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## A contingent valuation-multicriteria analysis case study on the taxonomy of three planning scenarios for a Coastal Zone of Sardinia (Italy)

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# A CONTINGENT VALUATION-MULTICRITERIA ANALYSIS CASE STUDY ON THE TAXONOMY OF THREE PLANNING SCENARIOS FOR A COASTAL ZONE OF SARDINIA (ITALY)

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## ABSTRACT

Research in the field of urban economics has defined methodologies to assess the degree of consensus of the local communities for policies that derive from land planning decisions. The *contingent valuation* methods, which are based on people's expressed thoughts and convictions, allow us on the one hand to evaluate their degree of consensus, and, on the other, to increase the level of public information and concern towards land planning policies. Undoubtedly, participation, concern, information and consensus must be deeply tied to each other in order to develop open processes, based on land planning policies, that generate consistency between the planning policies goals and the spatial organization of the city that the local communities would like to realize.

In this essay, a case study of contingent valuation is discussed, based on the dichotomous-choice-with-follow-up technique, to rank three planning scenarios concerning the reorganization of public services and infrastructure for outdoor recreation in the coastal zone of the town of Arbus. Through this technique, the three proposals are ranked with reference to the local community preferences and attitudes concerning a set of decision criteria. The weights of the decision criteria are defined considering the results of the contingent valuation application, and utilized in a multicriteria analysis, developed through the AHP (Analytical Hierarchy Process), in order to obtain two rankings of the proposed scenarios: the first ranking is based on the results of the contingent valuation application; the second ranking comes from the weights of the decision criteria derived from the local community preferences.

These two alternative rankings give the local planning context (the city administration, entrepreneurs of the profit and non-profit sectors, citizens, civic associations and committees, etc.) a comprehensive frame of the game rules of the decision-making processes, and a sound basis for discussing, recognizing and understanding their mutual convergences and conflicts. This would allow them to define an effective synthesis of their perceived needs, hopes and expectations for the future spatial organization of their city, in view of the implementation of the planning policies.

This essay has a marked methodological feature since a general framework- even if perfectible- which should bring near technical and common knowledge is defined in the practice of city planning. This is implemented through discussion and conflict mitigation concerning the relative importance (and weights) of the decision criteria. This should lead to a more-or-less extensive convergence on policy implementation within the city planning processes.

## 1. INTRODUCTION<sup>1</sup>

Multicriteria analysis (MCA)-based techniques represent a consolidated theoretical and practical framework to develop decision support systems and to improve the information quality for spatial planning policy-making and implementation, particularly if their effectiveness is strictly connected to the interaction of environmental, landscape, cultural, economic, social, preference, need and expectation-related processes of the local communities, as it happens in case they are referred to complex spatial contexts. The MCA procedures are generally based on the interaction, or dialectical cooperation (or conflict), of consultants, scientists, practitioners, officials, executives and politicians of the public administration, who identify criteria, weights and goals which should help make spatial planning processes informed and effective as much as possible.

The MCA approach is a natural reference point to compare planning options, even though significantly different from each other, since it is based on techniques which rely on more-or-less generally agreed-upon criteria and goals. With reference to this point, it is to be mentioned that the implementation rules of the Italian law on public works (*Regolamento di attuazione della legge quadro in materia di lavori pubblici* [Law enacted by decree of the President of the Republic] 554/1999) identify some of the most well-known MCA techniques as the methodologies “to calculate the most economically-advantageous bid” in tenders for contract (Articles 64 and 91, and Enclosure B).

On the one hand, the formal complexity of the MCA approach and the big problems which may arise when trying to involve the local communities in defining goals and criteria- often identified through the contribution of expert knowledge bearers only- make MCA an important tool to put together and manage the different and potentially conflictual points of view of public officials and executives, politicians, practitioners, scientists etc. involved in the definition and implementation of spatial plans and programs; on the other hand, complexity and problems make MCA almost totally useless to catalyze participation and interest of the local communities in identifying strategies, goals and criteria.

The methodological itinerary and the case study discussed in this essay recognize both the usefulness of the MCA approach and of the participation of the local communities for planning processes to be effective, especially if the local communities are part of these processes from their starting phases, which are the most strategic. This recognition asks for taking into consideration the inclusion of the strategic instances of the local communities in MCA applications. To work further in this direction, an attempt is made through a Contingent Valuation approach (CV), which reveals itself as particularly effective to promote integration of expert and common knowledge.

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<sup>1</sup> A first discussion of this case study is developed in the thesis of Selena Mascia, in the Program of the First Degree in Engineering for Environment and Territory, at the Faculty of Engineering of the University of Cagliari, Italy. This thesis, titled “Classificazione di scenari per la definizione dell’assetto della zona costiera del comune di Arbus basata su un approccio misto contingent valuation e analisi multicriteri” [A classification of scenarios for the spatial organization of the coastal zone of the city of Arbus based on a mixed approach contingent valuation and multicriteria analysis] was supervised by Corrado Zoppi. The thesis defense was held with the Graduation Committee of the First Degree Program in Engineering for Environment and Territory at the Faculty of Engineering, in June 2003. The thesis is available for consultation at the Sezione di Urbanistica del Dipartimento di Ingegneria del Territorio dell’Università di Cagliari, Italy [Urban Planning Section of the Department of Territorial Engineering, University of Cagliari, Italy].

This essay contains some of the most relevant results of the *Program of Relevant National Interest* on “Operative models of strategic environmental assessment to urban planning”, funded by the Italian Ministry of Education, University and Research, obtained by the Research Unit of the Program at the Urban Planning Section of the Department of Territorial Engineering, University of Cagliari (Scientific Responsible: Corrado Zoppi).

Through the CV approach, it is possible both to establish a connection between the degree of consensus (or disagreement) of the local communities with regard to planning policies at stake, and to link consensus to variables representing preferences, tastes, and social and economic conditions. As a matter of fact, the CV approach allows to:

- recognize and define a ranking of the planning options based on the degree of consensus of the local communities, which it is possible to compare to rankings generated through MCA applications;
- identify a ranking of the criteria identified by the public administration to assess the planning options based on the preferences of the local communities.

So, in this essay two rankings of three future planning scenarios for the coastal zone of Arbus, a city on the south-western coast of the island of Sardinia (Italy), are discussed: the first one is derived through the CV methodology named “DCFU” (dichotomous choice with follow-up) and the other through the MCA methodology named “AHP” (Analytical Hierarchy Process). In the latter, the criteria hierarchy is identified with reference to the local community preferences, through the results of the CV application.

This paper is organized as follows. In section 2, a general description of the coastal area of Arbus and of the three scenarios are presented. Research methodology and design are defined in section 3. The CV and MCA methodologies, used to define the rankings of scenarios, are discussed while paying particular attention to the peculiarity of this case study in relation to the connection of the criteria taxonomy and the outcomes of the CV estimates. Model specification is discussed and data sources for variables are summarized. Section 4 presents the results of the implementation of the CV and MCA methodologies applied to the Arbus coastal zone scenarios. Finally, Section 5 summarizes the indications and findings on CV and MCA integration as a promising way of dealing with the issue of how to take account of the local community visions when addressing complex problems of spatial planning. These indications and findings are particularly linked to the potential role of public and private subjects and their mutual relationship in designing and implementing urban planning processes and can be extended to urban planning practices in other countries.

## 2. THE COASTAL ZONE OF ARBUS AND ITS THREE FUTURE SCENARIOS

The town of Arbus is located in the southwestern coast of the island of Sardinia, bounded by the Sea of Sardinia to the south-west, by the territories of the towns of Guspini and Gonnosfanadiga to the east, and by the territory of the town of Fluminimaggiore to the south. In the territory of Arbus four of the one hundred and fourteen Sardinian *Sites of Community Importance* (SCI) are localized, which contribute to build the Nature 2000 Network together with the other Italian and European SCI, following the EU Directive 92/43 (the Habitat Directive). A SCI is “a site which, in the biogeographical region or regions to which it belongs, contributes significantly to the maintenance or restoration at a favourable conservation status of a natural habitat [...] or of a species [...] and may also contribute significantly to the coherence of Natura 2000 [...] and/or contributes significantly to the maintenance of biological diversity within the biogeographic region or regions concerned. For animal species ranging over wide areas, sites of Community importance shall correspond to the places within the natural range of such species which present the physical or biological factors essential to their life and reproduction” (Habitat Directive, Article 1, Indent k).

Two SCI define significantly the set of the most environmentally-important areas of the coastal zone of Arbus, that is *Piscinas* and *Da Piscinas a Riu Scivu* [From Piscinas to Scivu Creek]. These sites mark a ten-kilometer coastal line of the *Costa Verde* (the Green Coast), which extends, from south to north, between *Capo Pecora* [Sheep Cape], in the territories of the towns of Buggerru and Fluminimaggiore, and *Capo Frasca* [Leafy Branch Cape], in the territory of Arbus.

This coastal line is characterized by an area of about 3.000 hectares of sandy dunes- some of which are taller than 30 meters- which every year attract tourists and scholars from everywhere: this landscape looks somewhat like a desert, and, for this reason, this area is named “Sahara of Italy”.

The dunes are mirrored in the green, transparent sea, and extend more than two kilometers from the coast towards the interior, not far from the mine villages of *Ingurtosu* and Naracauli, amidst deserted galleries and trolleys which were once utilized for mineral transportation.

The wind regime of the Costa Verde is characterized by a strong wind from the northwest, which moulds over and over again the dunes amidst of which the juniper tree develops, and bends the trees. Important fauna species of community interest of the SCI of Piscinas include: the Sardinian deer, which has appeared again after long absence; the marine turtle; the common tortoise; the real eagle; the pilgrim hawk; the stone curlew; the goatsucker.

The landscape is characterized by uncontaminated nature which is integrated with the human signs left by the mine activities: houses, workshops, wells, galleries, and the mine village of *Ingurtosu*, which has been deserted since the 1970’s when the mines were closed. This settlement represents one of the world’s most important monuments of mine archaeology: the villa in Liberty Style, the houses of the miners, the old elevators, the church and the school, are plunged into a dreamland that dominates the sea of the *Costa Verde* and the dunes of Piscinas as a huge natural terrace.

An important project titled *Dune di Piscinas-Monte Arcuentu* [Dunes of Piscinas-Arcuentu Mountain] has been defined by the environmentalist association Legambiente with the cooperation of the Province of Cagliari, the city administrations of Arbus, Guspini and Gonnosfanadiga, and the XVIII Mountain Community of Sardinia, concerning the SCI of Piscinas, Da Piscinas a Riu Scivu, Capo Pecora and *Monte Arcuentu e Rio Piscinas* [Arcuentu Mountain and Piscinas Creek]. This project was funded by the program of the European Union “Life 1997”. Moreover, the four SCI are included in the Geomining, Historical and Environmental Park of Sardinia, where the villages of Ingurtosu and Montevecchio are also included<sup>2</sup>.

The implementation of the project *Dune di Piscinas-Monte Arcuentu* resulted in a *Management Plan* and an *Operational Plan*, which are available since January 1999. The Management Plan aims to:

- stop and possibly invert the ongoing deterioration processes of the natural resources;
- establish a regional natural park (according to the Articles 2 and 10 of the Law 31/1989 of the Italian Autonomous Region of Sardinia), which may include and connect the four SCI of the territory of Arbus;
- start an awareness, information, and scientific and cultural program to be implemented in cooperation between the team of the *Dune di Piscinas-Monte Arcuentu* project and similar management structures which operate in the Mediterranean area: the development of this program is essential for the success of the Life project and even more to build consensus of the local residents and of the scientific community on the establishment of the protected area;
- define ad-hoc guidelines to assess “Any plan or project not directly connected with or necessary to the management of the site [SCI] but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject

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<sup>2</sup> The Geomining, Historical and Environmental Park of Sardinia was established by the law enacted by decree of the Italian Ministry of the Protection of Environment and Natural Resources dated November 14, 2001. This Park has been officially recognized by UNESCO (Official Declaration of Paris, July 30, 1998) as the first park of the International Geosites/Geoparks Network established at the 29<sup>th</sup> UNESCO General Conference held in Paris from October 24 to November 12, 1997.

to appropriate assessment of its implications for the site in view of the site's conservation objectives” (Habitat Directive, Article 6, Paragraph 3).

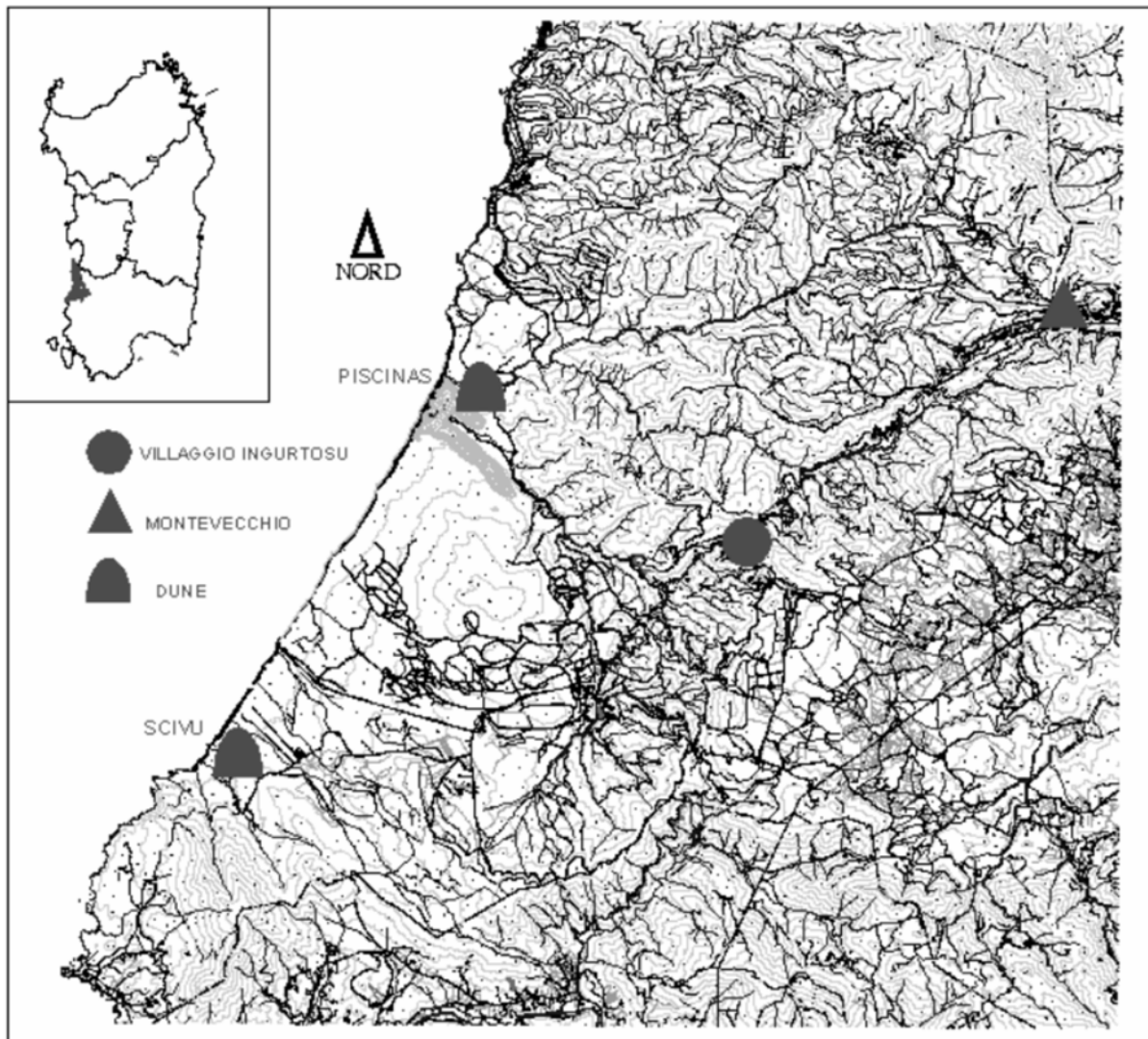


Figura 1. The Costa Verde, in the territory of Arbus, between Piscinas and Riu Scivu, with the location of the villages of Ingurtosu and Montevecchio (Source: Mascia, 2003)

Undoubtedly, in the light of the expressed wills of the local municipalities and of the XVIII Mountain Community of Sardinia, and fully accepted by the Province of Cagliari, even through the implementation of the Life project, it is possible that a regional natural park will be shortly established in the coastal line of Costa Verde which extends, from south to north, between the SCI of Piscinas and Da Piscinas a Riu Scivu. Three future scenarios concerning this park are described in the next sections.

### 2.1. First Scenario: Park as a Service Project

The first scenario, named “Park as a Service Project”, has the objective of implementing a spatial organization based essentially on the protection of the environmental resources in conservative terms, therefore not prejudicially opposed to transformation, but strongly motivated to assess carefully plans and projects likely to have significant effects on the Costa Verde in view of the site’s fragile ecological equilibria.

The scenario foresees the restructuring of the building which once housed the administrative department of the mine of *Montevecchio*, and which will become the *House of the Park*.

The House of the Park should also work as a center to provide information on the available services, to receive and address the requests of the visitors, and to manage the services provided by the park on the basis of their needs. The information service should also be provided telematically, through remote windows available in the towns of Arbus, Gonnosfanadiga and Guspini, and in the sites of the villages of Ingurtosu and Montevecchio, and of the settlements of *Torre dei Corsari* [Corsairs' Tower], Pistis and Funtanazza, located in the territory of the Park.

A *Center for Environmental Research* is foreseen in the village of Ingurtosu, where experimental scientific research and monitoring activities will take place. Seminars, courses and conferences will be held for experts in the environmental fields, and visiting researchers will be hosted in this center.

The analysis of the territory shows the presence of areas significantly polluted by heavy metals (lead, zinc, cadmium) coming from the past mine activities. For these areas an immediate intervention is definitely necessary. The most polluted areas are *Rio Irvi* [Irvi Creek], *Rio Roia Cani* [Roia Cani Creek], *Rio Naracauli* [Naracauli Creek] and Rio Piscinas. The research activity that will take place in the Center will provide a validated list of the animal and vegetal species to be protected, and identify the priorities for environmental restoration.

A *Center for Environmental Education* is also foreseen in the village of Ingurtosu whose main activities will consist in increasing awareness and education on environmental issues for different categories (pupils of the primary and high schools, citizens associations, tourist groups, etc.), and in organizing professional courses for environmental education operators.

A *Convention Center* is foreseen in the village of Montevecchio, which will be the reference point of the area for cultural events even if not directly connected with the Park.

A fundamental aspect of the environmental organization of this first scenario is the system of paths in the Park, that will be defined by the operators of the *Center for Environmental Research*, and set up with themes and activities, such as trekking, geological, riding, mountain-bike and archeological trails.

Moreover, it is necessary to repair the existing roads, that is, to restore the ditches, to secure the slopes, and to realize road-widening works to make it easier for vehicles to get around.

The wear coat of the road that connects the coastal area to the villages of Ingurtosu and Montevecchio will be completely restored to allow more comfortable access to the beach.

From the site of Casargiu, close to the village of Montevecchio, at the end of the asphalted road, an aerial railway, to be realized partly by restoring the old infrastructure once utilized in the mine activities for mineral transportation, and partly by a new section towards the coast, will lead to the village of Ingurtosu and the beach of Piscinas. This should favor the integration of internal and coastal areas, and of local and external spatial contexts.

This planning scenario defines a future situation in which reception facilities, as agricultural-tourist resorts, youth hostels and camping sites, will be available through reuse of the restored and revalorized mine villages. So, this scenario integrates policies that aim to push local economic and social development into environmental protection planning processes.

## 2.2. *Second Scenario: An Auto-organized Park*

The second scenario, named "An Auto-organized Park", implies a proactive role of the local community in building and implementing a new diversified local economic and social system, based on traditional productive activities. This park concept is tied to the idea of *hospitable town*, a town which is produced through integration of economies based on natural and anthropic processes, and the local community culture and traditions.

The spatial organization envisioned in this scenario is based on close cooperation between different levels of public administration, especially city administrations, urban planners, local

stakeholders, profit and non-profit firms, citizens, civic associations and committees, and so on.

The scenario objectives are strongly connected to each other and integrated into all the planning policies. These objectives are the following:

- de-seasonalization of tourist demand;
- public-private cooperation in natural environment and mine villages restoration;
- local community participation in defining, managing and implementing spatial planning policies.

Since one of the most important problems coming up with spatial and environmental analysis of the mine sites is represented by the presence of polluted areas, environmental restoration is a priority for the sites of Rio Irvi, Rio Roia Cani, Rio Naracauli and Rio Piscinas. Environmental restoration is also foreseen in the mine villages of Ingurtosu and Montevecchio, where a *Scientific Center* will be located to develop public-private joint research projects in the field of depuration of surface and artesian water-bearing stratum, in order to increase the supply of water for irrigation and domestic use. This implies the application of bioremediation, and phytodepuration systems, and of chemical and thermic treatments.

A part of the mine villages will be restored and utilized as tourist reception facilities or tourist landmarks, such as the Penal Camp of Is Arenas, the Seaside Camp of Funtanazza, and the archaeological, historical and industrial heritage sites.

Developing employment in the tourism sector will possibly reduce the unemployment rate in the towns of Guspini, Arbus and Gonnosfanadiga, which is higher than the average regional level. This could be achieved by building a few high-category hotels in the hilly areas around Arbus, some tourist villages close to the coast (a Valtur Village is already operative at Torre dei Corsari), and camping sites. New constructions will have to meet the requirement of not damaging the local natural and anthropic heritage.

The retail structure of the settlements of Torre dei Corsari, Pistis and Santadi will be strengthened to support the tourism development. Moreover, the existing paths will be restored to provide tourists with safe and fascinating excursion opportunities.

New outdoor recreation facilities are foreseen, such as the restored and renewed swimming pool of the Camp of Funtanazza.

Structuring sustainable spatial organization by land use planning and management implies the definition of policies for protection of the dunal system of Scivu-Piscinas and Monte Arcuentu, such as definition of an efficient monitoring service and of adequate number and locations of the park entrances. A particular attention must be devoted to policies for protection of the environmental dynamics of the dunes. For this reason, only light, removable seasonal structures will be allowed on the dunes, such as first-aid points, fast-food restaurants, restrooms, which in any case must not create problems for the dunal system. Frequent parking areas will be available along the coast, far enough from the dunes so that bad effects on beach users from noise and emission from vehicles will be minimized.

One of the major problems during the summer season is lack of water resources. On the other hand, floods are frequent in connection with intense rain events, especially during the winter season, because of insufficient capacity of the river basins. Floods occur in the valley-bottoms of *Fluminimannu* [Big River], *Rio Leni* [Leni Creek], *Rio Sitzerri* [Sitzerri Creek] and *Rio Montevecchio* [Montevecchio Creek], close to the river bank. A measure to address this problem is to set-up a water resource management system which compensates lack of water resources and flood peaks through a network of aquifers. This system should be based on agreements between the local cities which establish the possibility of shared utilization of water resources and infrastructure (for example, the city administrations of Arbus and Guspini could agree to share the basins of Donigani and Zerbino). The local water resource manage-



ment system will be based on: exploitation of the basins in the hilly areas; automatic control of water distribution infrastructure; treatment of waste waters from agriculture and industry in order to make available seasonal water supplies; definition of tools to support forecasting, prevention and management of emergency situations connected to lack of water resources.

From the point of view of energy supply, an expansion of the existing public electrical network is planned, which implies the closure of the ring that connects the villages of Montevecchio, Ingurtosu and Monte Arcuentu, and serves the tourist facilities and villages. Alternative energy production plants should be built and become operational in the short run under the provision of this planning scenario, such as aeolic generators along the windy slopes between the villages of Ingurtosu and Montevecchio, photovoltaic panels for domestic consumption in areas difficult to reach by the cabled electrical network, and solar installations. Moreover, it is planned to implement differentiated refuse collection, which should allow to make biomasses (marcs and husks) available for a new plant which will be located in the industrial zone of the town of Villacidro.

People's consultation and active participation into economic and cultural rearrangement of the mine corridor of *Montevecchio-Ingurtosu* are fundamental for this planning scenario. Fiscal and economic incentives to stimulate development of the local entrepreneurship will be provided together with training packages to improve the entrepreneurial capacity of the local community, and training programs will be implemented to form professional spatial planners who may contribute to increase the quality and the effectiveness of the planning process.

The road system will be articulated in two levels:

- the roads that connect the local settlements;
- the roads that connect the local settlements with the urban centers of regional or provincial importance.

The local community should contribute to set up a new and more efficient public transportation system, which should be perceived as a true alternative to private vehicles, especially to access difficult sites.

Since the road that flanks the mountain system of Monte Arcuentu, between the coast and the inland areas, is extremely winding, a less winding road will be built along a mule-track which at the moment cannot be travelled over.

Given that the not asphalted road that connects the town of Arbus to Piscinas, passing through the mine villages of Montevecchio and Ingurtosu, needs continuous maintenance, it will be covered with a wear coat of asphalt whose color will harmonize with the surrounding landscape. Moreover, Piscinas and Ingurtosu will be connected through the recovered mine railway, and through the aerial railway between Casargiu and Ingurtosu.

### *2.3. Third Scenario: A Park for Local Economic Development*

The third scenario aims to promote local economic development. Planning policies tend to maximize income and employment through the exploitation of natural and anthropic environmental resources. So, since tourism development assumes a peculiar importance as in the second scenario, it is necessary to set up an effective information campaign to promote the image of the Park as a fascinating and appealing place to spend a vacation.

A telematic service is foreseen to monitor the dunal system of Scivu-Piscinas and its surroundings. A *Center for Environmental Research* is foreseen as in the first scenario, with the same goals.

A radical strengthening of the transportation system is projected, through improvement of the existing road system (the road that flanks the mountain system of Monte Arcuentu will be widened), and through setting-up of a new collective transportation network whose nodes will be located in the internal zones of the country around the towns of Arbus, Guspini and Gonnosfanadiga, in the mine villages, and along the seashores (three electrical bus shuttles,

which, during Summer months, will provide a tourist service, and, in Winter, will be available for commuting workers and students).

The energy produced by the aeolic generator which will be built in the environmental corridor of Montevecchio will feed the batteries of the three bus shuttles equipped with forty seats.

The collective transportation network will be articulated in three lines:

- *Line 1*, which will connect the town of Arbus with the settlement of Funtanazza and the dunes of Piscinas;
- *Line 2*, which will directly connect Arbus with Piscinas;
- *Line 3*, which will directly connect Arbus with the dunes of Scivu.

The not asphalted road from Montevecchio to Ingurtosu is not taken into consideration because these bus shuttles would eventually be inadequate, due to road surface and excessive slope. Transportation fares will be unified into a daily ticket.

The old infrastructure leading to the village of Ingurtosu and the beach of Piscinas (7 km), once utilized in the mine activities for mineral transportation, will be restored, and a retail and restaurant center will be built in the dunal area of Ingurtosu.

From Montevecchio, it will be possible to reach the old Sanna Wash House through an aerial railway (6 km), which will be realized by restoring the old infrastructure once utilized for mineral transportation.

A tourist bus line (*Line 3*, from Arbus to the dunes of *Scivu*) will flank the mountain system Linas-Marganai-Arcuentu. Along its path services for tourists will be available, such as guided trekking, riding and mountain bike tours, which should eventually promote cultural and naturalistic tourism. These services could also be organized in the mine corridor of Montevecchio-Ingurtosu.

All the planning actions described above imply additional employment in the service and infrastructure management and maintenance, and professional education sectors.

Territorial analysis emphasizes serious water and energy supply shortages, which must be mitigated, if not eliminated, to implement durable medium and long run social and economic development strategies. So, in addition to the closure of the ring that connects the villages of Montevecchio, Ingurtosu and Monte Arcuentu, that will increase electrical energy supply, the installation of sixteen aeolic generators is foreseen between Ingurtosu-Montevecchio. In this way, it will be possible to produce 4 MW of electrical energy, that would serve about 500 users.

The installation of photovoltaic panels for domestic consumption in areas difficult to reach by the cabled electrical network is also foreseen. For these installations there is a public fund that finances up to 75% of the project cost.

One of the most relevant environmental problems is pollution from heavy metals (lead, zinc, cadmium) from past mine activities, particularly in the creeks of Rio Roia Cani, Rio Naraaculi and Rio Piscinas. To cope with this issue, phytodepuration treatments are planned, which consist in the use of particular plant species (especially *Phragmites australis* [common reed]), which absorb metals and, by doing so, reduce pollution concentration.

Public awareness is absolutely necessary to develop efficient use of water resources. There will be installations in newly built houses, which allow reuse of soap waters (from kitchen, washing machine, sink) for water-closets, and rain water accumulation for irrigation.

It is planned to implement differentiated refuse collection, which will imply various materials' recycling, such as paper, glass, plastic. Ecological islands will be available, where people will be able to find containers for different kinds of wastes, characterized by differentiated colors, shapes and dimensions. Ecological islands are public services and could be operated or managed by the city or by a private person or entity pursuant to a lease, contract, or other agreement with the city.

As in the case of the second scenario, it is planned to build a new plant to produce energy from biomass in the industrial zone of the town of Villacidro.

Forestry policies are very important for the implementation of this scenario, because of widespread erosion and washing away, mainly caused by frequent fires. Endemic flora will be re-introduced, which should allow to develop scientific education and research activities in the pharmaceutical and omeopathic fields, since some of the endemic shrubby and herbal species are relevant for these disciplines. Valuable arboreal species consistent with the local environment will also be introduced, such as the cork oak and the ilex, to favor development of wood cutting activities and craftsmanship.

A particular attention will be devoted to illumination of abandoned mine areas, implemented through yellow floodlights from below, which will emphasize buildings and features of the old settlements, in order to provide easy and comfortable access in evening and night, on condition that paths were restored and road signs laid out.

### 3. METHODOLOGY

The methodology consists of two steps. First, the degree of consensus on the three planning scenarios is assessed through a CV technique named “DCFU”, which provides a ranking of the three scenarios based on estimated willingness to pay for each of them, by means of a sample analysis referred to the resident households of the town of Arbus. Second, an AHP MCA application is implemented, where scenarios and criteria hierarchies are defined through the CV results.

A theoretical discussion of DCFU CV and AHP MCA techniques follows in the two sections below.

#### 3.1. Contingent Valuation

The implementation of the DCFU technique implies that people included in a random sample be asked if they would be willing to pay a given monetary amount, for example in the form of an annual tax, to benefit from the outcomes of the implementation of the planning policy to be evaluated. Then, the interviewed people are further asked if they would be willing to pay a monetary amount greater or smaller than the first one, depending on whether the answer was “yes” or “no”. León (1995) puts in evidence that a second inquiry may help increasing information on the interviewed people’s preferences, and efficiency of the estimates (Hanemann et al., 1991).

If the answer to the willingness-to-pay (WTP) question is “yes”, personal utility is perceived as greater if outcomes of the planning policy to be evaluated were available and a monetary amount was paid, than otherwise.

If this is the case, given

$$U(j, Y; S) = V(j, Y; S) + \varepsilon_j, \quad j=0,1,$$

where:  $U$  is personal utility;  $V$  is the expected value of  $U$ ,  $j$  is a dichotomous variable that is equal to 1 were the outcomes of the planning policy to be evaluated available and 0 otherwise,  $Y$  is annual household income,  $S$  is a vector of social characteristics,  $\varepsilon_j$  is a random variable, it follows that

$$U(1, Y - \Phi; S) \geq U(0, Y; S),$$

or

$$V(1, Y - \Phi; S) + \varepsilon_1 \geq V(0, Y; S) + \varepsilon_0,$$

where  $\Phi$  is the monetary amount an interviewed person is willing to pay for the implementation of the planning policy to be evaluated.

The probability of a “yes”,  $P_1$ , is given by the following expression:

$$P_1 = P[V(1, Y - \Phi; S) + \varepsilon_1 \geq V(0, Y; S) + \varepsilon_0] = P(\varepsilon_0 - \varepsilon_1 \leq \Delta V) = F_\tau(\Delta V),$$

where  $\tau = \varepsilon_0 - \varepsilon_1$ . This probability is equal to the value of the cumulative probability distribution of  $\tau$  at  $\Delta V$ , that is  $F_\tau(\Delta V)$ . Since the probability distribution of  $\tau$  can take whichever form consistent with the general rules of probability distributions, priors on this form are needed to implement estimates based on  $F_\tau(\Delta V)$ . In the literature, the priors assumed are usually the normal, logistic and Weibull distributions, and the derived models are named “Probit”, “Logit” and “Weibit”. For a basic discussion on these models see the relevant chapters of the Greene’s econometric manual (1993). Estimates implemented in this essay are based on a bivariate Probit model.

The functional form of  $\Delta V$  is specified as follows (León, cit.):

$$\Delta V(B) = \beta B + \alpha' C, \quad (1)$$

where  $\beta$  is a parameter,  $\alpha$  is a vector of parameters, and  $B$  is the monetary amount an interviewed person would pay had she answered “yes” to the question about her WTP.

If  $E$  is an interviewed person’s WTP, then:

$$F_\tau[\Delta V(B)] = P[\Delta V(B) \geq \tau] = 1 - G_E(B),$$

where  $G_E(B)$  is the value of the cumulative normal density of probability of  $E$  at  $B$ .

WTP can be calculated either with reference to the mean ( $M$ ) of the density of probability of  $E$ ,  $g_E$ , or with reference to the mean ( $MT$ ) or the median ( $MEDT$ ) of the normalized density of probability of  $E$  truncated at  $B = B_M$ ,  $g_{EN}$ . The mean of a density of probability function is more influenced by the tails than the median. Mean and median of the normalized density of probability of  $E$ , truncated at  $B = B_M$ , are calculated with reference to the density of probability of  $E$  truncated at the maximum value that  $E$  is supposed to take (*ibid.*).

$M$ ,  $MT$ , and  $MEDT$  are calculated as follows:

$$M = \int_{-\infty}^{\infty} B g_E(B) dB = \int_0^{\infty} [1 - G_E(B)] dB - \int_{-\infty}^0 G_E(B) dB,$$

$$MT = \int_{-\infty}^{B_M} B g_{EN}(B) dB = \int_0^{B_M} [1 - G_{EN}(B)] dB - \int_{-\infty}^0 G_{EN}(B) dB = \int_0^{B_M} \left[1 - \frac{G_E(B)}{G_E(B_M)}\right] dB - \int_{-\infty}^0 \frac{G_E(B)}{G_E(B_M)} dB =$$

$$= \int_0^{B_M} \frac{F_\tau[\Delta V(B)] - F_\tau[\Delta V(B_M)]}{1 - F_\tau[\Delta V(B_M)]} dB - \int_{-\infty}^0 \frac{1 - F_\tau[\Delta V(B)]}{1 - F_\tau[\Delta V(B_M)]} dB$$

$$\frac{F_\tau[\Delta V(MEDT)]}{[1 - F_\tau(\Delta V(B_M))]} = 0,5.$$

For DCFU applications, the estimates of parameters  $\alpha$  and  $\beta$  are implemented by solving the first-order maximization problem of the following log-likelihood function,  $\log(L)$ :

$$\log(L) = \sum_i \{ I_i^a \log[F_\tau(\Delta V(B_i^a))] + I_i(1 - I_i^a) \log[F_\tau(\Delta V(B_i)) - F_\tau(\Delta V(B_i^a))] + I_i^b(1 - I_i) \log[F_\tau(\Delta V(B_i^b)) - F_\tau(\Delta V(B_i))] + (1 - I_i)(1 - I_i^b) \log[1 - F_\tau(\Delta V(B_i^b))] \}, \quad (2)$$

where:  $I_i = 1$  if  $\Delta V(B_i) \geq \tau$  and  $I_i = 0$  if  $\Delta V(B_i) < \tau$ ,  $I_i^a = 1$  if  $\Delta V(B_i^a) \geq \tau$  and  $I_i^a = 0$  if  $\Delta V(B_i^a) < \tau$ , and  $I_i^b = 1$  if  $\Delta V(B_i^b) \geq \tau$  and  $I_i^b = 0$  if  $\Delta V(B_i^b) < \tau$ ;  $B_i^a, B_i$  are  $B_i^b$  are increased, initial, and decreased monetary amounts of DCFU questionnaire.

Empirical findings must be qualified with regard to potential distortion factors. Beyond problems connected to the implementation of econometric models, a particular attention must be

paid to the interviewed person's disposition and attitudes, and to the interaction between the interviewed person and the interviewer (Carson, 1991; Zoppi, 2003).

### *3.2. Multicriteria Analysis*

AHP technique provides a taxonomy of the planning scenarios, based on goals and criteria.

In the case study discussed in this paper, the hierarchical structure of the decision process, that is the process which provides the ranking of the scenarios, consists of three levels: the highest hierarchical level is represented by the general goal (GG). This goal is assumed to be "Setting-up a natural park which works as a model of a new urbanity consistent with the wants and needs of the local community". It has to be stressed that, before being taken as GG, this assumption, however reasonable, should have been discussed and verified through a negotiation process which should have involved public officials and executives, politicians, practitioners, scientists, citizens, entrepreneurs and so on. This has not been done because of limited financial resources available for this experiment. Nevertheless, there is no doubt that in planning practice MCA techniques are almost useless if goals and criteria are not established after maybe long and expensive negotiations between the involved stakeholders.

Second level is identified by criteria that specify contents and meanings of the GG. At third level there are the three planning scenarios, from now on labeled SC 1, SC 2 and SC 3.

Criteria are assumed to be the following:

- the coastal zone of Arbus should take a new tourist character (CRI 1);
- financial resources should be readily available (CRI 2);
- solidarity and cooperation should be boosted (CRI 3).

The scenarios ranking is based on the global weights which are calculated through the local weights of each level. These are determined with respect to the elements of the hierarchically preceding level. The procedure followed to compute global and local weights (Scarelli, 1997, 91-100) is described in the next section (3.2.1); the following section (3.2.2) contains a discussion on the methodological integration of MCA and CV with regard to the case study at stake.

#### 3.2.1. Local and Global Weights

The local weights come from the binary comparison of elements that belong to the same level with respect to the elements of the hierarchically preceding level. Therefore, scenarios are binarily compared with each other with respect to each of the three criteria; criteria are binarily compared with each other with respect to the GG.

The result of each binary comparison can be expressed quantitatively by means of Saaty Semantic Scale (SSS, the pairwise comparison scale, see Figure 2) (Saaty, 1988)

<i>Intensity of Importance</i>	<i>Definition</i>	<i>Explanation</i>
1	Equal importance	Two elements contribute equally to the property
3	Moderate importance of one over another	Experience and judgment slightly favor one element over another
5	Essential or strong importance	Experience and judgment strongly favor one element over another
7	Very strong importance	An element is strongly favored and its dominance is demonstrated in practice
9	Extreme importance	The evidence favoring one element over another is one of the highest possible order of affirmation
2,4,6,8	Intermediate values between the two adjacent judgments	Compromise is needed between two judgments
Reciprocals	When activity i compared to j is assigned one of the above numbers, then activity j compared to i is assigned its reciprocal	
Rationals	Ratios arising from forcing consistency of judgments	

Figure 2. Saaty semantic scale (Saaty, cit., p. 78)

Moreover, the following modalities are defined for each of the criteria, which help improve the identification of binary comparisons results in the SSS:

- for CRI 1: natural and built environment protection with no change; territorial transformations which aim exclusively to restore and valorize environment, buildings, infrastructure; more or less radical territorial transformations;
- for CRI 2: available financial resources are: mostly public; mostly private; almost mixed;
- for CRI 3: cooperative attitudes: will possibly be developed; are unlikely to be developed.

Procedure to calculate the scenarios local weights, given the results of the CV estimates, consists of the following steps.

1. Given that:

- for each scenario SC i (i=1, 2, 3) the average WTP,  $M_i$ , is known from the CV estimates;
- for each modality,  $MP_{ijk}$  (where i indicates the scenario (i=1, 2, 3), j indicates the criterion (j=1, 2, 3) and k indicates the modality (k=2, 3 if j=1, 2; k=2 if j=3)), the differential marginal effect on the average WTP,  $MARG_{ijk}$ , is known from the CV estimates;

a normalized value,  $NORM_{ijk}$ , is defined as follows, upon which is based the calculation of the weight of modality k of CRI j relative to SC i:

- $NORM_{ij1}=100$ ;
- $NORM_{ijk}=100+100*MARG_{ijk}$ , where: k=2, 3 if j=1, 2; k=2 if j=3.

2. The weight of SC i relative to modality k of CRI j,  $PR_{ijk}$ , is defined as follows:

- $PR_{ijk}=M_i * [(1/\sum_{k=1,2,3} NORM_{ijk}) * NORM_{ijk}]$ , if j=1, 2;
- $PR_{ijk}=M_i * [(1/\sum_{k=1,2} NORM_{ijk}) * NORM_{ijk}]$ , if j=3.

3. In this way, nine relative weights are defined for CRI 1 and CR 2, and six for CRI 3. In order to utilize SSS for binary comparisons of the three scenarios, the following taxonomy based on thresholds is defined, where thresholds are calculated with reference to mean (M) and standard deviation (S) of the relative weights:

- lowest threshold (a “very low” value):  $M-S$ ;
- second threshold (a “significantly low” value):  $M-0,9*S$ ;
- third threshold (a “low” value):  $M-0,6*S$ ;
- fourth threshold (a “weakly low” value):  $M-0,3*S$ ;

- fifth threshold (a “medium” value):  $M+0,3*S$ ;
- sixth threshold (a “weakly high” value):  $M+0,6*S$ ;
- seventh threshold (a “high” value):  $M+0,9*S$ ;
- eighth threshold (below: a “significantly high” value; over: a “very high” value):  $M+S$ .

Scores from 1 to 9 are assigned to each interval, starting from the interval corresponding to the lowest threshold. Binary comparisons are based on the absolute value of the difference of the scores of scenarios increased by one unit. Each binary comparison (three for each criterion) results in a positive integer number from 1 to 9, which identifies a value of “intensity of importance” of the binary comparison in the SSS. The intensity of importance of binary comparison of SC  $i$  ( $i=1, 2, 3$ ) with respect to SC  $n$  ( $n=1, 2, 3$ ) for CRI  $j$  ( $j=1, 2, 3$ ) is indicated as  $RAPP_{inj}$  from now on. The matrix of the  $RAPP_{inj}$ 's is indicated as  $SCEN_j$  ( $j=1, 2, 3$ ) from now on.

4. A vector  $v_{ij}$  ( $i=1, 2, 3$ ) is derived from  $SCEN_j$  as follows:

$$v_{ij} = \sqrt[3]{\prod_{n=1}^3 RAPP_{inj}} .$$

Finally, the local weights of the scenarios with respect to CRI  $j$ ,  $P_{ij}$  ( $i=1, 2, 3$ ), are calculated as follows:

$$P_{ij} = v_{ij} / \sum_{k=1,2,3} v_{kj} .$$

Vector  $P_j$  ( $P_{1j}, P_{2j}, P_{3j}$ ) is the vector of local weights of the scenarios with respect to CRI  $j$ .

The technique described above, called the “principal eigenvector method” (Fusco Girard and Nijkamp, 1997), since the  $v_{ij}$ 's are approximately the principal components of the eigenvector of matrix  $SCEN_j$ , can be applied seemingly to calculate the local weights of CRI 1, CRI 2 and CRI 3, relative to the GG,  $\Pi_k$  ( $k=1, 2, 3$ ), as follows.

1. Given that:

- for each scenario SC  $i$  ( $i=1, 2, 3$ ) the average WTP,  $M_i$ , is known from the CV estimates;
- for each scenario SC  $i$  ( $i=1, 2, 3$ ), the differential marginal effect on the average WTP of CRI  $j$  ( $j=1, 2, 3$ ),  $MARG_{ij}$ , is known from the CV estimates;

a normalized value,  $NORM_{ij}$ , is defined as follows, upon which is based the calculation of the weight of CRI  $j$  relative to SC  $i$ :

- $NORM_{i3}=100$ ;
- $NORM_{ik}=100+100*MARG_{ik}$ , where  $k=1, 2$ .

2. The relative weight of CRI  $j$ ,  $PR_j$ , and the weight of CRI  $j$  relative to SC  $i$ ,  $PR_{ji}$ , is defined as follows:

- $PR_j = \sum_{i=1,2,3} \{M_i * [(1/\sum_{k=1,2,3} NORM_{ik}) * NORM_{ij}]\}$ ,  $j=1,2,3$ ;
- $PR_{ji} = M_i * [(1/\sum_{k=1,2,3} NORM_{ik}) * NORM_{ij}]$ ,  $j=1,2,3$ ,  $i=1,2,3$ .

3. So, nine relative weights of CRI  $j$ 's relative to SC  $i$ 's are defined, which make it possible to calculate thresholds based on mean and standard deviation as before, and, by doing so, to implement binary comparisons of criteria with reference to SSS. The intensity of importance of binary comparison of CRI  $k$  ( $k=1, 2, 3$ ) with respect to CRI  $j$  ( $j=1, 2, 3$ ) (with respect to the GG) is indicated as  $RAPP_{kj}$  from now on. The matrix of the  $RAPP_{kj}$ 's is indicated as  $CRIT$  from now on.

4. A vector  $V_k$  ( $k=1, 2, 3$ ) is derived from  $CRIT$  as follows:

$$V_k = \sqrt[3]{\prod_{n=1}^3 RAPP_{kn}} .$$

Finally, the local weights of the criteria with respect to the GG,  $\Pi_k$  ( $k=1, 2$  o  $3$ ), are calculated as follows:

$$\Pi_k = V_k / \sum_{i=1,2,3} V_i .$$

Vector  $\Pi$  ( $\Pi_1, \Pi_2, \Pi_3$ ) is the vector of local weights of the criteria with respect to the GG. The global weights of the scenarios with respect to the GG,  $PG_i$  ( $i=1, 2$  o  $3$ ), are calculated by the vectors  $P_j$ 's and  $\Pi$  as follows:

$$PG_i = \sum_{k=1,2,3} P_{ik} * \Pi_k, \quad i=1,2,3.$$

### 3.2.2. Integration of CV and MCA

MCA AHP technique is essentially based on identification and definition of the taxonomy of three planning scenarios concerning the coastal zone of Arbus, based on a multi-level hierarchy, where the weights of elements at each level directly influence those of elements at the immediately higher level, and, by doing so, indirectly influence the weights of the elements at the other higher levels. In this case study, there are three levels: general goal, criteria ad scenarios. The taxonomy of the scenarios depends on each scenario's impacts on criteria, and on each criterion's impact on the general goal. Local weights which express priorities are defined with reference to each scenario's impacts on criteria, and to each criterion's impact on the general goal. These local weights are calculated through binary comparisons of scenarios and criteria implemented by means of Saaty semantic scale.

So, the crucial point of AHP technique is represented by the value judgments that found binary comparisons, which, in the case study under discussion, are based on the relative preferences of the local community derived from the marginal effects on WTP which are part of the results of the DCFU estimates. The reason for this contamination of AHP with DCFU is that the effectiveness and success of planning policies, that is the effectiveness and success of each planning scenario concerning the coastal zone of Arbus, heavily depends on how the local community of Arbus will behave during the policy implementation. In other words, the more local residents are in favor of a planning scenario, the more it is likely to be successful. So, priorities and weights of criteria and scenarios do not come from advices and thoughts expressed by scientists, politicians, public administration officials etc.. Instead, they are expression of the local community as a whole, or, at least, of that share of the local community whose people are interested to the future scenarios concerning the coastal zone between Piscinas and Riu Scivu. This point is critical to identify the connection between MCA and CV approaches, and the importance of their integration.

The local weights of the scenarios, that is the components of vectors  $P_j$  ( $j=1, 2$  o  $3$ ), are calculated by taking account of average WTP for each scenario which derives from the CV estimates, and of a scale of values normalized with reference to mean and standard deviation of the relative weights  $PR_{ijk}$ , which come from criteria and modalities. Computation of these relative weights is based on differential marginal effects on the average value of WTP of the relative preference for a criterion modality with respect to the others, also estimated through the CV DCFU application.

Seemingly, local weights of criteria, that is the components of vectors  $\Pi$  ( $\Pi_1, \Pi_2, \Pi_3$ ), are calculated by taking account of average WTP for each scenario which derives from the CV estimates, and of a scale of values normalized with reference to mean and standard deviation of the relative weights  $PR_{ji}$ , which come from criteria and scenarios. Computation of these relative weights is based on differential marginal effects on the average value of WTP of the relative preference for a criterion with respect to the others, also estimated through the CV DCFU application.

Preferences of the local community introduced in the implementation of AHP-based taxonomy through the CV estimates play a decisive role in the ranking of the scenarios, since they are a reference point for binary comparisons, and for the computation of local and global weights of the scenarios and criteria.

Finally, it must be stressed that the ranking procedure discussed so far does not disregard the role of the public administration (practitioners, officials, executives and politicians) who set



up the framework of scenarios, criteria and goals, which found and are the starting point of the decision process, as it will be furtherly discussed in the conclusion section of this paper.

#### 4. DATA AND VARIABLES

A random sample of residents of the town of Arbus is extracted by means of the association of a random number to each name listed in the phone list. A random sample of 746 people was extracted in order to obtain a sample of 210 people willing to cooperate, which means that the rate of cooperation was less than 1 out of 3,55. Only 263 people explicitly refused to cooperate, while 251 did not answer the phone call through which they would have been asked to cooperate in the CV experiment, and 22 people refused to cooperate when they were asked to answer a questionnaire during a second phone call, once they had accepted to cooperate in the first place.

People included in the sample received a first phone call to ask them if they were willing to cooperate. If a person gave her availability, an envelop was sent her containing an informational report on the three scenarios. The person was asked to read carefully this report, which would have been the informational basis to answer a questionnaire which would have been submitted through a further call, after about two weeks from the first.<sup>3</sup>

The questionnaire is submitted through a second call instead of being sent in the envelope containing the informational report for two reasons. First, by doing so the moment the interviewed person acquires information is totally separate from the moment she gives her answers. Second, the interviewed person can clarify through a direct contact with the interviewer doubts and misunderstandings she may possibly have on the meaning and informational goals of the submitted questions. So, the questionnaire is submitted to people who are informed on the goals of the planning scenarios, instead of being submitted to people who read an informational report aimed uniquely at filling in a form whose questions she had already known before reading the report, so that she could have been previously led to increase her information just at finding some politically correct answers.

Following the method proposed by Cooper (1993), and applied by Zoppi (2003), a pre-test was implemented in order to establish the most suitable bids to be asked in the WTP question of the questionnaire (see Section 3.1).

The pre-test results in an optimal number of bids equal to 3 for each scenario, and in the following monetary values (in Euro), follow-up's and per-bid number of people, listed by scenario:

1. SC 1 and SC 2: bids: 10 (follow-up: 3 and 20), 30 (follow-up: 15 and 50), and 50 (follow-up: 35 and 70); interviewed people: 18 for the first bid (10 and follow-up's), 34 for the second bid (30 and follow-up's), 18 for the third bid (50 and follow-up's);
2. SC 3: bids: 5 (follow-up: 2 and 15), 15 (follow-up: 5 and 25), and 30 (follow-up: 15 and 50); interviewed people: 18 for the first bid (5 and follow-up's), 34 for the second bid (15 and follow-up's), 18 for the third bid (30 and follow-up's).

WTP for the scenarios is estimated through the CV DCFU methodology discussed in Section 3.1. B explanatory variable of Model (1) is the bid derived from the pre-test<sup>4</sup>. The explanatory variables of vector C of Model (1) are listed and defined in Table 1. Descriptive variables are reported in Table 2.

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<sup>3</sup> Report and questionnaire are available upon request.

<sup>4</sup> Questions concerning WTP have the following form (two possible answers: "yes" or "no"): "In case the city administration needed funds for the management of the park, would you be willing to pay a contribution of 10/30/50 [SC 1 and SC 2] or 5/15/30 [SC 3] Euro in the form of an annual tax? If the answer is "yes", would you be willing to pay 20/50/70 [SC 1 and SC 2] or 15/25/50 [SC 3] Euro? If the answer is "no", would you be willing to pay 3/15/35 [SC 1 and SC 2] or 2/5/15 [SC 3] Euro?"

<i>BID</i>	Monetary bid, Euro					
<i>AGE</i>	Age of the interviewed person					
<i>SEX</i>	Dummy- Sex of the interviewed person (1 if it is male)					
<i>FAM3</i>	Dummy- Three-people family					
<i>FAM4</i>	Dummy- Four-people family					
<i>FAM5</i>	Dummy- Five-or-more-people family					
<i>FAM-14</i>	Dummy- People under the age of 14					
<i>EMPL</i>	Dummy- White or blue collar, retailer, craftsman					
<i>HOUWI</i>	Dummy- Housewife					
<i>PROF</i>	Dummy- University professor, practitioner, executive, manager					
<i>RETIR</i>	Dummy- Retired person					
<i>GRAD</i>	Dummy- University graduate					
<i>HISCH</i>	Dummy- High school graduate					
<i>MANMIX</i>	Dummy- Preference for mixed public-private park management					
<i>MANPRI</i>	Dummy- Preference for private park management					
<i>INC1020</i>	Dummy- Annual household disposable income between 10.000 and 20.000 Euro					
<i>INC20</i>	Dummy- Annual household disposable income greater than 20.000 Euro					
<i>ICNO</i>	Dummy- No information about household disposable income					
<i>CR1B</i>	Dummy- Preference for planning policies with low environmental impacts. This is the second modality of CRI 1					
<i>CR1C</i>	Dummy- Preference for planning policies with significant environmental impacts. This is the third modality of CRI 1					
<i>CR12B</i>	Dummy- Preference for policies implemented by the private sector. This is the second modality of CRI 2					
<i>CR12C</i>	Dummy- Preference for policies implemented through public-private cooperation. This is the third modality of CRI 2					
<i>CR13A</i>	Dummy- The interviewed person has a positive attitude to cooperation. This is the first modality of CRI 3					
<i>CR11</i>	Dummy- Preference for CRI1					
<i>CR12</i>	Dummy- Preference for CRI2					

Table 1 Variables used in the model

Scenario 1			Scenario 2			Scenario 3		
Variable	Mean	Std. dev.	Variable	Mean	Std. dev.	Variable	Mean	Std. dev.
<i>BID</i>	30,11	18,27	<i>BID</i>	29,25	16,54	<i>BID</i>	16,95	12,01
<i>AGE</i>	53,80	13,91	<i>AGE</i>	50,39	14,55	<i>AGE</i>	49,87	12,42
<i>SEX</i>	0,51	0,50	<i>SEX</i>	0,37	0,49	<i>SEX</i>	0,46	0,50
<i>FAM3</i>	0,19	0,39	<i>FAM3</i>	0,24	0,43	<i>FAM3</i>	0,29	0,46
<i>FAM4</i>	0,29	0,46	<i>FAM4</i>	0,34	0,48	<i>FAM4</i>	0,33	0,47
<i>FAM5</i>	0,13	0,34	<i>FAM5</i>	0,14	0,35	<i>FAM5</i>	0,19	0,39
<i>FAM-14</i>	0,14	0,35	<i>FAM-14</i>	0,26	0,44	<i>FAM-14</i>	0,23	0,42
<i>EMPL</i>	0,54	0,50	<i>EMPL</i>	0,41	0,50	<i>EMPL</i>	0,46	0,50
<i>HOUWI</i>	0,17	0,38	<i>HOUWI</i>	0,31	0,47	<i>HOUWI</i>	0,26	0,44
<i>PROF</i>	0,24	0,43	<i>PROF</i>	0,27	0,45	<i>PROF</i>	0,27	0,45
<i>RETIR</i>	0,27	0,45	<i>RETIR</i>	0,39	0,49	<i>RETIR</i>	0,34	0,48
<i>GRAD</i>	0,10	0,30	<i>GRAD</i>	0,09	0,28	<i>GRAD</i>	0,10	0,30
<i>HISCH</i>	0,34	0,48	<i>HISCH</i>	0,19	0,39	<i>HISCH</i>	0,26	0,44
<i>MANMLX</i>	0,10	0,30	<i>MANMLX</i>	0,17	0,38	<i>MANMLX</i>	0,23	0,42
<i>MANPRI</i>	0,26	0,44	<i>MANPRI</i>	0,21	0,41	<i>MANPRI</i>	0,19	0,39
<i>INC1020</i>	0,26	0,44	<i>INC1020</i>	0,31	0,47	<i>INC1020</i>	0,33	0,47
<i>INC20</i>	0,14	0,35	<i>INC20</i>	0,17	0,38	<i>INC20</i>	0,20	0,40
<i>ICNO</i>	0,10	0,30	<i>ICNO</i>	0,10	0,30	<i>ICNO</i>	0,11	0,32
<i>CR1B</i>	0,67	0,47	<i>CR1B</i>	0,77	0,42	<i>CR1B</i>	0,73	0,45
<i>CR1C</i>	0,17	0,38	<i>CR1C</i>	0,14	0,35	<i>CR1C</i>	0,20	0,40
<i>CR2B</i>	0,13	0,34	<i>CR2B</i>	0,17	0,38	<i>CR2B</i>	0,09	0,28
<i>CR2C</i>	0,57	0,50	<i>CR2C</i>	0,57	0,50	<i>CR2C</i>	0,64	0,48
<i>CR3A</i>	0,61	0,49	<i>CR3A</i>	0,67	0,47	<i>CR3A</i>	0,43	0,50
<i>CR1</i>	0,33	0,47	<i>CR1</i>	0,33	0,47	<i>CR1</i>	0,20	0,40
<i>CR2</i>	0,41	0,50	<i>CR2</i>	0,30	0,46	<i>CR2</i>	0,27	0,45

Table 2 Descriptive statistics on variables used in the bivariate probit model

People interviewed about the SC 1 show a prevailing preference for CRI 2 (41%), while a lower preference is given to CRI 1 (33%) and CRI 3 (26%). Outcomes are different for SC 2, since the prevailing preference goes to CRI 3 (37%), with respect to CRI 1 (33%) and CRI 2 (30%). Finally, the majority of people interviewed about the SC 3 give their preference to CRI 3 (53%), while the importance of CRI 1 relative to CRI 2 is the same as for SC 1.

Outcomes concerning the criteria modalities are quite consistent with each other:

- the most preferred modality of CRI 1 is “territorial transformations which aim exclusively to restore and valorize environment, buildings, infrastructure” (67% of the people interviewed on SC 1 prefer this modality, 77% in case of SC 2 and 73% in case of SC 3);
- the most preferred modality of CRI 2 is “available financial resources are: almost mixed” (57% of the people interviewed on SC 1 prefer this modality, 57% in case of SC 2 and 64% in case of SC 3); the preference for exclusive public investment is second (30%, 26% and 25%); finally, there is low trust in exclusive private initiative (13%, 17% e 11%);
- the most preferred modality of CRI 3 is “cooperative attitudes will possibly be developed” for people interviewed on SC 1 and SC 2 (61% and 67%), while the people interviewed on SC 3 show the opposite (57%).

## 5. EMPIRICAL RESULTS

### 5.1. Contingent Valuation

Estimates on WTP (mean and median) are developed by the “Bivariate” procedure of the econometric program “Limdep” (Greene, 1995).

The bivariate probit model gives estimates of

- coefficients of variables that maximize the likelihood function (2) connected to the cumulative probability distribution  $F_{\tau}(\Delta V)$ , where  $\Delta V$  is expressed by (1);
- marginal effects on average WTP of B and of the variables of vector C of (1) (Zoppi, cit.).

In most cases, the marginal effects on WTP of B and C variables (at the average sample values) result significant at 5% (Table 3).

	SC 1			SC 2			SC 3		
	Model: $\Delta V(B)=\beta B + \alpha'C$			Model: $\Delta V(B)=\beta B + \alpha'C$			Model: $\Delta V(B)=\beta B + \alpha'C$		
Variable	Marginal effect	z statistic	Hypothesis test: marginal effect=0	Marginal effect	z statistic	Hypothesis test: marginal effect=0	Marginal effect	z statistic	Hypothesis test: marginal effect=0
BID	-0,023	-376,206	0,000	-0,029	-475,931	0,000	-0,033	-1073,838	0,000
AGE	-0,051	-171,362	0,000	0,003	18,664	0,000	0,011	40,846	0,000
SEX	-0,246	-2,736	0,006	-0,719	-14,683	0,000	-0,244	-5,041	0,000
FAM3	0,148	0,461	0,645	-0,382	-10,456	0,000	0,109	2,122	0,034
FAM4	-0,346	-2,468	0,014	-0,670	-16,144	0,000	0,333	6,367	0,000
FAM5	-0,137	-1,557	0,119	-0,588	-7,455	0,000	0,153	2,157	0,031
FAM-14	0,792	13,110	0,000	0,581	15,831	0,000	0,179	2,595	0,009
EMPL	0,348	4,326	0,000	0,788	7,328	0,000	0,141	1,740	0,082
HOUWI	0,785	0,742	0,458	0,766	4,918	0,000	-0,028	-0,293	0,769
PROF	0,644	0,792	0,428	0,450	2,521	0,012	-0,264	-0,131	0,896
RETIR	0,126	0,105	0,916	-0,269	-1,680	0,093	-0,707	-0,351	0,726
GRAD	0,108	0,137	0,891	0,098	0,589	0,556	-0,277	-0,126	0,900
HISCH	0,830	0,836	0,403	0,707	2,497	0,013	-0,706	-0,339	0,735
MANMLX	0,294	2,649	0,008	0,668	20,952	0,000	0,022	0,332	0,740
MANPRI	0,198	1,301	0,193	-0,270	-4,204	0,000	0,159	2,831	0,005
INC1020	0,429	4,144	0,000	-0,059	-1,289	0,197	0,341	3,744	0,000
INC20	-0,493	-1,201	0,230	0,151	2,585	0,010	0,407	5,159	0,000
ICNO	-0,687	-2,551	0,011	1,202	10,372	0,000	0,648	5,138	0,000
CRJ1B	0,465	7,062	0,000	-0,296	-5,875	0,000	-0,485	-3,116	0,002
CRJ1C	0,174	1,850	0,064	-0,655	-5,755	0,000	-0,285	-1,457	0,145
CRJ2B	-0,064	-0,233	0,816	0,644	12,169	0,000	0,408	2,825	0,005
CRJ2C	-0,485	-3,988	0,000	-0,305	-8,735	0,000	0,451	7,795	0,000
CRJ3A	0,446	8,039	0,000	0,321	18,606	0,000	-0,192	-5,763	0,000
CRJ1	-0,058	-0,464	0,643	0,664	25,812	0,000	-0,271	-2,714	0,007
CRJ2	-0,234	-2,667	0,008	-0,270	-9,090	0,000	0,161	3,047	0,002

Table 3 Results of the bivariate probit model

The marginal effects of variable B are 0,023 (SC 1), 0,029 (SC 2) and 0,033 (SC 3). This indicates that WTP is quite inelastic with respect to the bid. Elasticity is comparatively higher in case of SC 3. A marginal effect of 0,023, 0,029 or 0,033 implies that WTP will decrease by 0,023, 0,029 or 0,033 Euro if the bid increases by one Euro. A low elasticity generally signals little responsiveness to bid increases, so it reveals a certain willingness to accept bid

increases as long as expectations on the beneficial outcomes of the scenarios are perceived likely to be fulfilled.

The coefficients of the modality and criterion variables allow to calculate the local weights of the scenarios with respect to each of the criteria and the local weights of the criteria with respect to the general goal. This procedure founds the AHP ranking of the scenarios on the preferences expressed by the community of the town of Arbus.

The estimates of the bivariate probit model imply values of per-household WTP which put in evidence significant consensus on the three planning scenarios (Table 4): about 26 Euro for SC 1; about 19 Euro for SC 2; about 16,5 Euro for SC 3.

As a consequence, total WTP's of the community of the town of Arbus (2.568 households<sup>5</sup>) for each of the scenarios are the following: about 66.800 Euro for SC 1; about 48.800 Euro for SC 2; about 42.400 Euro for SC 3, which correspond to present values (million Euros) of 2,45, 1,79 and 1,55, at 2,5% interest rate and at a useful life of 100 years.

So, the interviewed people's answers indicate that the local community of the town of Arbus is comparatively more favorable to a "Park as a Service Project" (SC 1) than to an "Auto-organized Park" (SC 2), and to a "Park for Local Economic Development" (SC 3). Moreover, the second scenario is slightly preferred to the third.

#### **Scenario "Park as a Service Project"**

Average willingness to pay (normal distribution)	25,953
Average willingness to pay (distribution truncated at 80 €)	25,897
<u>Median willingness to pay (distribution truncated at 80 €)</u>	<u>25,977</u>

#### **Scenario "Auto-organized Park"**

Average willingness to pay (normal distribution)	19,137
Average willingness to pay (distribution truncated at 80 €)	19,128
<u>Median willingness to pay (distribution truncated at 80 €)</u>	<u>19,140</u>

#### **Scenario "Park for Local Economic Development"**

<u>Average willingness to pay (normal distribution)</u>	<u>16,416</u>
<u>Average willingness to pay (distribution truncated at 80 €)</u>	<u>16,416</u>
<u>Median willingness to pay (distribution truncated at 80 €)</u>	<u>16,416</u>

Table 4 Per-household average and median willingness to pay (Euro)

### 5.2. Multicriteria analysis

The results of the implementation of the AHP method defined in Section 3.2 are reported below.

Table 5 contains the normalized values,  $NORM_{ijk}$  (i index is for scenarios, j is for criteria, k is for modalities), of the differential marginal effect on the average WTP for scenario i of modality k of criterion j. Differential marginal effects are estimated through the CV DCFU application.

Table 6 reports the normalized values,  $NORM_{ij}$ , of the differential marginal effect on the average WTP for scenario i of the preference for criterion j. These differential marginal effects are also estimated through the CV DCFU application.

<sup>5</sup> This data is taken from Table 3 of the 2001 Italian Census Survey on Population and Houses, whose provisional data are available on the Internet site of the Italian National Institute of Statistics (Istituto nazionale di STATistica, ISTAT). The address is the following: [http:// dawinci.istat.it/ daWinci/ jsp/ prTavola.jsp? tav=030& liv=4& ua=092& sep=0& ist=0](http://dawinci.istat.it/daWinci/jsp/prTavola.jsp?tav=030&liv=4&ua=092&sep=0&ist=0) on Internet.

Modality	Scenario 1			Scenario 2			Scenario 3		
	Criterion 1	Criterion 2	Criterion 3	Criterion 1	Criterion 2	Criterion 3	Criterion 1	Criterion 2	Criterion 3
1	0,2748	0,3977	0,4087	0,4880	0,2994	0,4308	0,4483	0,2591	0,5530
2	0,4025	0,3975	0,5912	0,3434	0,4923	0,5691	0,2311	0,3648	0,4469
3	0,3226	0,2048	*	0,1684	0,2081	*	0,3206	0,3759	*

\*Criteria 1 and 2 have three modalities; Criterion 3 has two

Table 5 Normalized values of the differential marginal effect on the average WTP for scenario i (i=1, 2, 3) of modality k (k=1, 2, 3) of criterion j (j=1, 2, 3)

Scenario 1			Scenario 2			Scenario 3		
Criterion 1	Criterion 2	Criterion 3	Criterion 1	Criterion 2	Criterion 3	Criterion 1	Criterion 2	Criterion 3
0,3478	0,2829	0,3693	0,4903	0,2150	0,2947	0,2521	0,4019	0,3460

Table 6 Normalized values of the differential marginal effect on the average WTP for scenario i (i=1, 2, 3) of the preference for criterion j (j=1, 2, 3)

The weights of the criteria modalities relative to each of the scenarios,  $PR_{ijk}$  (i index is for scenarios, j is for criteria, k is for modalities), allow to calculate the thresholds upon which binary comparisons of scenarios are based for each of the criteria with reference to SSS. Table 7 contains the  $PR_{ijk}$ 's; Table 8 reports binary comparisons in matrix form. The local weights of scenarios,  $P_{ij}$  (i index is for scenarios, j is for criteria), are listed in Table 9. These weights are derived from binary comparisons matrices through the procedure described in Section 3.2.

Modality	Scenario 1			Scenario 2			Scenario 3		
	Criterion 1	Criterion 2	Criterion 3	Criterion 1	Criterion 2	Criterion 3	Criterion 1	Criterion 2	Criterion 3
1	7,1289	10,3171	10,6025	9,4428	5,7934	8,3360	7,3593	4,2534	9,0780
2	10,4417	10,3119	15,3369	6,6448	9,5260	11,0121	3,7937	5,9886	7,3363
3	8,3689	5,3129	*	3,2585	4,0267	*	5,2630	6,1708	*

\*Criteria 1 and 2 have three modalities; Criterion 3 has two

Table 7 Relative weights of criteria modalities

<b>CRI 1</b>	<b>SC 1</b>	<b>SC 2</b>	<b>SC 3</b>		<b>CRI 2</b>	<b>SC 1</b>	<b>SC 2</b>	<b>SC 3</b>
<b>SC 1</b>	1	5	5		<b>SC 1</b>	1	3	4
<b>SC 2</b>	1/5	1	1		<b>SC 2</b>	1/3	1	2
<b>SC 3</b>	1	1/5	1		<b>SC 3</b>	1/4	1/2	1
		<b>CRI 3</b>	<b>SC 1</b>	<b>SC 2</b>	<b>SC 3</b>			
		<b>SC 1</b>	1	4	4			
		<b>SC 2</b>	1/4	1	1			
		<b>SC 3</b>	1	1/4	1			

Table 8 Binary comparisons of scenarios for each of the criteria

Criterion 1			Criterion 2			Criterion 3		
Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
0,72	0,14	0,14	0,62	0,24	0,14	0,66	0,17	0,17

Table 9 Local weights of scenarios

The weights of criteria relative to each of the scenarios,  $PR_{ij}$  ( $i$  index is for scenarios,  $j$  is for criteria), allow to calculate the thresholds upon which binary comparisons of criteria are based with reference to SSS. A binary comparison of two criteria indicates if and how much they differ from each other in the way they contribute to the general goal. Table 10 contains the  $PR_{ij}$ 's; Table 11 reports binary comparisons in matrix form. The local weights of criteria,  $\Pi_i$  ( $i=1,2,3$ ), are listed in Table 12. These weights are derived from binary comparisons matrices through the procedure described in Section 3.2. Finally, Table 13 contains the global weights of scenarios,  $PG_i$  ( $i=1,2,3$ ).

Criterion 1			Criterion 2			Criterion 3		
Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
9,0226	9,3819	4,1385	7,3390	4,1140	6,5976	9,5804	5,6391	5,6799

Table 10 Weights of criteria relative to each of the scenarios

GG	CRI 1	CRI 2	CRI 3
<b>CRI 1</b>	1	9	5
<b>CRI 2</b>	1/9	1	1/5
<b>CRI 3</b>	1/5	5	1

Table 11 Binary comparisons of criteria

Criterion 1	Criterion 2	Criterion 3
0,75	0,07	0,18

Table 12 Local weights of criteria

Scenario 1	Scenario 2	Scenario 3
0,700	0,154	0,147

Table 13 Global weights of scenarios

The ranking of the scenarios of the MCA AHP and CV DCFU applications are the same, even though there are quantitative differences. This derives from two reasons. First, the AHP results based on the CV DCFU application identify SC 1 as the scenario which most contributes to each of the criteria (Table 9). Second, differences between SC 2 and SC 3 with reference to each of the criteria are minimal, except for CRI 2, which gives the least important contribution to the GG, anyhow (Table 12).

In other words, the AHP results put in evidence a greater relative importance of SC 1 than the DCFU application, while differences between SC 2 and SC 3 are of similar size. The difference between SC 1 and SC 2 is around 55% in case of the MCA application, and around 25% in the other case; the difference between SC 2 and SC 3 is around 5% in case of the MCA application and around 15% otherwise.

These remarks indicate how much interpretation of the contamination between MCA and CV is difficult and questionable. So, the outcomes should not be taken as deterministic conclusions, and the issues which are likely to be decisive for the ranking of the scenarios should be made as clear as possible to all the actors who participate in the decision process (politicians, public administration officials, urban planners, local stakeholders, profit and non-profit firms, citizens, civic associations and committees, and so on), before the process starts and during its development.

Sensitivity analysis concerning the rankings of scenarios defined by MCA and CV applications is very important to test the robustness of their results. In this case study, the criteria of the MCA AHP application do not seem to be decisive for the ranking of the three scenarios derived from the CV DCFU application. In other words, the adopted set of criteria should be integrated by others, which may possibly enlighten more clearly the quantitative differences between the average (median) values of willingness to pay for each of the scenarios.

Undoubtedly, MCA techniques turn complex decision processes on planning policies into a few issues (criteria), and, by doing so, they may cause a loss of information. Sensitivity analysis makes it possible to inquire into how much this loss may be decisive.

## 6. CONCLUSIONS

The integration of MCA and CV methodologies makes it possible to base the choice on the relative importance of the criteria on the preferences of the local community, in participatory terms. This is fundamental to define the ranking of the planning scenarios. However, it has to be noticed that there is much left to be done for the CV and MCA implementation in terms of expert knowledge. In fact, the criteria for the MCA AHP and CV DCFU applications should be identified by experts on urban, regional and environmental planning, economics, geology and so on, who are appointed by the local administration. This is a precondition for



the process to start. It is evident that the choice of the criteria is decisive for the ranking of the scenarios, since the inclusion/exclusion of a criterion can almost completely change the results of the classification procedures. Of course, if the choice of the criteria were open to public discussion and participation, it would be possible to implement decision processes on public policies where experts and the local community would be able to share and possibly build common expectations on their future city environment, as the experience of Sustainable Seattle (1998) has shown.

Information and fairness of the decision processes, which are mostly ensured by awareness and participation of the local community in the definition and implementation of public policies, are important conditions for their effectiveness. The role of the city administration of Arbus would be decisive to develop a process of this kind to rank the three future scenarios concerning the coastal zone between Piscinas and Riu Scivu.

Moreover, the ranking of the scenarios could not be the end of the story. The ranking should be brought back to the local community and a public discussion on the outcomes and implications should start, since the ranking is just a representation of an “average” feeling, which comes from algorithms which are black boxes for the vast majority of people. What has been decisive for the ranking has to be made as clear as possible, and further consideration and discussion on the main issues must be welcome, even though they may possibly delay a little bit decision and implementation.

So, the methodology proposed and developed in this essay has to be taken into account not only as a decision support tool, but as a procedure to favor and improve information, awareness and participation. Goals, criteria and scenarios are defined by the public administration in the first place, and then integrated CV and MCA make it possible to start and implement a decision process where the participants (public officials and executives, politicians, practitioners, scientists, citizens, entrepreneurs and so on) cooperate and build the future of their city recursively and incrementally. A further step which should be considered with reference to the ranking of the three scenarios concerning the town of Arbus is the redefinition of Scenario 2 and Scenario 3, which are too far from Scenario 1 in the average feeling of the local community to be taken as true planning alternatives with respect to *a park as a service project*.

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