Landscape perception in fluvial ecological restoration projects. Contributions and perspectives for the implementation of the Landscape European Convention

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LANDSCAPE PERCEPTION IN FLUVIAL ECOLOGICAL RESTORATION PROJECTS: CONTRIBUTIONS AND PERSPECTIVES FOR THE IMPLEMENTATION OF THE LANDSCAPE EUROPEAN CONVENTION

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Introduction

The European Landscape Convention instituted, at the beginning of the 2000s, a new tool for the sustainable development of territories. The landscape is recognised as "an essential component of people's surroundings, an expression of the diversity of their shared cultural and natural heritage, and a foundation of their identity" (5a). Consequently, convention-promoted policies, aiming at landscape protection, management and planning (5b), have to be elaborated according to the aspirations of the public (1c). Moreover, the Convention recommends the landscape to be integrated in any policy with possible direct or indirect impacts on landscape (5d). Scientific research has contributed to these new issues and takes part in the implementation of the Landscape European Convention, especially within the context of environmental projects. This article aims at displaying the many contributions of a pluridisciplinary research, through the example of the restoration projects of floodplain lakes of the Rhône and Ain Rivers (1995-2005)[1].

Context

Interest of conducting landscape perception studies for ecological restoration projects

Until now, restoration objectives have essentially consisted in re-establishing the environmental references defined as ecological states or processes (Dufour and Piégay, 2009). Yet, the first feed-back displayed the necessity of taking into account the public perception of the restored landscapes in order to answer more specifically to the objectives of social valorisation (Bazin and Barnaud, 2002; Cairns, 1995; Charles and Kalaora, 2003; Davis and Slobodkin, 2004; Donadieu, 2002; Dufour and Piégay, 2009; Higgs, 1997; Hobbs, 2007; Hull and Robertson, 2000; Lesaffre and Décamps, 2001; Naveh, 1998; Naveh, 2005; Pfadenhauer, 2001). Participation policies are Landscapes are socially-appropriated objects bearing several values (Alessa, *et al.*, 2007; Berlan-Darqué and Kalaora, 1991; Brown and Raymond, 2007; Droz, *et al.*, 2005; Gobster, 1999). The success of a restoration project – insofar as it sometimes induces sudden landscape transformations – depends thus eminently on the attention paid to the social aspirations concerning landscapes (Gobster, *et al.*, 2007; Joliveau, *et al.*, 2008; Nassauer, 1992). Thus, the Convention principles, requiring this attention, are fully relevant within the context of ecological restoration. The establishment of "procedures for the participation of the general public" (5c) is really beneficial to reach an integrated and

[1] This research is performed within the working group « social observatory of large rivers » of the ZABR (Long Term Ecological Research – LTER - Group of the Rhône catchment). It is supported by INEE, CNRS (the « ecological engineering » interdisciplinary program, 2007-2008), as well as the Water Agency Rhone-Mediterranee and Corsica (2007-2009). Marylise Cottet is supported by a PhD grant funded by Lyon 3 University / Ministry of education ; 2006-2009).

democratic management of environments (Claeys-Mekdade, 2001; Harmonicop, 2005; Salles, 2006; 2009).

The case of the ecological restorations of the floodplain lakes (the Ain and Rhône Rivers)

Floodplain lakes are common landscape features along rivers (Bornette, *et al.*, 2001; Kalliola and Puhakka, 1988) and provide important habitats for aquatic and terrestrial communities. The Lower Ain and the Upper Rhône Rivers, east of Lyon, are characterized by the existence of these floodplain lakes caused by historical river migration and channel abandonment. But during the last century, these former channels became rare due to siltation and dewatering following channel incision resulting from different human pressures. This led to numerous ecological restoration projects conducted since 1995. These projects raised several issues in view of the implementation of the European landscape convention:

- Patrimonial issues: the floodplain lake's landscapes represent some very specific landscapes characterizing these fluvial corridors. Yet the evolution of these fluvial environments leads to a landscape standardization. It seems important to understand how the public perceives these landscapes and their evolution. Are they appreciated and valued? In other words, are they considered as a patrimony to preserve? Or are these landscapes not appreciated nor valued? Which would be the landscape attributes leading to such negative judgments?
- Operational issues: the restoration works performed on the Rhône and the Ain Rivers may involve some unappreciated landscapes. If the ecological objectives are not understood by the public, their perception may lead to the failure of the project. Having some responses to the above questions enables the managers to anticipate the problems and to favour the implementation of an effective dialogue between the different stakeholders.

What is landscape perception?

The landscape is a product of perception ("Landscape means an area, as perceived by people"; chapter 1, art.1). The landscape information (composition and structure) is first transmitted thanks to the different senses (sight, hearing, smell…). It is then treated, that is to say organized and interpreted in order to constitute a message. Perception is indeed a sensorial as well as a cognitive process. The landscape is thus a construction (Collot, 1995; Donadieu, 2007; Gumuchian, 1991) which depends on one's heritages: collective and individual memories according to Bertrand (1995) ; species phylogenetic heritage, cultural heritage and individual experience, according to Berque (2000). These heritages confer senses and values to landscapes. Consequently, studying landscape perception requires different objectives:

- to show which kinds of landscapes (compositions and structures) are preferred ;
- to identify the values associated to these kinds of landscapes.

These are two prerequisites in order to define what makes, according to the public, the quality of a landscape, as required by the European landscape convention (art.1c). These have led the perception study of floodplain lakes landscapes.

The definition of a methodological frame favouring pluridisciplinary collaborations

The Convention mentions the importance of multidisciplinary collaborations for the elaboration of landscape policies (6B). This multidisciplinarity is necessary in order to elaborate win-win restoration projects, inducing ecological as well as social benefits. However, the implementation of these collaborations is often difficult to reach, especially because of the diverging methodological approaches. More especially we may infer that social objectives are rarely integrated in environmental projects since knowledge of social processes (social data) is complex and delicate to translate into indicators. The present study tried to develop a methodological frame favouring the dialogue between environmental and social disciplines and facilitating the integration of landscape objectives in restoration projects.

The experimental paradigm: a continuous interface between physical and perceived characteristics of landscapes

Different paradigms characterize the landscape perception studies: the expert, experiential, and experimental paradigms (Dakin, 2003; Daniel and Vining, 1983; Le Lay, *et al.*, 2005; Zube, *et al.*, 1982). The first one deduces landscape quality from an environmental or landscape professional point of view. It does not take into account the “aspirations of the public” as required by the European landscape convention. The experiential paradigm considers that landscape values depend on the individual’s landscape experiences. This paradigm is consequently delicate to link with the ecological sciences. The experimental paradigm, on the contrary, recognises the fact that the objectives of the ecological restoration projects are multidisciplinary and so allows us to take into account the “aspirations of the public”. It considers there is a dependency between the landscape attributes and the individual landscape preferences. More precisely, this paradigm is divided into two specific approaches – the psycho-physical and the cognitive approaches – according to the type of data used. The psychophysical paradigm aims to explain landscape perceptions thanks to real and objective attributes of landscapes (presence of water, of human buildings, density of vegetation…). The cognitive paradigm uses rather perceived or subjective landscape characteristics (naturalness, danger, quietness…). The psychophysical paradigm appears to be really relevant when aiming to display which kinds of landscapes (compositions and structures) are preferred and to identify their associated values. The present study, as well as the corresponding methodology, is related to this paradigm.

The photo-questionnaire surveys: a well-controlled experimental frame

This study uses photo-questionnaire surveys: a set of landscape photographs is presented to people. These are then asked to assess each of them thanks to several predefined perception criteria. The validity of such a survey technique has already been demonstrated: although surrogates may induce perceptual distortion, individual responses to an actual physical setting are strongly and positively correlated to responses based on a comprehensive photograph of the same scene (Daniel and Boster, 1976; Shuttleworth, 1980; Vining and Orland, 1989; Zube, *et al.*, 1987). An analysis of 11 scientific papers yielded "a combined correlation of 0.86 between preferences obtained in situ and preferences obtained through photographs" (Stamps, 1990, p907). The use of photo-questionnaires induces several benefits. First, since photographs appear to be a valid surrogate for field, it enables to avoid carrying out surveys in real landscape. These steps are generally time-consuming and raise practical difficulties concerning landscapes such as floodplain lakes (especially difficult access). But above all, this kind of survey enables to test precise hypotheses: photographs are chosen according to

well-defined criteria which are supposed to influence the landscape perception. Most of the influencing parameters can thus be controlled.

This article relies on two surveys. Each of them uses a specific set of photographs chosen in order to test specific hypotheses. The first survey considers large views of floodplain lakes landscapes (annex 1). Since the appearance of water widely influences landscape perception (Campbell, 1978; Nasar and Minhui, 2004; Pitt, 1989; Sorvig, 1991; Ulrich, 1983; Whalley, 1988; Wherrett, 2000), the second survey focused on the waterbodies of floodplain lakes (annex 2). The physical parameters whose influence is tested in both surveys are synthesized in the table 1, as well as the assessment criteria and the experimental population.

	Influencing physical parameters		Assessment criteria	Experimental population
	Parameters	Modalities		
Floodplain lake landscapes (large views)	Landscape openness	Opened Closed	Frequentation desire Preservation usefullness	189 internet surveyed people (for more details, see annex 3)
	Type of fluvial margin	Distinct Mixed Indistinct		
Waterbodies of floodplain lakes	Visual parameters	Reflecting water With sediments With deep aquatic vegetation With surface aquatic vegetation	Aesthetics Perceived health	* 278 Internet surveyed people considered to be "naïve"(without expert environmental knowledge) * 179 pupils sampled according to three territorial factors: the living environment; the proximity of residence from floodplain lakes; the frequentation rate of floodplain lakes.
	Ecological parameters: trophy	Oligotrophic Mesotrophic Eutrophic		

Table 1. Experimental context of both surveys of this study, interested in large views of floodplain lakes and focused on the waterbodies

The use of an analogous visual scale: a tool favouring the crossing of ecological and social data

The different landscapes were assessed using an analogous visual scale. Initially developed in medicine for the treatment of pains (Lukasiewicz, *et al.*, 2001), it has been recently used to study landscape perceptions (Le Lay, *et al.*, 2005; Piégay, *et al.*, 2005). This scale is continuous and bounded with appreciative terms ("very aesthetic" *vs* "not aesthetic at all", or "very useful" *vs* "not useful at all"…) (figure 1). People have to cross this scale on the spot corresponding to their assessment. A grid enables then to interpret the position of the cross to transform it in a mark (/10).

The use of this scale is beneficial since it produces continuous quantitative variables. Such data are appropriate for statistical treatments, especially using mean marks of each photograph. Inter-group comparisons, as well as modelling of landscape preferences are then possible with simple statistical procedures. In addition, this type of data favours the crossing of perceived data with ecological data (often categorical or continuous data). The impact of ecological characteristics on perceptions may be more easily underlined.

Finally, all these methodological options may be favourable for multidisciplinary collaborations, answering in fact to the expectations of the European landscape convention. But above all, it enables to bring reliable results to define what makes, according to the public, the quality of the landscapes.

Figure 1. Visual analogous scale used for landscape assessments in the photo-questionnaires

The precise formulation of what is "landscape quality", through the example of floodplain lakes

"Each Party undertakes to define landscape quality objectives for the landscapes identified and assessed, after public consultation" (Art. 6D). Thanks to the methodology presented above, this study partially answered to this objective concerning the floodplain lake landscapes.

The influence of the landscape composition and structure

The preferences concerning floodplain lake landscapes depend widely on the landscape composition and structure. In particular, the landscape openness and the type of margin separating the aquatic area from the terrestrial one both significantly influence the assessments. The opener the landscape is, the more appreciated it is. Likewise, the more distinct the transitions between terrestrial and aquatic areas are, the more attractive the scenes are judged (figures 2A and 2B). The results focused on the waterbodies of floodplain lakes displayed a clear gradient between the trophic level of water and the aesthetic assessments. The higher the trophic level is, the less aesthetic the waterbodies are judged (figure 2C).

The public tends to prefer landscape looking more like a river rather than a wetland. This result is consistent with scientific literature (Bulut and Yilmaz, 2009; Ellsworth, 1982, cited by Herzog (1985)). The landscape closure often characterizing floodplain lake landscapes is judged unattractive, as other scientists underlined in totally different landscaped contexts (Deuffic, 2005; Luginbühl, 1999). Steep banks clearly separating aquatic and terrestrial environments are preferred to humid margins, having vegetation such as phragmits (Gregory and Davis, 1993; Kaplan, 1977; Tapsell, *et al.*, 2001). Likewise, eutrophic waters – muddy waters often colonized with poorly-structured aquatic vegetation – are disliked (Kooyoomjian and Clesceri, 1974; Steinwender, *et al.*, 2008). These results confirm the analysis of Nassauer (1997; 2001), according to whom perceptions answer to the "aesthetic of care" : people prefer neat and tidy landscapes. *"Typically, we do not dislike land; we do not dislike water. But we dislike land-water, the muddy mucky places where the land and the water mingle"* (Rolston, 2000, p 584); this observation appears to be the rule defining, according to the public, the quality of the floodplain lake landscapes.

The projection of different sets of values on the different types of landscape (composition and structure) may explain these preferences.

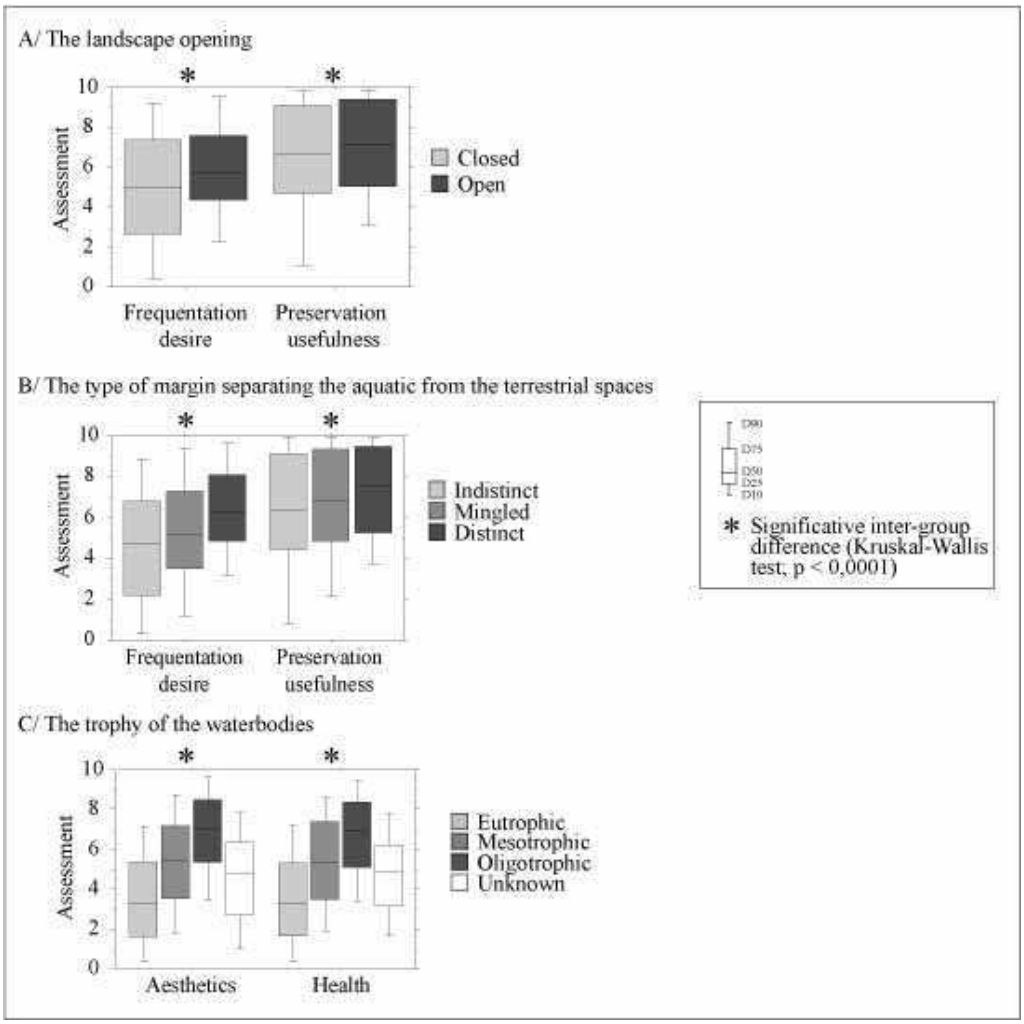


Figure 2. Box-plots displaying the influence of the landscape's composition and structures on the social perceptions.

Some differentiated sets of values according to the different landscape structures

According to the public, closed landscapes having indistinct margins between aquatic and terrestrial spaces are judged less attractive (figures 2A and 2B). They are nevertheless judged useful to preserve (the landscape structure influences the "preservation utility" less than the "frequentation desire" assessments). Each time surveyed people answered that it was useful to preserve a floodplain lake environment (mark > 5/10), they were asked to indicate the reasons of their judgements, crossing one or several propositions among a predefined list (table 2). Each of them constitutes a specific value potentially characterizing the landscapes. The citation percentages were analysed using a PCA (Principal Component Analysis) (figure 3).

Finally, different groups of landscapes can be distinguished, each of them being characterized by a specific set of values. The *F1* axis in particular is very structuring (54%). It distinguishes the open landscapes with distinct margins from closed landscapes having indistinct margins. The first ones are judged valuable for leisure and for the living environment. Whereas the second ones are valuable for their ecological and environmental values: "it helps to preserve a natural patrimony (fauna and flora)"; "to preserve wildlife for hunting and fishing"; "it contributes to a better water quality" and; "to retain water when river in spate and to protect buildings". We can observe that the landscape value is independent and contributes strongly to the *F2* axis loading (16%). It means that, according to the public, the

patrimonial value of some floodplain lake landscapes ("preserve specific landscapes of the Rhône Valley") is strong enough to justify on its own their preservation (F, B, I, O scenes).

These results may be interpreted according from an operational point of view. The floodplain lake restorations projects shouldn't raise intense conflicts since every kind of landscape is worth being preserved, according to the public. However landscape values have to be taken into account when elaborating a restoration project, since some of them may not fit to the defined objectives. As an example, if the project aims to include social objectives such as the development of leisure or the preservation of a patrimonial feature (creation of a path aiming discovering some specific natural environments), it must be implemented in a precise landscaped context to be successful. Only opened landscapes having distinct margins between aquatic and terrestrial areas should be considered because these landscapes correspond to what the public values when considering leisure. Such a conclusion is a first step in sight of the implementation of the European landscape convention, in the context of ecological restorations of floodplain lake environments. If the convention recommends to "integrate landscape into its regional and town planning policies and in its cultural, environmental, agricultural, social and economic policies, as well as in any other policies with possible direct or indirect impact on landscape" (art. 5.d), it can not be done without having information concerning the context of specific landscape perception. This is precisely the kind of information produced by these surveys, answering to the expectations of the European landscape convention requiring "to take into account the particular values assigned to [identified landscapes] by the interested parties and the population concerned" (art. 6C)".

List of values
It contributes to a better water quality
It contributes to a pleasant living environment
It helps agricultural production (timber, culture, breeding…)
It helps to preserve wildlife for hunting and fishing
It favours leisure
It helps to preserve typical landscapes of the Rhône valley
It helps to retain water when the river is in flood and to protect buildings
It helps to preserve a natural patrimony (fauna and flora)
Others (please precise)

Table 2. Lists of values proposed to the surveyed people to justify the "preservation usefulness" of the landscapes

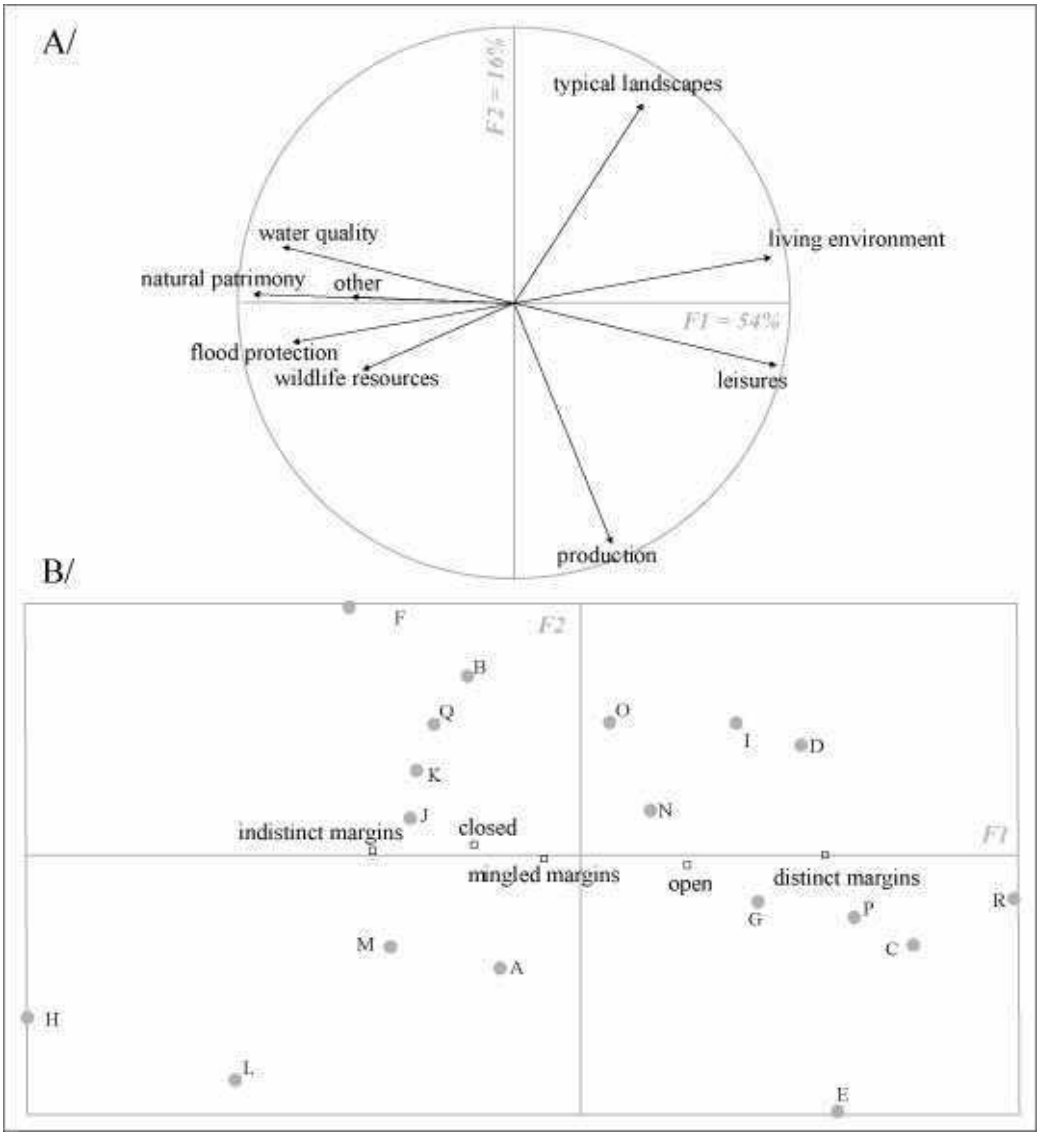


Figure 3. First factorial maps of the Principal Component Analysis (PCA) built from the values mentioned by the surveyed people to justify the usefulness of preserving these floodplain lakes environments.

A/ mentioned values (active variables); B/ floodplain lake photographs (individuals) and their physical attributes (illustrative variables)

A sociological variability of perceptions

Concerning landscape perception of floodplain lakes, the reality is still more complex. Not only the preferences and values depend on landscape structures, but they depend equally on the social profile of individuals. Several variables are known to influence the social perceptions of the lanscapes: some socio-demographical parameters such as age (Franco, *et al.*, 2003; Tahvanainen, *et al.*, 2001; Van den Berg and Koole, 2006; Zube, *et al.*, 1983), gender (Lyons, 1983), residence (Tahvanainen, *et al.*, 2001; Van den Berg and Koole, 2006; Yu, 1995), education level (Steel, *et al.*, 1994), or cultural factors (Gobster, 1999; Le Lay, 2007; Piégay, *et al.*, 2005). The influence of the territorial parameters has more specifically been considered in this survey: life environment (urban or rural), proximity of residence from river (riverside residence, not riverside residence) and frequentation rate (regularly, sometimes; never). School pupils, sampled for their territorial characteristics (table 3), were asked the questions above defined concerning the usefulness of preserving floodplain lake

landscapes and the reasons of their judgment. The citation rates of quoted values were treated using three discriminant analyses, the discriminant factors being the three territorial variables. The results displayed low classification error rates (5,56 % for the life environment, 5,56% for the proximity of residence from river, and 12,96% for frequentation rate). In other words, the usefulness of floodplain lakes environments is not considered in the same way according to different territorial characteristics persons (figure 4).

- The life environment: country people value mainly the "typical landscapes of the Rhône Valley", the "natural patrimony (fauna and flora)" these environments represent, and the "leisure" opportunities they induce. Urban people quote more often the role of these environments in "preserving wildlife for hunting and fishing".
- The proximity of residence from river: riverside residents value above all the "typical landscapes of the Rhône Valley" whereas non-riverside residents mention the "pleasant life environments" the floodplain lake environments represent.
- The frequentation rate: people never frequenting the floodplain lake environments appreciate them for the "leisure" opportunities they contribute and for some reasons not proposed in the predefined list. The precisions given to this "other reason" item underline that the aesthetics is mainly evoked. People frequenting occasionally the floodplain lakes environments value above all the "natural patrimony (fauna and flora" and the "typical landscape of the Rhône Valley" they represent as well as their role in "preserving wildlife for fishing and hunting". Finally, people regularly frequenting floodplain lake environments value them as a "resource for agricultural production", and for their role in favouring a "better water quality" and "a protection against floods".

Among the set of values characterizing floodplain lake environments, the landscape's patrimonial value qualifies the perception of some territorial groups only: only country and riverside people value these environments according to the specificity of the landscape they represent. We may infer the familiarity these individuals established with these landscape creates an original link explaining the strong score they are given. This conclusion confirms the necessity for environmental projects, when inducing landscape transformations, to involve the local residents.

More over, the influence of familiarity is confirmed when considering the divergent mentioned values according to the frequentation rate (the more people frequent the floodplain lake environments, the more familiar they are). People having a low familiarity with these environments evoke above all "surface values" (Stephenson, 2008), which are defined as direct perceptual response to landscape. Conversely, people having a higher familiarity (occasional frequentation) mention rather patrimonial values (typical landscapes and natural patrimony). These results are consistent with the conclusions of Stephenson (2008, p 136), asserting "*those with a relatively short experience of the landscape tended to express its significance in terms of physicality and sensory responses, whereas those with a longer experience spoke about relationships and understandings of the landscape that arose from its temporality"*. However, according to the results of this survey, beyond a certain degree of familiarity, the landscape is not considered for its patrimonial value any more, but for the diverse functions it provides. The perception of surveyed people regularly frequenting the floodplain lake environments is focused on the ecosystem functions: "it retains water when river in spate and it protects buildings"; "it contributes to a better water quality" and "it is a resource for agriculture production" are the values they mainly mentioned. They have such knowledge of the environment that the provided services are perceived above its formal qualities. As a conclusion, values assigned to an environment evolve with the experience and

the acquiring of knowledge: the “pleasure” landscape, the “patrimonial” landscape and the “functional” landscape qualify the perceptions of people increasingly familiar with an environment (figure 5).

A/

		Proximity of residence from river	
Frequentation rate	**Life environment**	riverside resident	non riverside resident
regularly	urban people	5	9
	country people	24	8
occasionaly (once to three times until now)	urban people	22	28
	country people	44	17
never	urban people	2	11
	country people	7	2

B/

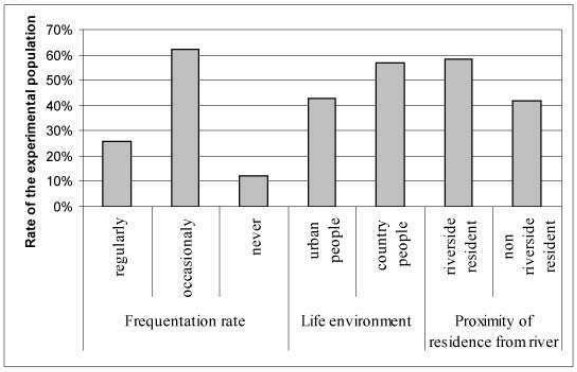
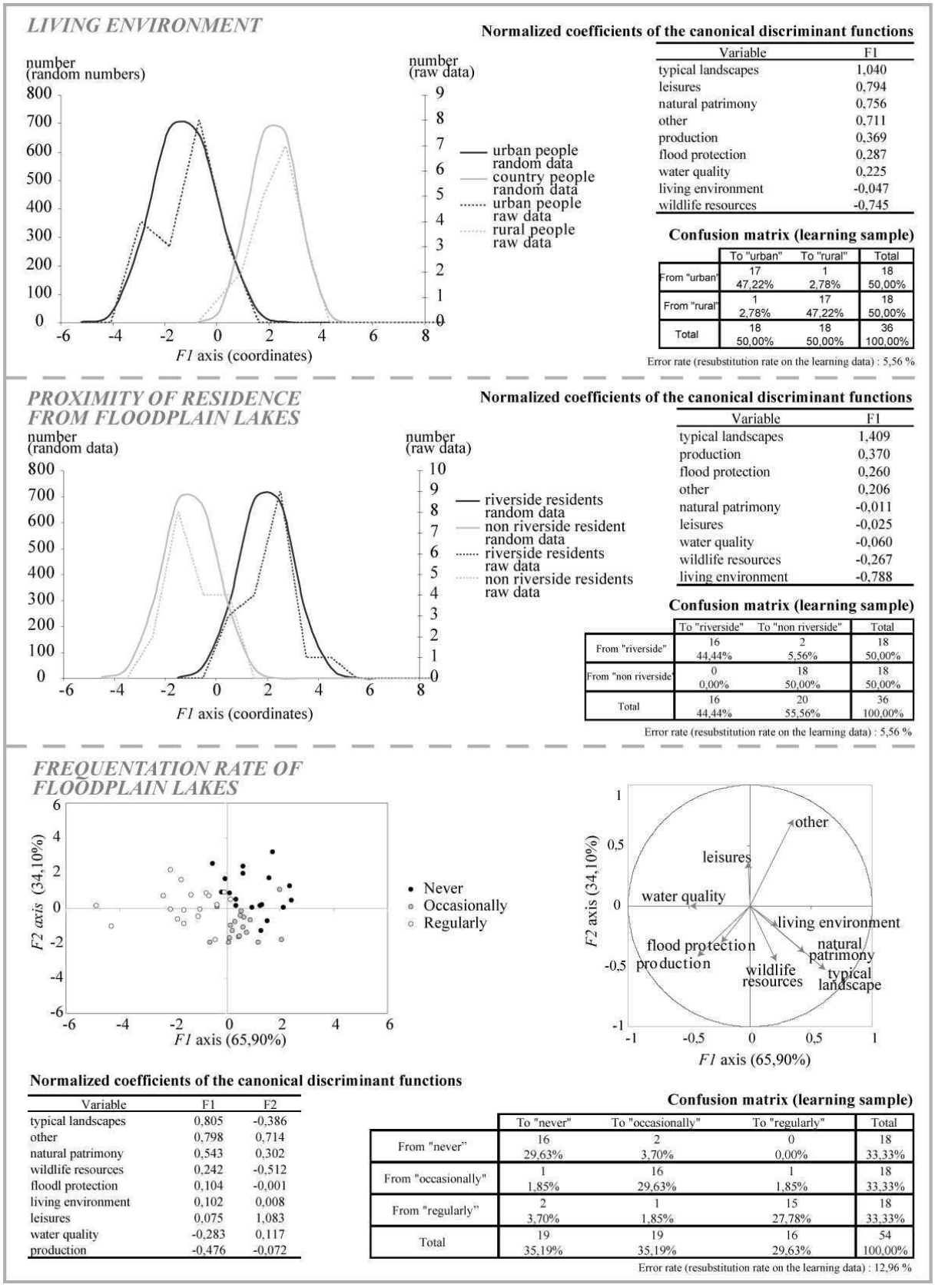


Table 3. Territorial characteristics of the surveyed pupils with absolute and relative corresponding numbers (e.g. in B, 100% for each of the three items frequentation rate, life environment and proximity of residence from river)



Normalized coefficients of the canonical discriminant functions

Variable	F1
typical landscapes	1,040
leisures	0,794
natural patrimony	0,756
other	0,711
production	0,369
flood protection	0,287
water quality	0,225
living environment	-0,047
wildlife resources	-0,745

Confusion matrix (learning sample)

	To "urban"	To "rural"	Total
From "urban"	17 47,22%	1 2,78%	18 50,00%
From "rural"	1 2,78%	17 47,22%	18 50,00%
Total	18 50,00%	18 50,00%	36 100,00%

Error rate (resubstitution rate on the learning data) : 5,56 %

Normalized coefficients of the canonical discriminant functions

Variable	F1
typical landscapes	1,409
production	0,370
flood protection	0,260
other	0,206
natural patrimony	-0,011
leisures	-0,025
water quality	-0,060
wildlife resources	-0,267
living environment	-0,788

Confusion matrix (learning sample)

	To "riverside"	To "non riverside"	Total
From "riverside"	16 44,44%	2 5,56%	18 50,00%
From "non riverside"	0 0,00%	18 50,00%	18 50,00%
Total	16 44,44%	20 55,56%	36 100,00%

Error rate (resubstitution rate on the learning data) : 5,56 %

Normalized coefficients of the canonical discriminant functions

Variable	F1	F2
typical landscapes	0,805	-0,386
other	0,798	0,714
natural patrimony	0,543	0,302
wildlife resources	0,242	-0,512
floodl protection	0,104	-0,001
living environment	0,102	0,008
leisures	0,075	1,083
water quality	-0,283	0,117
production	-0,476	-0,072

Confusion matrix (learning sample)

	To "never"	To "occasionally"	To "regularly"	Total
From "never"	16 29,63%	2 3,70%	0 0,00%	18 33,33%
From "occasionally"	1 1,85%	16 29,63%	1 1,85%	18 33,33%
From "regularly"	2 3,70%	1 1,85%	15 27,78%	18 33,33%
Total	19 35,19%	19 35,19%	16 29,63%	54 100,00%

Error rate (resubstitution rate on the learning data) : 12,96 %

Figure 4. Results of the discriminant factorial analyses (DFA) using some territorial variables as discriminant factors: the living environment, the proximity of residence from floodplain lakes, and the frequentation rate of floodplain lakes

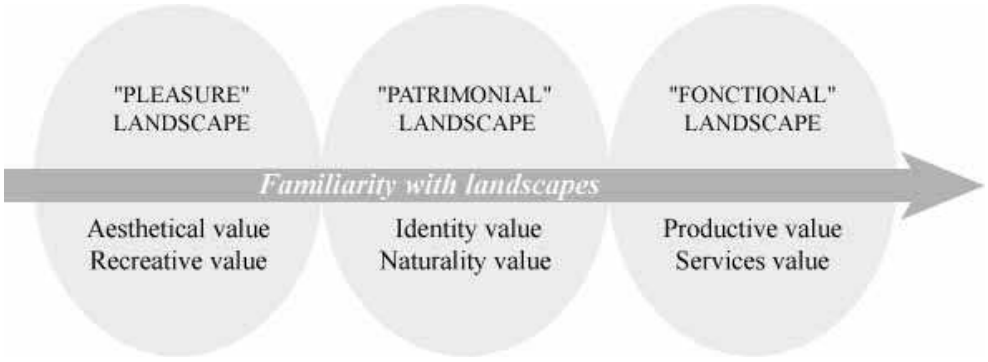


Figure 5. Variability of the landscape perception profiles according to the familiarity with the landscapes of floodplain lakes

The development of operational tools to integrate the social landscape perception into the restoration projects of floodplain lakes.

The previous results underline the way social sciences can display landscape perception information as well as the kind of information provided. However, in the view of implementing the European landscape convention, such methodologies can not be readily used by environmental managers (time consuming and requiring specific technical skills). We need to develop methods to allow knowledge transfer from the scientific domain to environmental managers, as underlined by the European landscape convention:*"To put landscape policies into effect, each Party undertakes to introduce instruments aimed at protecting, managing and/or planning the landscape"* (art. 6E).

The modelling of public landscape perceptions is a way to answer to these operational issues. The objective of the proposed modelling is to predict landscape preferences from a set of variables corresponding to qualitative visual attributes of landscapes. In order to demonstrate the efficiency of the method, the modelling considered in this study considers only one attribute of the floodplain lakes landscapes, the waterbodies – these attributes influencing over all the perception of aquatic landscapes (Campbell, 1978; Nasar and Minhui, 2004; Pitt, 1989; Sorvig, 1991; Ulrich, 1983; Whalley, 1988; Wherrett, 2000).

The modelling principles: a factorial regression

The modelling uses a factorial regression: a multiple correspondence analysis (MCA) is first performed to simplify the number of predictive variables (visual attributes of waterbodies) to a few factorial axes. The coordinates of each scene of waterbodies on these factorial axes are then used as independent variables for developing a multiple linear regression model.

- The dependant variable corresponds to the mean aesthetic assessments of each waterbody. A photo-questionnaire survey has been conducted in order to get this perception data: 100 students in geography were asked to assess the aesthetics of 34 floodplain lake's photographs. These photographs were sampled so that the diversity of the floodplain lakes of the Ain River is as much as possible represented.
- The predictive variables have been chosen from a set of 11 dichotomous visual variables identified as influencing the perception of waterbodies in a previous work (Cottet, in progress). The ones that discriminated the best positive from negative judgments were selected (figure 6). Finally, the model relies on six visual physical variables: (1) green dominance, (2) grey or brown dominance, (3) presence of warm and bright colours, (4) presence of a poorly-structured aquatic vegetation, (5) presence

of sediments, and (6) a muddy water. Each photograph was characterized according to them and a multiple correspondence analysis (MCA) was realised.

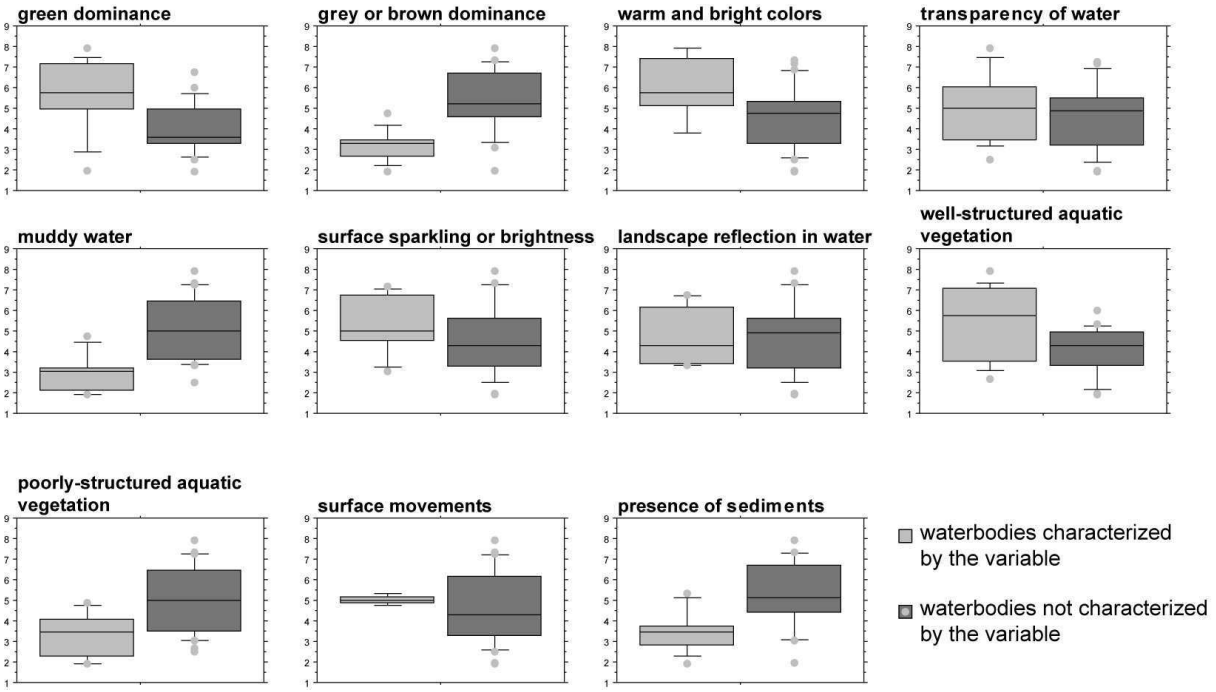


Figure 6. Box-plots of the assessments of the waterbodies according to 11 dichotomous visual variables identified in a previous study (Cottet, in progress) as influencing the social perception

A partial explanation of the perception mechanisms of floodplain lakes

Strong correspondences between variables are observed (60% of the variance explained) (Figure 7). The F_1 axis carries above all the information concerning the colour of the waterbodies; the F_2 axis is rather structured by the environmental objects (sediments, aquatic vegetation). The regression analysis was then built from the coordinates on these 2 first axes of the different waterbody photographs, according to the visual variables characterizing them.

$$Y = 4{,}7 + 2 \times F_1 + 0{,}9 \times F_2$$

Y is the predicted aesthetics of the considered waterbody

F_1 is the coordinates of the considered waterbody on the first factorial axis of the MCA

F_2 is the coordinates of the considered waterbody on the second factorial axis of the MCA

Some conclusions about perception mechanisms can be deduced from the resulting linear regression. The more the green colour dominates and the more the warm and bright colours are present, the more aesthetic the waterbody is judged. On the contrary, the more muddy the water is, the more the grey or brown colour dominates, and the more the poorly-structured aquatic vegetation are present, the least aesthetic the waterbody is judged. The influence of the sediments on the perception is more uncertain. These results are rather encouraging since two third of the preferences are explained by the model ($r^2 = 0.66$). Moreover the validation step, using the leave-one-out method, showed the robustness of the model (Figure 8): its generalisation power can further be considered. It nevertheless requires to be validated on a representative sample of riverside residents of the Rhône and Ain rivers.

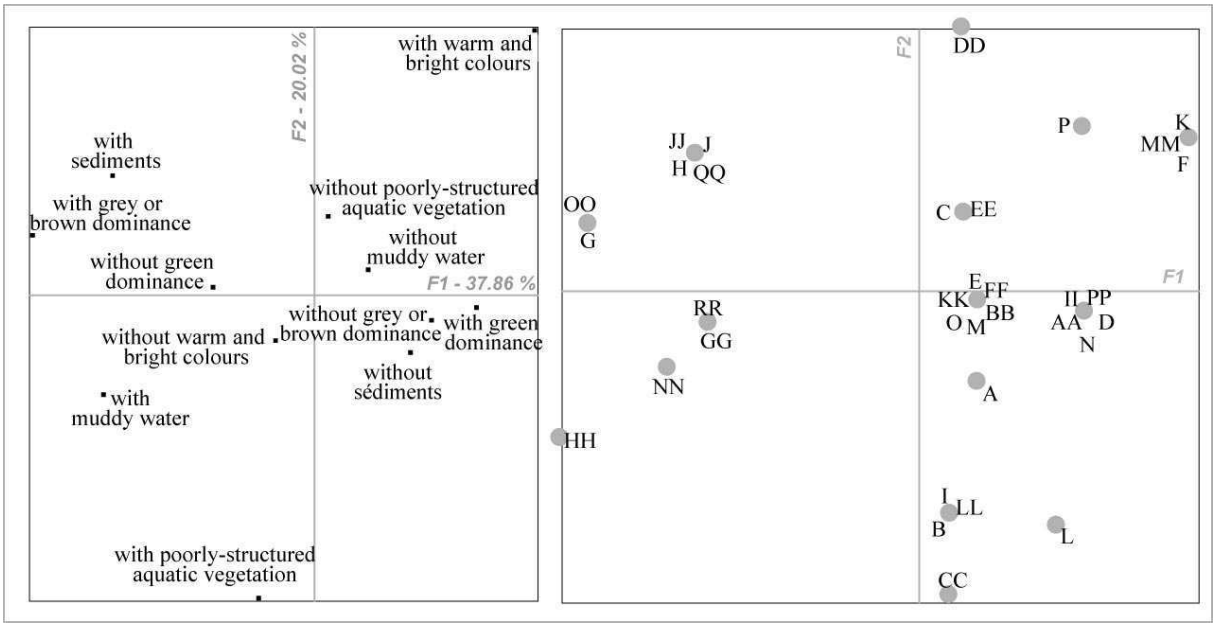


Figure 7. First factorial maps of a multiple correspondence analysis (MCA)

(On the left) Position of the modalities of the 6 dichotomous variables describing waterscapes (green dominance, grey dominance, muddy water, warm or bright colour, presence of sediment, presence of poorly-structured aquatic vegetation); (On the right) Position of the 34 photographs

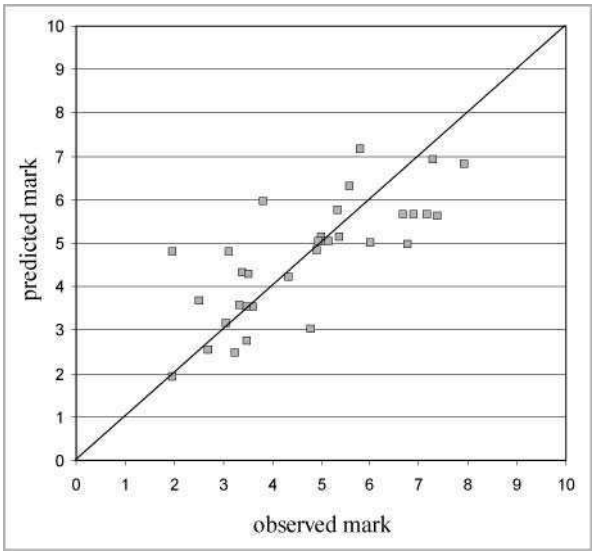


Figure 8. Scatter plot of the predictive versus the observed values of waterscape aesthetics

The predictive values are calculated with the multiple regression model performed on the F1 and F2 axes coordinates shown on Figure 7. It has been validated by a leave-one out procedure.

A tool favouring the operational implementation of the European landscape convention

If this model is validated using a representative local population, it could be short term used to implement floodplain lake management projects integrating landscape objectives as required by the European landscape convention (art 6D). An automation of the method may be considered for environmental managers. The achievement of a web interface would create an efficient tool for decision-making. The environmental managers would only have to characterize a waterbody according to the six qualitative visual variables previously defined to get a first idea of its perception by the public. In terms of restoration project, such

information may help to define communication strategies or to favour a choice of sites which offer social as well as environmental benefits.

Perspectives

This research has already contributed to the implementation of the European Landscape Convention in several ways:

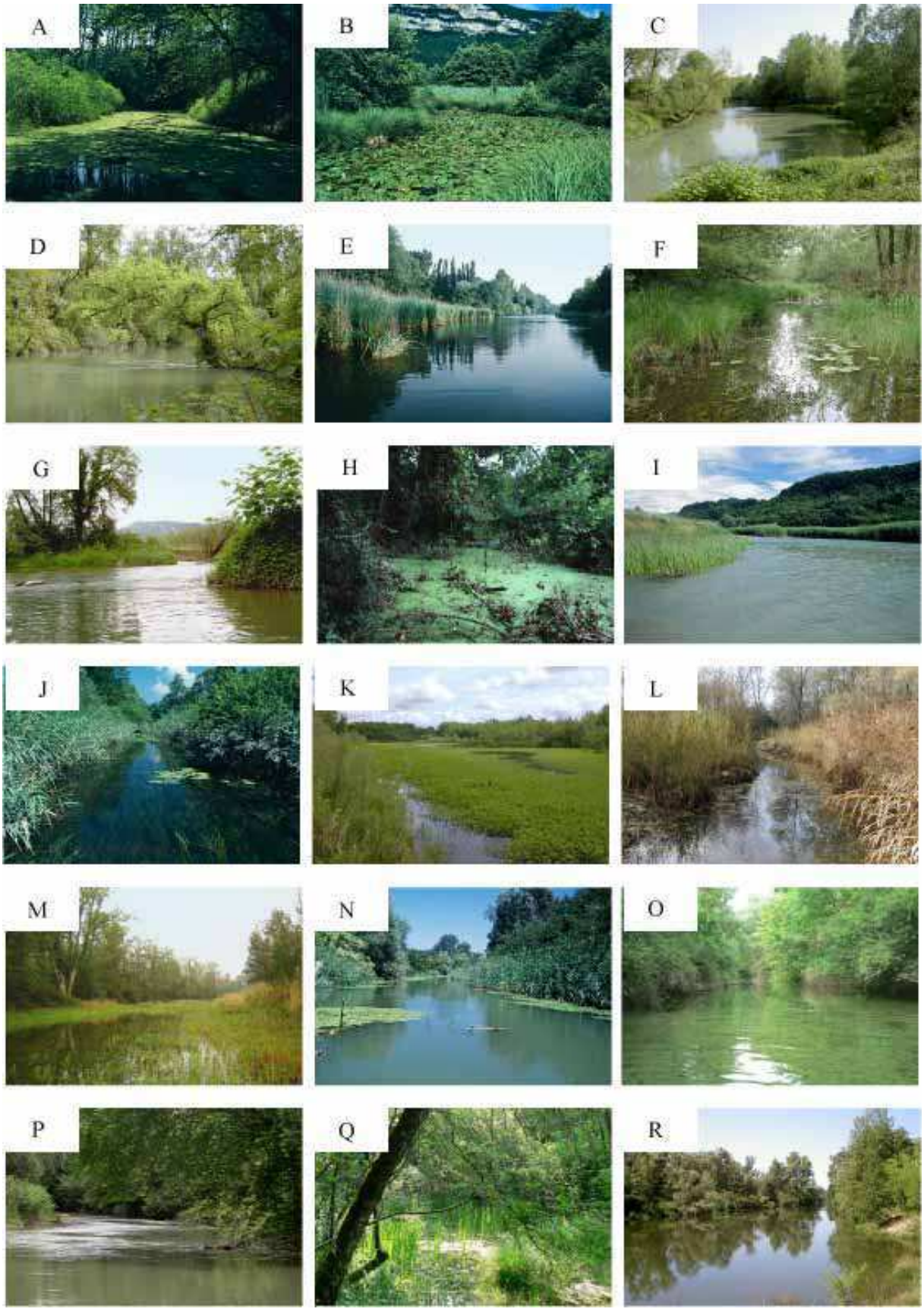
- By developing methodologies aiming to study landscape perception. These methodologies are not only valid concerning floodplain lake landscapes but can be used in other landscape contexts.
- By displaying knowledge concerning the perception of the floodplain lake landscapes. It is now better known what are the landscape compositions and structures influencing the preferences and in what way. A clearer definition of what, according to the public, makes the quality of a floodplain lake landscape is at the environmental stakeholder's disposal.
- By elaborating a prospective modelling favouring the knowledge transfer from the scientific sphere to the operational sphere (Cottet, *et al.*, 2009). It is an efficient tool for decision making and for the integration of social landscape objectives into environmental projects.

Several scientific perspectives rose from this study.

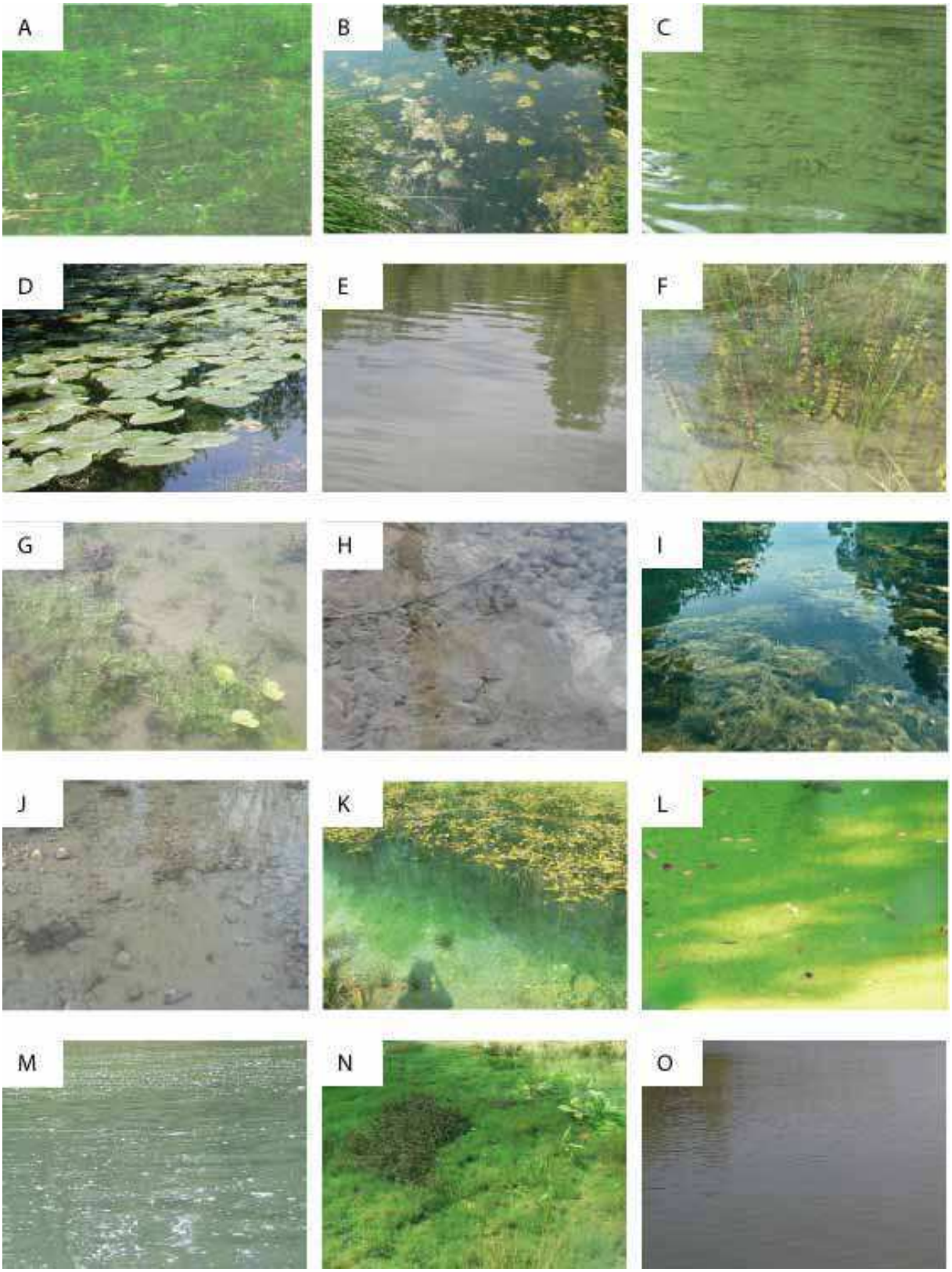
The links between physical attributes of landscapes and their perception must be further analyzed. The present study has only considered three landscape attributes (landscape openness, type of margins and water characters) and we must systematize such studies. Moreover, it is of a prime importance to consider more specifically the ecological parameters used as indicators of environmental quality. The "objective" landscape quality (the one defined by the experts) could be readily compared with the social perception. Such information may favour the implementation of win-win environmental projects, integrating ecological and social benefits.

The use of photo-questionnaires to study landscape perceptions has been very beneficial. It clearly displayed the way the landscape compositions and structures influence the social preferences. However, this methodology does not enable us to completely explain landscape perceptions. It only considers the role of the forms in the construction of perceptions and does not take into account the past of the individuals. Yet the role of the memory and of the experience is known to strongly influence perceptions (Antrop, 2000; Antrop, 2005; Berque, 2000; Bertrand, 1995; Ingold, 1993). As an example, in this study, people's familiarity with the floodplain lake landscapes appeared to influence their perception. The photo-questionnaire methodology must consequently be supplemented by other works using other methodologies. Further research works have already been realized to that end and results should be soon available.

Annexes



Annex 1. Set of photographs used in the first survey, presenting large views of floodplain lakes landscapes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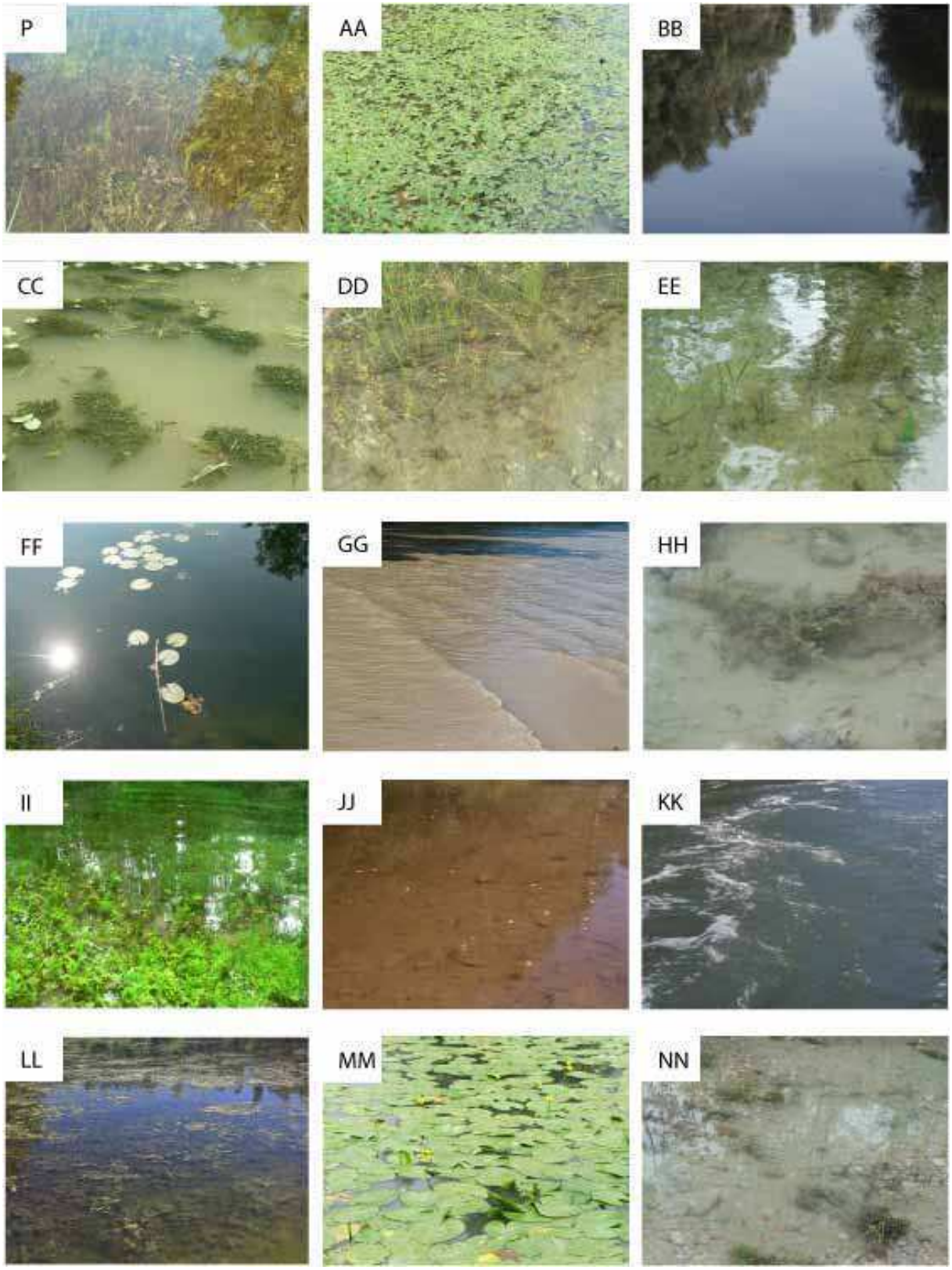
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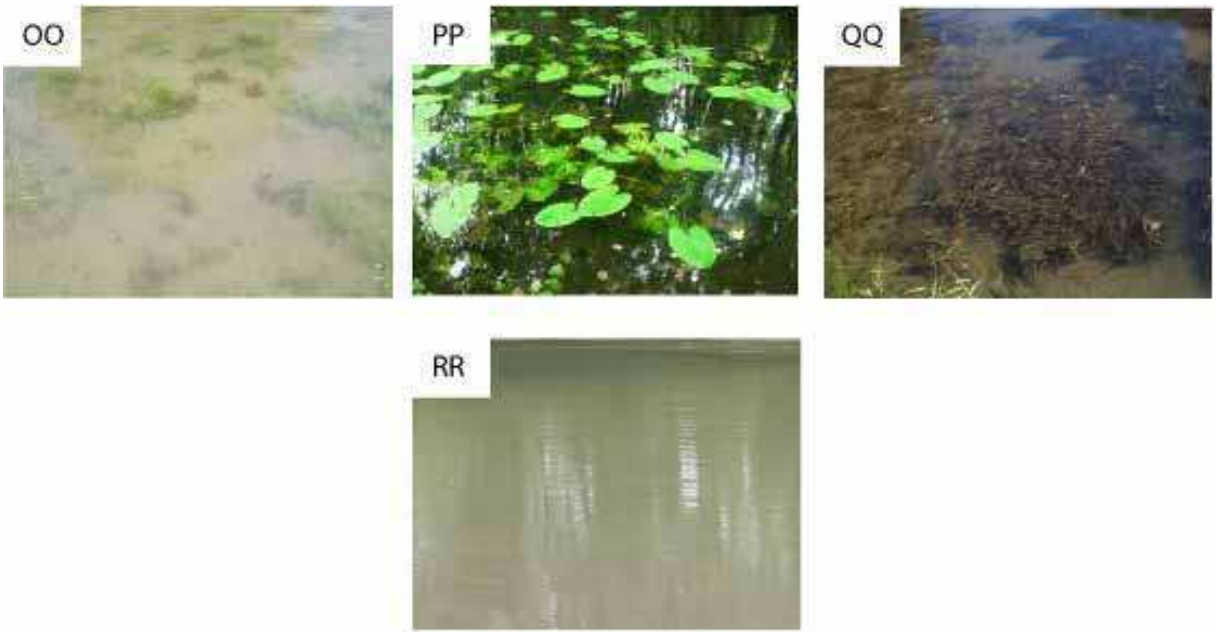

Annex 2. Set of photographs used in the second survey and in the modelling, presenting views of floodplain lake landscapes focused on their waterbody

The A to P photographs have been used to study the landscape preferences and values. The A to RR photographs have been used for the modelling

Variable	Modality	Number of respondants
Gender	Woman	85
	Man	104
Age	Less than 18 years	54
	Between 18 and 25 years	41
	Between 25 and 40 years	53
	Between 40 and 55 years	28
	More than 55 years	14
Type of stakeholder	Local elected member	27
	Manager	24
	Scientist	34
	Member of a hunting club	5
	Member of a fishing club	17
	Member of an association interested in the environment protection	13
	Riverside resident	27
	Student	44
	Pupils (primary and secondary schools)	54
Frequentation rate of the landscapes of floodplain lakes	Never	34
	Occasionally (between once and three times)	79
	Regularly	78
Living environment	In the country	77
	In a suburban territory	33
	In town	81

Annex 3. Sociological characteristics of the individuals sampled in the first survey concerning large views of floodplain lakes landscapes

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