

# **Evaluation of the changes at the forest landscape ten years after the Alqueva dam construction**

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## **Abstract**

**Landscape changes with time and land use changes affect the structure of the landscape and forest landscapes in particular. This is also the case of the Alqueva area. The construction of the Alqueva dam 10 years ago created the largest artificial lake of Europe that is placed in a forest area and affected the connectivity of the green infrastructure. This project aims to record, through a questionnaire, the opinion of experts from Portugal and Greece, locals and visitors on those changes and evaluate indirectly the Alqueva landscape. With the use of fourteen photographs of landmarks, of the former and current landscape, the participants were asked to evaluate and state their preferences in a series of 8 questions who tackle with aesthetical, economical and management issues. Participants seem to appreciate the former and the current state of the landscape with a small inclination to the last one. The forest and the green element in general were highly evaluated by the participants. Light management and restoration actions with a more naturalised approach of the landscape should be the main goal for future planning. Connectivity of natural and semi - natural areas, features and green spaces in rural and urban landscape should be enhanced during the development of the upcoming rural tourism projects.**

Keywords: landscape evaluation, assessment, aesthetics, questionnaire, Montados, forest landscape, green infrastructure

## **1. Introduction**

Throughout the years the quality of the surrounding environment is proved to be an indicator of the quality of life in an area. The evaluation of the quality of the green infrastructures and the pursuit of pinpointing the negatives and the positives of it can greatly help the future planning of the management and design of each landscape.

In this context, the forest landscape of Alqueva area is in need of evaluating the changes that happened, how those changes affected the landscape connectivity and what future design plan should follow. Due to the major changes taken place there, after the construction of the dam, there is a query about the current value of the landscape quality, compared with the former state, and the creation of a suitable future planning system in order to ensure best environmental condition of the landscape.

Green infrastructure (GI) is the network of natural and semi - natural areas, features and green spaces in rural and urban, and terrestrial, freshwater, coastal and marine areas, which together enhance ecosystem health and resilience, contribute to biodiversity conservation and benefit human populations through the maintenance and enhancement of ecosystem services. Green infrastructure can be strengthened through strategic and co-ordinated initiatives that focus on maintaining, restoring, improving and connecting existing areas and features as well as creating new areas and features.

GI is a successfully tested tool for providing ecological, economic and social benefits through natural solutions. It helps us to understand the value of the benefits that nature provides to human society and to mobilise investments to sustain and enhance them. It also helps avoid relying on infrastructure that is expensive to build when nature can often provide cheaper, more durable solutions. Many of these create local job opportunities. Green Infrastructure is based on the principle that protecting and enhancing nature and natural processes, and the many benefits human society gets from nature, are consciously integrated into spatial planning and territorial development. Compared to single-purpose, grey infrastructure, GI has many benefits. It is not a constraint on territorial development but promotes natural solutions if they are the best option. It can sometimes offer an alternative, or be complementary, to standard grey solutions.

A forest, also referred to as a wood or the woods, is an area with a high density of trees. The definition changes depending on the country and various cultural definitions. What is considered a forest may vary significantly in size and have different classifications according to how and of what the forest is composed.

According to the existing Greek Constitution, article 24, "As forest or forest ecosystem is meant the organic whole of wild plants with ligneous trunk on the requisite land surface, which, together with the co-existing flora and fauna, form throughout their mutual interdependence and interactions, a certain biological community (forest biological community) and a certain natural environment (forest environment). Wooded tract exists when in the aforementioned whole the wild ligneous vegetation, high or bushy, is sparse."

More specifically:

- a) areas with 0.5ha or 30cm strips with a tree crown closure that covers 10% of the area, or areas with 250 trees of a regeneration size, not used for other purposes or/and other services,
- b) areas where trees have been removed with a crown closure less than 10% and they have not been used for other purposes,
- c) areas with regeneration,
- d) brush lands (areas covered by evergreen broad-leaved trees).

Forest area (sq. km)

Forest area is land under natural or planted stands of trees of at least 5 meters in situ, whether productive or not, and excludes tree stands in agricultural production systems (for example, in fruit plantations and agroforestry systems) and trees in urban parks and gardens.

In Portugal Forest is considered to be an area greater than 2000m<sup>2</sup> and more than 15m wide. Includes exploitable forests, recently harvested or burned areas, recent seedlings and plantations, and green zones (reserves, protection forest and recreation forest)

Montado or oak forests, is the agro-silvo-pastoral system dominant in the southern part of Portugal. Already existing for many centuries, in more or less developed and intensive management forms. Commonly it is formed by open evergreen oak woodlands. The dominant species of trees are Cork oak (*Quercus suber*, L.) or Holm oak (*Quercus ilex*, ssp. *Rotundifolia*, L.). Traditionally this system is exploited by multiple land use, combining the exploitation of the tree cover, and a rotation of grazing, cultivation and fallow in the undercover.

Objective of this STSM is to evaluate the changes that happened in the forest area ten years after the construction of the Alqueva dam with the help of a questionnaire that was constructed in order to record the public opinion of scientists, locals and visitors. This research comes to answer in an indirect way the question about the value of the current landscape, in contrast with the former one and present some points to help maintain a better landscape quality and environmental condition,

with the help of stakeholders who share their opinions about the Alqueva landscape and other general aesthetic preferences.

## **2. Review of Existing Methods of Landscape Assessment and Evaluation**

Landscapes are considerably more than just the visual perception of a combination of landform, vegetation cover and buildings. They embody the history, land use, human culture, wildlife and seasonal changes of an area. These elements provide a distinctive local character and affect the way in which the landscape is experienced and valued. On the other hand landscape is also dynamic and evolves in response to natural or man-induced processes.

Landscape and visual impact assessment is an evolving practice that continues developing to take account of the now issues and assessment techniques. These include, among others, the continued importance of landscape character assessment and the greater emphasis on process and public participation, the development of systems for assessing environmental and "quality of life" capital, and the increased use of Strategic Environmental Assessment.

Landscape impact assessment includes a combination of objective and subjective judgements, and is therefore important to have a structured and consistent format. It is necessary to differentiate the more objective judgements (determination of magnitude of change) with the more subjective ones (assessment of landscape value).

Landscape should be recognised as a resource and is therefore a variable to be considered in land use decisions (Dearden, 1985). When evaluating landscapes one should use an interdisciplinary approach, communicate with other evaluators and, importantly, recognise the academic respectability of the elementary (Appleton, 1975).

A structured method of landscape assessment, linking description, classification, analysis and evaluation, will provide an integrated framework within which decisions on land use management and advice can be debated (Cooper and Murray, 1992). One of the biggest problems in developing quantitative assessment methods for scenic impacts is that of measuring the contributions of specific landscape elements to overall preference (Buhyoff and Riesenmann, 1979). During the late 1960's through to the '70s, there was an emphasis in landscape assessment to produce 'objective' and quantitative methods of attaching a numerical value for the 'subjective' responses to aesthetic or scenic quality. These methods were developed to act as evaluative tools to enable an evaluation to be repeated by different observers, or carried out in different areas and still produce comparable results (Robinson et al., 1976) that is they were expected to give reliable and consistent information about the observers' responses to landscape quality.

Unwin (1975) describes three phases of landscape evaluation.

- Landscape measurement: an inventory of what actually exists in the landscape
- Landscape value: an investigation and measurement of value judgements or preferences in the visual landscape
- Landscape evaluation: an assessment of the quality of the objective visual landscape in terms of individual or societal preferences for different landscape types.

### **2.2 Definitions in landscape evaluation**

Before the subject of landscape evaluation can be reviewed, it is necessary to define several key words. In the course of this report the term "total landscape" refers to the less tangible properties of the landscape as well as the more obvious visual properties and should not be confused with

"landscape" which refers to the visual properties only. Unfortunately, this differentiation is not always apparent in the literature.

#### *Landscape*

Hull and Revell (1989) define landscape and scenes as: "The outdoor environment, natural or built, which can be directly perceived by a person visiting and using that environment. A scene is the subset of a landscape which is viewed from one location (vantage point) looking in one direction ..."

The term landscape clearly focuses upon the visual properties or characteristics of the environment, these include natural and man-made elements and physical and biological resources which could be identified visually; thus non-visual biological functions, cultural/historical values, wildlife and endangered species, wilderness value, opportunities for recreation activities and a large array of tastes, smells and feelings are not included (Daniel and Vining, 1983; Amir and Gidalizon, 1990).

#### *Landscape quality*

Often landscape quality is defined as including a wide range of environmental/ecological, socio-cultural and psychological factors. According to Jacques (1980) the distinction between 'value' and 'quality' is meaningless, since both terms refer to the comparison of the landscape in front of your eyes to an idealised landscape in one's mind.

#### *Visual impact*

Visual impact on landscape quality is concerned with physical changes introduced to a site by a new development activity (Amir and Gidalizon, 1990).

#### *Objective definitions*

Visual quality - a phrase synonymous with beauty, but intended to convey an impression of objectivity; landscape evaluation - ascertaining of a single, often numerical, measure of visual quality, more appropriately would be "landscape quality survey"; judgement - the presumed ability by the design professions to evaluate 'visual quality', as distinct from value (Jacques, 1980).

#### *Subjective definitions*

Landscape value - a personal and subjective assessment of aesthetic satisfaction derived from a landscape type; landscape appraisal - the study of the effect of landscape changes upon landscape value; preference - the liking of one landscape type better than another (Jacques, 1980).

### **3. Study area**

The Alentejo Region reflects the predominance of non-irrigated agricultural areas and the affirmation of a typology silvo-pastoral system, *Quercus suber* and *Quercus ilex* woodlands, called by "*Montado*", factors which determine its identity. More extensively, Montado exist in the Iberian Peninsula and are large areas of woodlands dependant on human action forming a multipurpose agroforestry system. Alqueva is a multipurpose project that aims at a social and economic development of the Alentejo region in the south of Portugal, by means of setting up a strategic water reserve and providing a guarantee of water supply for irrigation (110000 ha), population and industry (EDIA, 2002).

Today, the Alqueva dam maintains Western Europe's largest artificial lake, covering an area of 250 km<sup>2</sup> with a reservoir's capacity of 4150 hm<sup>3</sup>.

## The Alqueva Dam

Getting through the hills at Portel was one of the greatest natural obstacles faced by the Guadiana. It was at this point that the rocky massif most resisted the momentum of the river, and this titanic struggle produced a geological scar, opening up a deep valley. It was this natural accident that allowed the construction of a dam, known as Alqueva, in deference to the nearest village.

The first studies to use this spot to build a major hydraulic work that would dam the waters of the Guadiana date back to 1957. A work of this kind would permit, later on, an ambitious irrigation plan for the Alentejo, an essential condition for overcoming the desertification and economic backwardness of the region.

However, it was only decades later that it was possible to go ahead with the "Alqueva Multi-Purpose Venture". After some coming and going, caused mainly by economic considerations, the project took off in 1998, and the main body of the dam was completed in January 2002. The gates were closed on February 8 that same year. The wall, with a height of 96 meters, formed an enormous reservoir, with a total surface area of 250 km<sup>2</sup>, and it thus considered the largest artificial lake in Europe.

Among the difference uses for this huge strategic reserve of water, we may highlight: "The Global Irrigation System", which will bring water to 115.000 hectares of land, through 2.000 km of ducts, also the production of electric energy, whose power will be sufficient to cover the consumption needs of the whole district of Beja. Added to these factors, is regularizing the flow of the Guadiana, the public water supply, and the realization of business expectations, particularly in the tourism of the area. The project also includes a hydroelectric plant, the Pedrogão Dam, an adducting system for water supply and an irrigation system (EDIA, 2002).

### **Character and characteristics of the Alqueva landscape:**

The deep Guadiana valley was lost in the area of Alqueva due to the filling of the dam. The surroundings of the lake are characterized by smooth slopes of mild altitude differences (100-200m) that create a diverse landscape of valleys and hills. The existence of water provides a significant visual impact as it provides the landscape with a set of islands and peninsulas that add up to the contrast of the presence of such a huge mass of water in a distinctly arid environment.

The landscape is surrounded by units of agro-forestry systems, Holm oak (*Quercus ilex* L.) woodlands and some olive groves, vineyards and agriculture (cereals and fodder plants) systems. Topographically, there are differences in altitude within the area (between 100 and 200 meters). The climate is Mediterranean with continental influence, with hot and dry summers, and mild winters (average annual temperature 16°C, Beja and Évora). Alentejo region is known for the dryness and immensity that lead to a poor soil quality. Geologically Central Alentejo is composed of rocks of the Pre-Cambrian and Paleozoic of several types: granites, gabbros, metamorphic limestone, shale and quartzitos.

Currently, the Alqueva landscape has experiencing changes that are expressed in the recent cultivation of vegetables, olive groves and intensive vineyards, both using irrigation, construction of small marinas, golf courses and rehabilitation of abandoned buildings of old farms into touristic resorts.

One of the objectives of this study is to evaluate those changes, in an indirect way, by gathering the opinions, of a specific number of landscape experts. With the help of pictures from the past and

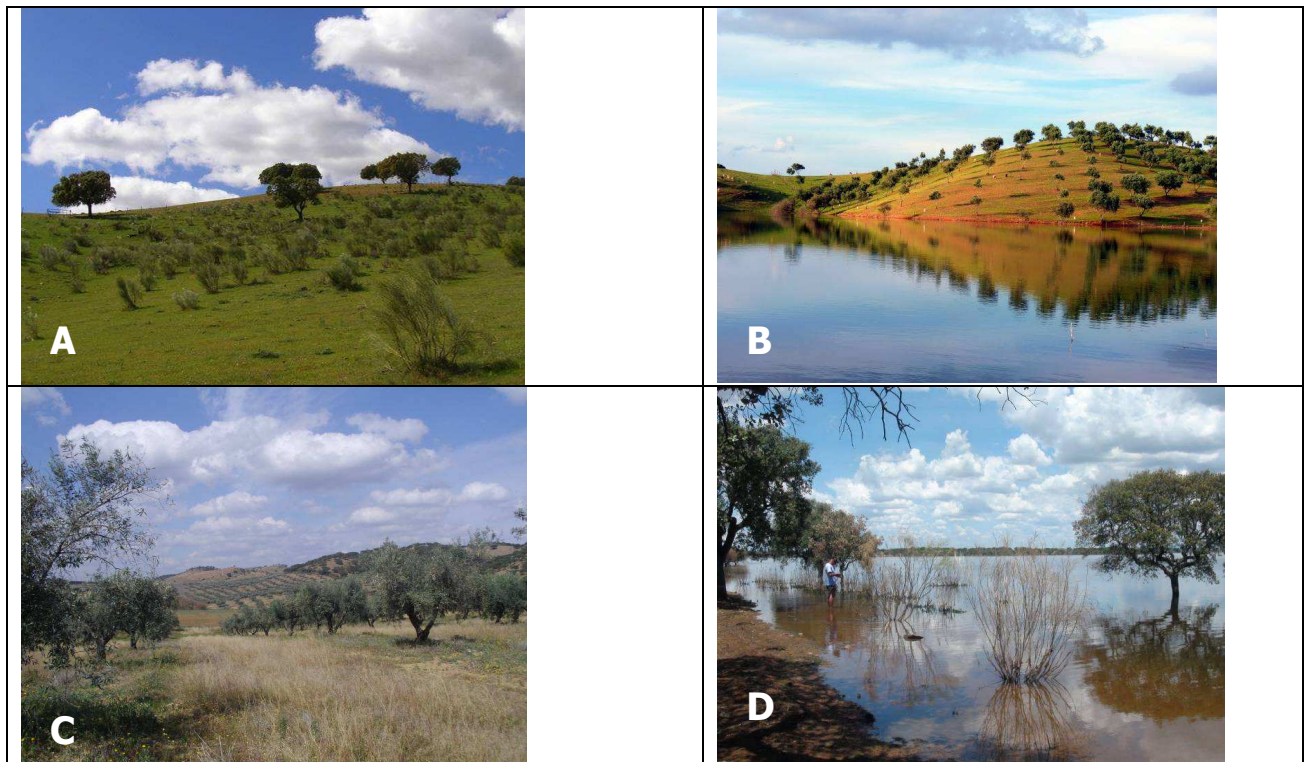
the present form of the lake's surroundings, those experts will be asked to judge and produce positive or negative comments on the chosen actions.

#### 4. Methodology

In order to evaluate the Alqueva landscape and his characteristics a questionnaire was formed to measure knowledge, perceptions, attitudes and behaviour. To ensure continuity and a very basic capacity to measure change between these to steps, we have included some "anchor" questions in which the person responding rates their response on a Likert scale. 77 people in total participated; 27 of them have a background in environmental studies (forestry, landscape architecture, environmental engineers), 30 are locals and 20 visitors that were found around the Alqueva region.

This questionnaire is structured in 3 basic parts, aesthetic analysis, economic evaluation and project management and some general demographic questions. After providing a small introduction of the Alqueva landscape and the purpose of this questionnaire, follows a question about the general opinion on the construction of dams.

In the first part the participants are introduced to 14 coloured photographs of distinctive locations of the Alqueva area before and after the construction of the dam (Table a). The participants had to rate the quality of the shown landscape in a scale from 1 to 5 (From 1 - very low, to 5 - very high). (See pictures A-N as shown bellow)







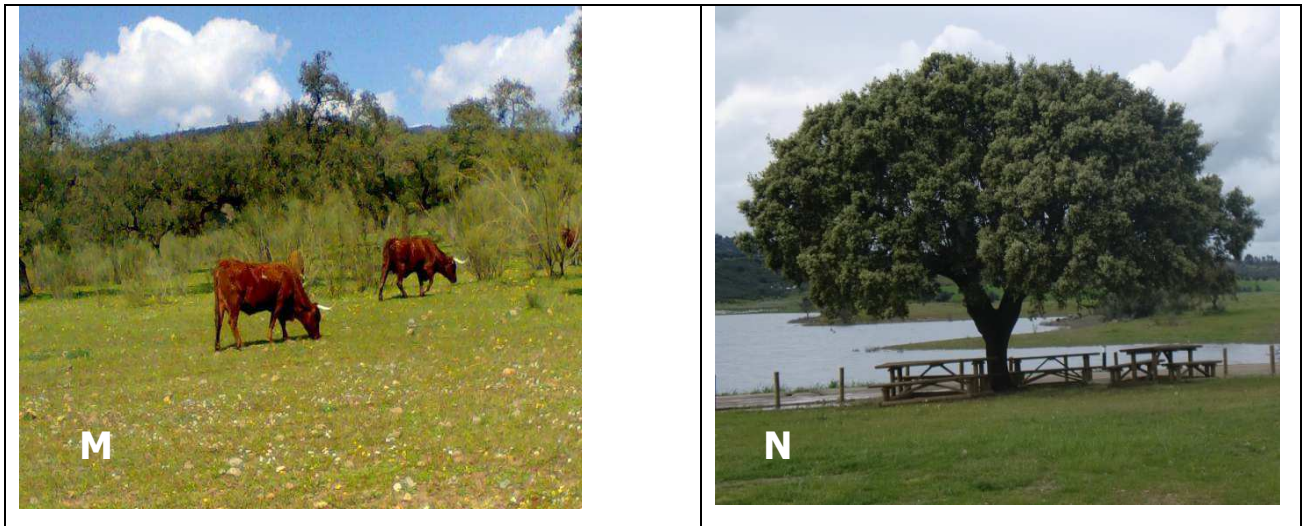


Table a. The 14 landscapes from the Alqueva area for evaluation

Following that, there are three more questions about the elements that can attract in a landscape, feelings that are being evoked from different types of landscapes (from 1-5, where 1 is “evokes no emotions” and 5 is “evokes strong emotions”) and the level of preference of a naturalised or not naturalised landscape. The second part deals with more pragmatic subjects, such as economic preferences and responsible management authorities. Lastly they were some questions for the demographic analysis of the stakeholders.

The answers were recorded in Microsoft Excel, and using equations of average, sum, and dispersal the results were put into graphs to assist with the analysis of the results.

## 5. Results and Discussion

There were a total of 77 participants, from three different stakeholders’ categories to try and have a more full view of the public opinion. The first group was consisted of 27 specialists of landscape architecture and land managers, the second one of 30 locals and the third one of 20 visitors. 40 of them were male and 37 female.

The majority of them are at the 25-35 age gap and secondly at the 18-25 one (Fig.1), with most of them having finished high school and Bachelor as a level of education (Fig.2).

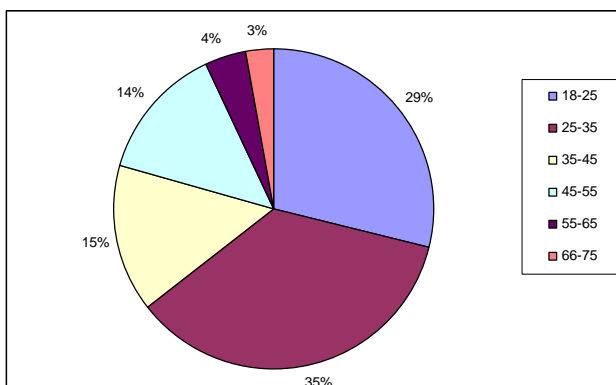


Fig.1. Age range of the participants

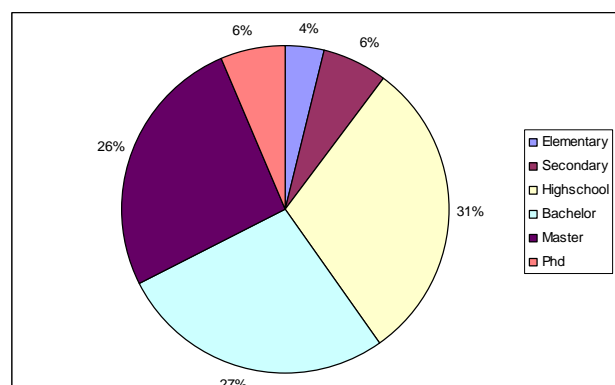


Fig.2. Educational level of the participants



The first question the stakeholders had to answer was about the general need of dams in the future. All groups stated that dams should be constructed only in areas in great need of water supply and renewable energy (Fig.3). Some scientists were also eager to suggest deconstructing some of the old dams and restoring the natural landscape.



Fig.3. Need of dams

At the first part, the pictures of past and present locations were put in couples so the participants could compare the former and current situation of the Alqueva area (Fig.4). The average higher grade was found to be in landscapes B, N and F, all from the new form, where the presence of water is evident. But there is an analogy in the evaluation of the former and current state which shows that participants could appreciate parts of both states. The lower average gathered landscape I, which depicts the urban part the area, more specific a road from the village Aldeia da Luz who had to move location altogether because the new formed lake would cover it with water. Landscape D also gathered one of the lowest scores. It depicts the forest landscape that has suffered loss of connectivity after the introduction of water. Participants appreciated the traditional Montado landscape with the presence of animals grazing (G and M).

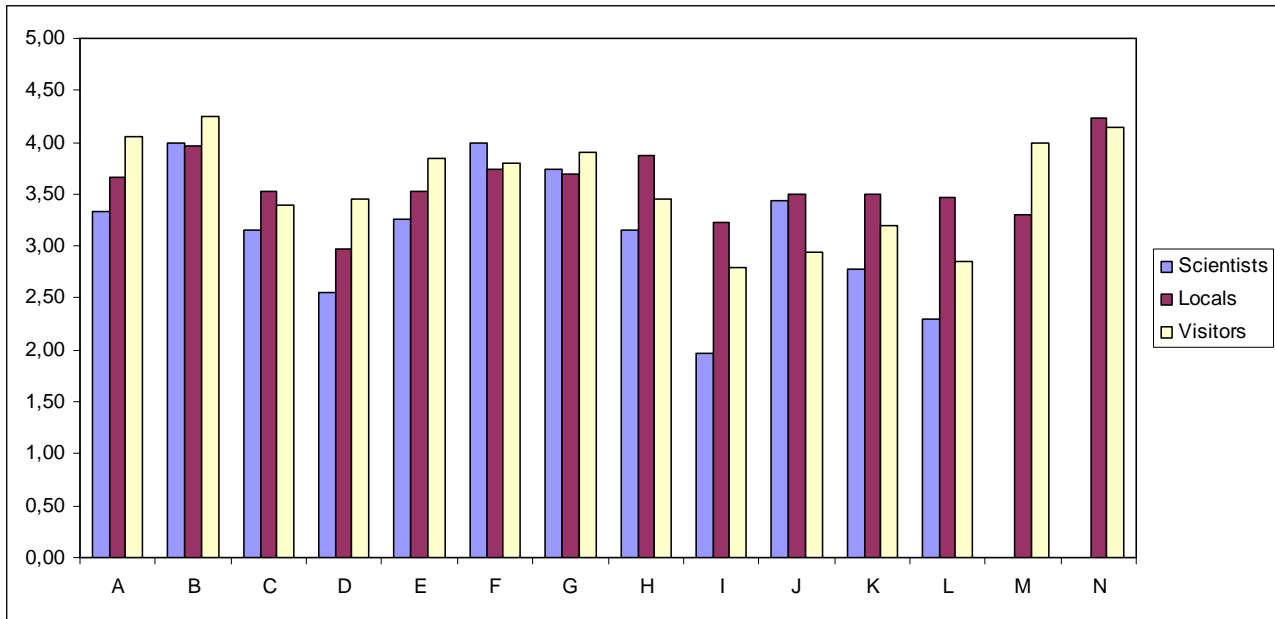


Fig.4. Evaluation of quality of landscapes shown in the pictures

Participants were asked to evaluate the elements of a landscape that attracts them and may show indirectly the reason of grading the landscapes shown before (Fig.5). For example the landscapes B and F were the top graded (water and valleys) and also water presence and valleys have been found massively attractive. Landscape G got also a high grade (natural landscape and animals) and it can be explained after checking the big preference of the existence of natural lines and wildlife. What is also interesting is that human presence was judged indifferent to the attractiveness of a landscape. Finally the temperature variability seemed also indifferent to the participants. In comparison with the results from Fig.4 there can be seen that even though people evaluated landscape B highly, a reforestation with complete symmetry, they noted that don't appreciate geometric lines as highly as natural ones. Human presence was voted to be the least attractive element in a landscape while panoramic view the most attractive one.

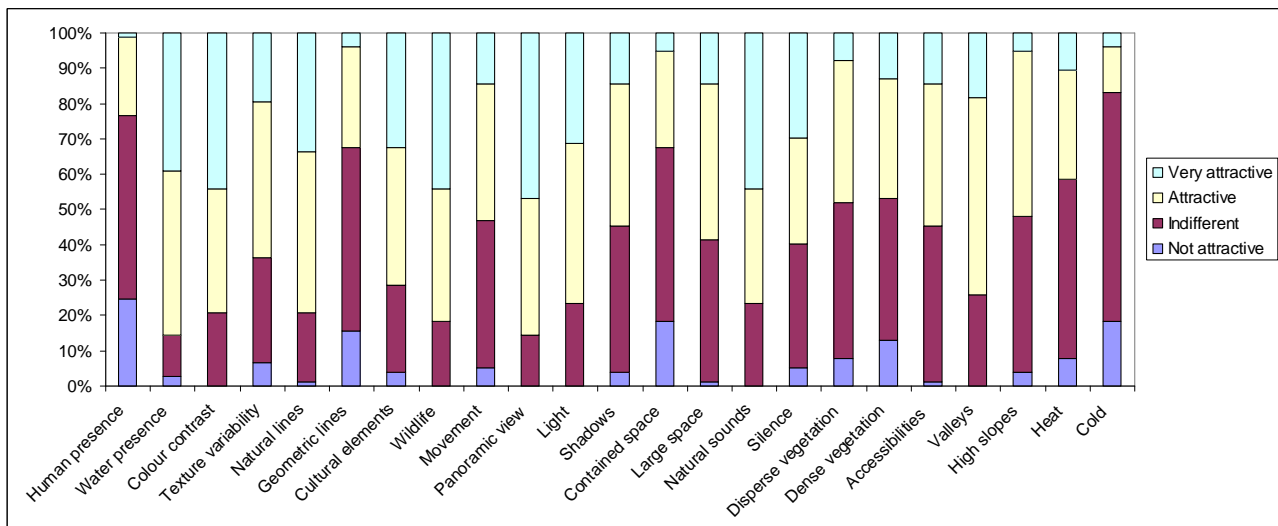


Fig.5. Aesthetic elements that may attract to a landscape

The 14 landscapes chosen could be also grouped in categories as they depict different types (Fig.6). For example C and G could be filled under agricultural category, A and E under mountainous forested, I, K and L under urban part of rural landscape and B, F and E under the

island type category. There is a similarity in the results between the mountainous forested and island type landscape in feelings such as enthusiasm, surprise, curiosity, harmony, equilibrium, happiness. Both of them, especially the mountainous forested type, gather the highest average scores. On the other hand, agricultural and urban types also have similar evaluation with both of them not evoking really strong emotions. Participants identified a variety of positive emotions, such as liberty, admiration, feeling of adventure, harmony and happiness, with forested landscapes. Island type even though it got a positive rating didn't score as high as the ones mentioned previously.

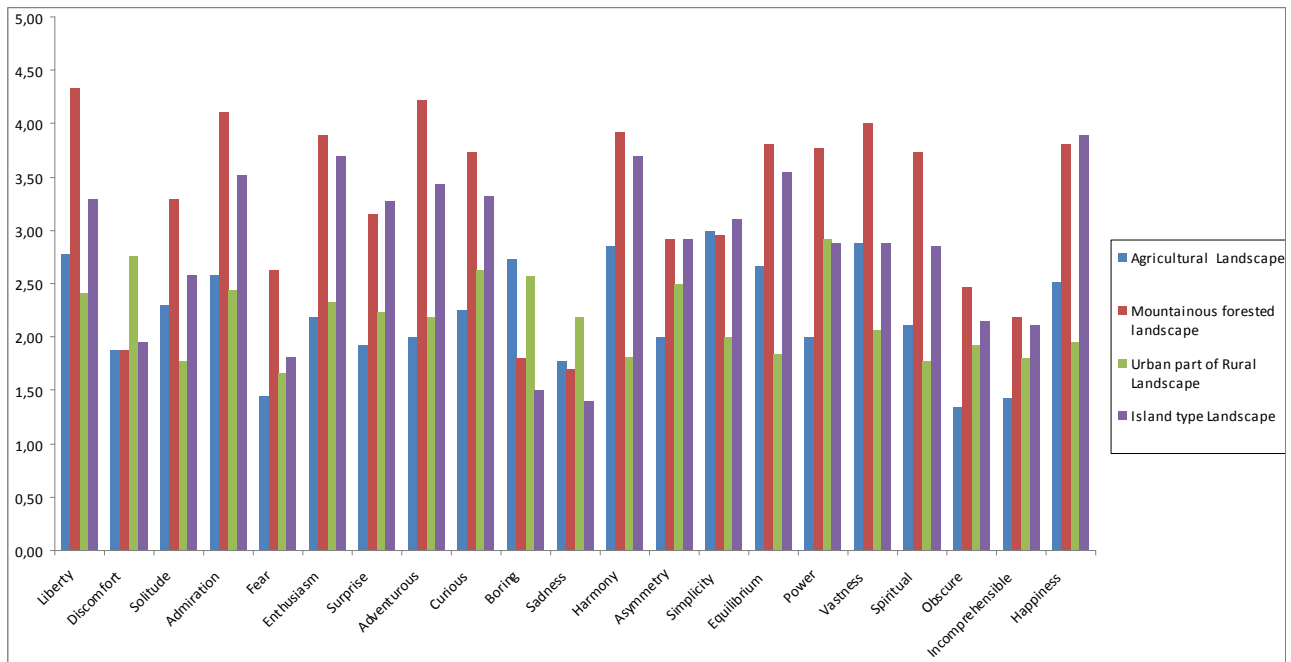


Fig.6. Feelings evoked by each participant when evaluating different types of landscapes

The last question of the first part was about the kind of landscape the participants would rather visit (Fig.7). Most of them answered a naturalized landscape but with some human intervention (eco-touristic activities) or some of them chose a strictly naturalised landscape (just trekking paths). Only a small percentage preferred a landscape where human interventions are clear and dominate the landscape (resort style rural tourism). There is also the contrast of locals and visitors where the first ones prefer the eco-touristic activities but the second seem to enjoy more natural environments with minimal intervention.

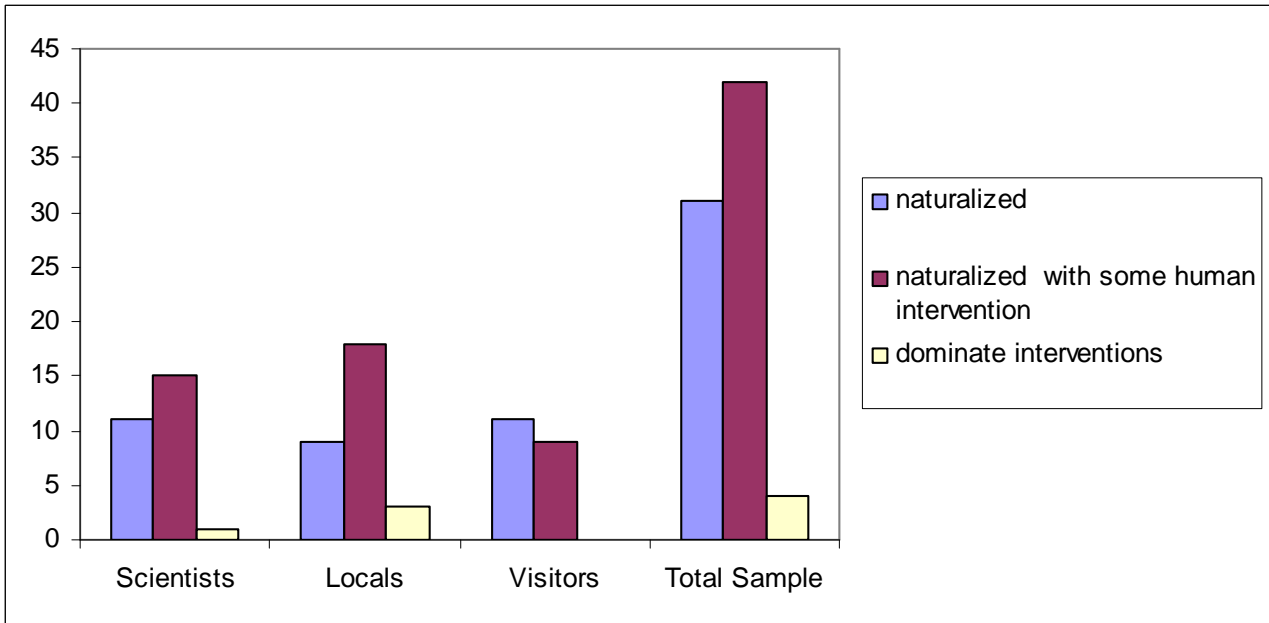


Fig.7. Landscape type that stakeholders prefer visiting

In the second part participants were asked to estimate some economic values for the landscape. The first one was how much money they were willing to spend for a weekend trip to the Alqueva area (Fig.8). Most of them expressed their will to spend from 100 to more than 250 Euro, with 150 Euro ranked as the highest percentage. From the 250 Euro and above bar (entails travel cost, lunch expenses, accommodation and a cruise in the lake) is a proof that scientists evaluate the landscape higher than visitors. It is also clear that the only a few of the participants answered with zero, which is logical since they probably don't need to pay any of the costs that are being entailed in the price.

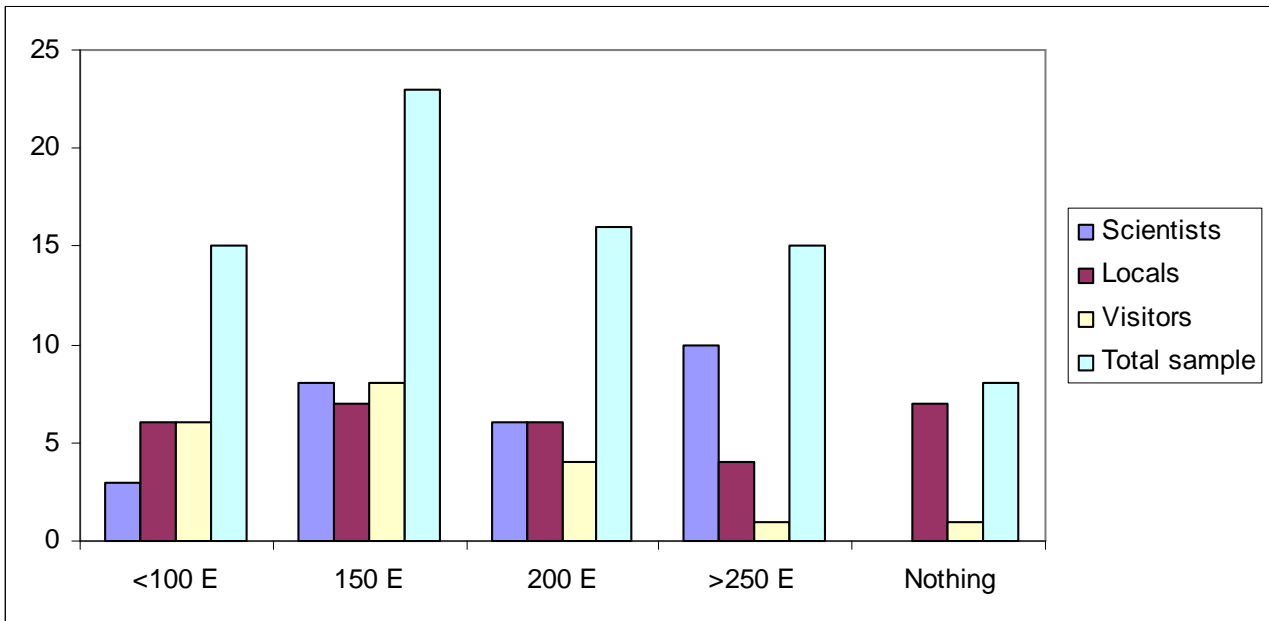


Fig.8. Possible budget willing to spend for a trip to the Alqueva forest area

Participants were also asked who should be the responsible authority that manages the changes in the Alqueva landscape (Fig.9). The highest percentage got both municipalities and regional government with 36% and 26% accordingly. Next big power with the same number of votes got

non-governmental organizations and landowners with 10-11%. This shows the need of local authorities to be in charge of their own landscapes.

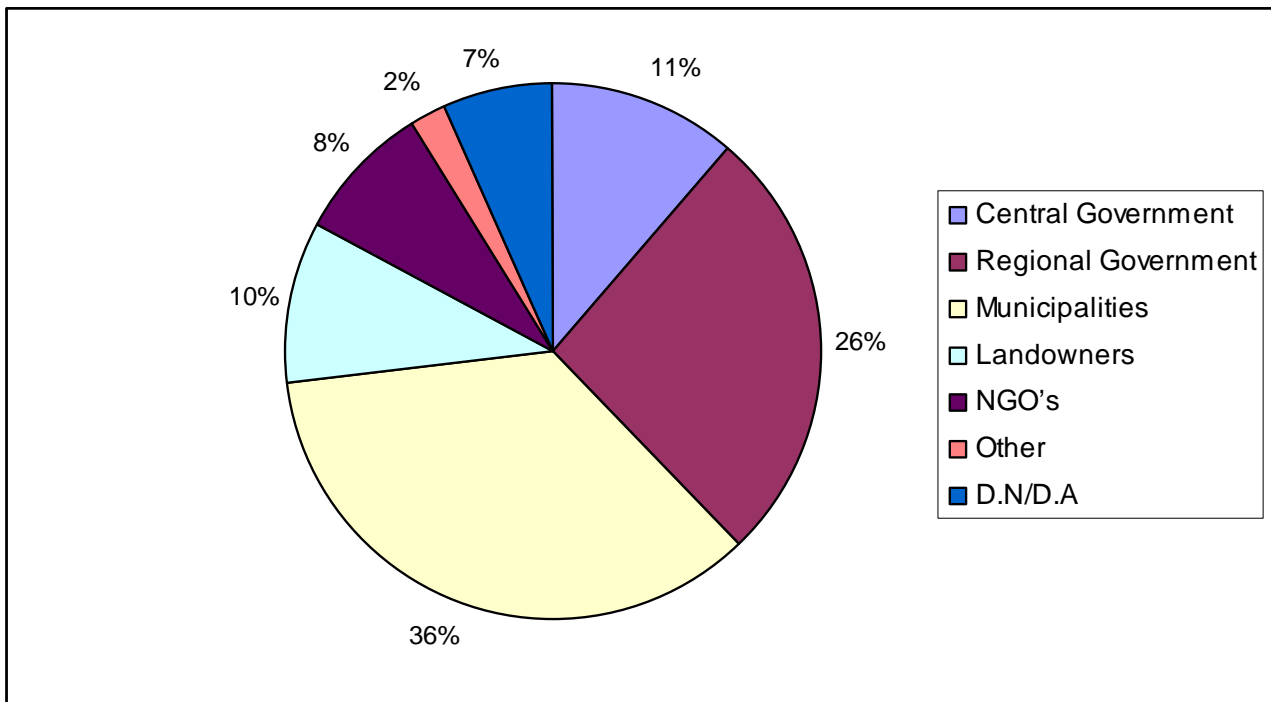


Fig.9. Preference of responsible authorities that should manage the future changes of the forest landscape

Lastly they were asked what level of intervention they would like to see in future projects in the area (Fig.10). Above the half, preferred light interventions mostly for eco-touristic activities (information booths, kiosks with local products), whereas, the less than half chose minimal intervention (bike paths, parking and picnic areas, hiking trails). In total there seems a need for light design to make the area more accessible, closer to eco-touristic activities and far from the more intrusive planning (creating golf courses, restaurants, shops, hotels) that don't interrupt the natural landscape.

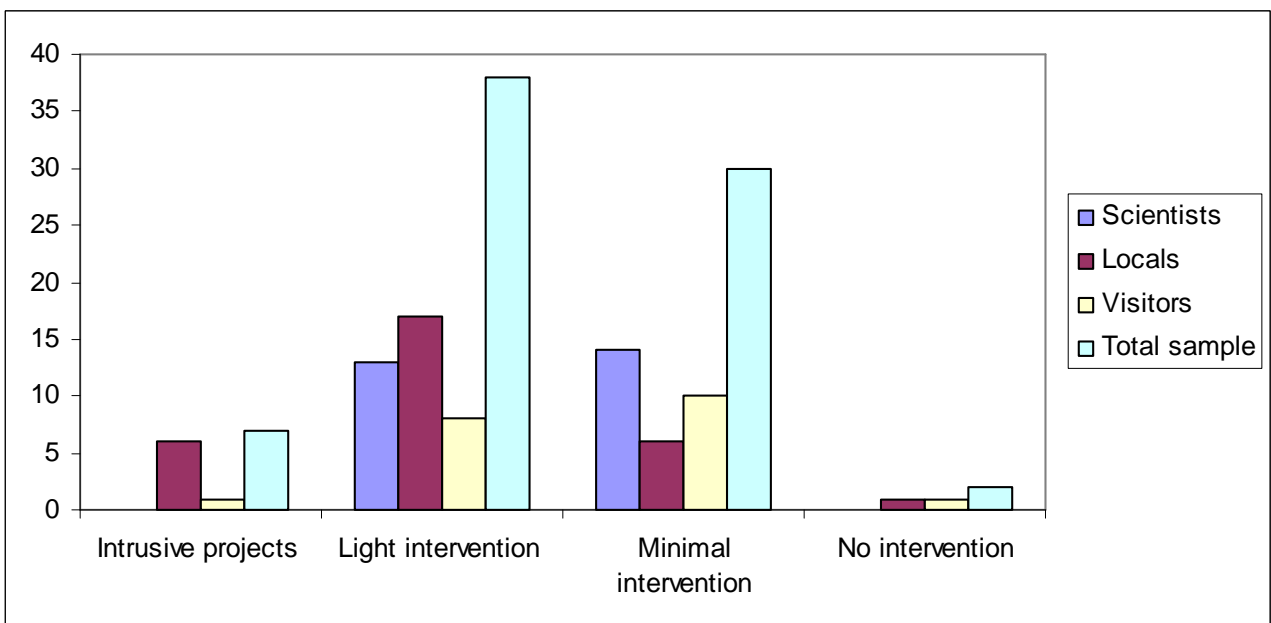


Fig.10. Desired level of intervention in a forest landscape



## 6. Conclusions

The former and current state of the Alqueva landscape has vastly changed with the construction of the dam. Although the former state was also appreciated from the participants of this research the current one got a small precedence. The changes that were taken place seem to improve the landscape quality. Especially the water element, as shown in the pictures of the landscapes, seems to trigger bigger reactions from the participants. On the other hand, it also creates a small concern about the loss of the connectivity of the landscape that the water led to. Parts of the traditional oak forest got drowned and parts are or going to be intensively cultivated.

The change of water management will lead to a more artificial image which is not very desirable as it is shown from the results from all the questions. There seems to be a need for design and light management of the area as long as this doesn't get too intrusive. The eco-touristic activities are chosen as the perfect way of promoting the new landscape without taking its toll on the environment. Natural lines and existence of wildlife were greatly appreciated which shows the path for a more natural approach when designing future projects.

The number of the participants cannot help us reach an affirmative conclusion of the exact value of the previous and the current landscape, but it gives us a sense of priorities that could put on the designing for the future Alqueva landscape. Although the two stages, former and current, of the Alqueva landscape were almost valued as equals, the results suggest a small preference of the newer state. Even though the landscapes with water presence were evaluated higher, landscape D took a mediocre evaluation. That shows that water alone doesn't provide a higher valued landscape if the loss of connectivity is very visible. Adding to that, the rural landscapes suffered some of the worst grades, proving the need for better thought out plans for the build areas so that they can also be touristic friendly.

In retrospect the current form of the Forest landscape of Alqueva appears to have a higher value than the former one, if only by a little. The area of Montado is well combined with the water element and by following an eco-touristic approach will create some nice spots of forest recreation. The biggest issue that the area has to face is the loss of connectivity. That means not only the animal paths that have been interrupted and the parts of the forest that are lost, but also whole villages that have been covered by the water. Although the new landscape seems to produce more ideal scenery the ecosystem's balance has been altered.

The Alqueva project has only started, that means a big part of it is still unrealized. Big golf courses, hotel resorts and recreational centers are meant to be built around the lake. Although the addition of water made the earth more fertile it is still an arid area with poor soil quality and intense climate. So the future land-uses and the irrigation system have to be based on the ecosystems abilities. By controlling the level of the intervention and future economic exploitation of the area will the landscape planners be able to avoid overstraining the soil condition. Those issues can be dealt with future GI planning. Well connected GI assets can create infrastructure that is adaptive and resilient to changes in climate, such as dramatic increases in rainfall.

Socially there is also a point to be made. The local participants have shown a wish for a more intensive economical exploitation of the area thinking of a possible bigger profit. In contrast the tourists and the scientists were more prone to an eco-touristic approach, in a more naturalized environment, closer to the forest. That proves that even though large projects may seem more lucrative there is another kind of tourism that is appealing to a new type of visitor. More environmentally conscious and active, that wants to get away from the urban lifestyle and not find a reproduction of one in the middle of the forest.

In conclusion, landscape professionals have to co-work with stakeholders to create a common vision for the Alqueva area, using GI to provide for character and beauty as well as functionality and health. Parts of the project have to be redesigned in order to bring a more natural touch, for example change the structure of the reforested plantations to be able to become more integrated with the natural ones. It is also important to convey to the locals that GI can also create job opportunities while being environmentally friendly. The natural and cultural elements that define an area's special character and can be integrated into practical, resilient and deliverable design proposals. This approach results in cost-effective and sustainable solutions to the many challenges associated with new development, including visual impact and the management of flood risk.

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