WP4.4 Pilot Case Studies indicators database for MCA

Structure of Astico decisional tree

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Author
Alessandro VIANELLO

Member number and name
PP2 – ARPAV – Agency of Environmental Protection of Veneto Region

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Summary

SHORT DESCRIPTION
This document intends to describe the structure of the SESAMO trees projects and the MCA application to the Pilot Case Study of Astico river.

Document Control

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Summary

The report summarizes the general methodological approach, the criteria and the indicators used to test the multi criteria analysis (MCA) on the Astico pilot case study. The report highlights the progression of MCA model development. The main analyzed aspects are:

- Focus on MCA application.
- Criteria, sub-criteria, & Indicators evaluation
- Layout of the decision tree.

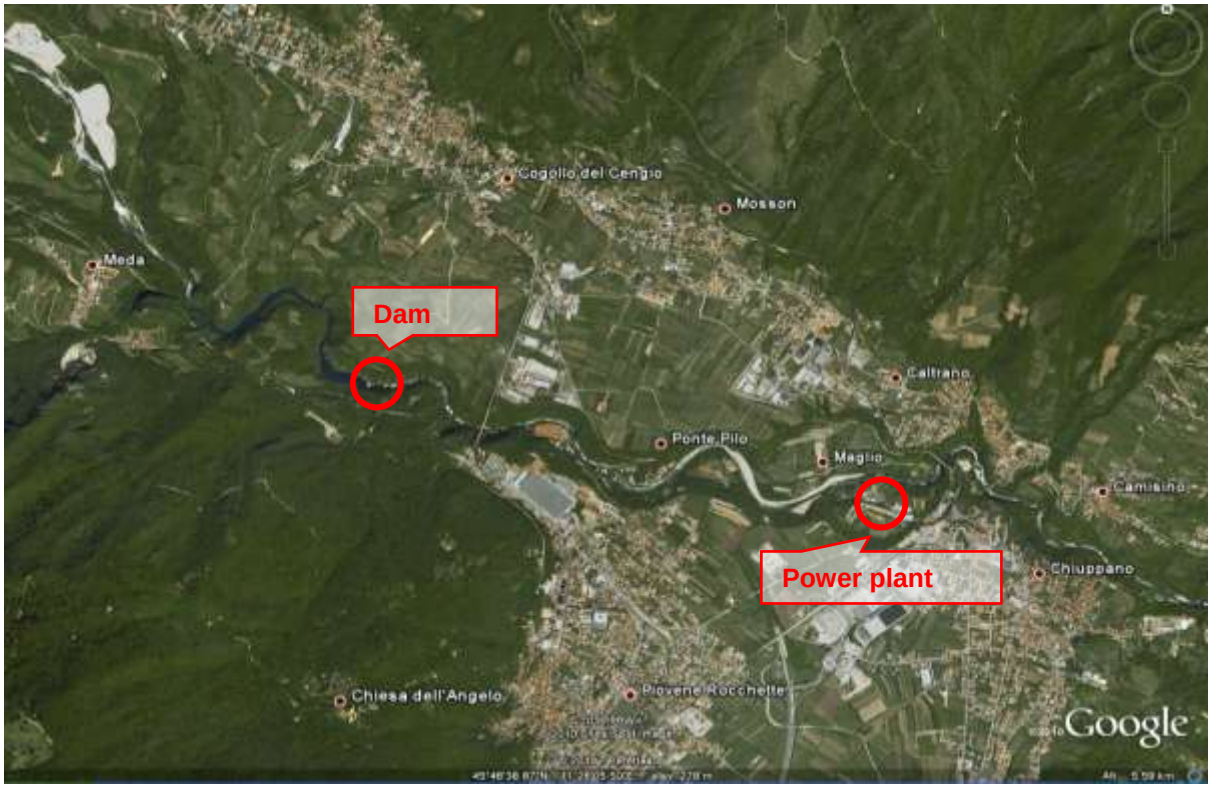
This report is devoted to an explanation and the justification for each of the branches of the Astico decisional tree model, until its leaves. We identified potential indicators useful to evaluate the chosen management alternatives.

Structure of Astico decisional tree

The Astico river is one of the main rivers of the Vicenza's Province. This part of the Veneto Region is densely populated and several industrial activities are also present. These are some of the reasons of the intense water exploitation within the Astico river basin. Water is therefore withdrawn for drinking, industrial and hydroelectric production.
Hydropower plants on the river Astico are mostly of the run-of-the-river kind, and do not require the presence of a reservoir. The only exception is the hydroelectric plant of Bessé, in the Municipality of Chiuppano (VI), which is served by a little reservoir, created with the construction of a concrete dam (Leda dam).
This plant has been the object of the Multi Criteria Analysis application to the Astico river basin pilot case study.

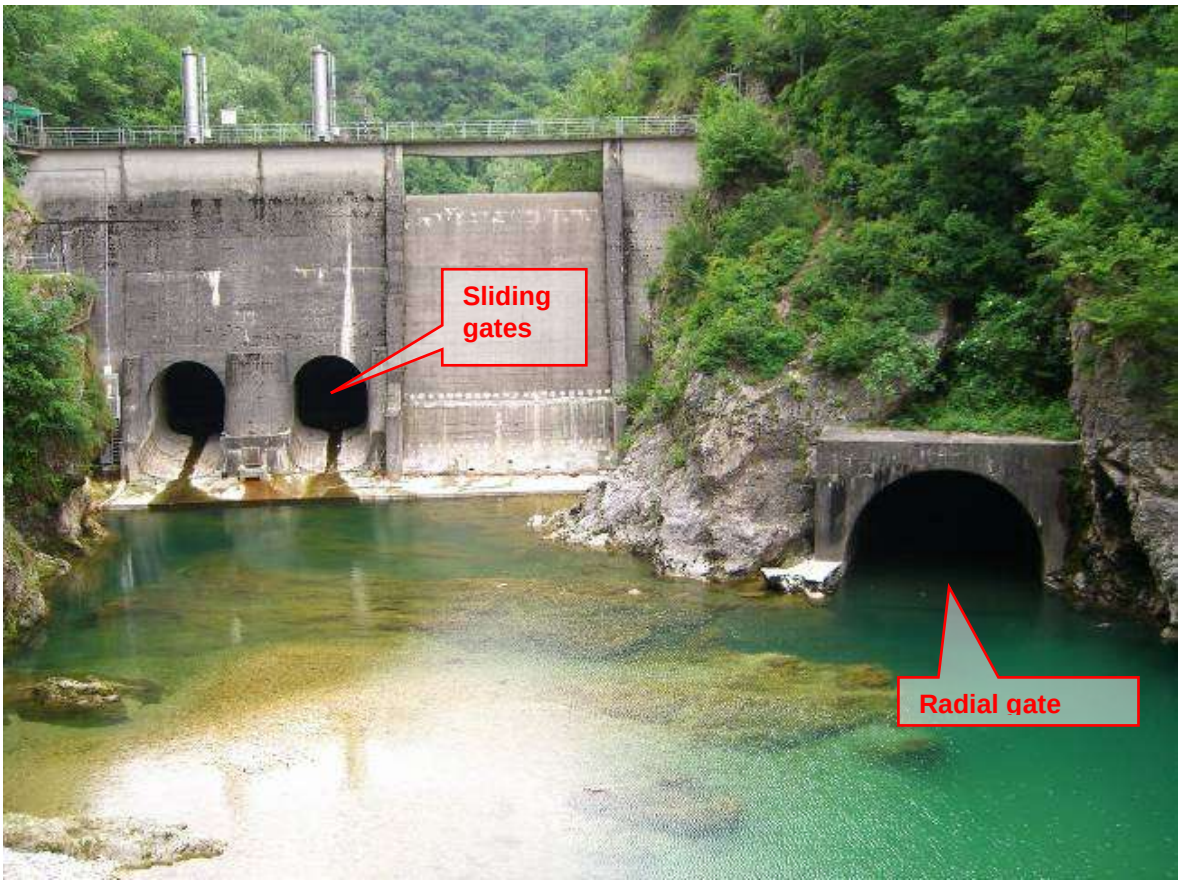
The hydropower plant

The plant of Bessé, in the Municipality of Chiuppano, is the only power plant on the Astico River, which is served by a little reservoir. This reservoir is located in the Municipality of Piovene Rocchette, and has been created with the construction of concrete dam, named Leda's dam, in the neighborhood of a little town named Meda.
This power plant is property of the Eusebio Energia S. p. A. company, one of the most important Italian energy companies, specialized in the energy production from renewable energy sources such as water and wind.



Aerial view of the Astico reach concerned by the Bessé hydropower plant

The Leda dam is 18 m high and the weir surface is 12 m long. The upstream basin is about 338 000 m^3. The minimum working water surface elevation is 227 m a.s.l., while the maximum is 231.5 m a.s.l.. The minimum elevation corresponds to the altitude of the intake facility, while the maximum is 1.5 m higher then the weir top height, that is 230 m a.s.l.. The emptying of the reservoir is possible by means of two sliding gates (discharge = 190 m^3/s each) and by a radial gate (200 m^3/s). The total discharge allowed by the gates is therefore about 600 m^3/s, near to the value of the maximum historical discharge of 1966, estimated to be about 700 m^3/s. The Italian Dam Register has imposed to the dam manager the complete reservoir emptying when the discharge flow exceeds 100 m^3/s. The dam is subject to periodic checks and is in operation since 1958.
Despite the presence of a reservoir, the HP plant effectively works as a run-of-the-river plant. This is due to the reduced possibility of water level regulation. The difference in height between the intake facility (227 m a.s.l) and the weir top (230 m a.s.l.) is in fact only 3 m. An old project planned the possibility of increasing the dam height in order to achieve a better regulation capacity and a larger reservoir volume, but it has never been enacted because of safety issues.

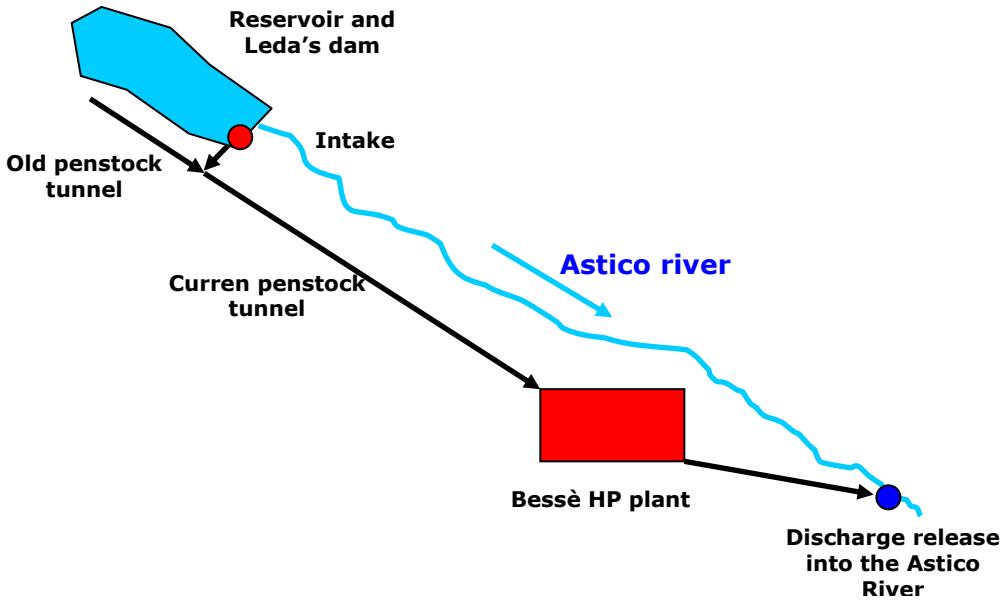


Leda's dam along the Astico River

The hydropower plant of Bessé is located about 3.5 km downstream the Leda dam. The energy is produced by two Francis turbines of an output of 1100 kW and 1880 kW respectively; the plant can be therefore be included in the small hydropower category. The total annual production is about 12 millions kWh. The mean working discharge is 5.9 m^3/s, while the maximum is 10.0 m^3/s.
The MIF that has to be released downstream the dam has been estimated to be 1 m^3/s, on the basis of the river basin surface upstream the dam that is around 300 km^2. The MIF is released by means of the radial gate. The amount of the released water is not directly measured by appropriate instruments, but it is estimated accounting for the opening degree of the radial gate on the left of the dam.
Approximately in the middle of the Astico reach concerned by this hydropower plant, at Ponte Pilo, a level measuring station has been provided by the company Eusebio Energia. In the corresponding cross section, a rating curve has been developed. Nevertheless, this relation cannot be used to measure the MIF released for two reasons. First, this monitoring station has been installed for hydraulic risk prevention: the measured data are in fact used to regulate the gate opening during floods. The rating curve has been therefore calibrated paying particular attention to fitting of high discharge values, since the gates opening sequence starts around 100 m^3/s. Secondly, in this reach the river Astico has dispersive features, and a noticeable amount of the flowing discharge infiltrates into the riverbed. Particularly in presence of low water flow, the discharge released immediately downstream the dam is higher than the discharge flowing at Ponte Pilo.

Bessé's hydropower plant

Discharge measuring station at Ponte Pilo



Hydropower plant scheme

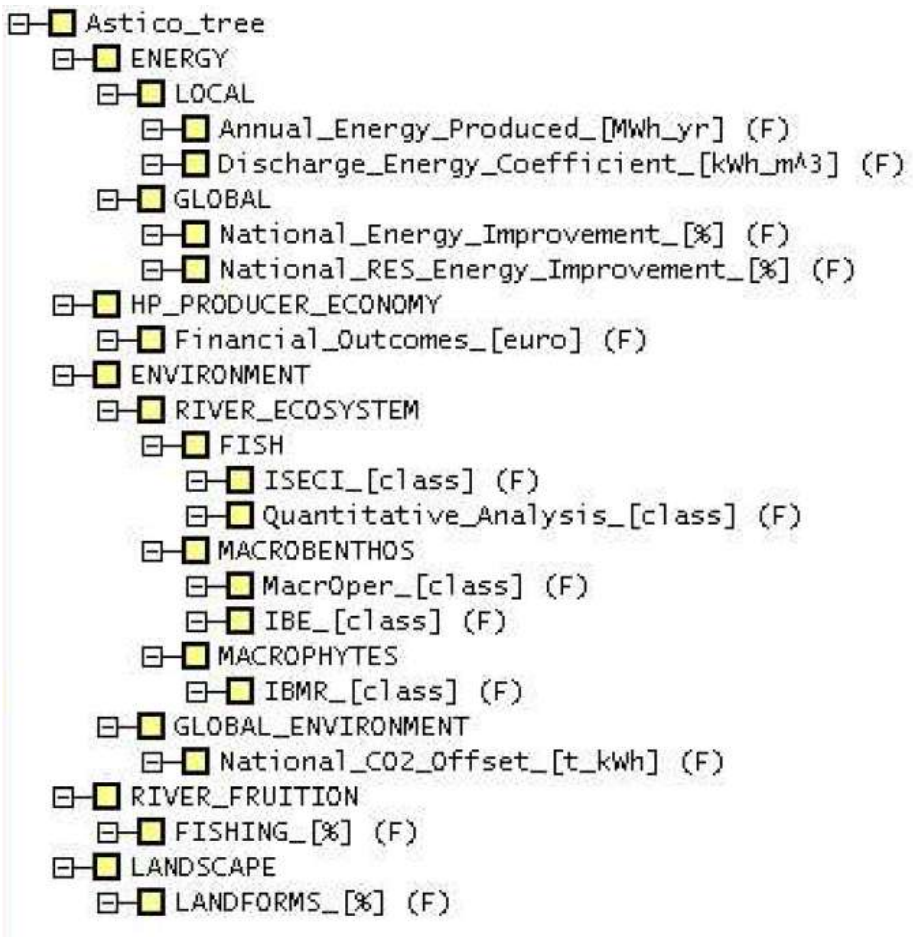
Alternatives description

The alternatives that have been examined with the MCA concern the amount of MIF release. This is in fact the main problem affecting the Astico river reach downstream the Leda's dam, since, because of the strong infiltration phenomena, the current MIF release is not always enough to ensure the presence of flowing water on the entire reach from the dam to the HP power plant outlet channel. The mean dispersed discharge in this reach is in fact about 0.7-0.8 m^3/s.
Four Alternatives have been be considered:

1. **ALTERNATIVE 0**: (HISTORICAL MANAGEMENT UNTIL 2008): until 2008 not MIF released.
2. **ALTERNATIVE 1**: Hydrological MIF release (current management)
3. **ALTERNATIVE 2**: Increase of the released water up to 150% of the hydrological MIF release
4. **ALTERNATIVE 3**: Increase of the released water up to 200% of the hydrological MIF release

It must be pointed out that Alternative 0 is no longer practicable, since the MIF release is, at now, mandatory. It has been inserted among the alternatives list as a reference condition, and to quantify the environmental advantages and the economic drawbacks consequent to MIF regulation.
The Alternative 1 is the current management solution. The hydrological MIF has been determined on the basis of the river basin area upstream the catchment. Therefore, it doesn't take into account, directly, the biological and morphological aspects. Alternatives 2 and 3 have in fact the role to investigate the effects of an increase in MIF, in order to understand if the hydrologically defined MIF is suitable also for river fauna, vegetation and functionality.
The alternatives affect the indicators and criteria evaluations, having the MIF variation effects on energetic production and on environmental features of the river.

Astico MCA tree



Astico river reach case study tree's constructed

Indicators description – Astico River PCS

The following section contains the metadata of every indicator used in the Astico River reach example directly related to MCA model Sesamo software.
The structure of the decision tree for pilot case of Astico River considers 4 main branches:

1. **Energy;**
2. **Economy;**
3. **Environment;**
4. **Social Criteria (Tourism, Landscape, etc.)**

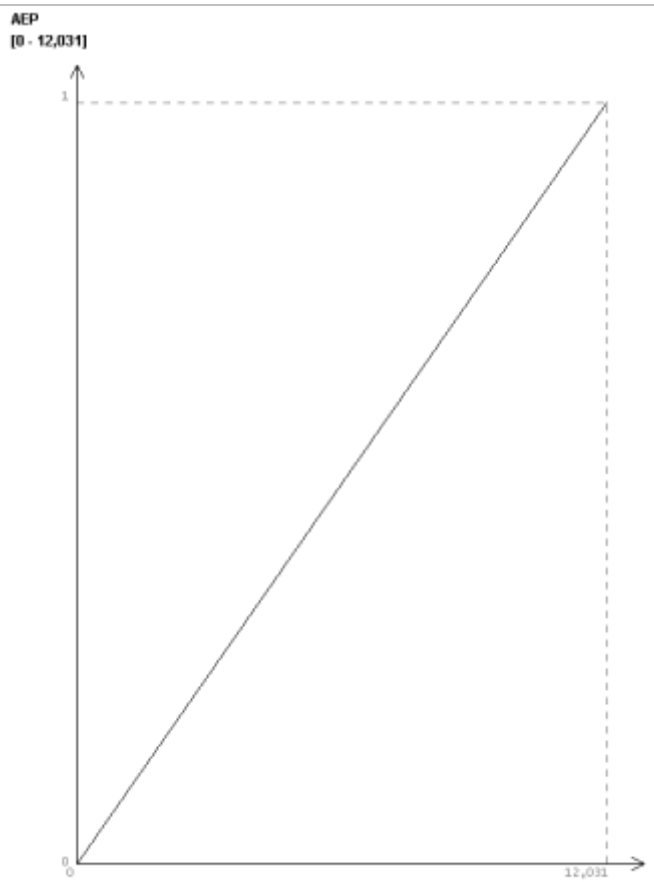
• The first branch called **ENERGY** includes local and global criteria on the hydropower production. It is divided into 2 sub-criteria:

LOCAL: this sub-criteria is evaluated through energy indicators such as:
- **Annual energy produced**;
- **Discharge energy coefficient**

GLOBAL: sub-criteria evaluated through energy indicators such as
- **National energy improvement**;
- **National RES energy improvement**

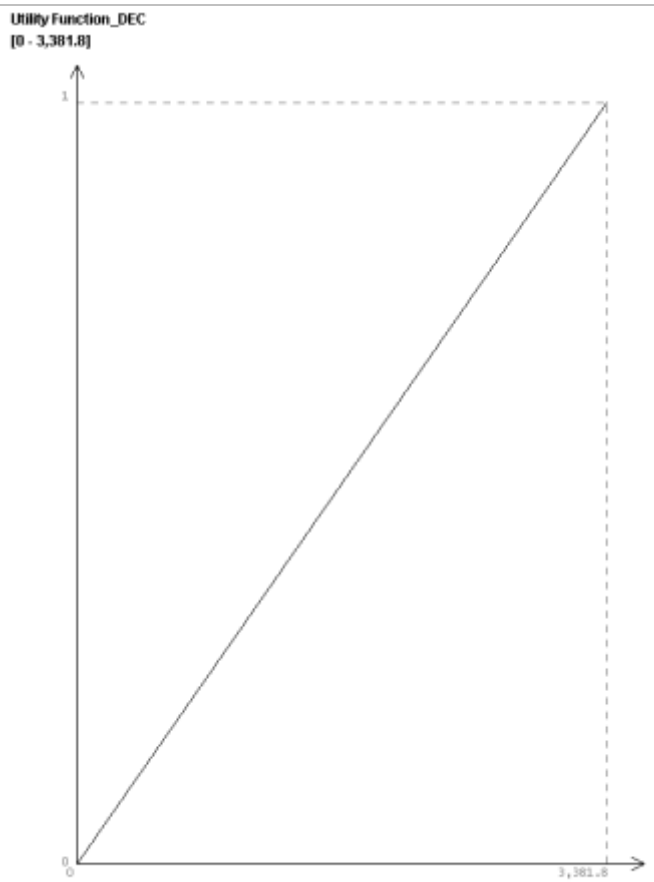
Astico tree | ENERGY | Annual energy produced

FIELD	DESCRIPTION
INDICATOR NAME	evaluation of the annual plant energy production (*GWh/year*) assessed (for proposed plants not already realised) or measured (for existing plants)
ACRONYM	*AEP*
DPSIR	D (Driving Forces)
DESCRIPTION	It furnishes an evaluation of the annual plant energy production (*GWh/year*) assessed (for proposed plants not already realised) or measured (for existing plants). The AEP was estimated through the Power (kWh) equation: $P = Q_m \cdot \Delta H \cdot g \cdot \eta$ Where P = energy power (kWh), Q_m the mean conceded discharge (m^3/s), DH the altitude difference between withdrawal and restitution points (m), g the gravity acceleration (m/s^2) and η the energy production performance (equal to 0.85 - 0.95).
AIM	It furnishes an evaluation of the annual energy production which is the master aim of every HP plant manager
KEY MESSAGE	The HP plant energy produced is the focal aim of every HP plant manager
MEASURE UNIT	*GWh/year*
REFERENCES	–
FIELD	**METHODS AND MONITORING STANDARDS**
INDICATOR ELABORATION	The energy produced by the plant is intended as the total amount of energy sold to the network authority; it is the net energy produced by the HP plant and directly measured by the electricity meter each year
INDICATOR LIMITS	----
EVALUATION	The main parameters considered and evaluated for the Leda dam are: **DH** 31.28 m **Qconc max** 10.0 m^3/s **Qconc med** 5.9 m^3/s **Installed power** 2.88 MW **MIF actual** 1.89 m^3/s The AEP for the different alternatives of Astico river at Leda dam correspond to: **ALT 0** 12031 MWh/yr **ALT 1** 6600 MWh/yr **ALT 2** 5044 MWh/yr **ALT 3** 3489 MWh/yr
AVAILABLE UF	YES
UF	The Utility Function adopted is LINEAR growing (0 – 12031 MWh/yr)

	
SHARE RELATED IND.	Linear annual power produced
COUNTRY CODE	IT
WFD HER	INNER ALPS SOUTH
FIELD	**DATASOURCES**
DATA SOURCE	HP producer
TIME COVER	~ 10 ÷ 1
UPDATE FREQUENCY	annual
NUT III CODE	ITD32
NORMATIVE REFERENCE	LOCAL
NORMATIVE RELEVANCE	----
SHARE PILOT CASE STUDY	Astico

Astico tree | ENERGY | Discharge energy coefficient

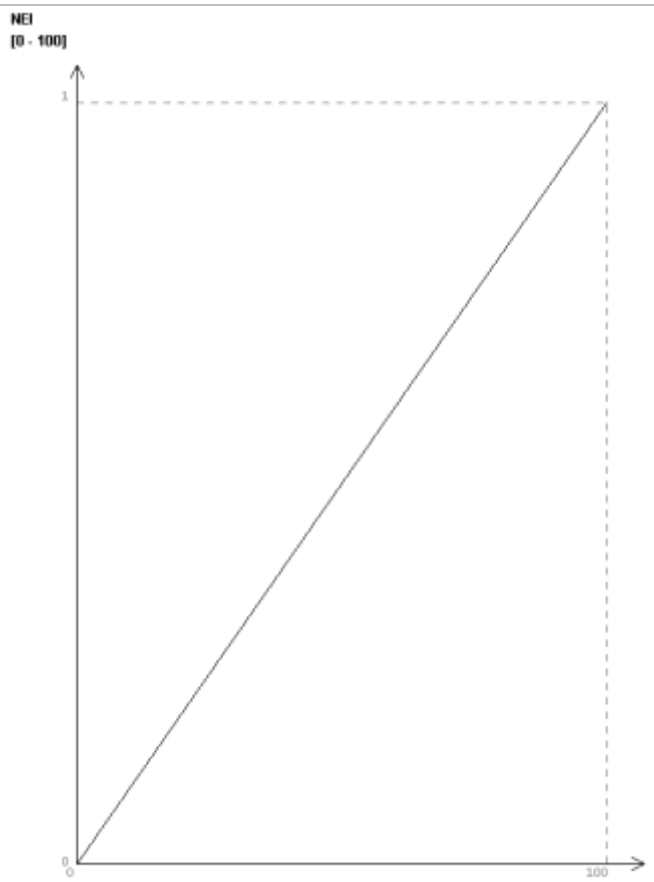
FIELD	DESCRIPTION
INDICATOR NAME	Annual energy produced in relation to the annual mean and released MIF discharges ratio
ACRONYM	*DEC*
DPSIR	D (Driving Forces)
DESCRIPTION	This indicator gives an evaluation of the HP plant effectiveness. It describes the annual energy produced in relation to the annual mean and released MIF discharges ratio: $DEC = AEP/(Qconc/Qrel)$, where the Q_{rel} values are of the order of 0.67 m^3/s. It gives an evaluation of the water volumes used by HP; the higher is the coefficient, the better is the effectiveness of the HP plant.
AIM	It gives an evaluation of the water volumes used by HP; the higher is the coefficient, the better is the effectiveness of the HP plant
KEY MESSAGE	The higher is the coefficient, the better is the effectiveness of the HP plant
MEASURE UNIT	*kWh/m^3*
REFERENCES	–
FIELD	**METHODS AND MONITORING STANDARDS**
INDICATOR ELABORATION	This indicator is computed as the ratio "Annual Energy Produced"/(Qconc/Qreleased)
INDICATOR LIMITS	----
EVALUATION	The DEC values for the different alternatives of Astico river at Leda dam correspond to: ALT 0 DEC 1360.1 kWh/m3 ALT 1 DEC 2545.6 kWh/m3 ALT 2 DEC 3250.3 kWh/m3 ALT 3 DEC 3381.8 kWh/m3
AVAILABLE UF	YES
UF	The Utility Function adopted is LINEAR growing (0 - 3250.3 kWh/m^3)

	
SHARE RELATED IND.	Annual power produced
COUNTRY CODE	IT
WFD HER	INNER ALPS SOUTH
FIELD	**DATASOURCES**
DATA SOURCE	HP producer
TIME COVER	~ 10 ÷ 1
UPDATE FREQUENCY	annual
NUT III CODE	ITD32
NORMATIVE REFERENCE	LOCAL
NORMATIVE RELEVANCE	----
SHARE PILOT CASE STUDY	Astico

Astico tree | ENERGY | National energy improvement (NEI)

FIELD	DESCRIPTION
INDICATOR NAME	Contribution of the considered HP if compared to the total national energy production
ACRONYM	*NEI*
DPSIR	----
DESCRIPTION	This indicator expresses the contribution of the considered HP if compared to the total national energy production; It gives a value of the HPP importance for the national energy production.
AIM	It gives a value of the HPP importance for the national energy production
KEY MESSAGE	The higher is the HPP importante, the higher has to be the weight given to energy production
MEASURE UNIT	*Adimensional*
REFERENCES	–
FIELD	**METHODS AND MONITORING STANDARDS**
INDICATOR ELABORATION	HPP Annual Energy Production / National Energy production
INDICATOR LIMITS	----
EVALUATION	The total NEI in Italy is equal to 288335 GWh (data origin: TERNA). The NEP values for the different alternatives are:
AVAILABLE UF	YES
UF	The Utility Function adopted is LINEAR growing (0 – 100%)

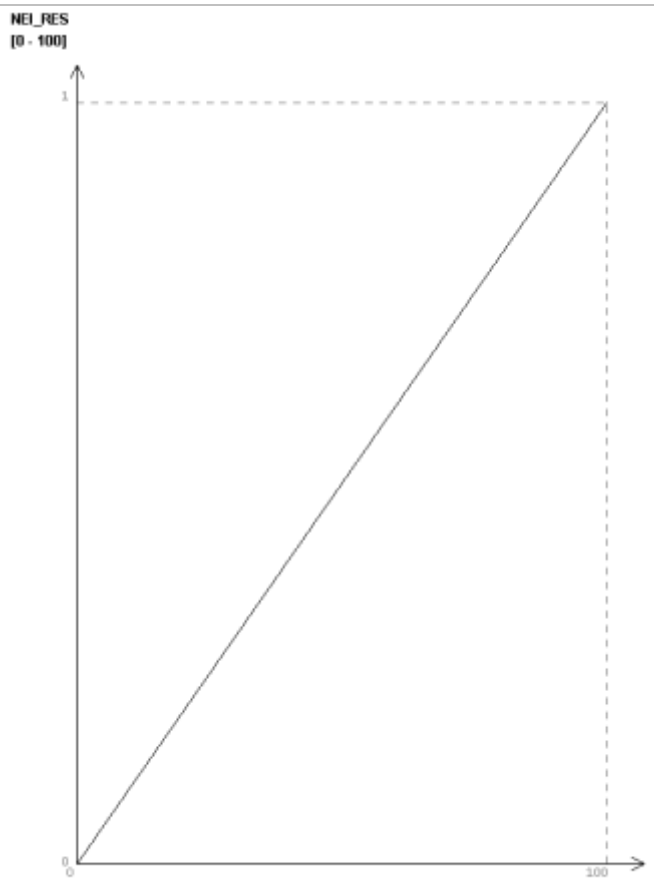
	NEI	%
ALT. 0	0.0000417	0.0042
ALT. 1	0.0000229	0.0023
ALT. 2	0.0000175	0.0017
ALT. 3	0.0000121	0.0012

	
SHARE RELATED IND.	-----
COUNTRY CODE	IT
WFD HER	INNER ALPS SOUTH
FIELD	**DATASOURCES**
DATA SOURCE	HP producer
TIME COVER	~ 10 ÷ 1
UPDATE FREQUENCY	annual
NUT III CODE	ITD32
NORMATIVE REFERENCE	EUROPEAN
NORMATIVE RELEVANCE	----
SHARE PILOT CASE STUDY	Astico

Astico tree | ENERGY | National RES energy improvement

FIELD	DESCRIPTION
INDICATOR NAME	Contribution of the considered HP if compared to the total national RES energy production
ACRONYM	*NresEI*
DPSIR	----
DESCRIPTION	This indicator expresses the contribution of the considered HP if compared to the total national energy production from RES
AIM	It measures the HPP imprtance in reaching the 2020 national objectives
KEY MESSAGE	The higher is the HPP importante, the higher has to be the weight given to energy production
MEASURE UNIT	*Adimensional*
REFERENCES	–
FIELD	**METHODS AND MONITORING STANDARDS**
INDICATOR ELABORATION	HPP Annual Energy Production / National RES Energy production
INDICATOR LIMITS	----
EVALUATION	The total NresEI in Italy is equal to 69329 GWh (data origin: TERNA). The NresEI values for the different alternatives are:
AVAILABLE UF	YES
UF	The Utility Function adopted is LINEAR growing (0 – 100%)

	NresEI	%
ALT. 0	0.0001735	0.017
ALT. 1	0.0000952	0.010
ALT. 2	0.0000728	0.007
ALT. 3	0.0000503	0.005

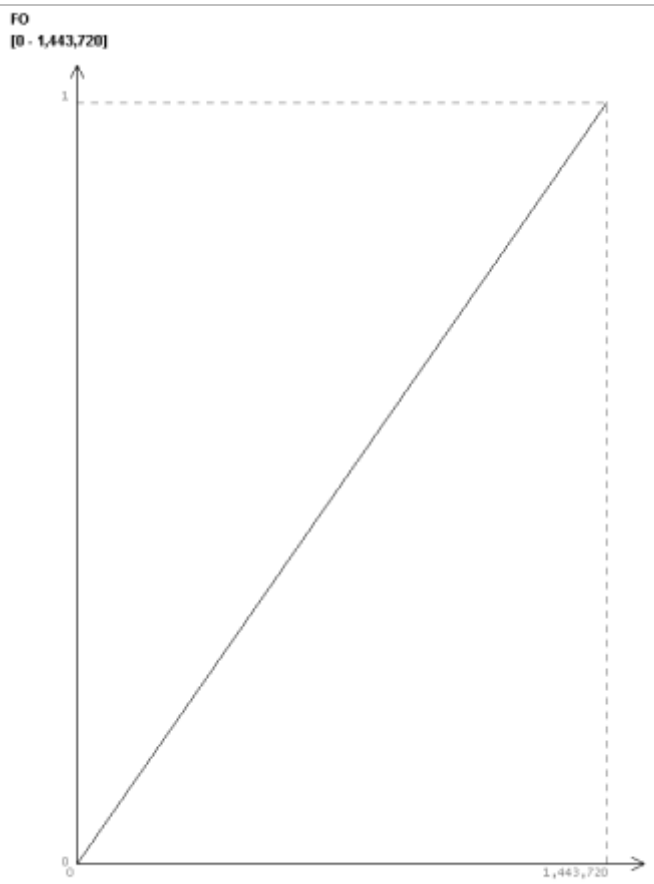
	
SHARE RELATED IND.	-----
COUNTRY CODE	IT
WFD HER	INNER ALPS SOUTH
FIELD	**DATASOURCES**
DATA SOURCE	HP producer
TIME COVER	~ 10 ÷ 1
UPDATE FREQUENCY	annual
NUT III CODE	ITD32
NORMATIVE REFERENCE	EUROPEAN
NORMATIVE RELEVANCE	----
SHARE PILOT CASE STUDY	Astico

- The second criterion called **HP PRODUCER ECONOMY** is here explained by the indicator:
HP producer level Financial Outcomes

Astico tree | HP PRODUCER ECONOMY | HP producer level Financial Outcomes

FIELD	DESCRIPTION
INDICATOR NAME	Financial outcomes and degree of satisfaction of HP producer
ACRONYM	*FO*
DPSIR	----
DESCRIPTION	This indicator furnishes an evaluation of financial outcomes and degree of satisfaction of HP producer related to the different management alternatives considered in the MCA
AIM	This indicator directly considers the producer aims that are mainly related to the economics outcomes
KEY MESSAGE	The financial outcomes are the main aim for investors involved in the HP production: financial conditions strictly shape the different management alternatives considered in the MCA
MEASURE UNIT	€
REFERENCES	–
FIELD	**METHODS AND MONITORING STANDARDS**
INDICATOR ELABORATION	The elaboration has to be shaped on a reasonable assessment on real financial outcomes variability
INDICATOR LIMITS	The economic outcomes of this indicators are related only to the HP producers and not to the territory or the region or the administrative unit
EVALUATION	Starting from the assumption that financial outcomes are of the order of 0.12 €/kWh, we obtain:
AVAILABLE UF	YES
UF	The Utility Function adopted is LINEAR growing (0 – 1 443 720 €)

	AEP	FO (€)
ALT. 0	12031	1 443 720
ALT. 1	6600	791 978
ALT. 2	5044	605 339
ALT. 3	3489	418 701

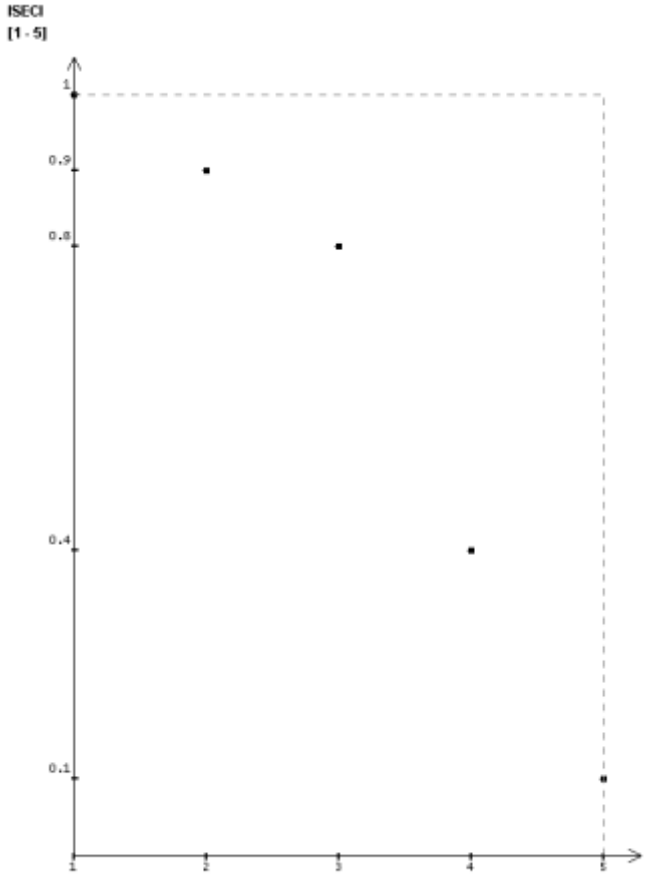
	
SHARE RELATED IND.	-----
COUNTRY CODE	IT
WFD HER	INNER ALPS SOUTH
FIELD	**DATASOURCES**
DATA SOURCE	HP producer
TIME COVER	~ 10 ÷ 1
UPDATE FREQUENCY	annual
NUT III CODE	ITD32
NORMATIVE REFERENCE	----
NORMATIVE RELEVANCE	----
SHARE PILOT CASE STUDY	Astico

- The third branch is **ENVIRONMENT**, which is divided into 2 sub-criteria:
  RIVER ECOSYSTEM: this sub-criterion is evaluated through specific indicators such as:
  - **Fish (ISECI, Quantitative Analysis)**
  - **Macrobenthos (IBE, MacrOper)**
  - **Macrophytes (IBMR)**

  GLOBAL ENVIRONMENT: sub-criterion evaluated through the indicator:
  - **National CO2 offset**

Astico tree | ENVIRONMENT – RIVER ECOSYSTEM | Fish - ISECI

FIELD	DESCRIPTION
INDICATOR NAME	Index of Ecological Status of Fish Communities
ACRONYM	*ISECI*
DPSIR	S – State indicator
DESCRIPTION	Naturalistic index based on the comparison between the expected ichthyic community and the condition of the indigenous populations sampled. In assessing the ecological status of fish, the ISECI index [Index of Ecological Status of the fish community] takes into account two main aspects: - the naturalness of the community, understood as the normal abundance of species represented by the presence of all those indigenous expected in relation to zoogeographic and ecological framework and the absence of alien species; - the good situation of indigenous species, understood as the ability to reproduce itself and have normal ecological-evolutionary dynamics. It is defined as an index of the ecological status of fish communities
AIM	The purpose of the Index of Ecological Status of the fish community, ISECI, is to assess the ecological status of fish fauna of a given stretch of river or stream, considering the natural fish community and the situation of indigenous fish community. Assessment of the state of the fish community with regard to its naturalness. It highlights the presence of allochthonous species. The aim of the ISECI index is to check the health of fish community, in particular the relationship between fish and hydromorphological conditions
KEY MESSAGE	The Index of Ecological Status of the fish community, ISECI, is based on 5 main indicators considering the different aspects shown below: 1. presence of indigenous species 2. biological condition of indigenous fish communities 3. indigenous populations with presence of ibrids 4. presence of allochthonous species 5. presence of endemic species Strenghts: simple index for the evaluation of the naturalness and biodiversity of the fish community Weaknesses: it is not an ecological index (presence of alloctonous species automatically attributes the worst class of quality, even if the ecological habitat is good and does not show any other impact) A good ecological status, sustained by a good hydromorphological status, should translate in a healthy fish community
MEASURE UNIT	N – quality index
REFERENCES	–
FIELD	**METHODS AND MONITORING STANDARDS**
INDICATOR ELABORATION	The methods for the indicator elaboration are available on the documents: Allegato 1 del Regolamento recante: "Criteri tecnici per la classificazione dello stato dei corpi idrici superficiali, per la modifica delle norme tecniche del decreto legislativo 3 aprile 2006, n. 152, recante norme in materia ambientale" "Zerunian S., 2009 – Adeguamento dell'Indice dello Stato Ecologico delle Comunità Ittiche alla Direttiva Quadro sulle Acque 2000/60/CE. (Sergio Zerunian, Andrea Goltara, Ileana Schipani, Bruno Boz). Biologia Ambientale, 23 (2): 1-16" This indicator uses a multimetric indices methodology, uses the presence/absence of reference species, in particular it is based on the presence/absence of indigenous fish species. The indicator consists in concrete measurments, but also expert estimation is needed to collect significative samples
INDICATOR LIMITS	The Ministerial Decree is on draft. There are not yet the reference communities

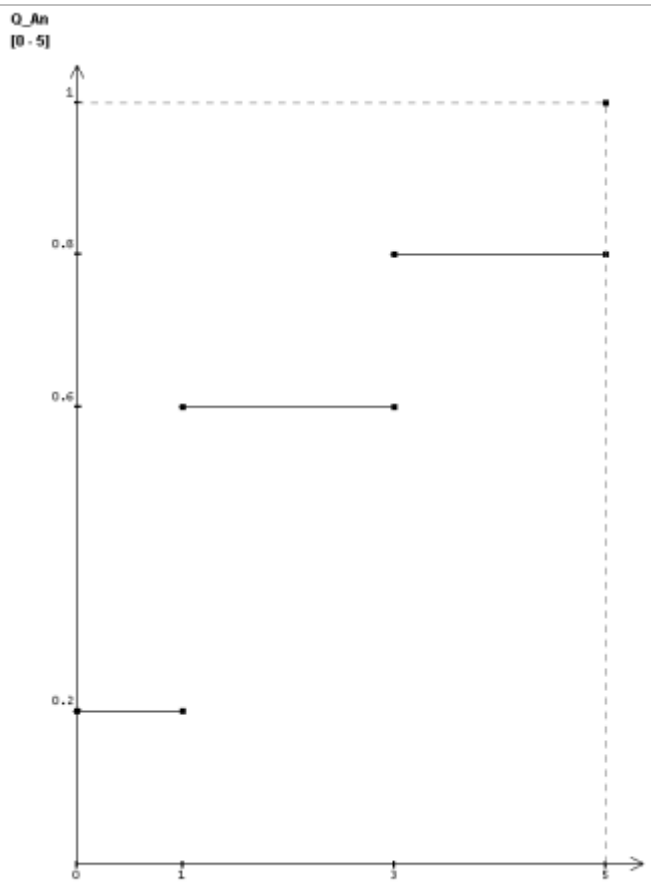
EVALUATION	The class values of ISECI for the different alternatives were defined starting from direct field surveys during summer and autumn 2011:  [table]
AVAILABLE UF	YES
UF	The utility function (UF) for the values normalization is SINGLE POINTS (1 - 5) decreasing 
SHARE RELATED IND.	Quantitative Analysis
COUNTRY CODE	IT
WFD HER	INNER ALPS SOUTH
FIELD	**DATASOURCES**
DATA SOURCE	Eaulogie s.r.l. per CVA trading PUBLIC: Research Institutes PRIVATE: Biology and Environmental Analysis Societies
TIME COVER	NONE
UPDATE FREQUENCY	TWICE A YEAR (low discharge and medium discharge periods)
NUT III CODE	ITD32

NORMATIVE REFERENCE	NATIONAL
NORMATIVE RELEVANCE	High
SHARE PILOT CASE STUDY	Astico

Astico tree | ENVIRONMENT – RIVER ECOSYSTEM | Fish – Quantitative Analysis

FIELD	DESCRIPTION
INDICATOR NAME	Index of Ecological Status of Fish Communities
ACRONYM	*Q_An*
DPSIR	S – State indicator
DESCRIPTION	This index considers the fish abundancy, regardless the species
AIM	The aim of this indicator is to evaluate river suitability for fishes, without considering the species origin (autoctone or alloctone)
KEY MESSAGE	A good ecological status, sustained by a good hydromorphological status, should translate in a healthy fish community
MEASURE UNIT	N – quality index
REFERENCES	–
FIELD	**METHODS AND MONITORING STANDARDS**
INDICATOR ELABORATION	number of elements recovered. Class values
INDICATOR LIMITS	----
EVALUATION	The class values for the different alternatives were defined starting from direct field surveys during summer and autumn 2011
AVAILABLE UF	YES
UF	The utility function (UF) for the values normalization is STEP (0 - 5) growing

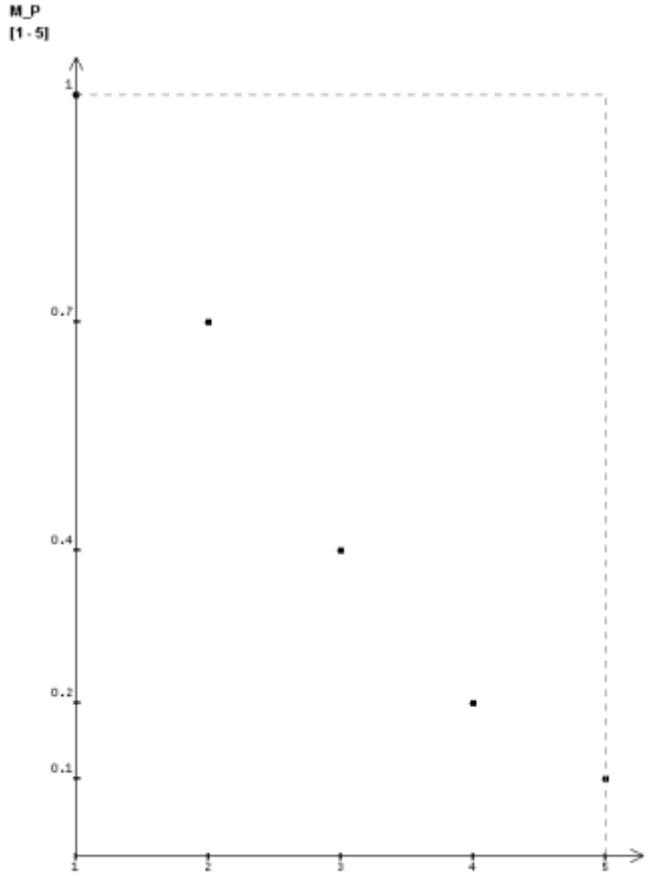
	Alt_0_Hystorical_Management_NO_DMV	Alt_1_Present_DMV	Alt_2_150%_Present_DMV	Alt_3_200%_Present_DMV
Quantitative_Analysis	3	4	4	3

	
SHARE RELATED IND.	ISECI
COUNTRY CODE	IT
WFD HER	INNER ALPS SOUTH
FIELD	**DATASOURCES**
DATA SOURCE	PUBLIC: Research Institutes PRIVATE: Biology and Environmental Analysis Societies
TIME COVER	~ 20 ÷ 1
UPDATE FREQUENCY	TWICE A YEAR (low discharge and medium discharge periods)
NUT III CODE	ITD32
NORMATIVE REFERENCE	NATIONAL
NORMATIVE RELEVANCE	----
SHARE PILOT CASE STUDY	Astico

Astico tree | ENVIRONMENT – RIVER ECOSYSTEM | Macrobenthos – MacrOper

FIELD	DESCRIPTION
INDICATOR NAME	Index of abundance of fish communities
ACRONYM	*MacrOper*
DPSIR	S – State indicator
DESCRIPTION	This method provides a quantitative sampling, capable of assessing the numerical abundance of biological communities and the application of methods that are standardized as possible, so as to maximize the comparability of results obtained by different operators. It is defined as an index of the ecological status and reasponse of biological communities of the river
AIM	The aim of the MacrOper is to make a diagnosis of the water quality in running water bodies. This diagnosis is based on the composition modification of macroinvertebrates communities, induce by pollutants or by significant physical alterations of river environment. In addition (with respect to IBE index) it takes into account also the habitat variance across the river cross- section
KEY MESSAGE	The key message is that macroinvertebrates oragsisms are sensitive to eco-system quality and changes, and can be used as an ecologic indicator. In addition (with respect to IBE index) it takes into account also the habitat variance across the river cross- section
MEASURE UNIT	N – quality index
REFERENCES	–
FIELD	**METHODS AND MONITORING STANDARDS**
INDICATOR ELABORATION	This indicator uses a multimetric indices methodology, uses the presence/absence of reference species (some macrobenthos are more sentitive to alterations). The indicator consists in concrete measurments, but also expert estimation is needed to collect significative samples
INDICATOR LIMITS	----
EVALUATION	class values of MacrOper for the different alternatives were defined starting from direct field surveys during summer and autumn 2011.
AVAILABLE UF	YES
UF	The utility function (UF) for the values normalization is SINGLE POINTS (1 - 5) decreasing

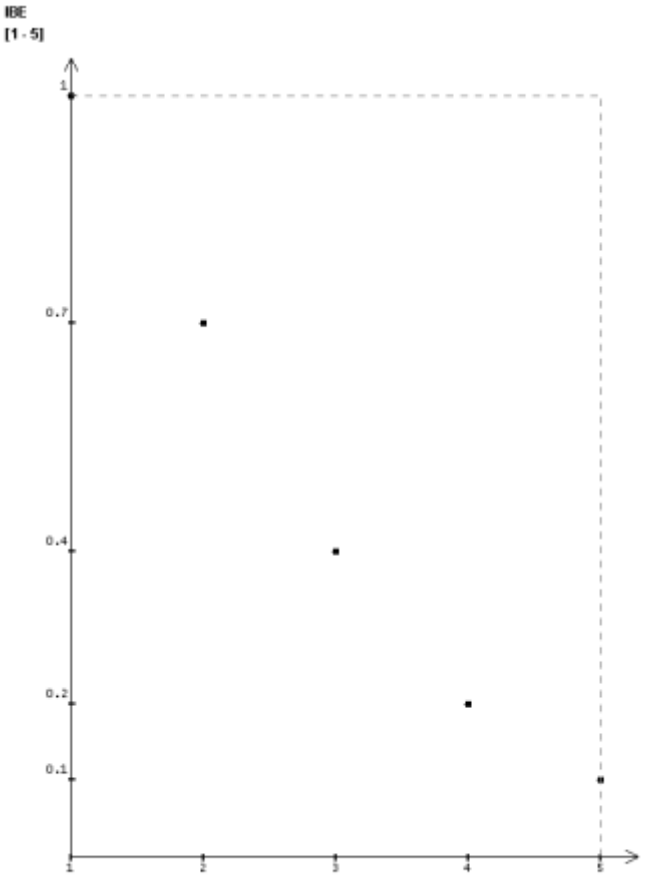
	Alt_0_Hystorical_Management_NO_DMV	Alt_1_Present_DMV	Alt_2_150%_Present_DMV	Alt_3_200%_Present_DMV
MacrOper	1	2	2	2

	
SHARE RELATED IND.	IBE
COUNTRY CODE	IT
WFD HER	INNER ALPS SOUTH
FIELD	**DATASOURCES**
DATA SOURCE	PUBLIC: Research Institutes PRIVATE: Biology and Environmental Analysis Societies
TIME COVER	NONE
UPDATE FREQUENCY	EVERY SEASON (4 times in a year)
NUT III CODE	ITD32
NORMATIVE REFERENCE	NATIONAL
NORMATIVE RELEVANCE	High
SHARE PILOT CASE STUDY	Astico

Astico tree | ENVIRONMENT – RIVER ECOSYSTEM | Macrobenthos – IBE

FIELD	DESCRIPTION
INDICATOR NAME	Index of abundance of fish communities
ACRONYM	*IBE*
DPSIR	S – State indicator
DESCRIPTION	Index based on the analysis of the composition of the benthic macroinvertebrate community, considering its diversity and the sensitivity of the different systematic units considered. The index appraises how the present macroinvertebrates community is far from the attended one. The method is conceptually based on a comparison between the composition of the "present" macroinvertebrate community in a particular stretch of river and composition of the "expected" community
AIM	This indicator expresses a assessment of the presence of pollutants with regards to the effects on macrobenthos and a quality judgment of a river environment on the base of the macroinvertebrates community composition modifications, induced from factors of pollution of the waters and the sediments or from meaningful physical and morphological alterations of the bankfull. The aim of the IBE Index is to make a diagnosis of the water quality in running water bodies. This diagnosis is based on the composition modification of macroinvertebrates communities, induce by pollutants or by significant physical alterations of river environment
KEY MESSAGE	This indicator allows to express judgments of quality in river environments on the base of the modifications in the macroinvertebrates community composition Strenghts: quick and consolidated index Weaknesses: only qualitative index, non WFD-complained. The key message is that macroinvertebrates oragsisms are sensitive to eco-system quality and changes, and can be used as an ecologic indicator
MEASURE UNIT	N – quality index
REFERENCES	–
FIELD	**METHODS AND MONITORING STANDARDS**
INDICATOR ELABORATION	It is carried out the semi-quantitative and taxonomic analysis of a benthos sample; a numerical value of the index is gotten that can be translated in five Classes of Biological Quality. The official methodology is described in APAT-IRSA CNR, 2003 To calculate this index, a table with two wntries is used. The first horizontal inlet is qualitative and shows the sistematic units from top to bottom, with a decreasing sensitivity to pollution. The second entry is vertical and regards the amount of sistematic units. The intersection between the horizontal and vertical input results in a number indicating the response of organisms communities to the quality of the water environment
INDICATOR LIMITS	The index is not applicable in transitional waters or in extreme situations. This index could be able to underestimate the pollution consequential from organic load. Low sensitivity to discharge changes
EVALUATION	The class values of IBE for the different alternatives were defined starting from direct field surveys during summer and autumn 2011.

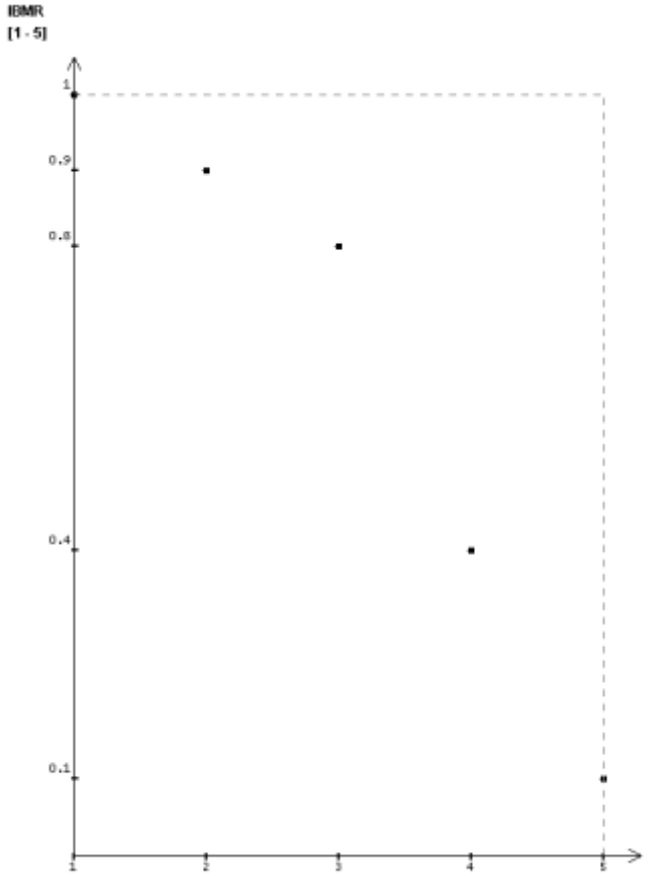
	Alt_0_Hystorical_Management_NO_DMV	Alt_1_Present_DMV	Alt_2_150%_Present_DMV	Alt_3_200%_Present_DMV
IBE	2	1	1	1

AVAILABLE UF	YES
UF	The utility function (UF) for the values normalization is SINGLE POINTS (1 - 5) decreasing 
SHARE RELATED IND.	MacrOper
COUNTRY CODE	IT
WFD HER	INNER ALPS SOUTH
FIELD	**DATASOURCES**
DATA SOURCE	PUBLIC: Environmental Agencies, Research Institutes, Provinces. PRIVATE: Biology and Environmental Analysis Societies
TIME COVER	~ 20 ÷ 1
UPDATE FREQUENCY	EVERY SEASON (4 times in a year)
NUT III CODE	ITD32
NORMATIVE REFERENCE	NATIONAL
NORMATIVE RELEVANCE	High
SHARE PILOT CASE STUDY	Astico

Astico tree | ENVIRONMENT – RIVER ECOSYSTEM | Macrophytes – IBMR

FIELD	DESCRIPTION
INDICATOR NAME	Index of abundance of river macrophytes
ACRONYM	*IBMR*
DPSIR	S – State indicator
DESCRIPTION	A new method to assess water trophy and organic pollution; Quality evaluation of the river
AIM	It is a trophic indicator, but it can be related to the overall ecological status of the community
KEY MESSAGE	Macrophtyes differently react to stress sources and are therefore part of ecological indicators
MEASURE UNIT	N – quality index
REFERENCES	–
FIELD	**METHODS AND MONITORING STANDARDS**
INDICATOR ELABORATION	This indicator uses a multi-metric indices methodology, uses the presence/absence of reference species, in particular it is based on the presence/absence of particular macrophytes species which are particularly sensitive to nitrates. The indicator consists in concrete measurements, but also expert estimation is needed to collect significative samples
INDICATOR LIMITS	Low pertinence
EVALUATION	The class values of IBMR for the different alternatives were defined starting from direct field surveys during summer and autumn 2011
AVAILABLE UF	YES
UF	The utility function (UF) for the values normalization is SINGLE POINTS (1 - 5) decreasing

	Alt_0_Hystorical_Management_NO_DMV	Alt_1_Present_DMV	Alt_2_150%_Present_DMV	Alt_3_200%_Present_DMV
IBMR	4	3	3	3

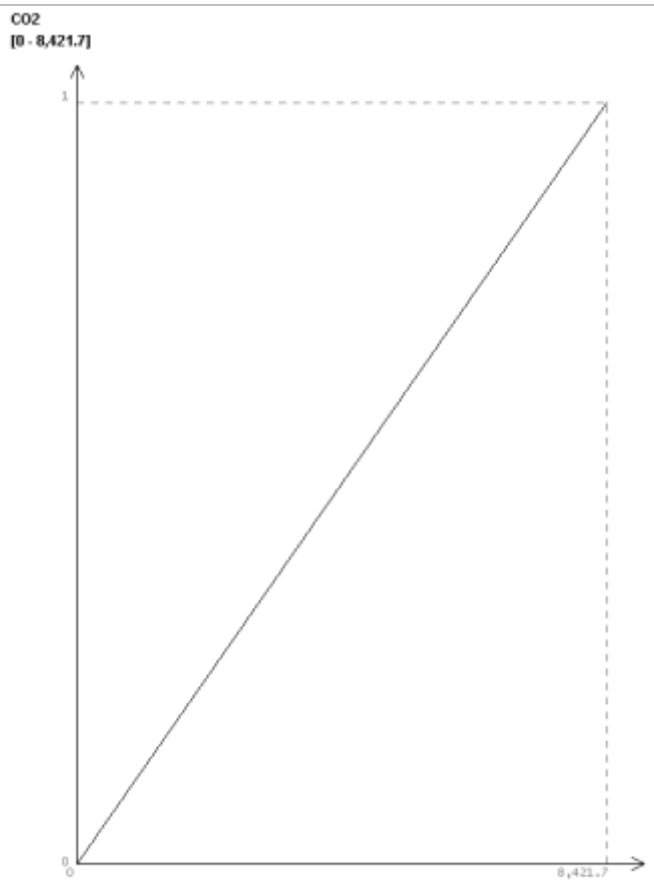
	
SHARE RELATED IND.	----
COUNTRY CODE	IT
WFD HER	INNER ALPS SOUTH
FIELD	**DATASOURCES**
DATA SOURCE	PUBLIC: Research Institutes PRIVATE: Biology and Environmental Analysis Societies
TIME COVER	NONE
UPDATE FREQUENCY	ONCE A YEAR (vegetative season)
NUT III CODE	ITD32
NORMATIVE REFERENCE	EUROPEAN
NORMATIVE RELEVANCE	High
SHARE PILOT CASE STUDY	Astico

Astico tree | ENVIRONMENT – GLOBAL ENVIRONMENT | National CO2 offset

FIELD	DESCRIPTION
INDICATOR NAME	Index of CO2 emissions reduction
ACRONYM	*CO2*
DPSIR	P – Pressures indicator
DESCRIPTION	This index express the contribution of this HPP to CO2 emissions reduction; CO2 reduction respect to other energy production typologies
AIM	This index expresses the contribution of this HPP to CO2 emissions reduction
KEY MESSAGE	The good status of the eco-system should translate in a good habitat presence for the biodiversity enrichment
MEASURE UNIT	kg
REFERENCES	–
FIELD	**METHODS AND MONITORING STANDARDS**
INDICATOR ELABORATION	----
INDICATOR LIMITS	----
EVALUATION	

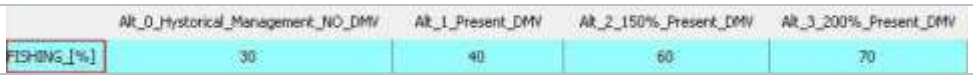
	AEP		CO2 reduction (g/kWh)	CO2 tot red (tonn/kWh)
ALT 0	12031	MWh/yr	700	8421.70
ALT 1	6600	MWh/yr	700	4619.87
ALT 2	5044	MWh/yr	700	3531.15
ALT 3	3489	MWh/yr	701	2445.91

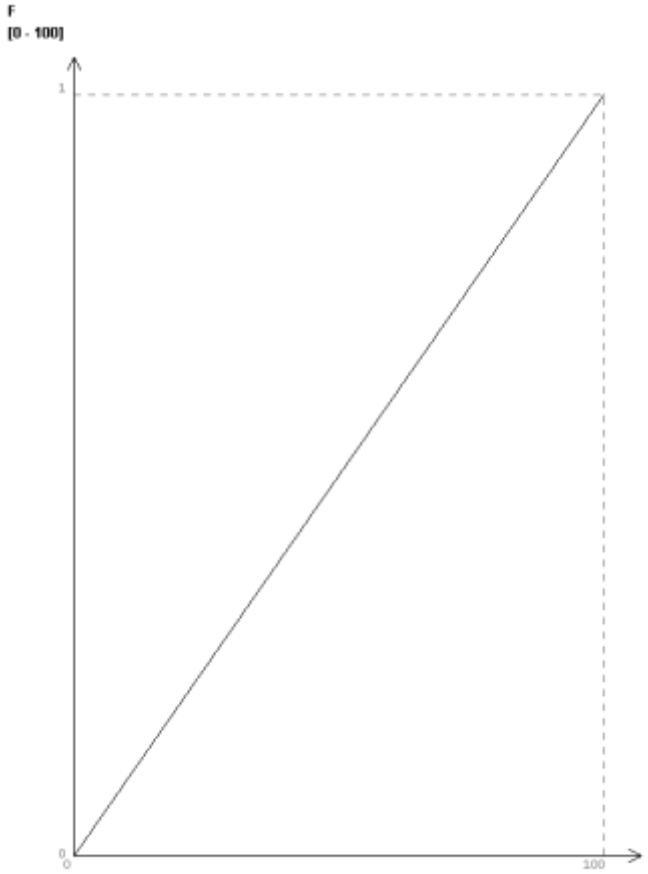
AVAILABLE UF	YES
UF	The utility function (UF) for the values normalization is LINEAR (0 – 8421.7 tonn/kWh) growing

	
SHARE RELATED IND.	----
COUNTRY CODE	IT
WFD HER	INNER ALPS SOUTH
FIELD	**DATASOURCES**
DATA SOURCE	PUBLIC: Environmental Agencies
TIME COVER	~ 10 ÷ 1
UPDATE FREQUENCY	Annual
NUT III CODE	ITD32
NORMATIVE REFERENCE	EUROPEAN
NORMATIVE RELEVANCE	Good
SHARE PILOT CASE STUDY	Astico

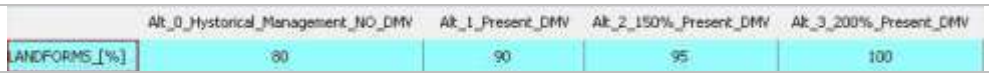
- The fourth criterion called **'SOCIAL CRITERIA'**, is divided in:
  RIVER FRUITION, evaluated through the indicator:
  - **Fishing**
  LANDSCAPE, evaluated through the indicator:
  - **Landforms**

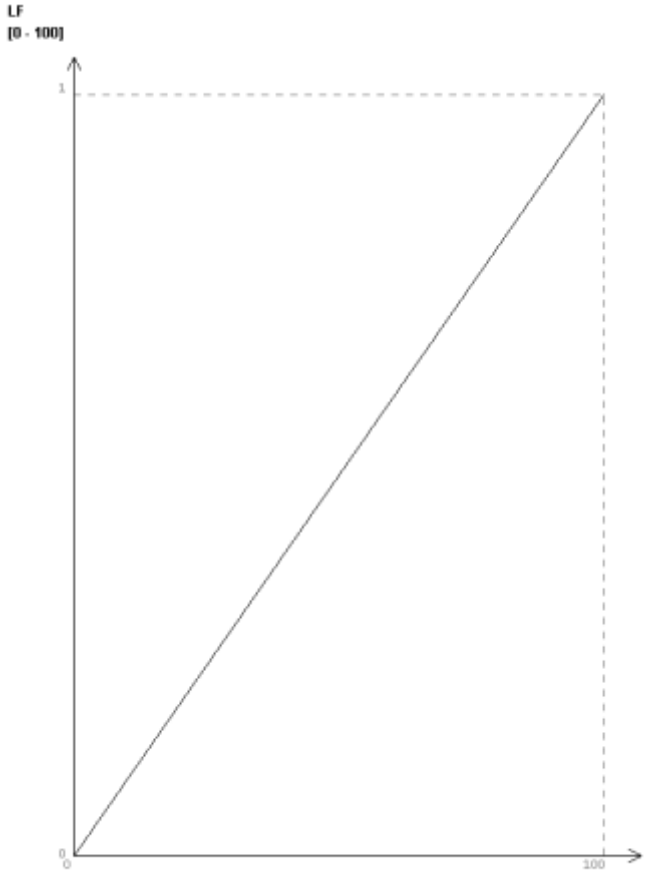
Astico tree | RIVER FRUITION | Fishing

FIELD	DESCRIPTION
INDICATOR NAME	----
ACRONYM	*F*
DPSIR	I – Impacts indicator
DESCRIPTION	Indicator giving the level pressure on water fishing uses due to HP activity
AIM	Fishing activity manteinance
KEY MESSAGE	----
MEASURE UNIT	€
REFERENCES	–
FIELD	**METHODS AND MONITORING STANDARDS**
INDICATOR ELABORATION	----
INDICATOR LIMITS	----
EVALUATION	
AVAILABLE UF	YES
UF	The utility function (UF) for the values normalization is LINEAR (0 – 100%) growing

	
SHARE RELATED IND.	----
COUNTRY CODE	IT
WFD HER	INNER ALPS SOUTH
FIELD	**DATASOURCES**
DATA SOURCE	----
TIME COVER	NONE
UPDATE FREQUENCY	----
NUT III CODE	ITD32
NORMATIVE REFERENCE	REGIONAL
NORMATIVE RELEVANCE	----
SHARE PILOT CASE STUDY	Astico

Astico tree | LANDSCAPE | Landforms

FIELD	DESCRIPTION
INDICATOR NAME	----
ACRONYM	*L*
DPSIR	S – States indicator
DESCRIPTION	Indicator evaluating the impact of HP on landscape of the territory
AIM	Reduction of landscape and environment impacts
KEY MESSAGE	----
MEASURE UNIT	%
REFERENCES	–
FIELD	**METHODS AND MONITORING STANDARDS**
INDICATOR ELABORATION	----
INDICATOR LIMITS	----
EVALUATION	
AVAILABLE UF	YES
UF	The utility function (UF) for the values normalization is LINEAR (0 – 100%) growing

	
SHARE RELATED IND.	----
COUNTRY CODE	IT
WFD HER	INNER ALPS SOUTH
FIELD	**DATASOURCES**
DATA SOURCE	PUBLIC: Environmental Agencies, Research Institutes, Provinces. PRIVATE: Biology and Environmental Analysis Societies
TIME COVER	NONE
UPDATE FREQUENCY	----
NUT III CODE	ITD32
NORMATIVE REFERENCE	EUROPEAN
NORMATIVE RELEVANCE	----
SHARE PILOT CASE STUDY	Astico

Weights assignment

The weights (W) assigned to the different criteria are shown in the following table.

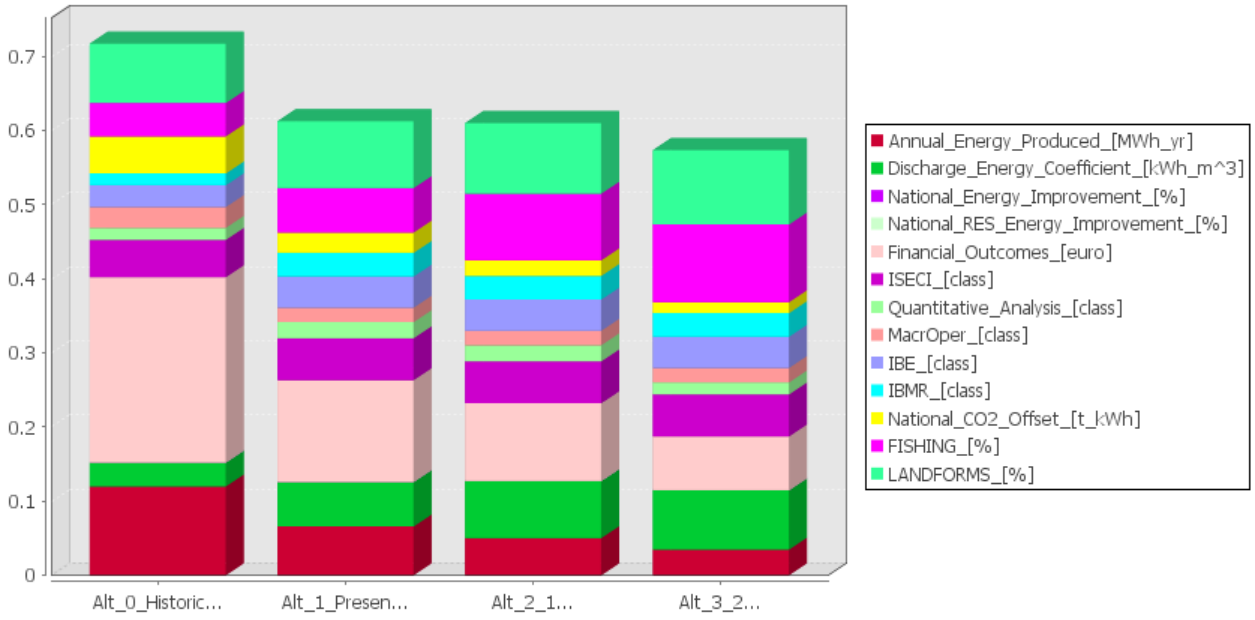
ASTICO TREE	CRITERIA	W	SUB-CRITERIA	W	INDICATORS	W	SUB-INDIC	W
	ENERGY	0.25	LOCAL	0.8	Annual en. produced	0.6		
					Discharge en. coefficient	0.4		
			GLOBAL	0.2	National en. improvement	0.3		
					National RES en. improvement	0.7		
	ECONOMY	0.25			Financial Outcomes	1.0		
	ENVIRONMENT	0.25	RIVER ECOSYSTEM	0.8	Fish	0.4	ISECI	0.7
							Quant. An.	0.3
					Macrobenthos	0.3	MacrOper	0.4
							IBE	0.6
					Macrophytes	0.2	IBMR	1.0
			GLOBAL ENVIRONMENT	0.2	National CO2 offset			1.0
	RIVER FRUITION	0.15			Fishing	1.0		
	LANDSCAPE	0.10			Landforms	1.0		

The weight value of 0.25 for the Environment Criterion was chosen according to the actual morphological river reach quality status calculated applying the ISPRA methodology. So, the morphological status can be considered as Status Indicator affecting the weight of the Environmental criterion. The channel Sub-reach 1 (Leda dam – Pilo bridge) is conditioned by the presence of the Leda dam, which leads to an interruption of the sediment transport and liquid discharges along the channel. Furthermore, even if the presence of small transversal works is not relevant, the strong reduction of the natural free sediment transport due to the dam and of the channel bed and section adjustment natural processes lead to a medium morphological quality status. Sub-reach 2 (Pilo bridge – Granatieri bridge) is influenced by the dam sediment interruption too; the presence of transversal works is negligible and don't affect strongly the sediment transport continuity, but longitudinal works are > 33% of the total banks length; the morphological status of the Sub-reach 2 is medium, according to IDRAIM (2011) method for river morphological quality evaluation. River ecosystem sub-criterion is the most important (0.8) inside the Environment criterion, and explaind by fish fauna, macroinvertebrates and macrophytes indicators.
Energy crietrium weighs the 25% of the whole tree, being the local energy more relevant than global energy sub-criterion. Financial outcomes (HP producer economy) weigh 0.25.
River fruition and Landscape criteria have a lower importance in the MCA, being the sum equal to 0.25. This is due to the characteristics of the river reach, poor of touristic elements, with the exception of fishing activity; the same is for Landscape, explained by landforms, which is not appreciable with the alternatives variations.

Evaluation of alternatives performance

Calculations have been made for three different Alternatives regarding SHP planning. The weights (importance) of the indicators for the Alternatives explaination are showed in the following graph and chart.

INDICATORS	ALT. 0 Until 2008 Management NO DMV	ALT. 1 Present DMV	ALT. 2 150% of present DM V	ALT. 3 200% of present DM V
Annual_Energy_Produced_[MWh]	0.120	0.082	0.088	0.081
Discharge_Energy_Coefficient_[kWh/m^3]	0.080	0.116	0.116	0.120
National_Energy_Improvement_[%]	0.015	0.016	0..15	0.016
National_RES_Energy_Improvement_[%]	0.035	0.036	0.036	0.036
Financial_Outcomes_[euro]	0.250	0.217	0.221	0.215
ISECI	0.063	0.075	0.071	0.071
Quantitative_Analysis	0.027	0.047	0.040	0.028
MacrOper	0.028	0.001	0.011	0.011
IBE	0.042	0.072	0.061	0.062
IBMR	0.040	0.080	0.065	0.066
National_CO2_Offset_[t_kWh]	0.050	0.009	0.016	0.008
Fishing [%]	0.150	0.165	0.172	0.180
Landforms [%]	0.100	0.113	0.112	0.116



The Alternatives performance gives a higher value (0.72) to the Alternative 0 (present management, no DMV), followed by the Alternative 1 (hydrological DMV equal to 1.0 m^3/s). The lowest value is that of Alternative 3 (0.57), characterized by the 200% of the actual DMV.

Alt_0_Historical_Management_NO_DMV	0.717
Alt_1_Present_DMV	0.613
Alt_2_150%_Present_DMV	0.61
Alt_3_200%_Present_DMV	0.573