Damage evaluation in the water field : contribution of a french database

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Summary

The progressive implementation of the framework directive will be marked by major steps forward in the area of economic expertise. This report serves this aim by supplying a number of results necessary for its application. It marks an operational step in the work on water economics and the integration of market or non-market damages in public decision-making. In this respect, it constitutes the first extension of the seminar organised by the INRA and the Water Department in Paris on the 21st of December 2001.

This report has three aims:

1. To illustrate the state of the art of water-related damage evaluation in France (listing of studies and synthesis of results obtained).
2. To attempt an evaluation of the contribution of these studies (reliability and transferability) with the aim of establishing tutelary values for water-related services in the sense defined by the European directive.
3. To assess the strong points and weak points of French expertise in the field and formulate recommendations (insufficiently investigated fields, needs for additional studies, inadequately solved methodological difficulties, standardisation of procedures and protocols for comparison purposes).

Around forty studies were brought together to constitute a homogeneous database of the existing work, under ACCESS. It covers practically all French results obtained in the field of economic evaluation of water-related damages and benefits. At the same time, a study presentation and interpretation table is proposed. This fits in with the framework directive (grouping according to a nomenclature of usages) and leads to an evaluation of the results obtained according to various criteria.

The usages are grouped in homogeneous categories linked to a conventional typology of hydrosystem functions which distinguishes between the supply, trophic productivity, purification, transport, recreational and patrimonial functions. There is clearly a shortage of knowledge concerning the strictly market usages: drinking water supply, productive usages, treatment, storage and transport of material, and network services. The information exists, but in a scattered form in the agencies or technical departments of the State, and has been produced by a variety of methods which are difficult to compare. Undertaking a major operation of gathering of this information therefore requires a prior evaluation of its potential to be used for the purposes of the study.

However, the evaluations relating to the non-market aspect already offer a coherent and comprehensive set of information on this category of usages. Their integration in a tutelary approach should not pose insurmountable difficulties. However, additional coherence tests should be carried out beforehand, making a distinction between leisure and contemplation usages on the one hand and ecosystems usages on the other. For each category, it is already possible to make progress on the question on the basis of existing work, by envisaging a meta-analysis.

The problem of transfer is central in operational terms. In numerous situations, a specific evaluation turns out to be too costly or to take too long to implement, which raises the question of the appropriateness of using results from similar studies. Is it justified to take these estimations as they are and adapt them in accordance with local conditions or according to a more sophisticated procedure? This is the benefit transfer technique, also known as value transfer, a term which is often preferred because it gives a more general character to this approach which is conventionally used in engineering sciences and in medicine. The analysis conducted in the report leads to a number of general recommendations but must be continued.

The simple transposition of an average unit value (tutelary value) can be envisaged, but between the base site and the application site there must be:

1. A modification of the natural asset to be valuated which is of the same order.
2. The same characteristics on both sites and the same activities practised on them.
3. A great similarity between the characteristics of the households.
4. The same price for the activities on the substitute sites and on the site itself.

In the absence of good comparability between the sites, the assets and the populations, more sophisticated procedures should be used. From this point of view, meta-analyses, which provide a statistical summary of past research, seem to be the solution to be developed.

Five proposals achievable by the end of 2004 can be formulated :

1. Constitution of a French database compatible with EVRI.
2. Agreement on a nomenclature of usages.
3. Establishing a list of usages to be studied as a matter of priority.
4. Establishing the methodology for the main usages.
5. Carrying out a meta-analysis of the studies available dealing with leisure activities and usages of ecosystems.

1. Introduction

Awareness of the fragile and sometimes conflicting relationship between man and his environment has progressively led developed countries to introduce an environmental policy from the 1960s onwards[1]. The implementation of this policy is justified by ethical reasons, the objective of maintaining the well-being of populations, and economic reasons. From the ethical point of view, we refer implicitly to the intrinsic value of nature, which must be protected for this reason. People must therefore behave in a responsible way and preserve the biosphere. The second category of justifications is based on the observation that the deterioration of the environment has negative effects on the well-being of individuals. This category of justifications concerns not only the present generation, but also future generations. Pollution has effects on human health which result in considerable costs, to which are added those of restoring contaminated environments. In addition, investment in more environment-friendly technologies can lead to efficiency gains for the economy (Porter's hypothesis[2]).
The assertion from 1987 onwards[3] of an objective of lasting development marks an additional step forward in awareness of the risks run because of the deterioration of the environment and the exhaustion of natural resources. The declared objective is development which meets present needs without endangering the ability of future generations to meet their own needs. Consequently, it is recommended to preserve the general balance and value of natural assets and define instruments for evaluation of policies in order to be able to determine the true costs of the conservation and use of these natural assets. The objective of lasting development therefore refers primarily to a criterion of intergenerational fairness. In addition, it also insists on the importance of a fairer distribution of resources between the regions and countries of the world. To achieve this objective, the report lists three conditions:

1. Generally maintaining the quality of life.
2. Maintaining permanent access to natural resources.
3. Avoiding all persistent environmental damage.

The concept of lasting development remains vague and can give rise to different interpretations[4], all of which emphasise the following three key points:

1. Importance of interactions between the economic system and the biosphere.
2. Integration of the objectives of fairness between generations and between regions.
3. Taking into account of long-term effects.

In promoting 'lasting use of water, based on long-term protection of available water resources' (article one), the framework directive of the 23rd of October 2000 (DCE) fits in with a perspective of lasting development, in line with the European Unity treaty adopted in Maastricht in 1991. It thus goes far beyond the set of texts which it replaces. It defines for all hydrosystems qualitative objectives based on the concepts of good ecological and physical-chemical condition, and for underground water masses it defines a quantitative objective implying a balance between their replenishment and the quantities drawn from them. The implementation of a management plan (article 13) integrating the programme of measurements stipulated in article 11 must enable these objectives to be attained. However, the main innovation of the DCE lies in central control of the effectiveness criterion to define

[1] Bonnieux F., Desaigues B. 1998. Economie et politiques de l'environnement. Dalloz, Paris.
[2] Porter M.E., van der Linde C. 1995. Toward a new conception of the environment-competitiveness relationship. Journal of Economic Perspectives 9: 97-118.
[3] Bruntland Report. 1987. Our common future. World Commission on Environment and Development, Oxford University Press.
[4] Pearce., Markandya A., Barbier E.B. 1989. Blueprint for a green economy. Earthscan Publications Ltd, London.

these instruments of public action. Effectiveness in the allocation of resources must be sought in each period and over time. This very logically involves evaluating, if possible in monetary terms, the effects of the usages of water on the resource and the environment, and the measures which we are led to recommended. Up to now, pragmatism has prevailed in that a cost-effectiveness logic has been preferred to an approach in terms of cost-benefit analysis, which is more ambitious but probably unrealistic for the moment. It is nevertheless clear that, in the long term, the ambition of the European water policy is to take into account both the costs and the benefits (or the damage avoided). Damage evaluation is therefore part of a vast process of preparatory thinking for this future evolution.

The approach adopted by the DCE leads to the choice of the most economical solution for a given objective. However, this solution may result in a considerable financial burden, which has led the legislator to introduce a concept of unbearable costs, leading to possibilities of concessions. A postponement may thus be justified by exaggerated costs and a reduction of the environmental objectives may be justified by disproportionate costs (article 4). Finally, the DCE emphasises price rates to allocate the resource and arbitrate between usages. This choice, which is consistent with the principles of the European environment policy, must facilitate the internalisation of external effects in accordance with the "polluter pays" principle. It results in particular in the 'recovery of service costs' made compulsory by article 9.

The concept of intrinsic value of an environmental asset scarcely has any sense in economics, with the result that economic evaluation is above all an exercise in comparison. Whether we are talking about damage or benefits, the aim is to measure losses or gains in well-being produced by reductions or increases in the availability or quality of an environmental asset. The evaluation of an asset involves in reality a comparison between a situation in which the asset exists and a hypothetical situation in which it does not exist. The comparative economic question conflicts with engineering and natural science practice which consists in reasoning in terms of the state of the resource and the associated environments. It is unreasonable to ask that monetary measurements be associated with measurements of physical or biochemical states, since monetary measurements are supposed to reflect the economic value of these states. This approach conflicts with the economic approach, which is based on comparisons of states and on the taking into account of the socio-economic context as a whole. In terms of economic evaluation, the DCE adopts an approach consistent with the economic question. It does not stipulate evaluation of the state of the environment but stipulates reasoning by comparison between the present state (before introduction of the directive), and the state aimed at by its objectives. The concept of 'costs' or 'damages' which results from this must therefore be understood as the monetary equivalent of the losses of well-being suffered by the community because the objectives of the directive are not attained at the present time.

The application of the DCE will lead to a double requirement for economic expertise. Firstly, it must be capable of linking the data on the current state of the masses of water with levels of social well-being. Secondly, it must be capable of projecting itself into the future, or more precisely into a situation in which the directive has produced its effects in terms of improvement of the state of the masses of water, and linking this 'objective' state to projected levels of well-being. The comparison between existing and projected levels must then provide the required measurement of benefits (or reduction in damage).

It should be noted however that there is no requirement to establish explicit links between these projective scenarios and the evaluation of the direct and external costs, i.e. in particular of the damages. The reason for this is a practical one: the uncertainty surrounding the future development of European economies is too great for us to make a sound assessment of the damages on the basis of hypothetical scenarios describing the development trends of national

economies[5]. Damage evaluation work must therefore be carried out by comparison of physical and biological states of masses of water in a given socio-economic context, i.e. in the present context.

The implementation of the DCE will be effective at the earliest in 2015 and at the latest in 2027 given the foreseeable postponements. Its progressive application will be marked by major steps forward in the area of economic expertise[6]. In this respect, the economic analysis to be conducted for December 2004 must characterise the various uses of water and the division of the costs into major categories (industry, agriculture and households). The drafting of the management plans and the measurement programmes by the end of 2009, and the implementation of an incentive price rate policy by the end of 2010, will necessitate further economic studies. This report supplies a number of results necessary for its application. Indeed, it marks an operational step in the work on water economics and the integration of non-market aspects in public decision-making. With regard to this we should cite the research conducted by the CNRS and the INRA, financed by the Water Department and the Department of International Economic Affairs, together with the work conducted under the aegis of the Hydrosystems Public Interest Group[7], on which it is based. It therefore constitutes the first continuation of the seminar organised by the INRA and the Water Department in Paris on the 21st of December 2001[8], the conclusions and recommendations of which are appended.

This report is divided into two main parts devoted firstly to a presentation and an analysis of the French studies and secondly to the question of value transfer. It has three aims:

4. To illustrate the state of the art of water-related damage evaluation in France (listing of studies and summary of results obtained).
5. To attempt an evaluation of the contributions of these studies (reliability, transferability) with the aim of establishing tutelary values for water-related services in the sense defined by the European directive.
6. To assess the strong points and weak points of French expertise in this field and formulate recommendations (insufficiently investigated fields, needs for additional studies, inadequately solved methodological difficulties, standardisation of procedures and protocols for comparison purposes).

A maximum number of studies were brought together to constitute a homogeneous database of existing work. This complements the preliminary work undertaken by the D4E in the Autumn of 2001 and it is enriched by standardising as far as possible the presentation and the method of interpretation of the results obtained. This operation has allowed the collection of around forty French studies with a variety of statuses, subjects and methodologies. Although probably not exhaustive, this list covers practically all[9] French results obtained in the field of economic evaluation of water-related damage and benefits. At the same time, we have established a system of interpretation and presentation of the studies, a system which can both fit in with the framework directive (grouping according to a nomenclature of usages) and lead to an evaluation of the results obtained according to various criteria. This information is organised in a database to which are attached detailed descriptive data sheets for each of the studies.

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[5] The usefulness of macroeconomic models integrating the environment needs to be underlined.

[6] See in particular the reports of the WATECO working group.

[7] Amigues J-P., Bonnieux F., Le Goffe P., Point P. 1995. Valorisation des usages de l'eau. Economica, INRA, Paris.

Point P., (ed.). La valeur économique des hydrosystèmes : méthode et modèles d'évaluation des services délivrés. Economica, Paris.

[8] See the report entitled 'Damage evaluation in the water field'.

[9] This was what resulted from a consultation of those present at the seminar organised by the Water Department on the 12th of December 2002.

The question of transfer, to which the second part is devoted, is central in operational terms[10]. In many situations, indeed, a specific evaluation turns out to be too costly or to take too long to implement, which raises the question of the appropriateness of using results from similar studies. Is it justified to take these estimations as they are and adapt them in accordance with the local conditions or according to a more sophisticated procedure? This is the benefit transfer technique, also known as value transfer, a term which is often preferred because it gives a more general character to this approach which is conventionally used in engineering sciences and in medicine[11]. Its use in economics has been more restricted up to now. However, the trend observed in the United States shows that it is destined to develop rapidly. The obligation of evaluation of public decisions and in particular of regulations has indeed led to the area of application of economic calculation being extended by integrating non-market environmental effects[12] and to the recommendation of transfer value in precise cases. The implementation of the DCE will lead to a comparable context which justifies an interest in the conditions under which this methodology is applied.

The analysis of the strong points and weak points of French expertise has been successfully carried out and leads to recommendations which will have to refined. In addition to the proposals which are made in the conclusion of this report, additional studies need to be envisaged.

[10] It carries on from Pierre Rainelli's contribution to the seminar of the 21st of December 2001.

[11] Heijungs R. 2002, « Some parallel in the development meta-analysis in the natural and social sciences », in Florax R., Nijkamp P., Willis K (eds.). Comparative environmental economic assessment, Edward Elgar Northampton Mass, pp. 19-34.

[12] Hanemann W.M., 1992. 'Preface', in Navrud S. (ed.). Pricing the European environment. Scandinavian, University Press, pp. 9-35.

2. Presentation and analysis of French studies

By modifying the context in terms of regulations, the implementation of the DCE leads to significant changes in the context of environmental evaluation. The routine conducting of evaluations requires the drawing up of rules. In addition, to archive the results and use them in other cases, it is necessary to have a precise nomenclature of the usages of water. Once these various points have been dealt with, we present the results obtained in France concerning damage evaluation and a synthetic evaluation of these results.

2.1. Context of environmental evaluation

It is strikingly apparent that the development of environmental evaluation was for a long time a matter for scientists. Although the evaluation of public projects and policy has a long history in economics, it is only in the past twenty years or so that environmental evaluation methods have become an element of what we might call public economic intelligence, i.e. all the systems of technical expertise, operational and financial research or management aimed at clarifying the economic effects to be expected from public decisions.
One might thus be tempted to summarise the history of recent years as that of a slow process of diffusion of ideas and methods of economic analysis in the sphere of public decision-making, an area which has progressively adopted the intellectual vision of the discipline in a kind of transfer of technology from science to politics. It therefore seems quite surprising that expertise in the evaluation field was confined for so long to the scientific sphere: many of those with expert knowledge (design offices, consultants, civil servants in the technical ministries) should have appropriated these techniques and integrated them, as a matter of routine, so to speak, in the study protocols prior to decision-making. We should note that this situation is not specific to France and has been observed in foreign countries[13]. This simple fact should therefore alert us to the simplistic nature of the theory of the "upstream to downstream" diffusion of concepts and methods. We can suggest two basic reasons for the underdevelopment of economic expertise in the area of environmental evaluation.
The first is related to the democratic nature of political decision-making in the water field. The economic dimension is only one of several aspects of the concerns of those involved, and is rarely a primary element. Expertise can frequently only develop in a context of conflict between contradictory types of expertise. The development of environmental evaluation will therefore occur only if the expected economic effects of the decision are sufficiently decisive to motivate those concerned to invest resources. If this is not the case, expertise will remain dependent on public orders and as such will be able to play only a marginal role in a negotiated decision procedure, owing to lack of understanding of what is at stake on the part of the players concerned.
The second reason is related to the methods themselves. Based on evaluation of the demand for environmental resources, they emphasise the sovereignty of the consumer. The method of contingent valuation referendums mimics a procedure of financial acceptance by tax-payers of a public action in favour of natural environments. The displacement costs method exploits the revealed preference for identifying the natural sites which are most remarkable from the point of view of the users. This emphasis on the sovereignty of the consumer poses a problem for the decision-maker who places his action more in a multi-criteria perspective. Why give

[13] For an analysis of the role of institutional contexts in Europe and the United States, see chapters 17 and 18 in: Bateman I.,J., Willis K., G. (eds.). 1999. Valuing environmental preferences: theory and practice of the contingent valuation method in the US, EU, and developing countries. Oxford University Press.

priority to protecting the sites in greatest "demand" from those who frequent them, when there are preserved natural sites which are much more important to protect for ecological or patrimonial reasons, perhaps precisely because they are little-known and rarely visited? Can we trust the results of referendum methods based on virtual payments, and of which we are not even sure that they reflect a strict preference for the environmental asset to be evaluated over other public assets supplied to the community?

This situation is nevertheless rapidly changing. Water agencies and technical ministries have conducted more and more economic evaluation studies over the past few years and we are seeing the emergence of genuine know-how in this field within public bodies. This trend can also be seen in a more advanced form in the United States both in the Environmental Protection Agency and in federal and state administrative departments. On the basis of this experience, we can estimate that the gap in the expertise of public bodies will be filled within the next decade.

2.2. Regulation context

In terms of management and economics, the framework directive on water breaks down human activities into 'services linked to the use of water' and 'use of water'. These two concepts are defined in article 2 (paragraphs 38 and 39).

> Paragraph 38) 'services linked to the use of water': all services which cover, for households, public institutions or any economic activity:
>
> a) the collection, damming, storage, treatment and distribution of surface water or underground water;
> b) the waste water collection and treatment installations which then carry out disposal in surface waters;
>
> Paragraph 39) 'use of water': the services linked to the use of water together with any other activity identified under the terms of article 5 and Appendix II liable to have a noticeable effect on the state of the water.

A service linked to the use of water constitutes an intermediary between the natural environment and the use of water proper. It therefore aims to:

1. meet users' needs by modifying the characteristics of raw water, for example by supplying drinking water, or
2. meet the requirements of the natural environment by modifying the characteristics of waste water.

A service linked to the use of water does not consume water and does not produce any pollution but modifies the characteristics of the water: spatial distribution, reservoirs, height, treatment, temperature. By introducing this concept, the legislator has emphasised an approach centred on the companies which provide the public services which are listed. The concept of use of water refers to a broader category since it includes the services linked to the use of water. However, this category does not include the usages of water liable to have a noticeable effect on the state of the water. We thus distinguish between two categories of usages, the technical specifications of Appendix II enabling us to associate them with one or the other. In addition, we should note that the economic analysis stipulated by article 5, scheduled for 2004, concerns only the uses of water.

The directive introduces the concept of an "activity", which can be considered equivalent to the concept of usage of water commonly used in the economic analysis of hydrosystems. Reference to "activity" or "usage" is fundamental for three categories of reasons.

1. The contingent nature of the concept of use of water: depending on its potential impacts on the state of the water, a usage will in certain cases or during certain periods be treated as a use of water, and in others it will not.
2. Conflicts of usages: certain usages (recreational, for example) do not have any noticeable effect on the state of the water and therefore do no fall into the category of uses; however, they may be prevented by uses which *are* taken into account, which leads to their being taken into consideration for arbitration. Indeed, the opportunity cost of a particular use may be evaluated on the basis of a usage which does not come under the "use" category.
3. Possible development of the economic approach: the directive retains the cost-effectiveness analysis to carry out the economic calculation. At some point in the future, we can imagine a trend towards a more complete taking into account of the non-market sphere leading to a cost-benefit analysis extended to all usages.

2.3. Functions and usages of water

Economic analysis emphasises the concept of usage of water which it associates with the functions of water[14]. This latter concept makes it possible to connect the environmental sphere with the economic sphere. The list of potential usages is obviously very long, hence the need for grouping in categories which are as homogeneous as possible. The evaluations made therefore concern usages of water or in most cases categories of usages[15]. It is therefore necessary to draw up a nomenclature of usages to establish a correspondence with the two concepts introduced by the directive, which must be evaluated in monetary terms. To successfully carry out this task, two steps are necessary:

1. Define a correspondence between the functions and the categories of usages of water.
2. Define a correspondence between the categories of usages and the usages of water.

By using a number of conventions in the assignment of the usages to the categories of usages and of the categories of usages to the functions, this procedure leads to a nomenclature of mutually exclusive usages of water which is broken down very finely. The uses of water can then be defined by an aggregation of usages.

Table 1 is constructed on the basis of a conventional typology which distinguishes the supply, trophic productivity, purification, transport, recreational and patrimonial functions. When these functions are performed, the hydrosystems generate usages, or more precisely usage potentials, to the benefit of human communities and living environments. Each function is at the origin of usages which can be defined without referring to a degree of technical development of the human communities which benefit from them.

[14] See in particular Amigues et al., op., cit. and Point, op., cit.

[15] These categories are sometimes called water services. This term will not be used in this report to avoid any confusion with water use services as defined by the directive.

Table 1. Correspondence between functions and categories of usages

Functions	Categories of usages
Supply (water cycle)	Supply, production and storage of the resource
Trophic productivity	Productive usages
Purification	Treatment, transport and storage of material
Transport	Network, infrastructures
Recreation	Recreational usages: leisure, contemplation
Patrimony	Ecological usages: biodiversity, preservation, protection

In the current state of the economic discipline, it is impossible to undertake a direct evaluation of the potential value of hydrosystems. Evaluation involves an indirect approach essentially based on an evaluation of the usage benefits or the damage. A water function does not automatically imply a usage benefit. The transport of material may mean erosion or the presence of natural contaminants in the surface water, i.e. a cost or a risk for the community. The same remark can be made for usages linked to the patrimonial function. The proximity of a stream or river represents a guarantee for a human community in terms of supply but may also signify a potential risk (flooding, for example). The economic evaluation does not concentrate solely on the categories of usages considered to be positive for the community, but also looks at the negative aspects, i.e. the risks generated by the hydrosystems.

Since the economic evaluation will essentially be based on usages, it would be desirable to be able to construct a nomenclature by a simple two-stage aggregation distinguishing between usages, categories of usages and functions of water, which would enable one or more clearly identified usages to be associated with each category of usages. Unfortunately, this will by no means always be the case. A given usage may involve various categories at the same time: for example, the disposal usage simultaneously calls upon the natural purification potential of the hydrosystems and their dilution and transport capacity. Conversely, a category is by definition a multi-usage category.

In table 2, at the price of simplifications, we have established a correspondence between the usages of water and the categories of usages in table 1, assigning each usage to a single category. This table calls for several prior comments. First of all it is based on an extended definition of the word "usage". By "usage" we mean here not only direct uses (collection and disposal) but also indirect uses of a patrimonial nature, which generate passive usage values or existence values.

Table 2. Correspondence between categories of usages and usages

Categories of usages	Usages
Supply, production and storage of the resource	Supply of drinking water Health (mineral waters and spas)
Productive usages	Halieutic production: commercial fishing, fish farming and shellfish farming Industrial water: supply to industry (manufacturing processes, cooling, washing) Hydroelectric energy Geothermal energy Agricultural water: supply to agriculture, irrigation Extraction of river and sea materials
Treatment, transport and storage of material	Sewerage: domestic and industrial waste Spread of agricultural pollutions Treatment and storage of waste Human health (biological and chemical contamination)
Network, infrastructures	Navigation: navigable rivers, canals, etc. Port activity (commercial and pleasure ports)
Recreational usages: leisure, contemplation	Leisure fishing Hunting Bathing and other nautical activities Walking Amenities (contemplation of sites and landscapes)
Ecological usages: biodiversity, preservation, protection	Protection of fauna and flora Reproduction (damp zones, spawning beds) Usages deferred for oneself and future generations (lasting development) Observation and study environment (training, research) Passive usage (existence of biodiversity...) Flooding protection (damp zones) Fire protection

Man is not the only user of natural environments. Room is therefore made for ecological "usages" linked to aquatic life itself. But the boundaries of these usages are by nature fairly blurred, as the distinction between direct usages (fauna and flora closely dependent on the aquatic environment) and indirect usages (all living organisms) is difficult to make.
The same observation can be made for human usages. If the bathing usage is a direct usage, should we consider the presence of seaside resorts as an indirect usage of water? If a port presupposes the presence of water, should we associate the productive uses of the port with a category of productive usages of water, or limit ourselves to transport alone? The same work of standardisation must therefore be carried out for the relevant nomenclatures of categories and usages and their relationship with the functions of hydrosystems.

Table 2 clearly highlights the following problem. While it is fairly easy to link the functions of hydrosystems to usage categories, i.e. concretely to link these categories to physical or biological indicators (flow rate measurements, evaluation of volumes stored in water tables or surface reservoirs, biochemical quality tables and description of surface networks), the grouping of uses in categories reveals the very great variety of socio-economic contexts in which they are placed.

2.4. Results obtained in France in the damage evaluation field

To begin with, we present in the form of a summary table the salient elements of the French studies listed. These studies were collected from three main sources:

1. Listing already carried out at the end of 2001 by the ministry's departments (D4E study).
2. Studies indicated by experts and researchers in environmental economics.
3. Studies passed on by players in the water field, i.e. essentially water agencies.

Certain disparities can be seen between studies of the second type and the third type. The studies indicated by the researchers comply with the usual canons of research in their methodology and their presentation of the methods, data and results. The studies conducted by the players reflect their primary concerns, the methodological description is concise, and their results are presented and discussed in a finalised or operational perspective in a context of preparation for a public decision. We have nevertheless chosen not to distinguish between them and to include them in the synthesis. We shall come back to this point in our comments relating to the evaluation of the results obtained.

Table 3 presents in summarised form the subjects, protocols and results obtained in the various studies brought together.

Before making a general commentary on this, a few detailed remarks are required. As far as possible, we have endeavoured to remain in line with the nomenclature used in tables 1 and 2 to classify the studies. Certain choices are therefore debatable. For example, to illustrate the case of purification, we consider a study on the costs of poor water quality for the DWS (Drinking Water Supply) usage. It was therefore the variable measured (the additional treatment cost) which served as a key for classification and not the purpose of the investment (which comes under the supply usage category). The hedonistic price studies on the effect of the quality of the riparian environment on property prices were associated with the deferred usages of the ecosystem. The patrimonial function therefore has a direct effect here on patrimony in the sense of property and not on the natural heritage.

Although containing an element of arbitrariness, the proposed classified is aimed above all at making it easier to see the results obtained. In concrete terms, we have constituted a database (under ACCESS) bringing together all the summary information concerning the studies. This database, which it will be possible to upgrade and improve in the future, will constitute a convenient comparison and analysis tool for future reflection.

Table 3. Synthetic presentation of studies

drinking water supply (2 studies)

STUDY	SITE AND YEAR	ESTIMATED VALUES	METHOD
Preservation of the Alsace water table (pollution by nitrates)	Alsace ground water table 1993, 1995	Usage value: 107 to 125 euros/ household/ year Option value: 58 to 99 euros/ household/ year	Contingent valuation
Improvement of the quality of the water of the Erdre for DWS	River Erdre 1996	Option value: 34 to 36 euros/ household/ year	Contingent valuation

Productive usages (2 studies)

STUDY	SITE AND YEAR	ESTIMATED VALUES	METHOD
Impact of pollution on oyster farming production USAGE: Shellfish farming	Breton coast 1995	0.06 to 0.18 euros/ kilo	Purification cost
Damage linked to extractions of granulates in Indre et Loire USAGE: Extraction of materials	Indre et Loire 1996	Price increase of 2.5 to 25 %	Scenario according to replacement materials

treatment, storage and transport of material (3 studies)

STUDY	SITE AND YEAR	ESTIMATED VALUES	METHOD
Impact of nitrate pollution on economic activity DAMAGE EVALUATION	Loire-Brittany Basin 1995	24 to 89 million euros	Simulation of damage on three sectors of activity
Impact of nitrate pollution on economic activity USAGE: DWS-CURATIVE	Loire-Brittany Basin – DWS catchments 1995	Good initial quality: 0.02 to 0,06 euros/ m3 Degraded initial quality: 0.02 to 0.16 euros/ m3 Very bad initial quality: 0.17 to 1.6 euros/ m3	Treatment cost
Benefits of purification function provided by the damp zones of La Bassée NATURAL PURIFICATION	Alluvial water table of la Bassée 1996	9700 euros/hectare/year	Replacement cost

recreational usages (17 studies)

STUDY	SITE AND YEAR	ESTIMATED VALUES	METHOD
Benefits of sporting salmon fishing on the Sée and Sélune USAGE: LEISURE FISHING	Sée and Sélune (Lower Normandy) 1990	Surplus of one day's salmon fishing: 52 to 75 euros	Transport costs
Benefits of sea trout fishing on La Touques USAGE: LEISURE FISHING	La Touques (Lower Normandy) 1990	Surplus of one day's trout fishing: 30 euros	Transport costs
Modification of the salmon quota system on the Sée and Sélune (Lower Normandy) USAGE: LEISURE FISHING	Sée et Sélune (Lower Normandy) 1991	105 euros/ angler	Contingent valuation
Benefits of reinforced surveillance on La Touques (Lower Normandy) USAGE: LEISURE FISHING	La Touques (Lower Normandy) 1991	19 euros/ angler	Contingent valuation
Benefits of the possibility of fishing for wild fish in Hérault and in Indre USAGE: LEISURE FISHING	Hérault and Indre 1999	14 to 17 euros/ angler	Contingent valuation
Benefits for fishing linked to transition from fast-flowing water to calm water USAGE: LEISURE FISHING	River Creuse 1994	Variation in an angler's surplus: 66 euros/ angler/ year	Transport costs
Benefits of improvement of the quality of the water of the Erdre USAGE: LEISURE FISHING	River Erdre 1996	7 euros/ angler	Contingent valuation
Valorisation of the fishing usage on the Lignon du Velay USAGE: LEISURE FISHING	Lignon du Velay 2002	7 to 20 euros/ angler	Contingent valuation
Benefits of improvement of the	Rhuys peninsula	26 euros/ person/ year	Contingent valuation

quality of the waters of the Rhuys peninsula USAGE: BATHING, WAKING…	1996		

Benefits of beachcombing USAGE: LEISURE FISHING	Beachcombing site on the Breton coast 2000	Surplus per visit: 57 to 58.5 euros	Transport costs
Protective behaviour against health risks for beachcombing on the Breton coast USAGE: LEISURE FISHING	Beachcombing site on the Breton coast 2000	Low risk: 12 euros/ visit High risk: 15 euros/ visit	Contingent valuation
Benefit of the kayak activity in the gorges of the Sioule USAGE: NAUTICAL LEISURE ACTIVITIES	Gorges of the Sioule 1994	24 euros/ visit	Transport costs
Leisure value of the Orient forest lake USAGE: NAUTICAL LEISURE ACTIVITIES AND RECREATIONAL	Orient forest lake 1991	5 to 9 euros	Contingent valuation
Benefits of recreational usage of water on the Lignon du Velay USAGE: RECREATIONAL	Lignon du Velay 2002	6 to 11 euros/ user	Contingent valuation

Potential benefits of bathing in the Erdre USAGE: BATHING	River Erdre 1996	23 to 28 euros/ person/year	Contingent valuation
Benefits of protection of Brest harbour USAGE: HEALTH AND PROTECTION	Brest harbour 1994	Health: 37 euros/ household/ year Ecosystem protection: 28 euros	Contingent valuation
Benefits of improvement of the quality of the water of the Erdre USAGE: TOURISM	River Erdre 1996	Surplus variation: 18 euros/ visit	Transport costs

river sailing (1 study)

STUDY	SITE AND YEAR	ESTIMATED VALUES	METHOD
Benefits of pleasure sailing on the Lot USAGE: PLEASURE SAILING	River Lot 1999	464 euros/ week of boat rental	Demand function

ecological usages and biodiversity (4 studies)

STUDY	SITE AND YEAR	ESTIMATED VALUES	METHOD
Value of the Arbas Basin restoration and maintenance programme USAGE: ECOLOGICAL AND TOURIST	Arbas Basin 1998	23 euros/ household/ year	Contingent valuation
Benefits of protection of the riparian forests of Garonne USAGE: BIODIVERSITY	Riparian forests of Garonne 1998	7 to 32 euros/ household/ year	Contingent valuation
Ecological benefits of the Orient forest lake USAGE: ECOLOGICAL	Orient Forest Lake 1991	12 to 14 euros	Contingent valuation
Benefits of a programme of reduction of the eutrophisation of the Etang de Thau USAGE: ECOLOGICAL	Etang de Thau 1992	12 euros/ person/ year	Contingent valuation

deferred ecological usages and protection (11 studies)

STUDY	SITE AND YEAR	ESTIMATED VALUES	METHOD
Value of non-usage of water on the Lignon du Velay DEFERRED USAGES AND PASSIVE USAGE	Lignon du Velay 2002	4 to 9 euros	Contingent valuation
Benefits of slowing down the filling of the Etang du Canet DEFERRED USAGES AND PASSIVE USAGE	Etang du Canet 1996	7 euros/ year	Contingent valuation
Flood damage in rural zones	Rural zones of the Loire-Brittany	50 to 840 euros/ hectare	Financial damage

USAGE: FLOOD PROTECTION	Basin 1995		(flooding)
Flood damage in coastal zones USAGE: FLOOD PROTECTION	Coastal zones of the Loire-Brittany Basin 1995	33 million to 84 million euros	Financial damage (flooding)
Flood damage in urban zones USAGE: FLOOD PROTECTION	Urban zones of the Loire-Brittany Basin 1995	84 200 to 168 000 euros/ hectare	Financial damage (flooding)
Flood damage in industrial zones USAGE: FLOOD PROTECTION	Flood-prone industrial zones of the Loire-Brittany Basin 1995	1.18 billion euros	Financial damage (flooding)
Benefits of flood protection by the damp zones of La Bassée USAGE: FLOOD PROTECTION	Alluvial water table of La Bassée 1996	9800 to 49000 euros/ hectare	Damage avoided Replacement cost (flooding)
Benefits of low-water support by the damp zones of the mid-Oise USAGES: PROTECTION OF FAUNA AND FLORA, REPRODUCTION	Damp zones of the mid-Oise 1996	5900 euros/ hectare	Replacement cost (low-water support)

Impact of the quality of the water of the Orge on property prices DEFERRED USAGES (VALUE OF PROPERTY)	River Orge 1999	Variation of average price: + 9.3 % with distance from the river	Hedonistic price equation
Impact of the quality of the water of the Scarpe on property prices DEFERRED USAGES (VALUE OF PROPERTY)	River Scarpe 1999	Variation of average price: - 7.5 % with distance from the river Variation of average price: + 21.5 % with view of the river	Hedonistic price equation
Impact of the quality of the water of the Erdre on property prices DEFERRED USAGES (VALUE OF PROPERTY)	River Erdre 2000	Variation of average price: - 7 % with distance from the river	Hedonistic price equation

2.6. Evaluation of results obtained

We can see that all of the studies were carried out over the past decade. As the dates given correspond to their time of publication, it would be pointless to try to measure the evolution of the annual number of studies over the period. Table 4 counts them according to the categories of usages and the measurement methods used.

• Table 4. Classification according to usages and methods.

Categories of usages	Number of studies	Methods	Number of studies
Drinking water supply	2	Contingent valuation	19
Productive usages	2	Transport costs	7
Treatment, storage and transport of material	3	Hedonistic prices	3
Recreational usages	17	Replacement costs	3
River sailing	1	Damage (expert statements)	5
Ecological usages and biodiversity	4	Treatment cost	2
Deferred ecological usages and protection	11	Substitution scenarios	1
Total	40		40

This table clearly shows that it is recreational usages, and in particular those relating to sports and leisure fishing usages, for which we have the most studies available. If we group the usages roughly into market usages (supply, production and purification) and non-market usages (recreational, ecological and patrimonial), it can be seen that two thirds of the studies concern the latter category of usages.

This phenomenon can easily be interpreted. The productive usages of water are generally dealt with within the framework of project evaluation in the areas of water supply to populations, purification or productive use of water in energy production, industry or agriculture. It is not environmental usages which are evaluated in this case but private usages or collective or public usages. This does not mean, of course, that the environmental dimension, in terms of quality of raw waters or availability of the resource in particular, does not play role in these studies, but that the environment is dealt with in them as a technical or regulatory constraint and not as a stake to be evaluated economically.

One of the difficulties of the tutelary approach will be precisely to extract from these studies information with figures which can provide material for an environmental evaluation.
It is therefore clear that the environmental evaluation in the strict sense of the term mainly concerned non-market usages, which are much less well known and much more liable to indicate the social benefits of better protection of natural environments.
We can therefore easily understand the preponderance of evaluation methods as the contingent approach in the panel of studies compiled (19 studies out of 40). This method is particularly well suited to the measurement of non-market benefits. It is the only one which can estimate the existence or passive usage values, which makes it an important tool for studying ecological and patrimonial values.
An examination of table 4 also reveals the preponderance of scientists in environmental evaluation: 26 studies emanate from environmental economics laboratories or were conducted with the usual scientific method in the evaluation of the non-market aspect.
The territorial coverage also appears to be very uneven. We are a long way even from covering the whole of France, the Loire-Brittany Basin being by far the best-represented region in the studies.
We note the very great disparity of what is actually measured in the studies. Quite often, they give aggregate values of benefits and damages in their conclusions, but we have endeavoured here to show what is actually measured, before any aggregation. Certain values are given per household, others per cubic metre or per hectare, which results in a wide variety of aggregation keys[16]. We have also listed the aggregated values and the aggregation keys on a number of studies. For some of them, we do not have aggregation keys and we are pursuing additional work on this theme using the reports proper.
This initial examination, which is not yet finalised, leads to the following lines of reflection for an evaluation:

1. The recreational usage studies form a relatively homogeneous and comprehensive whole. The establishment of tutelary values for this type of usage should not pose any insurmountable difficulties. The great difficulty is define the measurement index: day of fishing or per angler per year, for example.
2. The ecological and patrimonial usages raise the difficult problem of existence values. It is worth noting the recent effort of water agencies in the area of evaluation by the hedonistic method. Very little practised in France, this method nevertheless offers interesting opportunities. It is fairly complex to implement and especially to bring to completion. The existing studies in the literature often content themselves with estimating a hedonistic price equation without going as far as a surplus or demand measurement for the environmental attributes. The available French studies do not escape this difficulty.
3. The supply, production and purification usages have mainly been the subject of technical-economic studies or expert statement listings. They are therefore not very homogeneous in their methodologies and particularly difficult to assess as regards their reliability. A considerable effort therefore needs to be made for these categories of usages: searching for other studies, comparison of methods, tests of resistance to initial calculation hypotheses, etc. They are also very incomplete (numerous productive usages are not dealt with in them), few in number and far from covering the whole of the national territory.
4. Even for the categories of usages for which we have a large amount of information obtained from homogeneous methodologies (for leisure fishing in particular), we are struck by the great variability of the values measured. When these are values measured

[16] The values in table 3 are taken from conversions into 2002 euros (with correction for inflation) of the initial values in francs.

'in the margin' (Willingness-to-pay (WTP) for an additional day of fishing, for example) there is nothing surprising about this. Reasoning in terms of 'average' surplus wipes out most of these differences. Nevertheless, it reveals the persistence of spatial variations (types of sites) and variations of usages to which we will need to remain attentive in the construction of categories of tutelary values.

3. Value transfer

We specify the nature of the problem then discuss its reliability before tackling the question of meta-analyses, concerning ourselves more particularly with the non-market field.

3.1. Nature of the problem

In the area of evaluations of non-market assets we have methods capable of supplying value indicators, even if many theoretical and practical questions remain to be answered. However, whatever the approach used (*ex ante* or *ex post*) its implementation requires relatively weighty resources. For contingent analysis, the rules stipulated by the panel of experts brought together by the *National Oceanic and Atmospheric Administration* following the shipwreck of the Exxon Valdez[17] are seen in some cases, justifiably, as brakes on the monetary assessment of environmental damage. This means that a contingent valuation conducted in line with professional rules takes up a lot of time and money. The same reflections are valid when we wish to implement the *ex post* methods, whether we are talking about hedonistic prices or the displacement costs methods, and also apply to the evaluation of market effects.
In certain cases, the costs involved in obtaining an evaluation in compliance with professional rules may be disproportionate to the amount of damage. Such operations should therefore be launched only in the face of ecological disasters or large-scale developments liable to disturb natural environments of particular interest. For operations of limited scope, to counteract the lack of information, we commonly refer to the transfer of value, i.e. we use estimates from studies concerning this type of asset. Thus in the United States, the 1980 law known as CERCLA (*Comprehensive Environmental Response, Compensation and Liability Act*) and the texts on oil slick damage which followed it, distinguish two types of accidents: those of type A, the effects of which are limited, and those of type B, characterised by major effects. For the first, transfers are recommended. Specific evaluations are recommended only for type B accidents. In this spirit, attempts to constitute databases according to the type of non-market asset were undertaken all over the world. We shall cite in particular the initiative launched in 1993 by Environnement Canada with the creation of EVRI^{TM}, Environmental Valuation Reference Inventory^{TM} [18](From CIVITA *et al.*, 1998).
From the point of view of economic efficiency, the use of transfers is justified when the benefits of the information supplied by the direct approach are greater than the additional cost which results from it. However, this presupposes that this approach gives usable results. This is where the whole debate lies! As no one really calls into question the approach, the basic

[17] Arrow K., Solow R., Portney P.R., Leamer E.E., Radner R., Schuman H. 1993. "Report of the NOAA panel on contingent valuation", Federal Register, 58, (January 15), pp. 1601-1614.
[18] De Civita P., Filion F., Frehs J., Jay M. 1998. Environmental Valuation Reference Inventory^{TM} (EVRI^{TM}) : A new tool for benefit transfers. Paper presented at the World Congress of Environmental and Resource Economists, Venice, Italy June.

question becomes that of the limits of the exercise, and of the protocols to be implemented to obtain acceptable results.

Before examining briefly the way in which the approach has change, we need to specify a few points of terminology. Rather than the notion of transfer of benefits, and sometimes of damages, it is better to use the concept of 'transfer of environmental values' because of its greater generality. This method corresponds to the use of existing information, designed in a specific framework, to deal with a question related to a different context[19]. We propose to use the notion of primary data from study sites or base sites, as opposed to secondary data which will be used in the evaluation of the asset on one or more application sites.

To begin with, the notion of transfer corresponds to the establishment by United States administrations of a scale of unit values judged to be reasonable on the basis of expert statements. Thus, in 1982, the forestry department published amounts of surplus per day for outdoor activities. For specialised activities such as hiking in the wild, trout fishing, big game hunting and white water canoeing, amounts ranging from $6,10 to $17,90 were recommended. For common activities such as picnicking, bathing, small game hunting, camping and boating, the figures ranged between $1.50 and $4.50. In the same way, the *Water Resources Council* established at the beginning of the eighties a set of unit values per day for water-related recreational activities. Such price scales were useful not only for judging the benefits of development operations, but also for the courts during trials concerning environmental damage. Values applicable to France were proposed for a series of recreational activities, on the basis of a set of results available in similar contexts[20].

The working out of unit values is based on a simple transposition of primary data or an adaptation in accordance with the characteristics of the sites and populations. The fact that these transpositions are based on expert statements has been criticised, the exercise being described as 'economic alchemy'. The key point of this criticism is the absence of a microeconomic model justifying this transposition. Applying an average value is at first sight a reductionist process, given that the amount of willingness-to-pay depends on a set of characteristics which are better represented by a demand equation than by a one-off estimate. This does not mean that such a manner of proceeding should necessarily be ruled out. Indeed, if the explanatory variables (socio-economic characteristics of households, nature of the asset to be evaluated and substitutes) are similar, the transfer is justified since this comes down to using the demand equation implicitly while remaining within the framework of the *ceteris paribus* clause. The later phase therefore consisted in resorting to the use of observed behaviours and preference revealing mechanisms, i.e., in a more or less elaborate form, demand functions. The aim is more prosaically to avoid the use of any form of black box.

3.2. Reliability of the transfer

To assess the reliability of the technique, we can compare the results derived from the transfers with the real results obtained in the field. For this purpose we have a limited number of foreign studies and one French study which we shall examine afterwards. Table 5 thus presents the results of seven studies, some of which give several estimates and comparisons. The margin of error between the 'true value' and the amount obtained by transfer allows the reliability of the transfer to be assessed.

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[19] Desvouges W., Johnson F., Banzhaf H. 1998. Environmental policy analysis with limited information : Principles and applications of the transfer method. Edward Elgar, Northampton Mass.

[20] Amigues et al., op., cit.

Table 5. Transfer errors for seven studies concerning environmental assets.

Authors	Method	Asset evaluated	% of error
Loomis, 1992	Transport cost	Recreational fishing	5-40 5-15
Parsons and Killy, 1994	Transport cost	Improvement of water quality	4-34 1-75
Loomis et al., 1995	Transport cost	Recreational activities on rivers	1-475
Bergland et al., 1995	Contigent evaluation	Improvement of water quality	25-45 18-41
Downing and Ozuna, 1996	Contigent evaluation	Recreational fishing at sea	1-34
Kirschoff et al., 1997	Contigent evaluation	Rafting	24-56 6-228
Brouwer and Spaninks, 1999	Contigent evaluation	Biodiversity	27-36 22-40

Source : Brouwer R. 2000. Environmental value transfer : state of the art and future prospects. Ecological Economics 32: 137-152.

The conclusions which can be drawn from these comparisons are disappointing, particularly as regards the superiority of the displacement costs with respect to the contingent valuation. Indeed, the latter can sometimes give higher values than the former, when we would tend to expect the opposite. Beyond general considerations concerning the more or less explanatory nature of the methods, we should examine in greater detail certain studies, which sheds light on certain transfer difficulties.

The work of Kirchhoff *et al* (1997) in Arizona and New Mexico relating to 24 comparisons of benefit measurements, leads to a preference for transfers based on demand functions rather than on averages. However, we may question the scope of these results because of the heterogeneous nature of the sites and of the assets evaluated (in New Mexico there are several activities).

Evaluations concerning the value of two peat bogs in the Netherlands presenting a specific ecological interest lead to the same conclusion concerning the sturdiness of the benefit function (Brouwer and Spaninks, 1999). But there again there are problems of comparison between the two sites because of a difference in size, 500 ha in one case and more than 15 000 ha in the other, which is liable to skew the results considerably. In addition, there are postal surveys with return rates of around 30%, and a high proportion of "protest zeroes". These two factors limit the scope of the results.

Two studies carried out using exactly the same methods (Downing and Ozuna, 1996, Scarpa et al., 2000) are more significant. The first, concerning the willingness-to-pay of anglers in the Gulf of Mexico, relates to samples of 700 to around 1400 people surveyed three years running. The tests conducted on the basis of 128 regressions lead to the rejection of the possibility of using the demand functions to carry out transfers. The authors criticise the non-linearity inherent in the logit method used to estimate the demand functions and the non-linearity of the estimates of the unit values. These non-linearities apparently introduce asymmetries leading to divergences between statistically identical functions and the respective unit values.

The second study, conducted in 14 forest parks in Northern Ireland and 13 in the Republic of Ireland among more than 9400 visitors, yields much more encouraging results. With the same specifications as before the authors show that 62% of the tests concerning averages and 51%

concerning medians allow the transfer of unit values. These positive results are attributed to the size of the sample and to the homogeneity of the sites and the attributes.
The only French study which exists to our knowledge is more negative. It concerns the value of preservation of the quality of the Alsace ground water table on the basis of a contingent valuation conducted among 817 households[21]. The hypothesis of equal willingness-to-pay is confirmed in only 24% of cases when we reason with the demand function. On the other hand, transfer by the average gives slightly better results, since equality between the predicted and transferred willingness-to-pay is confirmed in 30% of cases. In addition to the problem of the size of the samples which leads to a high error rate, the mediocrity of the results can be explained by the difference in the nature of the pollution, the fact that they did not take place in the same period, and the fact that the populations' reactions are not the same. However, the basic reason lies in the specific nature of the underground water asset. The hypothetical scenario is difficult to construct because there is no direct perception of the asset by the persons questioned. In addition, passive usages and deferred usages are of great importance here.
With two samples of 380 and 1049 people questioned in Costa Rica about their willingness-to-pay for a treatment station improving the quality of water, another study leads to similar conclusions[22]. It shows that averages adjusted to take account of differences in income give better results than the transfer of demand functions.
Five remarks need to be formulated on the basis of these various studies.
1. If we wish to carry out tests and define confidence intervals, it is obvious that the size of the samples plays an essential role.
2. The statistical procedures concerning the specification of the model and the econometric processing of the data, including truncation questions, require great care.
3. The empirical procedures, and particularly the preference revealing methods (open question, discrete choice, single or double system of reinforcement, etc.) are important.
4. Transfers are all the better if there is a high degree of homogeneity between sites, and the attributes which are associated with them, and the populations have similar characteristics.
5. The theoretical superiority of transfer by means of demand equations over transfer (adjusted or otherwise) of averages is not demonstrated empirically. This may result simply from a compensatory effect of the deviations on the averages.

3.3. Contribution of meta-analyses

The reasons why transfers remain so problematic is because the variables liable to be used in the explanation of the behaviour are not all taken into account in the study site with respect to the application site. On the other hand, the fact that we have better results when there is a high degree of homogeneity of the sites and attributes means that we do not have a tool with great operational power. We therefore need to have a transfer function which is sufficiently general to include the various explanatory variables. We shall thus use demand functions grouping together the basic data of several studies of the same type, or use the broader approach of meta-analysis enabling the integration of a greater number of parameters including different specifications. It should be recalled that the latter approach has long been practised in psychology and in biology.

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[21] Rozan A., Stenger A. 2000. Intérêts et limites de la méthode du transfert de bénéfices. Économie et Statistique 336 : 69-78.
[22] Barton D. 1999. The transferability of benefit transfer : An experiment in varying the context of willingness-to-pay for water quality improvements. Discussion Papers D-10/1999 NLH, Agricultural University of Norway.

Based on databases constituted from case studies, meta-analyses consist of a statistical analysis aimed at explaining the variability of the results. They therefore allow reasoning on the basis of "all other things being equal" and enable useful generalisations. More generally, these meta-analyses generate a value function, generally based on average values, of the following type:

$CAP_S = a + bX_{Sj} + cY_{Sk} + dZ_{Sm} + u_S$

CAP_S is the average willingness-to-pay obtained in the study s

a,b,c,d are parameters

X_{Sj} designates the characteristics of the asset in the study of j

Y_{Sk} represents the characteristics of the population surveyed

Z_{Sm} represents the characteristics of the study

u_S is the error term.

The criticisms made of this approach fall into the following three categories:

1. selection bias,
2. heterogeneity linked to non-compliance with statistical hypotheses, and
3. a tendency to favour quantity over quality.

The criticism of selection bias is based on the fact that the studies available, and therefore used in meta-analyses, are those which are found in reviews, which therefore correspond to reliable results both from the economical and from the statistical point of view. Procedures aimed at quantifying this bias, and therefore at making adjustments, have been proposed. In fact, a comparison between the published results and those which have remained unpublished shows that the scale of this bias seems to have been exaggerated.

The criticism concerning the heterogeneous nature of the studies used in meta-analyses is based on the idea that this approach makes improper use of the techniques of inferential statistics, which are not necessarily appropriate. Once again, the criticism is not entirely damning because for one thing this problem goes beyond the framework of the approach, and for another thing there are techniques which can be used to control fixed and random effects between basic studies. Beyond that, the question arises of the lack of a strict framework in the production of the primary data.

As for the criticism relating to the predominance of quantity over quality in the primary data, this criticism does not seem to us to be well grounded, given in any case that the decision to retain a particular study is partly a matter of personal judgement.

This brief discussion concerning the limits of meta-analyses shows that a reasoned usage of this technique helps to dispel certain ambiguities. The examination of a few results will enable us to understand better the usefulness of this approach.

Among the most significant analyses, we shall cite that of Smith and Kaoru[23] 1990, which uses 77 out of 200 studies on recreational spaces using the displacement costs method. This analysis is a response more to methodological concerns than to a transfer approach. It aims to establish more clearly the procedure for a good implementation of the displacement costs method with an evaluation of the sensitivity of the results in accordance with the hypotheses adopted. It shows in particular the sensitivity of the surplus estimated for the following five factors.

1. The nature of the recreational site: whether it is intended for usages of a local nature, like a golf course, tennis courts, a swimming pool, etc., or whether it is specific to a

[23] Smith K., Kaoru Y. 1990. Signals or noise ? Explaining the variation in recreation benefit estimates. American Journal of Agricultural Economics 72 : 419-433.

resource of a national nature with specific attributes making this site different from others, or an intermediate site such as a reservoir, a forest, etc. enabling various activities such as camping, fishing, boating, etc.

2. Measurement of the usages according to the site: large spaces presenting a certain diversity such as forests or estuaries with multiple points of entry; site types of a homogeneous nature where the internal substitution possibilities are great, such as lakes or areas where skiing is possible; and sites whose description or characteristics do not allow isolation of the resource at the origin of the recreational usage.
3. The way in which the time opportunity cost is handled. Thus the use of an average salary rate or an average income considerably reduces the amount of the surplus compared to an estimate made with the individual rates.
4. The taking into account of substitutes. The absence of substitute sites leads to an increase in the surplus.
5. The way in which the consumer's behaviour is modelled (specification of the direct or indirect utility function).

The meta-analysis conducted by Rosenberger and Loomis[24] is of a much more general nature since it concerns a set of 682 estimates drawn from 131 studies conducted between 1967 and 1988 in the United States and Canada on the value of recreational spaces. Here, all the studies are used, whether the approaches are *ex ante* or *ex post*, provided, of course, that they are sufficiently rigorous. Various meta-models are estimated, taking into account all the explanatory variables and also incorporating the national or regional nature of the data. The tests show that all the models allow transfer, but the models based on national data give slightly better results than those using regional data. In terms of use, these results reveal limits due to the lack of primary data for certain recreational activities, such as boating, bathing and cross-country skiing. The quality of the transfers increases when the amount of information is greater. The authors draw the conclusion that it would be worthwhile to develop meta-analyses centred on a type of activity and based on a sufficient amount of information.

In this spirit, Santos's synthesis[25] on the evaluation of landscapes is instructive. The author brought together the results of 19 contingent valuations carried out in 7 countries (Europe, United States and Australia) corresponding to 61 estimates. On this basis, he constructs a meta-model with 16 explanatory variables, 14 of which are significant, concerning the nature of the landscapes (uniqueness, size, substitutes), the characteristics of the people surveyed (residents, outside persons, income) and the preference-revealing modes (discrete or non-discrete choice, truncation of data, etc.). A second meta-model was constructed with a more limited selection of 32 estimates and 7 variables concerning WTP for the preservation of landscapes within the framework of agro-environmental policies.

The conclusion drawn from a comparison of the quality of the transfers is that the second meta-model which is more targeted, since it concerns the same policy, does not give better results than the more general meta-model. Secondly, by testing the various forms of transfer on the basis of the closest studies and the targeted meta-model, five observations can be made.

1. All transfers based on a revelation of preferences using the discrete choice technique (or questions which are open but adjusted in such a way to have the equivalent in discrete choice) are satisfactory.
2. To obtain a secondary data presenting a low margin of error the transfer must be carried out either on the basis of a base study which is very similar in terms of the asset to

[24] Rosenberger R., Loomis J. 2000. Using meta-analysis for benefit transfer : in-sample convergent validity tests for outdoor recreation database. Water Resources Research 36 : 1097-1107.

[25] Santos J.M.L. 2001. A synthesis of country reports on demand measurement of non-commodity outputs in OECD agriculture. Workshop on multifunctionality, OECD, 2-3 July.

be evaluated and the population concerned, or on the basis of a meta-analysis in which the preference revealing methods are the same.

3. A base study concerning the same type of asset, but with a slightly different population, enables an acceptable transfer if we use the same method and if we make an adjustment for income.
4. Equal to this, we then have transfer from a demand function drawn from a base study relating to a fairly similar asset but a different population, or transfer from a simple average obtained from studies which are not very different, using of course the same technique.
5. The transfer of an average value from a base study evaluating an asset which is not very different, but with a different population and using the same method, and nevertheless without adjustment of the values of the variables, gives slightly inferior results.

These results are largely confirmed by a meta-analysis relating to 14 studies concerning the willingness-to-pay of Spanish visitors to Natural Parks and National Parks[26]. The convergence tests show that around two thirds of the forecasts are made with a margin of error of less than 25 %. The only difference lies in the fact that the methodological characteristics do not play any role.

Finally, we shall cite two meta-analyses based on the hedonistic approach. The first concerns the results of 30 estimates drawn from 19 studies on the effects of aircraft noise on property values and gives convincing results in terms of transfer[27]. The second concerns the impact of domestic waste dumps on the price of land. It was used in the United Kingdom to set the rate of tax on the burying of household waste[28].

[26] Rodriguez M.X.V. 2001. Transferability of recreational benefits from natural areas : Spanish experiences. Medit. Prospettive e proposte mediterranee- Rivista di Economia, Agricoltura e Ambiente 1 : 45-55.

[27] Schipper Y., Nijkamp P., Rietveld P. 2002. Thirty years of aircraft noise value studies: a meta-analysis, in Florax R., Nijkamp P., Willis K. (eds). Comparative environmental economic assessment. Edward Elgar Northampton Mass, pp. 235-245.

[28] Florax et al., op., cit.

4. Conclusion and prospects

4.1. Coverage of the field

There is quite clearly a shortage of knowledge concerning strictly market usages: drinking water supply, productive usages, treatment, storage and transport of material, and network services. The information exists, but in a scattered form in the agencies or technical departments of the State, and has been produced by a variety of methods which are difficult to compare. Undertaking a major operation of gathering of this information therefore requires a prior evaluation of its potential to be used for the purposes of the study.
However, the evaluations relating to the non-market aspect already offer a coherent and comprehensive set of information on this category of usages. Their integration in a tutelary approach should not pose insurmountable difficulties. However, additional coherence tests should be carried out beforehand, making a distinction between leisure and contemplation usages on the one hand and ecosystem usages on the other. For each category, it is already possible to make progress on the question on the basis of existing work, by envisaging a meta-analysis.

4.2. Methodological aspects

We have already underlined the fact that in practice it is the economic evaluations of the usages which will provide material for evaluation of the value of hydrosystems. The evaluation approach will therefore differ according to the nature of these usages. For productive usages, it is the producer's surplus, i.e. the profitability of the water factor in the production, which is the variable to be measured. For the other usages, we base ourselves on the variations in well-being caused by variations in the quantity or quality of the resource, which leads us to take an interest in the consumer surplus calculation. These two approaches are combined when a significant effect on the market balance is noted.
The evaluation techniques have been adapted to the various cases, taking into account the data available. Thus, for navigation usages, in particular for the evaluation of the infrastructures, we use methods inspired by that used for evaluation of public projects, i.e. technically the study of public assets. We compare the existing infrastructure with replacement solutions to determine their marginal collective advantage.
For usages linked to the treatment, storage and transport of pollutants, two approaches are combined. Firstly, we attempt to reconstitute the damage suffered by other users from the estimation of demand functions for water quality, complementing this evaluation as far as possible by a monetary assessment of the ecological damage, and secondly we reason on the basis of the value of the usages of the hydrosystems by comparing it with an artificial alternative (costs avoided in terms of additional purification plants, for example). Such approaches are clearly fairly difficult to implement. They presuppose a relatively narrow framework of initial hypotheses and their reliability and sturdiness are therefore difficult to assess.
Reference to consumers implies the definition of a demand function for the environmental asset. For non-market usages, the evaluation proceeds from an extension of the consumer theory. It makes it possible to define the willingness-to-pay which measures, for various levels of availability or quality of the natural asset, the intensity of the demand for the resource and therefore its value. This approach, which is common in the area of recreational practices, has been extendable to a certain extent to the establishment of values for usages of

the ecosystem, at the price of additional hypotheses. These hypotheses require the assimilation of existence values to the category of usage values. We shall not go back over here the difficulties, now well-documented in the economic literature, raised by such an assimilation, not to mention the methodological difficulties which it poses, as the evaluation of existence benefits can only be based on the contingent method.
However, the evaluation of certain usages such as the dilution or self-purification potential of hydrosystems, the economic value of the river network for navigation, or the ecological and patrimonial values, are far from being based on homogeneous methodologies. We are still dealing here with one-off studies, or the study of cases specific to a given situation in a particular basin. Generally speaking, so long as it is a matter of applying a tried and tested method to situations benefiting from feedback and a basis of comparison with other studies, there are scarcely any difficulties. But when it is necessary to combine methods and adapt them to specific terrain constraints, no general methodological rule can any longer be used. This automatically results in great disparities in the figures produced and their ability to be included in a cost-benefit analysis.
Surplus calculation methods (consumers and producers) are relatively standardised (which does not mean that they are abundant and routinely implemented in environmental evaluation). The non-market evaluation methods applied to recreational leisure activities are also increasingly standardised, even if efforts still need to be made in this area.

4.3. Usefulness of tutelary values

On numerous occasions, the usefulness of having tutelary values for the main usages of water has been underlined. It obviously justifies the constitution of the database for the relevant studies. By proceeding by aggregation of usages, the public decision-maker could thus quite easily obtain evaluations of damage or benefits by category of usages, which would enable him to meet the requirements linked to the implementation of the framework directive over the next few years.
Without rejecting this approach, we need to stress one limitation of the aggregation approach in the event of association of consumption or production. To illustrate our point, let us consider two usages, A and B, and a project which affects both of them. We have tutelary values revealed by an analysis of the demand and estimated by the willingness-to-pay values WTP(A) and WTP(B). We can show that: $WTP(A \& B) \leq WTP(A) + WTP(B)$, therefore a simple aggregation of the tutelary values lead to an underestimation of the value of the group of usages. A similar remark applies when the tutelary values are estimated from production costs and we have range savings. They correspond to the situation where it is less costly to manufacture two products simultaneously than to manufacture them separately, which results in cost complementarities. Once again, we will overestimate the value of the pair (A,B) by adding up the tutelary values of A and B. Conversely, the superadditivity of the costs associated with range unsavings corresponds to the case where it is more advantageous to produce the two products separately. The use of separate networks to handle rainwater and wastewater separately probably gives one example of this, at least in certain cases.
In addition, we need to ask ourselves what is the acceptable error level. Admittedly, the answer obviously depends on the final usage of the estimate. A scale ranging from a low level of demand for accuracy when we simply carry out a study for its own sake, to the highest level of demand for accuracy when we are evaluating damages within the framework of a court case, serves as a guide for reflection. In evaluations linked to economic policy decisions, the level will be intermediate.

4.4. Transfer technique

Under certain circumstances, the simple transposition of an average unit value can be envisaged, but between the base site and the application site there must be:

1. A modification of the natural asset to be valorised which is of the same order.
2. The same characteristics on both sites and the same activities practised on them.
3. A great similarity between the characteristics of the households.
4. The same price for the activities on the substitute sites and on the site itself.

In the absence of good comparability between the sites, the assets and the populations, more sophisticated procedures should be used. From this point of view, meta-analyses, which provide a statistical summary of past research, seem to be the solution to be developed This technique allows the embracing of a large number of situations, and therefore a better understanding of the causes of the variability of the results. It will be noticed that the transfer of averages with adjustment to take account of the differences between key explanatory variables, is based on the results of meta-analyses, which indicate how a given variable influences the surplus, all other things being equal.

In addition, it is better to turn to homogeneous models in terms of assets evaluated or methods and techniques, rather than construct very general meta-models encompassing all sorts of work. In any case, it is imperative to constitute databases based on high-quality basic studies complying with all professional rules.

4.5. Proposals

Following this report, we can make five proposals which follow on from the recommendations formulated at the end of the seminar of the 21st of December 2001[29].

1. Constitution of a French database compatible with EVRI.
2. Agreement on a nomenclature of usages.
3. Establishing a list of usages to be studied as a matter of priority.
4. Establishing the methodology for the main usages.
5. Carrying out a meta-analysis of the studies available dealing with leisure activities and usages of ecosystems.

These proposals can implemented by the end of 2004, and in the relatively short term the constitution of the database can be completed. In our opinion, the specification book should take account of the following elements.

The French studies database must be able to communicate in both directions with the EVRI database, for two reasons:

- Supply of the EVRI database with a number of national studies, and
- Enrichment of the national database with studies selected from the EVRI database.

These are two major requirements which imply that the fields retained in the French database include all the fields of the EVRI database. But the latter are insufficient to allow value transfers to be carried out, and must therefore be complemented. In terms of information (number of fields), the French database will therefore be richer than the EVRI database, a fact which is directly translated in computer terms. The need for an economical (without a search engine) and operational solution within a few months leads us to propose the creation of a website dedicated to the French database. A sub-set of the information gathered would then be

[29] See appendix.

included in the EAUDOC database. Implementation by the International Water Office presupposes an agreement on the fields finally retained. In this respect, our proposals must be compared with those of the other partners. If, in an initial phase, the validation of the data to be integrated in the database can be carried out by researchers, it will be necessary quickly to envisage another procedure. The studies brought together must not be limited to the water field alone. In addition, we think that the French database can serve as an embryo for a European database, which means that we must as of now raise the question of the language used.

Appendix. Conclusions and recommendations of the seminar of the 21st of December 2001

Institutional context and economic foundations

The transposition into French law of the framework directive on water of the 23rd of October 2001 favoured the organisation of this seminar devoted to the value of damages suffered by hydrosystems. This directive is liable to affect the mode of operation of water agencies at some points in the future. The innovations in terms of price rates, incentives and cost recovery principle will modify the calculation of dues and the distribution of the financial burden between the different economic players. They lead to questions concerning the quantification and the monetary expression of the effects of human activities on the usages of hydrosystems. The application of the framework directive therefore brings us back to the question of damages and their taking into account, which is part of the broader question of evaluation of public decisions in the water field.

Damages are assessed on the basis of the reduction in the value of the usages; they are in a sense a mirror image of the benefits, which correspond to an increase in the value of the usages. Thus, whether we look at things from the point of view of deterioration and therefore damages, or from the point of view of improvement and therefore benefits, the economic analysis proceeds in terms of variation of the value of the usages. It is therefore immediately necessary to have a precise nomenclature of the usages of hydrosystems. These usages can be grouped in major categories corresponding to functions of water such as the ecological function, the recreational function or the productive function. The discussion showed that clarification and definition work was necessary to move on from the academic work stage to the decision-making aid stage. The categories of usages and the usages may be compatible or competing, which is then expressed in usage conflicts. The examples are numerous, but once again a harmonisation would have to be undertaken.

The usages of hydrosystems closely depend on the quantity and the quality of the resource. We are dealing here with a field which is not related to economics, but the lack of scientific knowledge restricts the possibilities of application of economic calculation. In terms of quality indicators, the statistical efforts made for surface waters and coastal waters are considerable. On the other hand, both the relationship between quality and quantity and the usages have not been extensively explored. For example, the effects of a variation of low-water flow rates on fish populations and therefore on fishing are not very well known. In the water field, the work devoted to dose-response functions is insufficient. Admittedly the question is more complex than for air, but research mobilising various scientific disciplines is necessary (in the short and medium term).

Observation of the transactions carried out on the markets supplies precious information on the choices and behaviour of those involved. It is the basis for the techniques which are used to evaluate the damage suffered by producers. The damage is assessed in this case on the basis of the profit variation. One of the difficulties encountered here is linked to information on companies' results, which it is not necessarily in their interests to reveal sincerely. On the demand side, this observation will enable the application of techniques based on revealed preferences, the displacement cost method, the hedonistic prices method and the protection costs method. The methods based on constructed markets, particularly the contingent valuation method, provide a more flexible approach which allows estimation of the non-usage

values, particularly the existence value. In spite of the progress made, we need to be prudent in its use. Collaboration with psychologists should generally be recommended. We also need to distinguish between ex ante calculation of the damage, which aims at optimum allocation of the resources between competing activities, and ex post calculation of damages, which is concerned with their repair.

State of the art of integration of damages in public decision-making

The problem of damage and benefits brings us back to the question of tutelary values.
This is a legitimate question which refers us back to three questions:

- What is the state of knowledge?
- What is the scope of the transfer technique?
- Can we aggregate values?

- **State of knowledge**

A number of comments can be made on the basis of the day's presentations and discussions. The case studies carried out in France since the beginning of the eighties are relatively numerous. In this regard, analysis of foreign experience does not reveal any notable shortage in France. However, these studies should first of all be archived, then, in a second stage one or two years from now, a database could be constituted. We should not conceal here the difficulties of the operation in view of the absence of harmonisation as regards the collection of the data, the choice of the techniques and their implementation. At the same time, the inventory of shortcomings which is already well advanced could be successfully completed and lead both to studies conducted on a routine basis and to research to be undertaken. The studies to be conducted on a routine basis must be defined on the basis of a critical analysis of the syntheses already made, in order to identify the highest-priority fields. It is clear at this stage that the ordering of studies must be subordinated to the drawing up of a methodological guide to good practices, revisable in accordance with the progress of knowledge. An initial (non-exhaustive) synthesis of the studies shows that two areas of research are notoriously ill-explored, the valuation of damages suffered by ecosystems and the valuation of morbidity. Some pioneering work has admittedly been carried out, but it remains insufficient and largely unusable for public decision-making. For these two areas, however, we need at the same time to acquire more precise knowledge of the dose-response functions.

- **Value transfers and aggregation**

The most recent analyses carried out on water-related leisure activities and on landscapes shows that value transfer is a valid method. However, this transposition is more reliable for values obtained from methods based on revealed preferences than for values obtained from methods based on constructed markets. This result also militates in favour of the constitution of databases and a reasoned increase in the studies conducted on a routine basis which have just been mentioned. The databases constituted on the basis of these studies must in the medium term allow the conducting of meta-analyses on the basis of a French panel. The execution of this work programme must lead to tutelary values for a number of water-related usages, particularly leisure activities.
When the damage affects several usages from which the same parties benefit, the aggregation of tutelary values is not justified because it leads to an overestimation of the damage. In addition, for major disasters, reasoning in terms of partial balance is no longer possible and we need to make direct evaluations of the damage. The aggregation of individual damages,

whatever the method used, requires knowledge of the population concerned, which is rarely the case.

Recommendations

A few short-term goals:

- Rapidly draw up a nomenclature of usages of hydrosystems.
- List and archive the work carried out.
- Design a database.
- Draw up a methodological guide to good practices.
- Subscribe to EVRI until the French panel allows the conducting of meta-analyses

A few medium-term goals:

- Carry out routine studies.
- Produce tutelary values for leisure activities.
- Improve statistical knowledge concerning leisure activities (time budget of the French population).

A few long-term goals:

- Start research on the dose-response and epidemiology functions.
- Strengthen research on the valuation of biodiversity.
- Strengthen research on the valuation of morbidity.

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