
1 active molecule	2	0,1	0,1	-
Total active molecules	5	0,5	0,5	-

Table 9 : Comparison of pesticide thresholds

For **groundwater,** there is consistency in the pesticide thresholds between directives. The "groundwater" directive, daughter of the WFD, is aligned with the thresholds of the drinking water directive. (see tabl. 9)

[13] According to the nitrate directive vulnerable zones are areas where the European limit values for nitrate concentration in surface water intended for drinking water are exceeded (> 50mg / L) or threaten to be. In these areas it must be implemented a program of action (DIREN, 2009).
[14] The drinking water directive request to monitor also "Pseudomonas aeruginosa" and the number of colony for bottled water and container. And the "raw water" directive also calls for monitoring total coliforms and fecal coliforms.

In contrast, for **surface water,** there are some differences in standards. The WFD is sometimes more stringent than the "drinking water" and "raw water" directives, sometimes less. The WFD is less restrictive than the "drinking water" directive when the threshold of good chemical status, namely environmental quality standards (EQS), are higher than the standard for drinking water (0.1 mg/L). This is the case for pesticides such as alachlor, atrazine, chlorfenvinphos, diuron, isoproturon and simazine (see Annex 1). The WFD is also less restrictive than the "raw water" directive for simazine. Indeed the EQS maximum allowable concentration is 4 mg / L for simazine (> to 2 mg / L of the "raw water" directive).
It is the same for three PAHs: the EQS maximum permissible concentration of fluoranthene, anthracene and benzo (a) pyrene exceeds the standard of potability of PAHs (see Annex 1)

In summary: on these parameters, water in good status may not be drinkable and can be harmful to human health. Similarly, simazine water in good condition may not be potabilisable. This is explained by the fact that EQS are calculated as the standard of drinking water or potable. An EQS is the concentration of a particular pollutant or a group of pollutants which should not be exceeded to protect human health and environment (through ecotoxicity, bioaccumulation test ...) (see article 2 of WFD).

Metals

Regarding **metal parameters, water in its natural state** is not necessarily drinkable (Blum et al. 2007).
Indeed, groundwater, depending on the nature of soils and sub-soil in through which it has passed, may be loaded with chemical elements that we can find in the surface water. In the Puy de Dôme, for example, in 1200 springs and wells, about 10 to 15% had traces of arsenic from natural sources, at rates sometimes exceeding 10 mg / L standard for drinking water.

Synthesis studies conducted at French and European level (BRIDGE[15] project) show that chemical parameters in groundwater that may exceed naturally standards for drinking water and may cause diseases are **arsenic, antimony , nickel, selenium, fluoride** and to a lesser extent **boron**. For all other elements, concentrations do not exceed, in general, naturally, the quality standards.

Iron and manganese[16] are not in this list because of their low toxicity although they are omnipresent elements in rocks, soils and groundwater (Blum et al. 2007).
Knowledge of background natural groundwater is of particular importance with the WFD[17], because it requires that water bodies reach the 'good status' ie return to their reference states that does not mean potable (see Annex 2).

In summary :
- Overall, the four directives do not cover the same parameters
- On some common parameters such as nitrogenous and pesticides (groundwater), there is consistency between the different thresholds
- For other common parameters such as certain pesticides, PAHs (superficial water) or heavy metal, water may be in good status without respecting the standards for potabilisation or drinking water.

0 INFLUENCE OF THE STATE OF THE AQUATIC ENVIRONMENT ON THE PURIFYING CAPACITY

The question asked here is: Is a watercourse in good status (whose ecosystem works well) giving more services than streams in poor condition?

[15] Background cRiteria for the IDentification of Groundwater thresholds.
[16] There are guide values in the "drinking water" and "raw water" directive on the iron and manganese .
[17] Currently among the metals mentioned, only arsenic as a specific pollutant is part of the definition of WFD good status.

The concept of service is the sum of the capabilities of water systems (purification capacity, ...) and their uses today, or in the future (bathing, drinking water supply. ..) (Fustec and Lefeuvre 2000).

Definition of purifying capacity

The purifying capacity of the aquatic environment is the set of processes which eliminate all or a portion of the pollutants. Various types of treatment plants in use are the industrialization process of active purifying in rivers: sedimentation, aeration, adsorption, biodegradation, anaerobic digestion ... A watercourse may be considered as a biological reactor whose input values determine the performance (Edeline, 2001).

Purification capacity of nutrients

The Aldridge studies (Aldridge et al. 2009) indicate that a watercourse in good status has a greater purification capacity on **nutrients** than streams in poor condition. Indeed they showed that the reintroduction of coarse particulate organic matter, in the form of leaf litter, into a degraded urban stream, has improved biofilm activity and **phosphorus** retention. In the same vein, it has been demonstrated (Meyer et al., 2005) that degraded stream ecosystem have a reduced capacity to intercept nutrients, which has been attributed to reduced standing stocks of organic matter.
In addition it has been proved[18] (Gucker and Boechat, 2004) that stream morphology controls **ammonium** retention. They found that transient solute storage was large in swamp reaches, intermediate in step-pool and meandering reaches and low in run reaches. Therefore, according to this study, a river that has undergone a hydromorphological restoration (with meander) and therefore has calm areas, has the ability to reduce ammonia. The process improvement would permit the thresholds set by the "raw water" and the "drinking water" directive on the nitrogen parameters to be met more easily.
Furthermore, a watercourse in good condition often means an abundant and diverse riparian forest nearby which works particularly well as a filter, and in several ways (Brem, 2007). **Phosphorus** substances for example, are in the water in particles. Therefore they are prevented from reaching the river network thanks to the roots of plants. It must also rely on the ability of trees to absorb certain undesirable substances such as **nitrates**. Finally, the roots provide a favorable environment for bacteria capable of denitrified their environment (Brem, 2007).
In summary, according to these studies, a river in "good status" seems to have **better capacity to purify nutrients** than streams in poor condition.

Purifying capacity on chemicals

However few studies exist on the links between water status and their ability to remove **chemicals**. A study of Fisenko (Fisenko, 2004) proved that a river in a very bad status (after it has received cyanide and heavy metals) had retained a purifying capacity by creating natural froth where pollution was collected. A stream in poor status therefore retains the ability to remove chemicals. Therefore, to draw a general conclusion about the link between the condition of the watercourse and its ability to purify chemicals would require further knowledge in the field.

Thus a watercourse in good status seems to give more services than rivers in poor status particularly on **nutrient removal**. Which is positive for uses such as drinking water (less processing to do) or swimming (less algae). We will now discuss the modalities of implementation of these 4 directives and their implications.

COMPARISON OF PROCEDURES FOR IMPLEMENTATION OF THESE DIRECTIVES

France currently has about 35 000 catchments of drinking water. Only 5% of these catchments use a superficial resource. However they represent in volume 1/3 of the drinking water supply, mainly for urban areas (Paris, Toulouse ...) (Gentilini et al., 2009).

[18] In tropical headwater in Brazil.

0 THE PROCEDURES FOR IMPLEMENTATION IN FRANCE THE PROTECTION OF CATCHMENTS

The protection perimeters of catchments: a former creation

In France, to protect the catchments of drinking water from **point source pollution**, **protection perimeters were established**. This is not a recent creation (Mizia & Djamé, 2008). A 1964 law made it compulsory for all new catchments of drinking water. The 1992 law generalized the obligation to all the catchments in establishing a period of 5 years for the retrofitting of existing structures. To strengthen the implementation of the protection perimeters, the Government has set targets through its National Plan for Health and Environment established in 2004. Thus in 2008, 80% of catchments of drinking water would have benefited from a protected area including requirements limiting the risk of pollution, and 100% in 2010 (Gentilini et al., 2009). But at last count in 2008, only 55% of catchments of drinking water currently in service have benefited from this regulatory protection (AELB, 2008).

Quality deterioration is the primary cause of catchments closure

Each year tens of catchments are closed. The annual number of closures is estimated at one hundred (Miquel, 2001).
Moreover, even if the catchment is abandoned, the drilling still exists. But drilling carelessly abandoned are a source of pollution, since the defects of maintenance of sealing and corrosion, become almost inevitable (Miquel, 2001). And even if all abandoned drilling are filled by appropriate techniques to ensure absence of movement of water and no transfer of pollution occurs[19], in the long run a drilling is conducive to pollution (Miquel, 2001). This is not the non-degradation of resources requested by the WFD.

The first cause of closure is the **quality deterioration** of water abstracted. That is to say non-compliance with the thresholds of the “raw water” directive. For example, in the Seine-Normandy Basin in 2001: 17 catchments have been closed due to exceeding the thresholds of pesticides and 29 exceeds the nitrate threshold (AESN, 2006). The second cause of abandonment is the difficulty or the inability to protect catchments. This last factor, alone, should be decisive in the future (Miquel, 2001). For example, in the Loire-Bretagne on the period 2000-2006, 28% of abandoned catchments were due to technical reasons (lack of flow and / or degradation of structure and lack of **protection of catchments**) (AELB, 2007) .

The need for extended protection of drinking water catchment areas

WFD demands that Member States provide the necessary protection of their water to prevent the deterioration of its quality in order to reduce the level of purification treatment required for drinking water production (Cf. WFD art. 7).
To meet the WFD requirement, in general, on drinking water catchment areas, the actions prescribed in the programs of measures for each river basin district are strong and require a significant reduction of chemical inputs (pesticides and nitrates). Concretely, for example, the program of measures of Seine-Normandy basin demands the purchase of farmland by cities and / or conversion (and maintenance) to organic farming or grasslands or wood (AESN, 2008). However, these actions of program of measure should be difficult to fund and implement (Barthes et al., 2009).

To help implement and fund a portion of these measures, the law "Grenelle 1" predicts that by 2012 "action plans" must be defined to protect 507 catchments within the areas most threatened by diffuse pollution. In the supply areas of these catchments, priority must be given to organic or low input surfaces to preserve the resource and reduce treatment costs. The law "Grenelle" gives the possibility to classify the 507 Drinking Water Catchment Area (DWCA) in "areas subject to environmental constraints [20])» in order to obtain agricultural subsidies (ICCE[21] plus MAE[22]) to help meet targets (MEEDDAT, 2009 b).

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19 Specific technical provisions of “ arrête” “drilling” of September 11, 2003 (Articles 12 and 13).
20 Operative outcome of article 21 of law on water and aquatic environments in 2006.

In this case, we can detect a **synergy** between the goals of preservation / restoration of the resource and the issue of preserving the usage : drinking water supply.

0 THE PROTECTION OF WATER BY THE LOCAL AUTHORITIES AND THE MANAGEMENT OF WATER SERVICES

Towards greater surveillance of aquatic environments?

According to Ms. Paoletti[23], as the deadlines of the water framework directive get closer and as there is an awareness on the concepts of sustainable development, **local state authorities** tend to be more concerned by the environment upstream of the catchment area or bathing area. For example, they want to use on rivers and coastal waters particularly the device named "Sirène". Using probes and sensors, this system monitors water pollution. Following in continuous physico-chemical parameters of water (BOD, COD[24], turbidity ...), with the "Sirène" system it is easier to identify the origin of pollution and their impacts on the aquatic environment. This device is also able to issue warnings if there is a pollution (oil ...). This tool for protecting the water environment is now being implemented, particularly in the Thau lagoon (Paoletti, 2009).

More actions on environments upstream of catchments?

In France, there are about fifteen operations where the delegate water service could be involved to change farming practices and / or to protect the aquatic environment in the upstream of the catchment area (Gatel, 2009). This is mainly to reduce processing costs such as nitrates and pesticides. Suez Environment is therefore engaged in the restoration of aquatic environment recently in Rhône-Alpes by developing a system of in-situ treatment of PCB pollution to clean up contaminated waterways (Mizia & Djamé , 2008). Local sate authorities may also choose to be engaged in preventive rather than curative actions. This option was chosen by the union of drinking water of “Sille-le-Guillaume” (72) which helped acquire 12 hectares of farmland by the union joint planning so that they are wooded These lands lie on the zone of influence of its catchment (Becker, 2009). We can also cite the case of the city of Bourges, which has agreements with local farmers for protection against diffuse pollution on the “Porch” catchment basin (ASTEE, 2009).

However, according to Mr. Gatel (Veolia), such practices do not tend to be generalized, since in many cases the gain related to treatment costs avoided is not sufficient. However this is not the opinion of the Water Agency Rhône-Méditerranée-Corse, which states that promoting investment in preventive action to preserve the water quality can be cost effective (AERMC, 2004).

0 THE CONTRIBUTION OF THE FUTURE "WATER SAFETY PLANS

Purpose of WSPs

The "drinking water" directive under review will certainly incorporate an approach of risk management under the Anglo-Saxon terminology of "Water Safety Plans” (WSPs). This is translated into French as " plan de sécurité sanitaire des eaux » . The WSPs approach was developed to make assessment and risk management from water resources at the tap of the consumers. The WHO recommendations on drinking water, published in 2004, incorporate this concept (WHO, 2008). The WSPs are based on the principles and concepts of other approaches of risk management, particularly HACCP[25], widely used in the food industry. To go in the same

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21 ICCE : Indemnité Compensatoire de Contraintes Environnementales, outcome of article 38 of the Rural Development Regulation.

22 MAE : Mesures Agri-Environnementales, outcome of PDRH (Plan de Développement Rural Hexagonal)

23 Working at the center of competence in aquatic environments of the Lyonnaise des Eaux

24 Biological or Chemical Oxygen Demand

25 Hazard analysis critical control point.

direction, the french health ministry has produced a guide in 2007 about the inclusion of monitoring (sanitary control) of water intended for human consumption (Health ministry, 2007). Indeed the french code of public health provides the opportunity to make fewer checks if the manager has a HACCP type approach. (Gatel, 2009)

Means necessary for the implementation of WSPs and interaction with current tools

According to Mr. Gatel this type of approach is a long term project. Indeed the ASTEE is currently investigating the whole French territory to determine how many structures have made this step. But only 5 to 7 major retailers have filed a case because it is extra work. Indeed Gatel says this type of approach is nothing extraordinary but it corresponds to a year working for a company already certified ISO 9001.

In theory the WSPs are intended to be strongly connected to the existing tools presented above, to protect water: namely protection perimeters and measures in the catchment basin (Gatel, 2009). For example all the studies on the risk of not achieving good chemical status of the WFD must be put in the WSPs field. Nevertheless Mr. Gatel advised to remain cautious and he hopes that these tools will be linked in the simplest way possible. Furthermore, we can, ask how these tools would be interlinked themselves in their implementation and how people would adopt them ?

0 INDUCED CONFUSION FOR WATER MANAGERS ?

According to Ms. Paoletti, although **local state authorities** are increasingly sensitive to sustainable development, they do not totally have mastered the WFD, the thresholds and the associated recommendations are complex. These actors do not always perceive the differences between the Water Framework Directive and the 3 use directives. The operators of water services such as Veolia Water and Lyonnaise des Eaux has a better understanding of the WFD. They develop new projects around the natural environment to meet as close to its goals. For example, Lyonnaise des Eaux develops Zone libellule, Zone of biology freedom and fight against micropollutants "to meet the objective of good ecological status by 2015".
In addition, another participant in water management, **water unions,** do not appear to use the water framework directive to implement actions on their land. So when the drinking water union of Sille-le-Guillaume was asked how the WFD interfered in their work, they responded that it did not intervene on a daily basis[26] (Becker, 2009). This proves that the actions concerning the protection of drinking water are separated from the regulations of the WFD. Yet it is a water union which has on his land a catchment identified as priority by the "Grenelle".
However confusion in applying these 4 directives lies in the fact that: On the one hand, the Health Ministry, guardianship of DDASS[27], recommends (in conjunction with the "drinking water" directive) to use the best water in the alluvial plains for human consumption. While, on the other hand, some DREAL[28] (in conjunction with WFD) advises to take water in karst and not to drain the wetlands and to destroy ecosystems (Cadic, 2009).

In conclusion, these 4 directives use different terminology and are not necessarily interested in the same parameters. On the common parameters in general there is consistency between the various thresholds (nitrogenous substances, pesticide in groundwater). In addition, the directives appear to have complementarities since the protection of catchment basin complete the protection perimeters already created. However we must not forget that the first cause of closure of catchments is the deterioration of water quality. Therefore when you cannot use resources for drinking water, and they are abandoned, there is a risk that they will never attain good status (loss of use and therefore loss of interest).

[26] Everything is given to their tenant-farmer: the company SAUR.
[27] Direction départementale des actions sanitaires et sociales.
[28] Direction régionale de l'environnement.

Thus the achievement of WFD objectives seems to be difficult because the project leaders of the measures to reach the good status (local authorities, farmers ...) are very diverse and are not those responsible towards the European Union. The state is responsible. Regarding the other 3 directives the responsibilities are more clearly established[29] (the mayor or president of the local state authority ...) which seems to be a better guarantee of success.

Throughout this synthesis we have observed no major contradictions between these four directives, however their implementations are complex and likely to cause confusion and poor implementation by those involved in water management. Also the superimposition of different tools (perimeter protection, measures in catchment basin, WSPs ...) may hinder an effective synergy between the policies. Should we then move towards a multi-purpose directive to simplify the whole?

29 Cf responsibility in particular in Article L. 1332-3 of French Public Health Code.

Annexe 1 : Comparison of pesticides and PAHs thresholds in surperficial water

		Raw water dir.	Drinking water dir.	WFD				Bathing dir.
N° WFD	Substance (µg/L)	Compliance threshold	Compliance threshold	Annual average value-EQS Inland surface water	Annual average value-EQS Other surface water	Maximal allowable concentration - EQS Inland surface water	Maximal allowable concentration -EQS Other surface water	
Pesticides								
1	**Alachlor**	**2**	**0,1**	**0,3**	**0,3**	**0,7**	**0,7**	
3	**Atrazine**	**2**	**0,1**	**0,6**	**0,6**	**2**	**2**	
8	**Chlorfenvinphos**	2	0,1	0,1	0,1	**0,3**	**0,3**	
9	Chlorpyrifos	2	0,1	0,003	0,003	0,1	0,1	
9 bis	Cyclodiene pesticides	2	0,1	∑ = 0,01	∑ = 0,005	not applicable	not applicable	
9 ter	DDT total	2	0,1	0,025	0,025	not applicable	not applicable	
9 ter	para-para DDT	2	0,1	0,01	0,01	not applicable	not applicable	
13	**Diuron**	**2**	**0,1**	**0,2**	**0,2**	**1,8**	**1,8**	
14	Endosulfan	2	0,1	0,005	0,0005	0,01	0,004	
18	Hexachlorocyclohexane (each isomeric) lindane	2	0,1	0,02	0,002	0,004	0,02	
19	**Isoproturon**	**2**	**0,1**	**0,3**	**0,3**	**1**	**1**	
29	***Simazine***	***2***	***0,1***	***1***	***1***	***4***	***4***	
33	Trifluralin	2	0,1	0,03	0,03	not applicable	not applicable	
PAH								
2	**Anthracene**	**1**	**0,1**	0,1	0,1	**0,4**	**0,4**	
15	**Fluoranthene**	**1**	**0,1**	0,1	0,1	**1**	**1**	
28	**Benzo(a)pyrene**	**1**	**0,01**	0,05	0,05	**0,1**	**0,1**	
	Benzo(b)fluoranthene Benzo(k)fluoranthene	1	0,1	∑ =0,03	∑ =0,03	not applicable	not applicable	
	Benzo(g,h,i)perylene Indeno(1,2,3-cd)pyrene	1	0,1	∑ =0,002	∑ =0,002	not applicable	not applicable	
Legend	**Molecule :** Substance whose WFD standards exceed the drinking water directive standards							
	Molecule : Substance whose WFD standards exceed the raw water directive standards							

Annexe 2 : Comparison of metals thresholds for surperficial waters

Metals (µg/L)	Raw water dir. compliance/non compliance threshold	Drinking water dir. compliance/non compliance threshold	WFD good/moderate or good/bad threshold	Bathind dir.
aluminium		200		
antimony		5		
arsenic	100	10	Geochemical background + 4,2	
baryum	1 000	0.7		
boron	valeur guide	1		
cadmium	5	5	depends on water hardness (< 0,2)	
chromium	50	50	Geochemical background + 3,4	
Copper	valeur guide	2 000	Geochemical background + 1,4 µg/L	
cyanide	50	50		
Iron	valeur guide	200		
fluoride	valeur guide	1 500		
mercury	1	1	0.07	
manganese	valeur guide	50		
nickel	valeur guide	20		
Lead	50	10	7.2	
selenium	10	10		
zinc	5000		depends on water hardness (max : Geochemical background + 7,8)	

Legend: **metal :** substance which naturally could exceed threshold of drinkability

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Glossary

AELB Agence de l'Eau Loire-Bretagne
AERMC Agence de l'Eau Rhône-Méditerranée-Corse
AESN Agence de l'Eau Seine-Normandie
ASTEE Association Scientifique et Technique pour l'Eau et l'Environnement
AWB Artificial Water Body
BRIDGE Background cRiteria for the IDentification of Groundwater thresholds
CEMAGREF CEntre national du Machinisme Agricole du Génie Rural des Eaux et des Forêts ou Institut de recherche en sciences et technologies pour l'environnement.
DDASS Direction Départementale des Actions Sanitaires et Sociales
DIREN Direction Régionale de l'Environnement
DREAL Direction Régionale de l'Environnement, de l'Aménagement et du Logement
EC European community
EEC European economic community
HACCP Hazard Analysis Critical Control Point
HMWB Heavily Modified Water Body
ICCE Indemnité Compensatoire de Contrainte Environnementale
INVS Institut National de Veille Sanitaire
MAE Mesure Agri-Environnementale
MEEDDAT Ministère de l'Ecologie, de l'Energie, du Développement Durable et de l'Aménagement du Territoire (old MEEDM)
MEEDM Ministère de l'Ecologie, de l'Energie, du Développement durable et de la Mer
NWB Natural Water Body
OMS Organisation Mondiale de la Santé
ONEMA Office National de l'Eau et des Milieux Aquatiques
SEES System of Evaluation of the Ecological Status
WFD Water Framework Directive
WHO World Health Organization
ZCSE Zone Soumise à Contrainte Environnementale