WP4-action 4-4: Design of the experimental setting

Structure for Isère decision tree

Date
23-08-2011

Report version
WP4 (action 4.4)

Author
Hernàn ALCAYAGA SALDIAS, Philippe BELLEUDY, Camille JOURDAIN

Member number and name
PP09 ï Joseph Fourier Grenoble University, Laboratory of study of the Transfers in Hydrology and Environment (UNI Grenoble)

SHARE - Sustainable Hydropower in Alpine Rivers Ecosystems
http://www.sharealpinerivers.eu

Project reference number: 14-2-3-IT
Priority 3 ï Environment and Risk Prevention
Project duration: 36 months ï 1/08/2009 ï 31/07/2012

Lead partner
Andrea MAMMOLITI MOCHET

ARPA Valle d'Aosta
Loc. Grande Charrière, 44
11020 Saint Christophe - ITALY
Tel: 00390165278551
a.mammolitimochet@arpa.vda.it

Document Control

TITLE	TITLE	
Project	SHARE	
Type	Report/Deliverable	Dissemination Restricted to the Consortium and JTS
Authors	Hernàn ALCAYAGA SALDIAS, Philippe BELLEUDY, Camille JOURDAIN	
Contact details of the author	hernan.alcayaga@ujf-grenoble.fr	
Origin	PP9-WP7	
Doc ID*	SHARE_WP4-4_Design of the experimental setting_PP9_110616_v3	

Version Control

VERSION	DATE	AUTHOR	AUTHOR'S ORGANIZATION	DESCRIPTION/CHANGES
V01.00	07.01.2011	**Belleudy**	LTHE	1st version
V02.00	17.06.2011	**Belleudy**	LTHE	After homogenization stage of the decision tree
V03.00	23.08.2011	**Belleudy**	LTHE	After comments from LP, PP3, and MCA external experts

SHORT DESCRIPTION

This report provides an explanation of the decision tree made for the pilot case of the Isere River.

Hyperlink:
http://www.share-alpinerivers.eu/pp-area/WP4/action-4.4/wp4-34-to-39/product-wp4-34-mca-trees-version-1-1/SHARE_WP4-4_Design%20of%20the%20experimental%20setting_PP9_110616_v3.doc/view

Table of contents

Abstract

This report is focussed on a general SESAMO tree for the Isère river basin. Suggestions from PPL, PP2 and PP3 which appeared in the report called "Arc-Isere Pilot Case Study," comments on the decisional tree deliverable in 27 may 2011, the suggestions made during the meeting carried from 27/01/2011 to 28/01/2011 in Grenoble were considered in the construction of the tree, as well as comments from LP, PP3, and MCA external experts delivered electronically on July 29, 2011.

The principal criteria used are Environment, Energy, Economy, Landscape, Tourism, River Fruition, Competing uses, and Flood risks.

This report describes the application of the SHARE methodology to a large scale, namely the Grésivaudan Valley. It attempts to include complex catchment processes. The alternatives underlying this project are an evaluation of existing hp equipments, adapted to today's preoccupations.

This report is the third proposal for the layout of the general decision tree. It is still potentially subject to change, some criteria may be eliminated in the future.

Introduction

This report provides an explanation of the decision tree made for the pilot case of the Isere River. The numeric codes and text colours correspond to each of the branches, from the main branches to the leaves. Specifically, **red** represents the four main branches (macro-criteria) of the tree, then **blue** follows representing criteria, then **burgundy**, etc.

This report is devoted to an explanation and a justification for each of the branches of the Isère decision tree model, including the leaves. In some cases we identify potential indicators that can be used to evaluate the alternatives. This sketch of the Isère tree model may be subject to changes. The alternatives have not been characterized in sufficient detail at this stage of the work and it is is only possible to deliver some physical processes to some extent. It is also possible that as this work goes ahead, some of the branches / leaves be eliminated, depending on the relevance of how they are affected by each alternative.

As the project went through a homogenization stage for the decision trees (at the level of macro-criteria and criteria), the structure presented in this report is the final approach. Compared to previous approaches for the Isère decision tree, more macro-criteria are included, and in consequence the structure within each macro-criterion is simplified. Although some overlap exists between different macro-criteria because of their high number, this approach is chosen as decision-makers may want to consider each separately.

Since one of the characteristics of this pilot case is to test the application of the SHARE methodology to a large scale basin, an additional section will explain how this methodology will be applied in a large system with heterogeneous reaches.

The data base or input data is the object of another report, and will not be considered here.

Isère Tree Structure

The decisional tree structure depends primarily on water uses, basin uses, and stakeholders. Thus some macro-criteria are generalist, and will be used for all case studies. Beyond these, the trees will be ñsite specific.ò Resulting from the homogenisation phase, 7 macro-criteria will be considered in all tree structures:

- Environment
- Energy
- Economy
- Landscape
- Tourism
- River Fruition
- Competing uses

Because we consider it relevant to the Isère River basin, another criterion will be used in our tree:

- Flood risks

It is important to note that not all macro-criteria are relevant in all sections of the study area. This will be taken into consideration mostly at the phase of coefficient attributions.

The structure of the decision tree for the pilot case of Isère River is made of eight main branches: **ENVIRONEMENT (1), ENERGY (2), ECONOMY (3)** and **LANDSCAPE (4), TOURISM (5), RIVER FRUITION (6), COMPETING USES (7), FLOOD RISKS (8).**

Figure 1 shows the overall structure of the tree, as a reference to follow the present report.

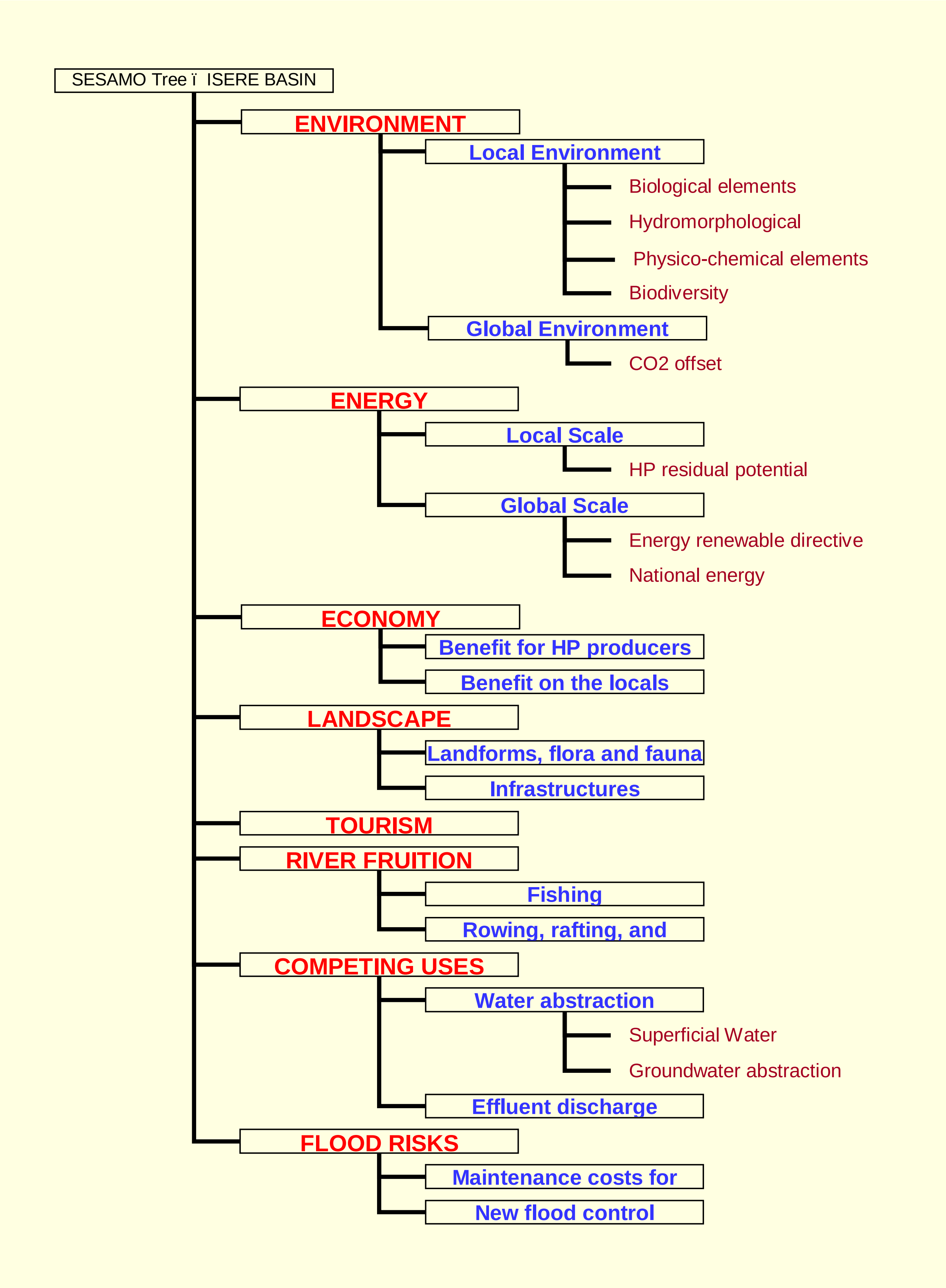

Figure 1: Overall Structure of the Isère Decision Tree

Environmental macro-criterion

The **Environmental (1)** macro-criterion considers two criteria: **Local Environment (1.1),** and **Global environment (1.2)**. Hydropower affects the local environment in many different ways, by refashioning the river environment through chemical, morphological, and consequently biological and biodiversity impacts. It affects the global environment more indirectly, mostly as "clean energy," replacing the use of fossil fuels. For this reason, the **Local Environment** criteria has more sub-criteria and may be attributed more weight in future stages than the **Global environment**.

- **Local Environment (1.1)**. This criterion is defined by 4 sub criteria: **Biological elements (1.1.1)**, **Hydromorphological (1.1.2)** elements supporting the biological elements and Chemical and **physico-chemical (1.1.3))** elements supporting the biological elements, and **Biodiversity (1.1.4)**. The three former sub-criteria are explicitly considered by the Water Framework Directive (WFD). They are found in the annex V of the WFD for surface water bodies and specifically for rivers, along with the indicators used in the tree. These three criteria allow the assessment of the ecological status for fluvial ecosystems into the watershed. Biodiversity is included here as it is logically connected to the WFD indicators, and is part of the local environment.

  In earlier versions of the Isère tree, the criteria falling under the WFD were considered separately from the criteria non-considered by the WFD. We were advised against making such a distinction, because it would ultimately imply that two such branches could be given different weights in the SESAMO procedure, which is contrary to the aim of the SHARE project.

  - **Biological elements (1.1.1)**: Annex V indicates that the following population characteristics must be considered for the evaluation of the biological status: **Composition and abundance of aquatic flora (1.1.1.1)**, **composition and abundance of benthic invertebrate fauna (1.1.1.2)** and **composition, abundance and age structure of fish fauna (1.1.1.3)**

    We will use, to characterize each population, the following biological indicators that are compatible with the French norm. Their descriptions are available in the reports *SHARE_WP5_Good-status-requirements_PP9_080710* and *SHARE_WP5-32_Tech_Review_of_WFD_PP9_101222.*

    - **Composition and abundance of aquatic flora (1.1.1.1):**
      - Macrophyte Biological Index in Stream (Indice Biologique Macrophyte en Rivière, **IBMR)**: The quality of the flora population is estimated using the IBMR. It is based on a comprehensive survey of macrophyte population. The method follows the French norm NT T 90-395, dated from October 2003.
      - Biological Diatom Index (Indice Biologique Diatomées, **IBD**): The composition and abundance of aquatic flora (WFD, Annex 5) are evaluated via the Biological Diatom Index. The version of the biological diatom index used is the IBD 2007 (Norm AFNOR NF T 90-354 published in December 2007). The class limits have been validated during the European inter-calibration exercise and included in the Commission decision issued on 10 December 2008.

    - **Composition and abundance of benthic invertebrate fauna (1.1.1.2):**
      - Global Biological Index Standardized (Indice Biologique Global Normalisé, **IBGN**): The composition and abundance of benthic invertebrates (WFD, Annex 5) are evaluated via the Global Biological Index Standardized. This index is according to the French Norm NFT 90-350. The class limits were

validated and included in the decision of the Commission on 10.12.08 published in the Official Journal of the European Union.

- **Composition, abundance and age structure of fish fauna (1.1.1.3):**
  - Fish River Index (Indice Poissons Rivière, **RPI**): The composition, abundance and age structure of fish fauna (WFD, Annex 5) are evaluated using RPI. The class limits to be considered are found in the original publication of the Fish River Index.

- **Hydromorphological elements (1.1.2):** The Annex V of the WFD states that the evaluation of the hydromorphological condition must considerer three elements: The **hydrological regime (1.1.2.1)**, the **river continuity (1.1.2.2)** and the **morphological condition (1.1.2.3)**. Each one of these sub-criteria is composed of others elements that characterize it. In this list, hydromorphological criteria will only be examined in so far as they have a direct impact on biology. Yet hydromorphological processes as they infer in several parts of the tree are described with specific parameters in the database.

- **Hydrological Regime (1.1.2.1):** WFD define two component for the hydrological flow regime:

- The **quantity and dynamic of water flow (1.1.2.1.1)**: The guidance emphasizes the necessity to maintain and/or restore the morphological floods at frequencies of acceptable return periods (e.g. return period of 5 years). The index most commonly used worldwide for the assessment of hydrological disturbances is the Indicator Hydrological Alteration, IHA (Richter et al, 1996). The IHA considers 32 parameters for evaluation and takes into account primarily the effects on the biological elements.

- **Connection with groundwater (1.1.2.1.2):** Emphasis is also focused on the relationship between the river and groundwater. Therefore we propose to use a qualitative indicator (high, good, regular, poor, bad) in relation to the reference condition. In general, Hydropower generation could change the connection between river and groundwater if clogging occurs. This will depend on a lot of variables, notably on the operation of the dam, on the sediment supply, and on channel morphology prior to the building of the dam (presence of zones favourable to clogging, vegetationé).

- **River continuity (1.1.2.2):** this concept is introduced in Annex V of the WFD, as a quality element for the classification of the ecological status of rivers. An optimal continuity condition occurs when **the continuity of the river is not disturbed by anthropogenic activities and allows undisturbed migration of aquatic organisms and sediment transport**. Thus, this concept seeks to restore the possibilities of movement (upstream and downstream migration) of aquatic organisms at spatial scales compatible with their development cycle and long-term survival in the ecosystem. It is similar to **restoring sediment flows**, necessary to preserve or restore habitat conditions for communities corresponding to high condition. We will pay particular attention to the following:
  - The presence of sills and/or hydraulics works.
  - The possibility of biological connection between the different reaches of the river
  - The modification of the sediment transport
  - The connectivity between riverbed and floodplain.

Therefore, we consider two dimension of continuity:

- **Longitudinal continuity (1.1.2.2.1)**: refers to **sediment transport** and **fish migration** indicators. These indicators are qualitative. For example, if the hydropower station considers the devices that preserves continuity for fish, known as fish ladders, fishways, fish passes or fish steps (e.g. pool and weir, baffle fishway, fish elevator, rock-ramp fishway or vertical-slot fish passage) and if the fish devices are effectives, we will consider that the HP is transparent; the fish continuity will then be evaluated as good, but never as high. The same logic will be used for sediment continuity. We must include a special mention to flushing operations. This kind of operations could ensure some sediment continuity but not for all sediment (e.g. coarse sediment), and depending on the operation-policies, the frequency, the magnitude and the duration of a flushing event, this kind of operation is likely to be considered as bad practice as far as HP management relative to sediment continuity is concerned.

- **Transversal continuity (1.1.2.2.2):** as in the case of longitudinal continuity, we consider two elements for its evaluation**: Floodplain ï river connectivity/ fragmentation** and **main stream ï secondary channels connectivity**

Floodplain ï river connectivity/fragmentation: for this element we will consider the nature of the river bank and the degree of connection of the river with its floodplain. The occurrence of a HP could change the degree of river-floodplain connection. For example, if an incision/scour occurred within the bed because of the HP-dam, this would affect the transversal connectivity.

Main stream ï secondary channels and tributary connectivity: The connection of the principal channel with secondary channels is important because these are refuge areas during floods and represent a singular habitat for fishes in juvenile state or for other types of biota (e.g. macro-invertebrates and amphibious). This is due to the fact that in secondary channels, water is generally warmer, water depth is shallow, and the stream velocity is lower than in the main channel. The connectivity of a stream with its tributary can also be altered by HP in the case of an incision of the bed following dam construction. This can be detrimental to fish because they take refuge in clear tributary during flushing events of the main channel.

Comment: The relations between flood plain and river ecosystem are dynamic and have an important role for the **riparian vegetation**, **landscape** and **river corridor**. These three concepts will be explained later.

- **Morphological conditions (1.1.2.3):** They must provide adequate habitat conditions for communities as regard to their development and their sustainable survival. The morphology of the river channel and its relation to its floodplain is in complex interaction with vegetal and animal biodiversity, and is primordial to the ecosystem processes. Figure 1 illustrates the diversity of transitional habitats that can be found within the main channel and floodplain, and which host a great diversity of plants and animals.

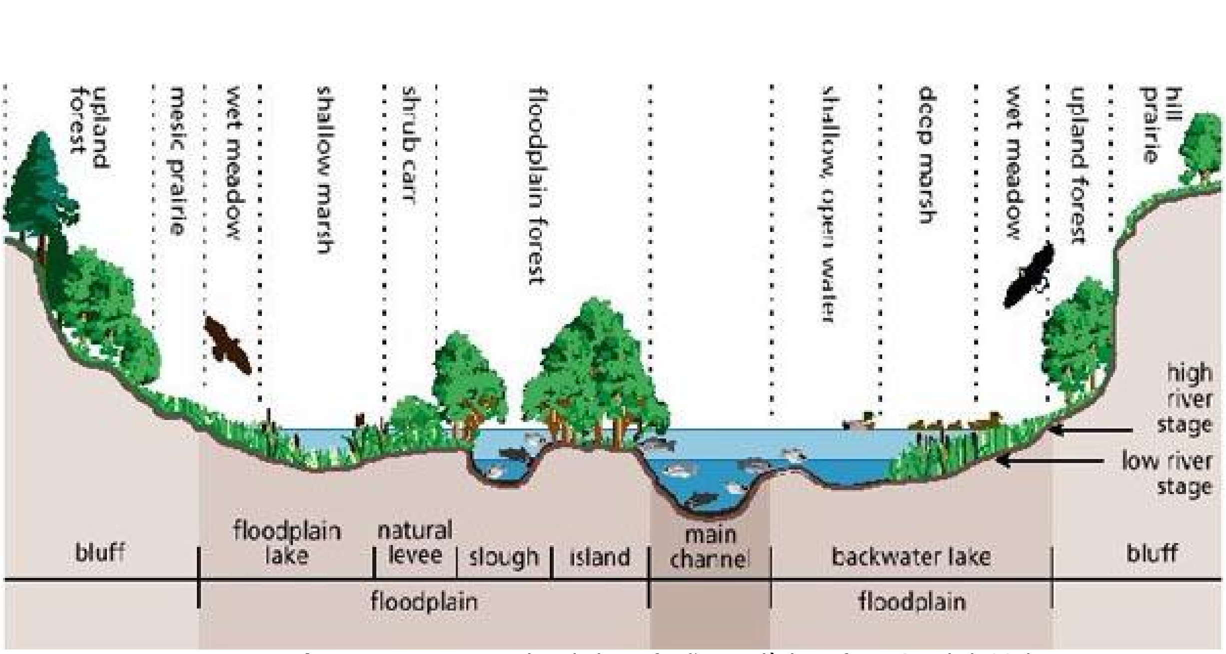

Figure 1. A cross sectional view of a "natural" river, from Spark (1995)

In order to describe these complex habitats, the WFD looks at three components for the evaluation of the +subsub-criterion "morphological conditions": **the river depth and width variation (1.1.2.3.1)**, **structure and substrate of the river bed (1.1.2.3.2)** and **structure the riparian zone (1.1.2.3.3)**. Below is explained how each component is evaluated.

- **The river depth and width variation (1.1.2.3.1)**: the Width to Depth Ratio (WDR) is computed as the quotient of mean bankfull depth (d) to bankfull width (BW), as illustrated by figure 2. The mean depth is taken at bankfull, by dividing bankfull area (A) by bankfull width (BW).

$$WDR = BW/d = BW^2 / A$$

From a hydromorphological point of view, this parameter indicates the geodynamic activity of the stream. Indeed, an active stream, characterized by important lateral erosive processes and a high sediment contribution, should have a high WDR of 20 or more (Malavoi and Bravard 2010; 2011).

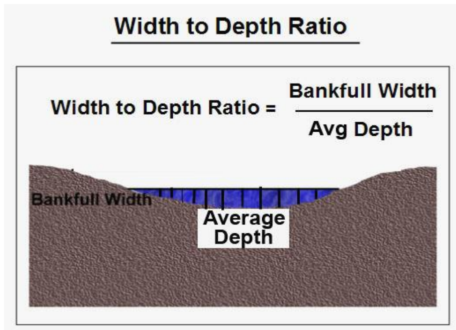

Figure 2. Width to depth ratio

- **Structure and substrate of the river bed (1.1.2.3.2):** we have considered two components for the assessment of the alteration degree of this element, the **longitudinal profile** and the **sediment grain-size** of the river bed. Both elements will be evaluated of qualitatively, through the degree of deviation from the original condition, after HP operation alternatives. In the case of **sediment grain-size**, the HP operation can lead to bed armoring.

- **Structure the riparian zone (1.1.2.3.3)**: We consider as riparian zone the areas that surround water bodies in the watershed and are composed of moist to saturated soils, water-loving plant species and their associated ecosystems. This zone does not encompass the whole diversity of habitats surrounding a stream as described above.
A HP project can change the structure of riparian zone, allowing its growth (encroachment) or its elimination, according to the modification of the bed form (e.g. channel aggradation/degradation).

- **Physico-chemical (1.1.3)**: The WFD distinguishes between **general pollutants (1.1.3.1)**, within which they are considering five elements: **thermal condition (1.1.3.1.1)**, **oxygen condition (1.1.3.1.2)**, **salinity (1.1.3.1.3)**, **acidification status (1.1.3.1.4)** and **nutrient condition (1.1.3.1.5)**, and **Specific synthetic pollutants & specific non-synthetic pollutants (1.1.3.2)**.

    - **General pollutants (1.1.3.1):**

- **Thermal condition (1.1.3.1.1)**: indicator for this element will be the delta temperature after and before the HP operation, $\Delta T = T_{after}-T_{before}$. The increase in temperature due to HP production can easily be computed from the HP energy production and losses.

- **Oxygen condition (1.1.3.1.2):** for this case we consider the parameter **dissolved oxygen** as representative. However, the SEQ-EAU (Système d'évaluation de la qualité de l'eau des cours d'eau), in english : Water quality assessment system for current waters, takes into account the following parameters: DBO_5, O_2 saturation rate and DQO.

- **Salinity (1.1.3.1.3)**: like in the previous case, the SEQ-EAU takes inton account these parameters for salinity condition of surface water bodies: electrical conductivity, salinity, Cl^-, SO_4^{2-}, Ca^{2+}, Mg^{2+}, K^+, Na^+, Total Alkalimetric Titre, and total hardness (hard water). We propose to use only the **parameter salinity**. This variable may not be relevant to the impacts of HP, especially in the Isère Basin.

- **Acidification status (1.1.3.1.4):** there are two parameter used by SEQ-EAU the pH and dissolved Aluminium. We propose only the **pH**.

- **Nutrient condition (1.1.3.1.5)**: for the assessment of nutrient condition, SEQ-EAU consider three groups: i) Nitrogenous elements without nitrates (NH_4^+; NKJ; NO_2^-); ii) Nitrates (NO^{3-}) and iii) Phosphorous elements (PO_4^{3-} and P_{tot}). We have made a cluster of two elements families the **nitrogenous** and **phosphorous**.

Given the size and the variety of the HP facilities, the relevance of the taking into consideration of these parameters will be considered when implementing the model.

We will use as thresholds of concentration of alls of physical-chemical parameters, the 2008/915/CE published in October 30 to 2008.
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:332:0020:0044:EN:PDF

- **Specific synthetic pollutants & specific non-synthetic pollutants (1.1.3.2)**. In the case of **specific pollutants** of ecological status are defined in the Decree of 25/01/2010. They were fixed by the Ministry of Ecology, proposed by the ONEMA, Office National de l'Eau et des Milieux Aquatiques, (in English, The French National Agency for Water and Aquatic Ecosystems). The control covers 9 pollutants: i) **non synthetic pollutants**: dissolved Arsenic, dissolved Chromium, Copper and Zinc dissolved, ii) **synthetic pollutants:** Chlortoluron, Oxadiazon, Linuron, 2,4 D, MCPA 2.4.

For the pilot case Isère – Arc rivers, the Schéma Directeur d'Aménagement et de Gestion des Eaux (SDAGE), 2010-2015 (the translation is: Outline for the organization of the development and management of water resources) made by the Water Agency Rhône-Méditerranée and Corse, is interested in the **Heavy metals** and **Polycyclic Aromatic Hydrocarbons** (HAPs).

In the first development of the tree, we consider that these pollutants will not be influenced by HP whether through sources or through the modification of transfer processes. Further investigation on the Isère Basin is taking place in the framework of another research in the LTHE, and this aspect could be developed later if necessary.

- **Biodiversity (1.1.4)**: Here we mean the biodiversity of not only aquatic species but also of terrestrial species that depend on the stream and its surrounding ecosystems for their survival. It will take account of the richness of the bio-conditions (see figure 1), but also of the fluvial corridor, meaning the properties of the riparian zone as regard to a longitudinal transfer of species across the basin.

- **Global Environment (1.2):** We consider in this criteria the benefits that hydropower can bring to to the global environment as compared to other energy sources. HP, as it is a substitute to the consumption of fossil fuels, can be seen as a mitigator of global warming. One sub-criteria represents this dimension, namely **CO2 offset (1.2.1)**:

  - **CO2 offset (1.2.1)**: This sub-criterion corresponds to the evaluation of the alternative in comparison with the other sources of energy, for example thermal power plants. Despite its strong link with the ENERGY macro-criteria explained below, CO2 is included here as a recognition that energy production affects the environment globally.

Energy macro-criterion

The **ENERGY (2)** macro-criterion considers two criteria also according to the spatial scale: **Local (2.1)** and **Global (2.2)**.

- The **local** branch of the decision three has only one leaf, **HP residual potential (2.1.1)** or power utilization from river (potential of a river to generate electricity).
  - **HP residual potential** refers to the ability of a river to produce energy in relation to the power that will be generated by the alternative. Their calculation in percentage is: power produced by the alternative/power with the ability possessed by the River. Eventually, in this calculation we could use the VAPIDRO-ASTE tool.
- On another hand, the branch called **global** has two sub-criteria, **the Energy renewable directive (2.2.1)** and **National energy improvement (2.2.2)**. These two sub-criteria are explained below.

  - **Renewable Energy Directive (2.2.1)**. This criteria represents the contribution of each alternative (considering the power it can generate) to comply with the directive on renewable energy, expressed as a percentage of its contribution to the archive of the Directive objectives. As this criteria must be archived by the country (because the Directive applies to all of the countries), for calculation we should consider the amount of energy produced by the alternative in relation to the total amount of renewable energy produced in the country. This calculation is: power produced by the alternative / total power of the renewable energies in France.

  - **National energy improvement (2.2.2)**: This sub-criterion corresponds to the contribution of the alternative to the country's total energy matrix. We make the difference between the **base energy (2.2.2.1)** and **high demand energy (2.2.2.2).**

    - **The base energy (2.2.2.1)** is the percentage that is contributed by the alternative to improve the energy available during period of low electrical demand.

    - **High demand energy (2.2.2.2)** is the percentage that is contributed by the alternative to improve the energy available during the period of high electrical demand.

Economy macro-criterion

The **ECONOMY (3)** macro-criterion considers two criteria that take in count the direct economical **benefit for HP producers(3.1)** and the undirected economical benefit: **benefit on the local (3.2)**.

- **Benefit for HP producers(3.1):** is the fruitful net of the enterprises (benefit = revenues - costs). The calculation of the revenues includes a measure of base and high demand energy production (the later having a greater economical value). Although it translates an idea very similar to energy production, it is included in the Economy macro-criteria for the purposes of homogenization with the other case studies of the project.
  The costs include maintenance of the HP facilities, which are mainly related to morphological processes, addressed in this case study. However, in the first implementation of the tree, those costs will be calculated as a percentage of the revenues.

- **Benefit on the local (3.2)**: corresponds to the economical benefit that a HP plant gives indirectly. For example, a HP with dams creates an artificial lake, which allows the development of aquatic sports, fishing and tourism, sources of economical revenue.

Landscape macro-criterion

LANDSCAPE (4): This macro-criterion corresponds to the attractivity, the conservation, and the aesthetical value the surrounding area. This macro-criteria includes two criteria:

- **Landforms, flora and fauna (4.1)**: for example, the construction of a HP can lead to the creation of a lake which changes the landscape, and hosts migratory birds, making it potentially more attractive. It can be defined as a high/poor index.
- **The infrastructures (4.2)**, in contrast, the construction of a large dam, and a plant, as well as the construction of power cords may disturb the natural landscape and make it less attractive. It can be defined as a high/poor index.

Tourism macro-criterion

The **TOURISM (5)** macro-criterion is linked to the **ECONOMY**, **LANDSCAPE**, and **RIVER FRUITION** macro-criteria. However it is included as a separate criterion since in the context of decision-making it may be necessary or interesting to consider it separately. No specific criteria are used here, but rather a measure of weather each alternative leads to more or less tourism whitin the basin, following a qualitative index. Tourism can be positively impacted by the creation of artificial lakes and the possibility of new recreational activities, and it can be negatively affected in the case of a landscape loosing aesthetical value because of the massive construction of infrastructures.

River Fruition macro-criteria

RIVER FRUITION (6): For this criterion we consider the various recreational activities:

- **fishing (6.1)** mostly as a hobby in the case of the Isère River (little or no professional fishing)
- **rowing, rafting and canyoning (6.2)** that could be affected by variations in water level that we call hydropeaking. The locations for the practice of these sports are reckoned in the SDAGE made in 1996. We will consider the loss of sites due the HP alternatives.

Competing Uses macro-criteria

COMPETING USES (7): For this macro-criterion we consider the following three criteria:

- **Water abstraction (7.1)** for agriculture, industry and drinking. For this sub-criteria we differentiate the **superficial water abstraction (4.2.1)** and the **groundwater abstraction (4.2.2)**. It is noteworthy that in both cases the fluvial morphology plays an important role. An incision in the bed can cause problems in both types of water extractions, decreasing the water-table or the water surface level.

- **Effluent discharge (7.2)** for industry and urban treatment plant is the flow in the river available for diluting the effluents. Some HP can regulate the flow regime, in particular the HP plants that produce hydropeaking. If the intra-hourly flow variation cause the variation of water volume for a time step (water flow in the river integrate in the time), then the pollutant concentration in the river coming from the effluents (Industry and urban treatment plant) will change also. We could have included this criterion into the Environmental/WFD/physical-chemical parameter, but the in general, the changes in concentration due to the water discharge by hydropeaking are produced to a scale less than the measures incorporated in the water quality analysis for the assessment of ecological status.

Flood Risk

FLOOD RISK (8) macro-criteria: We considered two criteria called **Maintenance cost for flood control structures (8.1) and new flood control structures (8.2),** which are defined below. It is interesting to note that the flood risks are strongly link with the hydromorphology of the river, since the shape of the channel itself depends on the high flows.

- **Maintenance cost for flood control structures (8.1)**: Corresponds to the effect generated by each alternative on the cost of civil works maintenance and cleaning of the channel, which is directly related to the erosion of the bed, banks or structures and/or deposition of sediment on the bed.
- **New floods control structures (8.2):** Corresponds to cost of news structures due to the operation of HP. Remark: in general the PH projects contribute to the attenuation and delay of the flood peaks

Application of the methodology to a large basin

The section chosen as the pilot case study for the Isère River encompasses several reaches which show a lot of heterogeneity from one to the other. Our objective in this project is partly to show how the SHARE methodology can be applied to such a large scale. In terms of the input data base, each delimited reach will have a set of specific values. These data will be entered into the SESAMO software, along with a valuation coefficient for each criteria described above, so that each reach will have an overall score assigned for each given alternative. However, this will not give an overall score to the whole study area, so that the alternatives will not be able to be compared directly at the basin scale, which is the final aim of this project.
In order to aggregate the reach scores to obtain a single score for the study area, several factors must be taken into consideration. First, the most straightforward factor is the length of the reach. Second, its role is also important. For example, a reach flowing through a natural or semi-natural environment may be more important in terms of floodplain connectivity and less important in terms of economy. In contrast a zone that is located near a city may be more important in terms of risks or in terms of chemical composition for drinking water supply than in terms of environment. The third factor that must be considered is the typology. For instance, the significance of a longitudinal discontinuity varies depending on the reach: the first dam installed on a river branch has more impact than the second or third. Once a discontinuity is present on a branch, whether two or three are also present matters less.
In order to take all factors into consideration, it has been decided to assign different weights to the criteria depending on the reach in the SESAMO software. The reaches can be grouped into more or less homogeneous sets, that will accept the same weights for the same criteria. Characteristics such

as Strahler stream order, altitude, slope, or water body can be an approximation of commonality between reaches for our purposes. In the future, the grouping could be done in more detail, using finer characteristics (presence/absence of a natural zone in the drainage area, presence/absence of important citiesé). Then, the average score of the entire study area can be computed, by assigning weights to the reaches simply depending on their length. In this way, we believe that all important factors can be taken into account, and that the final scores will be representative of the state of the basin as well as of the relative importance given to each reach as regard to different criteria.

Conclusion

This report presents a general structure for decision tree, which includes a large number of criteria. Considering their significance in relation to alternatives, and the difficulty to make a reasonable evaluation, some of these criteria may be discarded mater. It will depend of the available data and the real importance of the criterias.
Some ideas have to be discussed and improved with other specialists, especially when considering the branches that evaluate the ecological aspects of hydropower production.
The evaluation must consider benefits and impacts on the Grésivaudan valley. This pilot case aims at testing the SHARE methodology taking in count the large basin upstream of the Grésivaudan valley, which must be split in an upstream→downstream logic. Within the basins, governing processes are different, depending on the different characteristics of the reaches under consideration.
We focus on this first version on the central reach and on criteria related to morphological consequences and issues regarding the other uses of the river in such a reach. On one hand, it will be certainly necessary to replace certain parts of this tree by specific subtrees developped for the upstream-type basins on other PCS. On the other hand, ideas concerning morphology, other uses or upstream/downstream influence could be transposed to other PCS.

References

European Communities 2008/915/EC. Commission Decision of 30 October 2008, establishing, pursuant to Directive 2000/60/EC of the European Parliament and the Council, the values of the Member States monitoring system classifications as a result of the intercalibration exercise. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:332:0020:0044:EN:PDF

Richter, Brian, Baumgartner, Jeffrey V., Powell, Jennifer, Braun, David P., 1996, A Method for Assessing Hydrologic Alteration within Ecosystems. Conservation Biology 10:1163-1174.

SHARE_WP5_Good-status-requirements_PP9_080710.pdf

SHARE_WP5-32_Tech_Review_of_WFD_PP9_122210.pdf

Sparks R. E. 1995. Need for ecosystem management of large rivers and their floodplains. BioScience 45:168ï 182

Tavzes B. and Urbanic G. 2009. New indices for assessment of hydromorphological alteration of river and their evaluation with benthic invertebrate communities; Alpine case study. Review of Hydrobiology. 2: 133-161.