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MEETINGS

Water status and the Water Framework Directive: review of assessment methods

In view of the second management cycle of the Water Framework Directive (WFD), 2011 constituted a key year for developing and ensuring the compliance of water status assessment methods. In this context, the French Ministry for Sustainable Development and ONEMA (French National Agency for Water and Aquatic Environments) invited over 200 experts and managers to attend a series of meeting held from 19 to 22 April 2011. Participants included the Ministry, Water Agencies, DREAL (Regional Directorates for the Environment, Planning and Housing), ONEMA, research establishments and technical institutes, etc. These meetings were organised with the support of the International Office for Water (IOWater). Two scientific information days focusing on bioindication were followed by two days of discussions in order to review the progress made, the prospects for the development of methods used for assessing water status in France, and the tools of the Water Status Assessment System (Système d'évaluation de l'état des eaux - SEEE).

The implementation of the Water Framework Directive has prompted Member States to make unprecedented efforts concerning the development and harmonisation of methods used to evaluate the chemical status and ecological status of surface water (rivers, lakes, coastal waters and transitional waters), in addition to the chemical status and quantitative status of groundwater. Whereas the current assessment rules apply to the first river basin management cycle (2010-2015), 2011 has been notable for the completion of numerous projects carried out over several years that have been designed to develop assessment methods in line with the requirements of the WFD. Although there is still room for improvement in certain categories of water bodies, especially inshore waters (coastal waters, estuaries and lagoons), the new methods, which shall apply for the 2016-2021 management plan, will be useful for updating the river basin characterization starting in 2013.

Surface water: from status to diagnosis

With the WFD, bioindicators have become established as the determining factors in the assessment of the ecological status of surface waters. A very large number of bioindicators are currently being developed or made compatible with the WFD in the different European Union countries, including France, and this applies to each category of water body and biological quality component (algae, macrophytes, demersal macroinvertebrates and fish. In relation to bioindication as it has been applied over the past 20 years, the WFD is a major step forward: it establishes a global approach to the ecological health of aquatic environments and forms part of a common conceptual framework for all European water bodies. As the cornerstone of the entire edifice, the assessment of ecological status is envisaged according to the following rule: if a single biological indicator gives a score corresponding to a medium (or poor or bad) status, the entire water body is declassified and declared to have a medium (or poor or bad) status. Again according to the WFD, in addition to bioindication, the ecological status of water bodies is also influenced by the physico-chemical parameters which support biology, defined for different quality components (temperature, oxygen balance, transparency, etc.), and by the hydromorphological parameters supporting the very good ecological status (see below). Finally, pollutants

Example of a river with good ecological status.

specific to ecological status (especially metals) have been defined and are monitored at the national level, in addition to the 41 substances included in the assessment of chemical status.

This apparent complexity reflects the very ambitious nature of the efforts required to achieve the good status of water bodies by 2015, taking account of the maximum number of elements likely to act upon the structure and functioning of aquatic ecosystems.

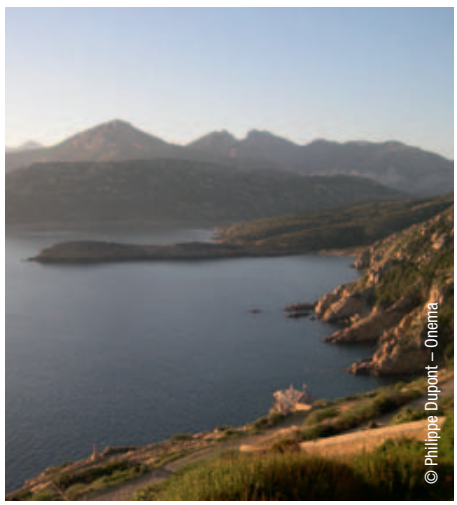
Demersal invertebrate larva (Perlidae) used in the development of the new multimetric index (I2M2) for the bioassessment of rivers.

A key moment for the scientific and technical bodies, led by CEMAGREF (now IRSTEA) and IFREMER, responsible for the development of these methods, comes at the end of 2011: this is the deadline for the production of a range of finalised and intercalibrated1 biological indicators. Likewise, diagnostic elements based on the physical chemistry and hydromorphology supporting the biology will be required. A complete appraisal of the development of these tools was carried out during the seminar. The results were considered to be very satisfactory given the progress made.

Rivers appeared to have a complete set of intercalibrated, WFD-compatible bioindicators by the end of the year. With regard to lakes, the work carried out by the Onema- Irstea Aix-en-Provence centre and its partners has made up for a significant amount of lost time in the field of bioindication and the understanding of the links between anthropogenic (physical and chemical) pressures and biological status. Special attention must, however, be paid to several points in the coming years. Coastal and transitional waters (estuaries and lagoons) are still lagging behind in certain aspects of biological quality, due to a lack of historical data series. Finally, the case of Highly Modified Water Bodies (HMWB) and Artificial Water Bodies (AWB) will also require increased attention, as will developing a detailed understanding of the links between anthropogenic pressures and ecological status for different categories of water bodies.

Chemical status: tools for evaluating chemical status and contamination risks

A “good” classification for the status of a water body implies that it has a good (or very good) ecological status and a good chemical status. This second condition is satisfied when the concentrations of the whole 41 polluting substances listed by the European Union do not exceed the environmental quality standards established for each substance. The data required for this assessment are currently being acquired and entered into a databank in the framework of the monitoring programme defined by the Order of 25 January 2010. The chemical status of unmonitored water bodies can be extrapolated on the basis of pressure and modelling data, and analogies with similar water bodies, or expert opinions.



The initial assessments carried out in particular by the Water Agencies identified areas for improvement in the methods currently used (see box on page 3). Numerous tools are currently being developed in response to these expectations. Aquaref’s[2] technical requirements for sampling and analysis will improve the reliability of status data from 2012. Environmental quality standards for sediments and the biota (for certain substances), and a technical guide to the use of bioavailability models for compliance assessment of trace metals in fresh water, shall be available by 2013. A national assessment model for the risks of diffuse contamination of aquatic environments by nutrients and phytosanitary products will also be finalised in 2012.

Bioassessment: the “health status” of environments

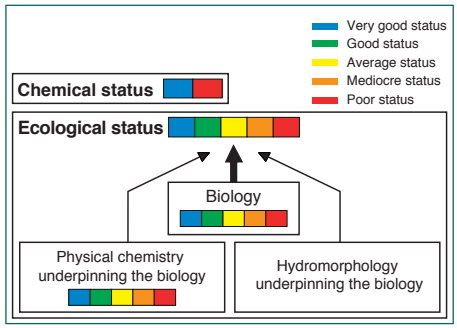
Created by combining different parameters (occurrence, abundance and diversity) of the biological community present, and taking into account either the species or the characteristics of these species (biological traits), a bioassessment tool provides information about the ecological status of an environment (very good – good – medium – poor – bad). The status attributed to a water body is all the more representative given that it integrates three factors: the natural variability of parameters of the biological communities in space, the natural variability of the communities over time and the impact of different pressures affecting the communities.

(1) Intercalibration is a mandatory exercise at the European level, and is designed to ensure that the different Member States have the same requirements in terms of good status for the different components of biological quality.

(2) Aquaref: national reference laboratory for aquatic environments monitoring.

Hydromorphology: supporting good biological status and the condition for classifying the status of water bodies as “very good”

Hydromorphology is the physical framework that is essential to the development of biocenoses and it conditions the efficient operation of aquatic ecosystems. Especially emphasised by the WFD, this new term can be broken down into different quality items, namely: morphology, hydrology, ecological continuity (sediment flows and free circulation of aquatic organisms) and hydrodynamics, which more specifically concerns coastal waters. The assessment of their quality is adapted according to each type of water bodies and reveals the amount of physical alteration of aquatic environments (e.g. for rivers: reduced flows, river bed resizing, removal of riparian vegetation, interruption of continuity, silting of substrate, etc.) and the constraints to which living organisms are subjected. Hydromorphology must consequently be accounted for in the inventories (analysis of the risk of failing to achieve the environmental objectives for all surface water bodies), and in the regular assessment of the characteristics of sites in the WFD monitoring programme with a view to diagnosing the statuses of environments, identifying the causes of biological alterations and designing effective programmes containing measures to preserve or restore good ecological status. In addition, the qualification of these elements is essential for classifying the status of surface water bodies as “good”.



The characterisation of the hydromorphology of watercourses has led to the launch of several scientific programmes at the national level. This applies to the SYRAH project (Système Relationnel d’Audit de l’Hydromorphologie des cours d’eau – Relational System for Auditing the Hydromorphology of Rivers). It is designed to validate the data from geographical information systems and translate them into alteration symptoms at the basin and sub-basin level (map of areas at risk of hydromorphological alteration created on the basis of land use and soil types, developments and uses, etc.) and also at the river section level (risks of alteration of quality elements based on data concerning riparian vegetation, obstacles, transportation routes, etc.).

SYRAH is designed to produce mapping based on hydromorphological alteration risk indicators. It will be available at the start of 2012 and will contribute to updating the inventories in 2013. It is supplemented by the CarHyCe protocol (standardised national protocol for monitoring the Hydromorphological Characteristics of Rivers), which describes each element of hydromorphological quality at the scale of the monitoring sites and will qualify a deviation from the reference by means of specific status indicators by 2013. SYRAH is also based on the national list of obstacles to river flows, whose third version was published by ONEMA in November 2011 and today lists over 60,000 hydraulic structures throughout France.

For lakes, the Onema/Irstea centre is also developing integrative tools named Alber (protocol for characterising bank alterations) and Charli (protocol for characterising habitats, banks and the coast), based on a photographic interpretation (IGN orthophotos) combined with field observations. These tools should be validated in around thirty lakes in 2011 before their national rollout starting in 2012.

Cédric Halkett,
Artois Picardie Water Agency

Ways to improve the current methods

An assessment of the chemical status of surface waters in the Artois-Picardie basin was carried out in 2007 and published in 2009. The results show that for the most part, downgrading is linked to the presence of Polycyclic Aromatic Hydrocarbons (PAH) of diffuse and atmospheric origin. Apart from PAH, the status of almost half of water bodies is good and in the end, very few substances lead to downgrading. This assessment should, however, be qualified. Certain compounds are covered by very low environmental quality standards, which are inaccessible for the laboratory. The presence of hydrophobic substances, which are currently analysed in water, is also poorly assessed: it would be more appropriate to search for these substances in sediment or in living organisms, where they accumulate in greater quantities. This would require standardised protocols for sampling, analysis and the interpretation of results, including via threshold values and assessment grids. In the end, additional analyses would appear to be necessary for a real estimation of the chemical status of the environment, at the risk of possibly casting doubt on the currently observed classifications. The improvement of diagnoses relating to the contamination of waters by micro-pollutants will involve taking greater account of emerging pollutants by using new monitoring tools, such as passive samplers, and by tracking the impacts on the environment through the development of biomarkers. It will also be important to correlate this information with pressure data.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Measuring particle size, Carhyce national protocol.

Groundwater: quality and quantity

The WFD requires the achievement of a good quantitative and chemical status for groundwater bodies. Significant efforts are currently being made to improve the methods used for assessing the qualitative (or chemical) status of these water bodies. The criteria and procedures established by the Order of 17 December 2008 are currently being updated: changes in the assessment procedure and threshold values should be made in a circular by the start of 2012. In Loire-Bretagne (Brittany), the first assessment of all points of the operational control network and the monitoring network was carried out by calculating the mean of the inter-annual means of the concentration of each substance during the 2003-2008 period. This assessment revealed an improving trend for the qualitative status of groundwater bodies, 50% of which are now classified as having a good qualitative status (most being situated in the upstream part of the basin). Declassifications were due to the following causes in equal proportions: nitrates exclusively, pesticides, and both types of contaminants. When thresholds were exceeded, additional investigations were conducted: partial representation of the water body and diagnosis of saltwater intrusions according to expert opinions. However, these diagnoses remain difficult to carry out due to the lack of information and knowledge. This exercise is representative of the difficulties of assessing groundwater bodies. In particular, the monitoring control network does not appear to be dense enough to be representative of the heterogeneity of groundwater bodies. Their large size also makes it difficult to define programmes of measures at the local level. Finally, the issue of the annual variability of contaminant concentrations leads us to consider adapting the time-related aspects of the sampling strategy.

Assessing the good quantitative status of groundwater bodies

The summary of the quantitative data for 2010 is notable for the small number of declassifications, and the fact that 90% of level 1 groundwater bodies (the first to be encountered from the surface) had a good status. However, this must be accompanied by a critical analysis, the broad outlines of which have been presented. Thus, at the methodological level, only the Adour-Garonne basin has attempted to implement all tests (see box opposite); it is also the only basin, with Guadeloupe, to have used the "unknown" quantitative status for certain water bodies, which probably raises a methodological problem.

The French Ministry responsible for Sustainable Development has asked the BRGM to draft a report containing specific instructions concerning the procedure to be implemented for assessing whether a groundwater body has a good quantitative status. This report will be appended to the future circular for the updating of the Order of 17 December 2008. In addition, the basins have identified several areas for improvement in this assessment. The acquisition of monitoring data shall firstly be accompanied by the implementation of piezometric levels monitoring for water bodies that are not monitored in this way. The linking of water abstraction points is one of the major areas for improvement: the current measurement system, carried out at the commune (municipality) level, bears no relation to the hydro-geological reality.

National Abstractions Databank in operation for all water bodies in 2012

National Abstractions Databank in operation for all water bodies in 2012

The need for precise knowledge of the abstractions carried out from groundwater and surface water bodies led to the launch in 2010 of the national water abstractions databank. ONEMA is the project holder with the aim of creating a national databank for the collection, storage and provision of reference data. Pending the establishment of common reference datasets and the development of the associated tools, an initial phase was launched using the water agencies' fee data. This transitional phase, scheduled to begin in 2012, will allow the consolidation and centralisation of the data used for updating the inventories and the homogenisation of methods used to calculate indicators of pressures. It will also facilitate their national dissemination. In the current phase, the databank will consolidate the data collected by different organisations and tools (data declared by industrial operators, agency fees, etc.). For the 14 French WFD basins3, it will

Étienne Frejefond,
Dreal Adour-Garonne

Updating the quantitative status of groundwater bodies

«In order to update the quantitative status of groundwater bodies, finalised in 2009, we used the four tests derived from the WFD: recharge-sampling balance, exchanges with surface waters, impacts on associated terrestrial ecosystems and saltwater intrusions. The exercise resulted in a real improvement in knowledge, with the lifting of doubts concerning 20 water bodies, especially through the use of groundwater-river models for the second test. However the confidence level remains generally low. The first reason for this relates to the availability and reliability of the piezometric and hydrological data. The linking of monitoring points and water bodies may prove to be tricky and certain time series, which are too short, make it difficult to analyse trends. Likewise, the geolocation of pressure data remains inaccurate, in a context of a significant accumulation of water bodies - up to 10 orders - in our basin. In addition, the heterogeneous and incomplete environmental data and the lack of methodology have ultimately led us to drop the «impact on terrestrial ecosystems» test. Finally, for the «saltwater intrusions», it would be beneficial to have a methodological guide which could limit the exclusive reliance on expert "opinions".

centralise all known volumes abstracted from the water resource, for each water body and each type of use: irrigation, industry, drinking water, etc.
Another area for improvement is the relationships between aquifers, rivers and terrestrial ecosystems, which in general, remain poorly understood. In particular, it seems necessary to improve the compatibility of the reference datasets for surface water bodies and groundwater bodies in order to take greater account of the impact of abstractions on terrestrial ecosystems. This is the objective of the Naprom project, based on the monitoring of geochemical and biological metrics recorded at five experimental sites, and their comparison with the results obtained by modelling. Managed by Onema, this project will end in 2014 with the publication of a methodological guide to the characterisation of the relationships between aquifers and rivers.

Piezometer used for continuously measuring the variations in groundwater levels.

Water status evaluation system: interim review

The joint efforts undertaken by scientists and managers to develop and implement assessment methods are generating an increasing amount of information, consisting of millions of observational data, numerous indicators (indices, metrics and calculation rules) and miscellaneous reference datasets. The management of this information and its dissemination to all partners involved in each category of water and in the topics requires the creation of shared information technology architecture and clearly stated rules for its use based on a common language. This is the aim of the Water Status Assessment System (Système d'évaluation de l'état des eaux -SEEE), on which public stakeholders in water and aquatic environments at the national level have been working since 2007: Ministry responsible for Sustainable Development, ONEMA, Irstea, IFREMER, INERIS, BRGM, and the Water Agencies.

Overarching concepts and a shared data warehouse...

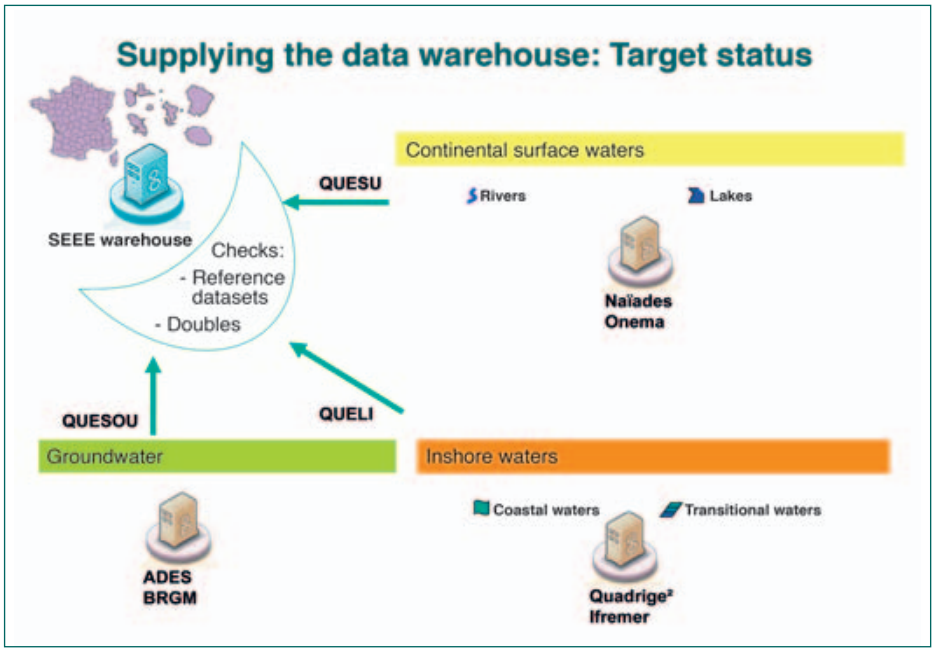
Designed as a component of the Water Information System (Système d'information sur l'eau - SIE) dedicated to the assessment of water status, the SEEE has required the definition of overarching concepts (applicable to all categories of water and topics) by the French National Service for Water Data and Reference Datasets Management (Service d'administration national des données et référentiels sur l'eau - SANDRE), e.g. assessment sites, quality elements tree structures and assessment results. An overarching data warehouse has been established in order to supply observational data to IT (Information Technology) applications. It is based on a common model with a flexible and homogeneous structure, allowing for the calculation of all types of indicators based on observational data for environments. This data warehouse will eventually be populated by national databanks *(See Figure on page 6).*

ADES, the unifying database for groundwater quality and quantity since 2003, centralises the data issued by all information producers: DREAL, ARS, BRGM, Water Agencies, water supply companies (Syndicats des eaux) and local authorities... In 2011, it contains 24 million analyses of 53,500 water points and 292 declared networks, and offers a range of functions: not only data storage, but also the management of reference datasets, network administration, query, consultation, data export and exploitation, such as the hydrological situation report and the comparison of drinking water abstractions with former industrial sites. It already supplies data for the SEEE used for calculating the indicators in force and currently benefits from new tools on an experimental basis, especially in the field of statistical tests for assessing development trends in contaminant concentrations.

• Quadrige[2], the reference database for coastal and transitional waters, managed by IFREMER, now contains over 4.5 million results from three main national networks (Phytoplankton Monitoring Network, Demersal Network and the Chemical Contaminant Observation network), to which the new local networks have been added (Lagoon Monitoring Network and the Biological Integrator Network). Currently nearing completion and from this year, the conversion of these data into the SANDRE format will allow for the transmission to the SEEE of complete datasets for phytoplankton, general physico-chemical elements, nutrients and the contaminants in several basins. The structuring of «demersal» data should be finalised in 2012. Data concerning fish, initially archived by Irstea, shall be transferred to the Quadrige[2] databank in 2012.

• The SEEE currently receives data concerning continental surface waters from a variety of sources (Irstea's «Plandeau» (lakes) and «Pandore» (rivers) databases, ONEMA's BDMAP (freshwater fish database) and the Water Agencies' databases). This entire range of data will soon be centralised in the Naïades national database which ONEMA began creating in 2010. The project, which includes the reuse of previous data from the basins, has been dimensioned in response to the amount of data produced : 500,000 to one million taxon determinations per year for hydrobiological monitoring ; over 15,000 annual data items for hydrogeological monitoring (derived from the Carhyce protocol) and up to 20 million annual analyses of nearly 900 substances for physico-chemical monitoring. The physical chemistry and hydromorphology components are due to be brought into service at the start of 2013 and the start of 2014 respectively. For hydrobiology, the training of the first users will begin in the spring of 2012. In addition to being a supplier of data for the SEEE, Naïades will also be its customer: the calculations of indicators proposed as support for the validation of data to users of Naïades will be carried out by the WFD.

(3) France is divided into 14 WFD basins, each of which comes under the authority of a basin committee, and is assigned a monitoring programme, a management plan and a programme of measures in application of the Water Framework Directive.



Target system for supplying data to the SEEE data warehouse (Julie Chataigner, ONEMA, SEEE seminar 2011)

QUESU: Standardised exchange scenario at the national level (SANDRE) for the exchange of continental surface water quality data.
QUESOU: Standardised exchange scenario at the national level (SANDRE) for the exchange of groundwater quality data.
QELI: Standardised exchange scenario at the national level (SANDRE) for the exchange of inshore water quality data.
Naïades, Ades and Quadrige²: national databanks storing data concerning the monitoring of continental surface water, groundwater and inshore water respectively.

Multiple functionalities...

In addition to its overarching data warehouse function, the SEEE also possesses two IT applications offering a wide range of functionalities: one dedicated to simulation and the other to evaluation. No fewer than 70 scientific contributors and managers have participated in their design and development since 2007.

The simulation tool allows for the development and tuning of methods (metrics, indices and rules) on a local computer workstation. After entering the relevant information and drafting a concise description of the future method, the expert user programs the corresponding algorithms: calculations of metrics and indices, aggregation rules. He or she specifies the different data tables (e.g. class thresholds, taxon guilds and lists of substances) required for the execution of the calculation – a bioindicator for example. The simulation tool allows for the launch of bulk calculations of single-topic indicators, directly from the observational databases extracted from the central server.

Once the methods have been validated, they must then be made available to the professional community: this is the role of the SEEE's assessment tool. This password-accessible Web application, created using a structure that is compatible with the simulation tool's structure (same dataset for observational data and assessment methods), allows for the creation of assessment strategies (methods assembled according to the quality elements tree) and their implementation (production of results). These activities can be shared by a group of users and the results can incorporate the corrections or precisions formulated by experts. Detailed information about each method, duly archived, is easily accessible. The calculation of raw results may be requested for a given space-time context, and the results obtained may be exploited in different ways: «replay», PDF or XML export, sharing for expert appraisal, etc. through to the production of assessment reports. A complex product (75 indicators and rules) can be calculated in four to five minutes. Approximately 4.5 days are thus required to perform a sequential calculation for the 1,500 sites in the WFD monitoring control network of rivers, but there's no need to panic because several calculation queues can be launched simultaneously to reduce this period.

The revision of the supply rules for the data warehouse, the quality assurance of reference datasets and the development of indicators is carried out simultaneously. The SEEE shall be made available to users at the start of 2012 for validation of the implementation of methods and strategies used to assess the status of water used for the WFD management plans (SDAGE) 2010-2015. This will initially apply to rivers and groundwaters. These first activities will allow for the verification of the consistency of the results with the assessments carried out by the basins. The system will then be gradually made available to different groups of users. Designed to be adaptable in its use, the tool will then be equipped with a cartographical selection interface, based on the software application package used in the SIE. It will integrate new data (including from the French overseas départements) and new topics, such as hydromorphology.

For further information:
Bioindication: tools to assess the ecological status of water. Meetings-summary to be published in 2012.

Seminar organisers:

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