



ONEMA

Meetings

Overseas territories, the WFD and bioassessment

A symposium organised by Onema with support from the Water offices of Guadeloupe, Guiana, Martinique and Réunion, as well as the Marine nature park in Mayotte and IOWater.

Over the past five years, the development of bioassessment tools suited to the overseas territories has made rapid progress. The symposium held on 20 and 21 March 2014 at the Porte-Dorée tropical aquarium in Paris was an occasion to report on the progress achieved and to assess the work that must still be undertaken for the upcoming management cycles of the Water framework directive (WFD). A review.

Of the 11 435 French water bodies monitored for WFD purposes, 1 033 are located in the five tropical French territories (Guadeloupe, Martinique, French Guiana, Réunion and Mayotte), including 841 for rivers in Guiana alone (Source: Onema, WFD report 2013). These territories boast remarkable (and often fragile) aquatic biodiversity, notably the islands. They have been the topic over the past five years of concerted scientific efforts to develop bioassessment tools suited to their specific environments. The symposium was an occasion to share information and feedback widely among scientists and the local managers of aquatic environments, in particular the Water offices and the Directorates for environment, development and housing (DEAL). The work in progress, the results obtained and the remaining challenges were presented for each territory and for each biological quality element (BQE) targeted by the WFD, namely phytoplankton, phytobenthos, macrophytes

and angiosperms, benthic invertebrates and fish. Some of these BQEs do not exist in continental France and are present in very special forms in the tropical territories (reef benthos, mangroves, macrocrustaceans, etc.).



Pascaline Loricourt,
Guadeloupe Water office

The symposium was a very useful occasion to share information on methods and viewpoints among the various territories. For the Guadeloupe Water office, still a very young institution, these meetings are very important, but still too infrequent, even if we can call on the experience of our colleagues from Martinique. In terms of bioassessment, we are confronted with very uneven pressure gradients, ranging from highly disturbed coastal areas to virtually pristine uplands in river basins. The physical-chemical monitoring that will be carried out over the next three years should enable us to validate the network of reference sites. R&D work will also be pursued in parallel. In rivers, the macroinvertebrate assessment generalist tool has already produced promising results this year. The diatom index should provide additional information on chemical pressures.

Phytoplankton: an operational network, a bioassessment tool requiring adaptation

In the coastal waters of the five territories, the architecture of the monitoring networks for phytoplankton and the related physical-chemical parameters was strengthened over the last few years in the framework of the WFD monitoring network (RCS). In Martinique, which inherited the “phytoplankton network” monitoring systems (REPHY) managed by Ifremer, regular and more targeted sampling campaigns are now carried out at 15 monitoring points. In Guadeloupe, similar monitoring is done at 18 monitoring points. In Réunion, the hydrological network for littoral areas (RHLR, 13 monitoring points) is used for quarterly and bi-monthly monitoring. In Mayotte, the RCS network, initially deployed in 2008, now has 17 monitoring points. Finally, in Guiana, approximately 30 coastal

and estuarine sites have been regularly sampled eight times per year since the beginning of 2013. In every territory, the various participants stress the importance of the methods employed in ensuring high data quality.

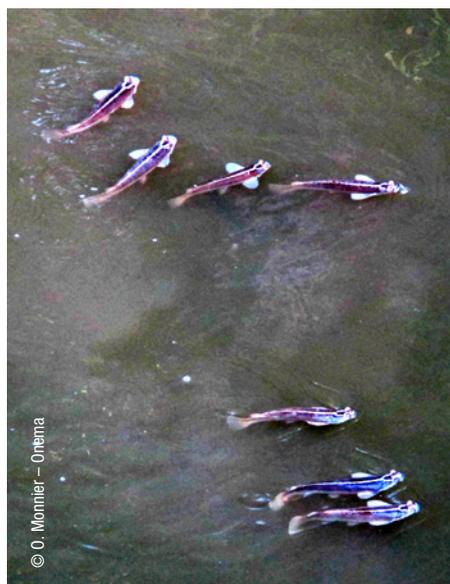
Entry of the collected data in Quadrige², the reference dataset for monitoring of littoral environments, is now under way, with support from Ifremer. Progress is uneven, ranging from nearly completed in Réunion and well advanced in the Antilles to just beginning in Mayotte and Guiana. Significant work is still required to make full use of the stored data. The initial assessment results for the Antilles and Réunion, run using the assessment tool developed for continental France, did not produce very convincing results. It will be necessary to adapt to the overseas environments the thresholds determining WFD status classes for the two metrics (biomass and abundance), by running an analysis on the pressure-state relations. This work, carried out with support from Ifremer, should produce a set of validated and operational assessment tools for littoral waters in the five territories in time for the third WFD cycle (2022-2027). It should also be noted that for continental waters, a study (Asconit Consultants) carried out in 2008 was completed in 2010 to determine the feasibility of developing a phytoplankton assessment

tool for large rivers in Guiana. The initial results confirmed the value of the BQE and clarified the selection conditions for sampling sites.

Diatoms: finalized bioindicators for rivers

Development work was launched in the 1980s on the phyto-benthos BQE (of which diatoms are one of the main components) for rivers in continental France. The work resulted in a number of indices, notably the Pollution sensitivity index and the Biological diatom index which has been standardised and is required by regulations to meet WFD requirements. The launch of complete sampling programmes in organised monitoring networks, in Réunion since 2008 and the Antilles since 2009, made it possible to adapt the indices using the same approach, i.e. statistical analysis of the data was used to separate diatom species according to their sensitivity to various physical-chemical parameters representing anthropogenic pressures (see Figure 1).

The development work carried out locally, which first required a significant effort to identify the taxa (often endemic), resulted in the research teams (Asconit Consultants & Irstea) creating a Réunion diatom index (IDR) and an Antilles diatom index (IDA), with the corresponding status classes. The tools developed for the three territories have been validated for the second WFD cycle. In Mayotte and in parallel with more traditional methods, innovative approaches are being experimented, using genetic analyses (barcoding) and the study of the links between the phylogeny of species (the evolutionary relationships among taxa) and pollution sensitivity, on the basis of the work done in continental France on the BQE. This work was started recently and targets the third WFD cycle.



Typical fishes (*Anableps* genus) of the transitional waters of Guiana.

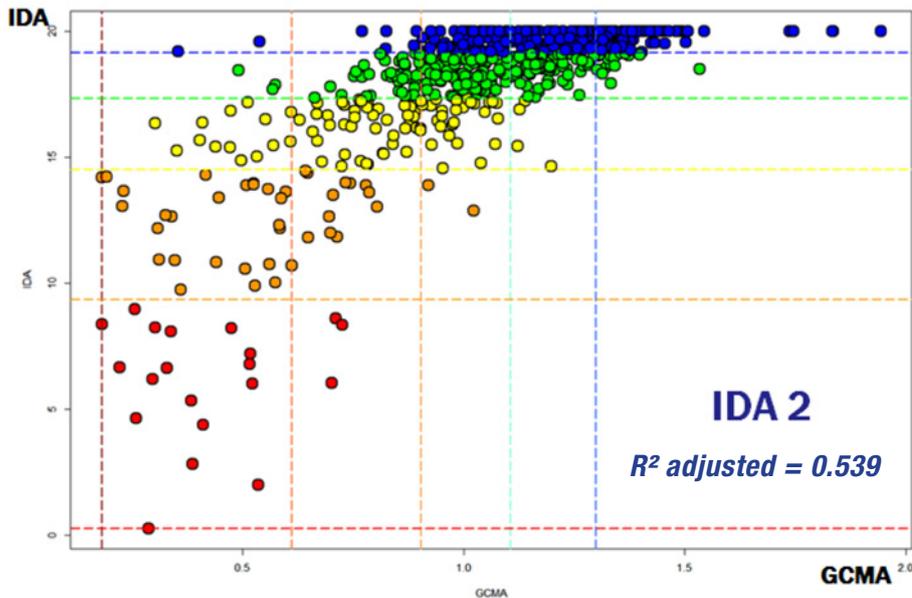


Figure 1: Response of the Antilles diatom index (IDA) to the GCMA anthropogenic gradient. The colour of the points, ranging from blue (high status) to red (bad status), corresponds to the five status classes of the assessment. The graph shows a non-linear, but fairly robust pressure-state relation, in spite of a number of outliers. (Source: Asconit Consultants & Irstea)

Concerning littoral waters, research is being done on diatoms in the coastal waters of Martinique (Asconit Consultants & University of Toulouse). A major effort to identify taxa has been launched and a sampling protocol using an artificial substrate has been proposed, that could be used on a routine basis. Other work addresses diatoms in Guianan estuaries. The results (IRD) presented during the symposium

concern the links between different diatom assemblages (oceanic, benthic, euryhaline) and the very specific sediment dynamics in Guianan estuaries. This work will pave the way for an assessment tool based on this BQE for Guianan transitional waters, where most of the anthropogenic pressures in the territory occur and for which no specific bioassessment tools currently exist.

Macrophytes: no freshwater bioassessment tools, pursued efforts for littoral waters

To what extent do bioassessment tools based on macrophytes (angiosperms and macroscopic algae) produce relevant results for the assessment of the ecological status of rivers in the overseas territories? This question was the starting point for a field mission carried out by Irstea in 2012 and 2013. The conclusions of the study, based on observations at over 160 sites in the five territories and numerous discussions with local stakeholders and water managers, revealed the limited use of macrophytes in assessing the WFD ecological status of rivers in the overseas territories. The study noted the insufficient density of the observed vegetation, insufficient taxonomic knowledge (notably in Guiana) and the high impact of natural forcings (cyclones) compared to the anthropogenic degradation affecting plant communities, particularly in the islands. However, this compartment would appear to be potentially useful for monitoring invasive species by developing “alert” metrics signalling this anthropogenic pressure.

For the littoral waters of the Antilles and Mayotte, on the other hand, work continues in view of obtaining operational



Measurements on a bed of seagrass in Martinique.

Myriam Debris,
Guiana environmental agency

The development of bioassessment tools is an ambitious undertaking in the Guianan context. Access to drinking water is not always available and sanitation networks are often not up to the task, given the increases in population on the coast and along rivers. Thanks to the WFD, however, a number of valuable tools have been developed for rivers. Our current priority is to devise at least one robust bioassessment tool for transitional waters, where most of the pressures are concentrated. But, concerning the assessment of water status, we are also counting on alternative techniques, e.g. passive samplers to acquire an integrated measurement of pressures and satellite images to monitor phytoplankton and the turbidity of coastal waters.

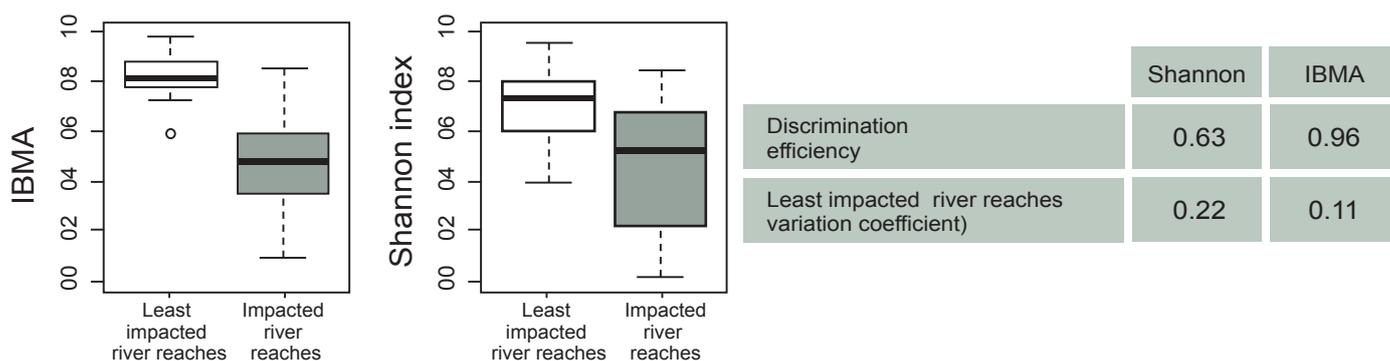


Figure 2: Comparison of scores obtained for the Antilles macroinvertebrate biological index (IBMA) and the Shannon index, using biological data from Martinique. The Shannon index is a diversity index, used here as a metric for biological diversity (Source: Asconit Consultants & University of Toulouse).

“angiosperm” assessment tools for the third WFD cycle. In the Antilles, the monitoring sites have been selected and the various sampling protocols have been tested. A typology of seagrasses in Martinique has been drafted (MNHN). The preliminary results presented by the national work group created in 2011 by Onema and MNHN made clear the difficulties involved and the limited potential of the work. The assessment suffers notably from a lack of reference sites (few or no disturbances) and a lack of older data. Selection of protocols and of the parameters to be measured will continue in 2014, taking into account the results of recent studies in the field and the contributions of a number of European and regional studies.

Benthic invertebrates: validated tools for rivers

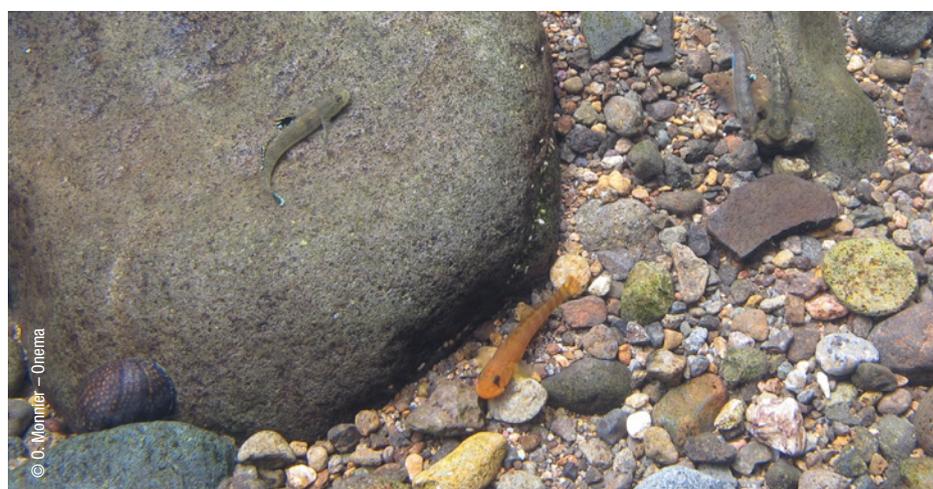
Significant progress has been made on bioassessment tools based on benthic invertebrates, given that the scientific teams could use the work already done in France on the multi-metric invertebrate index (I2M2)¹. For rivers in Réunion, the Réunion macroinvertebrate index (IRM) comprises eight density and richness metrics for 29 taxa (CNRS & ARDA). Applied retrospectively to the monitoring campaigns from 2007 to 2011, the index must still be improved to better take into account local variability in the reference conditions in order to obtain a more discriminate response than

is currently the case. For Martinique and Guadeloupe, which have fairly similar invertebrate communities, the final work on a common index (Asconit Consultants & University of Toulouse) was recently finished. Called the IBMA (biological macroinvertebrate index for the Antilles), this fairly reliable bioassessment tool detects impacted sites but does not distinguish between pressures, i.e. it corresponds well to WFD requirements (see Figure 2).

In Guiana, a multi-metric index has been developed for small rivers (Hydreco & University of Toulouse). Following a major effort to identify taxa, carried out on approximately 100 sites, five metrics were selected for the index. The tool, which will certainly be validated in time for the third WFD management cycle, should however provide initial results during the second cycle. For Mayotte, where work only recently began, the first step has

addressed the identification of taxa, many of which are endemic. On the small island, the research has consisted of experiments on innovative methods to detect taxa, such as barcoding (Inra & Ethyco), and the use of “alternative” metrics, e.g. life forms and ecological guilds, that are sensitive to different types of pressures.

In addition, the symposium also presented the preliminary results of several studies to assess the usefulness of the “marine invertebrates of mobile sedimentary bottoms” compartment for the littoral waters of Guiana (IRD), Réunion, Mayotte (University of Réunion) and Martinique (University of Réunion & Impact Mer). For the islands, this work produced valuable knowledge on the ecology of the environments and confirmed the potential use, but also the challenges of developing this type of bioassessment tool for the third WFD management cycle.

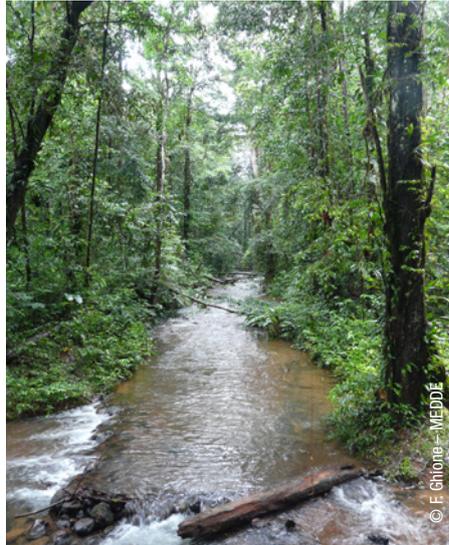


Fish of the *Sicydium* genus, typical of the fauna found in rivers in the Antilles.

¹ For a report on the work carried out to develop bioassessment tools in continental France, see *Bioassessment tools to assess the ecological status of aquatic environments*, published in 2013 in the Onema “Meeting Recap” series.

Fish indices: validated tools for rivers in Réunion and Guiana

In the islands, a vast majority of fish species are diadromous and highly sensitive to hydromorphological alterations in the ecological continuity of rivers. The development of bioassessment tools based on this compartment therefore requires specific research work to determine how to take into account the high degree of variability in the number of fish making their way to the estuaries (the larvae develop in the sea, then converge on the estuaries in order to colonise rivers). How can relevant pressure-state relations be developed if there are no sites that have not been disturbed in terms of their hydromorphology? These are questions that the national work group for "Diadromous fish in the insular territories", created in 2014 by Onema and MNHN,



Small rivers represent 80% of all water bodies in Guiana.

will attempt to answer in assessing the feasibility of developing such tools, on the basis of a summary of existing knowledge and of the available data on local communities and pressures.

The work group will organise a first national symposium on the topic in December 2014. In the meantime, the only island having a validated fish index is Réunion, where a fish-monitoring network existed even before the WFD. The work on the IRP (Réunion fish index) was started in 2003 and benefited greatly from a research programme carried out by CNRS and ARDA from 2008 to 2012. The assessment results for the years 2008 to 2011 were presented during this symposium and paved the way for improvements of the index, for example through integration of macrocrustaceans and acknowledgement of the major potential impact on fish communities of "bichique" fishing (capture of post-larval fish during migration).

The situation is, of course, very different in Guiana, where the vast hydrographic network (110 000 km of river) is home to hundreds of fish species, for some of which very little information is available. The old IPG (Guiana fish index) was suited to mid-sized to very large rivers. It was improved (Hydreco & IRD) starting in 2009, notably by taking into account new biological knowledge

and additional data. It is now operational and will be used for the second WFD cycle. In parallel, research work has been carried out on a bioassessment tool for small rivers, which represent a majority (80%) of water bodies in Guiana. The tool (Hydreco & University of Toulouse) has already provided highly valuable information on fish assemblages in small rivers, however its routine use remains limited in the absence of a non-lethal sampling protocol, given the low mineralisation levels of the water making electrofishing ineffective. Finally, the very specific functioning and fish populations of estuarine waters in Guiana were the topic of a special study indicating that it should be possible to develop a bioassessment tool (Irstea).

Reef benthos: a national work group and an important debate

Coral reefs are iconic ecosystems along the coasts of Réunion, the Antilles and particularly Mayotte. In these territories, the expected integration of the benthic-invertebrate BQE has led to planning for the development of WFD-compatible bioassessment tools based on the reef communities that constitute an important common heritage and have long been studied by scientists. A report on the work already carried out to that end in the four islands was presented during the symposium. In Réunion, where four of the coastal water bodies (of 12) are of the reef type, a proposal has been made (Ifremer) to develop three distinct bioassessment tools, corresponding respectively to macro-algae, the communities in the back-reef and reef-crest zone (shallow zone along the reef) and communities in the fore-reef zone. For the latter zone, an initial index has been developed based on coral vitality (the percentage of the potentially colonisable substrate effectively colonised by coral, see Table 1).

Preliminary results and a number of recommendations were also presented

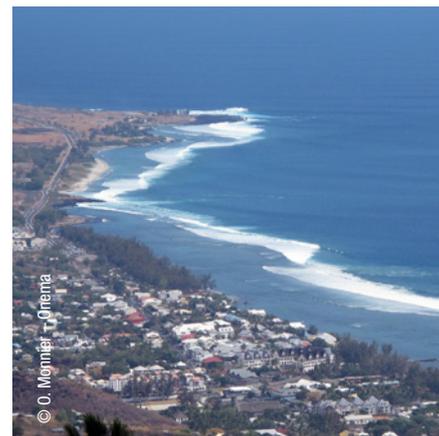
Alexandre Moullama,
Réunion Water office

The development of WFD bioassessment tools for the overseas territories requires a significant investment on the part of the Water offices and local scientists, who must deal with an absence of long data series and insufficient taxonomic knowledge. In Réunion, we have a number of suitable tools for rivers that must now be tested. The main challenge currently concerns monitoring of littoral waters, which concentrate most of the pollutants with limited pressure gradients. For compartments such as phytoplankton and benthos on hard bottoms and mobile sedimentary bottoms, we must improve our understanding of pressure-state relations in order to identify metrics that respond well to a given pressure. That will require additional R&D work.

for Mayotte, where a wide variety of reefs are found in the coastal waters (PNMM & Pareto), and for the Antilles, where a statistical study was run on the elements measured since 2007 (Impact Mer & Pareto). In view of future WFD monitoring, the above studies received advice on methods from the national work group for “Seagrass and reef benthos”, created in 2011 by Onema and MNHN to set and coordinate guidelines for the methods used to develop the bioassessment tools. However, debate continues concerning the value of tools based on coral ecosystems for the WFD. A number of symposium participants noted the very high influence of natural forcings and those linked to global change (cyclones, bleaching), as well as the very long time required by coral ecosystems to recover after a perturbation. These characteristics may be incompatible with the development of bioassessment tools designed to meet management objectives over relatively short time spans, in conjunction with a reduction of local anthropogenic pressures.

All of the work and the results presented over the two-day meeting, with highly informative debates, demonstrate the commitment of

the scientific community and water stakeholders to the development of bioassessment tools suited to the requirements and specific conditions of the overseas territories. In just a few short years, starting in many cases with little available data and limited knowledge, dozens of joint research projects have been carried out, producing significant progress and setting effective guidelines for environmental management, while complying with the requirements set by the WFD. Eight of the bioassessment tools developed to date have been validated for the second WFD management cycle (2016 to 2021) and still others will be reinforced or perfected for the third cycle. The need to pursue the national effort to develop bioassessment tools and make them available to the people in the field is greater than ever. Above and beyond regulatory reporting requirements, bioassessment is a powerful tool for monitoring and restoration of overseas aquatic environments by local water managers. It is also a means to identify the main issues in biodiversity conservation, which remains a major challenge for the overseas territories. ■



A coral reef along the coast in Réunion. The coastal area is subject to high pressures.

For more information

www.onema.fr

www.oieau.fr

Recap of the symposium soon to be published:
<http://www.onema.fr/collection-les-rencontres-syntheses>

Symposium organisation:

Olivier Monnier, Research and development department, scientific officer for “Overseas ecosystems”

Yorick Reyjol, Research and development department, scientific officer for “Biological assessment of aquatic ecosystems”

Marie-Claude Ximénès, Research and development department, scientific officer for “Littoral waters”

Dominique Hauw, executive assistant, Onema-Irstea-IMFT Ecohydraulic centre

Table 1: Parameters and metrics selected for Réunion by the WFD work group for “Reef benthos”. In blue, the parameters for which a rise in the metric is positive, in red, the parameters for which it is negative. ACT: table acropora; ACB: branching acropora; CAC: acropora coral in general (Source: Ifremer).

Parameter	Metric
Living-coral cover	Coral vitality = % of colonisable hard substrate covered
Acropora-coral cover	% CAC = % of acropora in living coral
ACT + ACB cover	% ACT+ACB = % ACT+ABC in acropora coral
Upright-algae cover	% upright algae = % covering the available substrate
Calcareous-algae cover	% calcareous algae = % covering the available substrate
Soft-coral cover	% soft coral = % covering the available substrate

ONEMA Meetings



Publisher: Elisabeth Dupont Kerlan
 Coordination: Véronique Barre, Research and development department, and Claire Roussel, Information and communication department
 Authors: Laurent Basilio, Olivier Monnier and Yorick Reyjol
 Translation: Bartsch & Cie (info@bartsch.fr)
 Editorial secretary: Béatrice Gentil, Information and communication department
 Layout design: Eclats Graphiques
 Production: Bluelife
 Printed by: IME
 Printed on paper from sustainably managed forests.
 Onema: 5 Square Félix Nadar - 94300 Vincennes
 Document available at:
<http://www.onema.fr/Les-rencontres-de-l-Onema>

