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A Socio-Economic and Environmental Analysis of the Implementation of Sustainable Urban Drainage Systems in Vega Baja—Alicante (Spain)

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Abstract: One of the territories most affected by flooding in Spain is the district of Vega Baja del Segura, located in the southernmost point of the province of Alicante. The objective of this article is to estimate the socio-economic and environmental efficiency of implementing sustainable urban drainage systems (SUDS) as part of the Vega Baja Nature Plan. This plan seeks to optimise rainfall management by reproducing and restoring the natural hydrological processes altered by the urban development of cities through integrated actions that generate new natural areas to be used and enjoyed by the residents. To this end, a cost–benefit analysis was carried out in accordance with the methodology established by the European Commission, and a social profitability of 4.3% (IRR) was obtained for the project, which shows the social benefit to be gained from its execution.

Keywords: floods; SUDS; social cost–benefit analysis; IRR

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1. Introduction and Methodology

The district of Vega Baja del Segura is a high-risk flood area. This risk was heightened by the floods occurring due to the isolated depression at high levels (DANA) during September 2019. Many municipalities collapsed and were cut off, and serious personal and material damage was caused, which is still visible in the territory today.

The region of Vega Baja is located in the southeast of Spain, specifically in the province of Alicante, which belongs in turn to the Autonomous Community of Valencia (Figure 1). The metropolitan area is composed of 27 municipalities with a population of around 350,000 inhabitants and an area of 957 km^2, which means a population density of 365 inhabitants/km^2, a figure that corresponds to 1.5 times the mean for the Autonomous Community of Valencia.

Within this framework, in response to this situation, the Regional Government of Valencia established the "Regeneration Plan of Vega Baja—Vega RenHace" in order to repair the damage caused by the DANA in the district and to prepare the territory for future adverse extreme weather effects.

Within Line 1 of the Plan Vega RenHace, focused on improving the hydraulic infrastructures, and more specifically in the section on "Sustainable urban actions against flooding—Action #7: Investment in sustainable drainage systems. Sustainable urban drainage systems (SUDS)" [1], the sustainable drainage plans of the 27 different municipalities of Vega Baja were drawn up. They seek to optimise rainwater, reproducing and restoring the natural hydrological processes altered by the urban development of the municipalities.

The operation of the SUDS is based on surface water drainage techniques designed in accordance with the economic, ecological and social principles of sustainable development.

They complement the conventional drainage systems and increase their safety levels. Their objective is to reverse the negative effects of waterproofing derived from urbanisation processes, increasing the permeability of the soil and significantly reducing the peak flows [2].

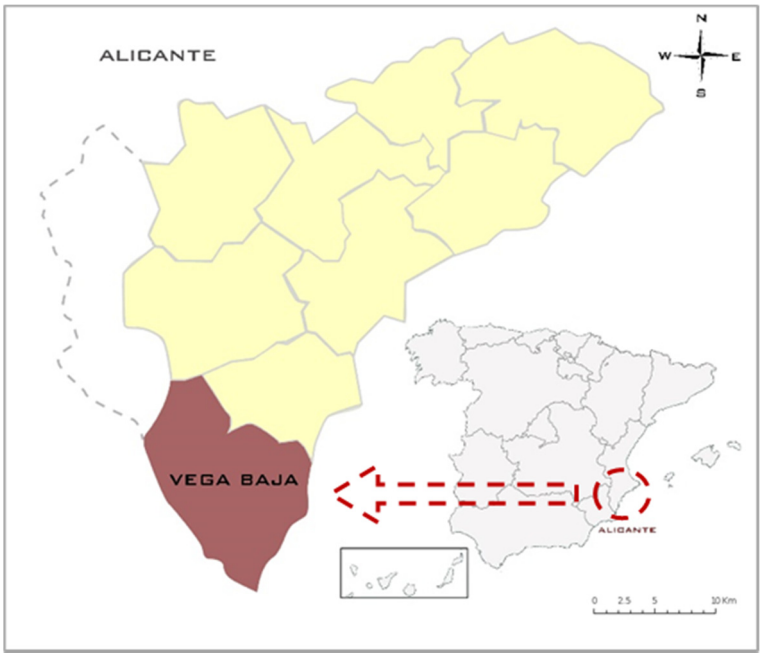


Figure 1. Location of Vega Baja. Own research.

As we can observe in Figure 2, in the event of major rainwater floods, the SUDS reduce the flows, facilitating the evacuation of water and their discharge into the natural environment based on retention and infiltration techniques in order to reduce the run-off.

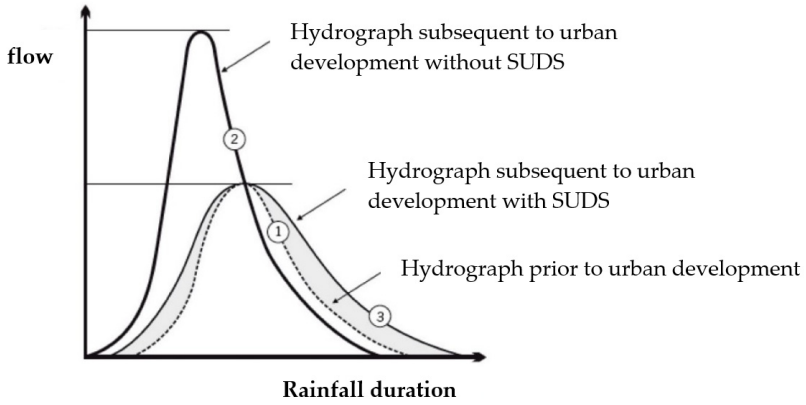


Figure 2. Hydrograph of surface run-off existing in undeveloped land, urbanised without SUDS and after the implementation of SUDS. Own elaboration based on [2].

In this way, the SUDS generate a reduction in the depth of the flood, thereby mitigating the damage to property.

This is a method that seeks to reduce the risks derived from urban run-off and to contribute to improving the environment and landscape of urban areas. It is based on the storage of run-off water in "green infrastructures", which is then reused for the irrigation of crops, green spaces or to restore natural and recreational areas as part of the promotion of the circular economy.

Other possible flood protection measures will also be implemented in this project, such as breakwaters and polders, or actions to correct wadis and ravines existing in certain

urban centres. Systems for the monitoring and sensing of precipitation and surface run-off water will also be implemented in order to expand the knowledge on the urban hydrology of the district.

The impacts of this project on the territory will be diverse and relevant, given its great transformative capacity. This article will focus on the positive impacts that the project will generate, classified into three large blocks: (1) health and well-being, including gender equality policies; (2) environmental preservation; and (3) the protection of assets against floods, and the enhancement of the value of property.

The first block begins with the analysis of the recovery of natural spaces which have recreational value. Next, and related to the impact on gender equality, the emphasis will be placed on the New Urban Agenda (NUA) of 2016. This addresses the gender inequalities in urban areas [3], and the concept of the mobility of care [4], in order to achieve a better integration of the gender perspective in planning.

The second block first quantifies the benefits obtained from the preservation of the ecosystem and the biodiversity, according to the "Red Natura 2000", which summarises the results of the different studies conducted on the different groups of habitats [5]. On the other hand, the execution of green zones in urban areas represents an alternative for the effective mitigation of climate change [6], due to their capacity to reduce the greenhouse effect (GE). Therefore, in order to quantify this reduction in the GE, the previously mentioned article by [7] will be taken as a reference. With respect to the reuse of water, the benefits for agriculture in accordance with productivity per hectare of crops in the area are estimated thanks to the data gathered by the Segura Basin Hydrological Plan 2022–2027 [8].

In the third block, the reduction in the damage to property is estimated based on research involving the development of a series of depth–damage curves for different types of property use in the city of Barcelona and the corresponding regional adjustments to enable its extrapolation to other areas of Spain [9]. Furthermore, the increase in the value of the properties close to the green zones is also quantified, which depends on this proximity and the size of the green zones [10]. Finally, the recovery of the productivity of the land is quantified according to the model established in the PATRICOVA [11] and the Guide to Cost–Benefit Analysis [12].

Given that most of these impacts can be quantified economically, the article uses this monetisation to formulate an economic (or social) cost–benefit analysis according to the "Guide to Cost–Benefit Analysis of Investment Projects" of 2014 [12]. This will assess the appropriateness of its execution with a view to applying for possible European financing within the multiannual financial framework or that related to the Next Generate EU funds.

Studies to date have analysed partial questions about the social benefits of cost–benefit analysis—for example [13], only the costs and benefits of dynamic water storage management to improve flood control in a wetland system were evaluated in a Texas study. Meanwhile, in an article from Slovakia [14], the authors carried out a cost–benefit analysis following the guidelines of the European Commission, but only evaluated the reduction in greenhouse gases, ignoring, among many other things, the preservation of the ecosystem and biodiversity. Similarly, [15] discussed benefits such as carbon reduction and increased property value, but did not take into account, for example, reduced property damage.

Finally, and of a general nature, other research has been carried out on floods and stormwater management system as a result of urban development [16,17].

In contrast to the articles above, this article analyses the totality of socio-economic benefits according to the European Commission's Cost–Benefit Analysis Guide [12], in addition to other environmental benefits particular to the area in question which are explained below.

2. Economic Cost–Benefit Analysis

Cost–benefit analysis is an analytical tool used to evaluate investment decisions. Its purpose is to facilitate a more efficient allocation of resources, directing them towards those projects that are more beneficial for society compared to other alternatives.

Economic cost–benefit analysis is carried out following the guidelines established by the European Commission in its Guide to Cost–Benefit Analysis of Investment Projects of 2014. According to the provisions established by the EU regarding projects that could potentially receive finance through the different European mechanisms, two of the thematic objectives for smart, sustainable and inclusive growth are [18]:

- "To promote the adaptation to climate change and the prevention and management of risks", and
- "To conserve and protect the environment and promote the efficiency of resources".

In this respect, the Guide to Cost–Benefit Analysis specifies that investment priorities should follow these principles [12] (p. 170):

- "the development of strategies and action plans for environmental management on a national, regional and local scale to construct a base of knowledge and capacities to observe the results obtained . . . "
- "an increase in investment for the preservation of natural capital, for example, eliminating the damage and increasing the resilience of constructed areas and other infrastructures, protecting human health, investing in defences against floods and reducing the vulnerability of the ecosystems."
- "the development of disaster management tools and systems that facilitate resilience to disasters and the prevention of natural risks."
- "Priority will be given to projects (. . .) that include green infrastructures and have an approach based on adapting to the ecosystem . . . "

As we can observe, the Vega Baja Nature Plan is fully aligned with all of the investment objectives and priorities related to the protection and prevention of environmental risks, which renders this project an exemplary case in terms of transforming the territory to increase resilience.

3. Cost–Benefit Analysis Methodology

The methodology for carrying out the economic or social cost–benefit analysis highly recommended for infrastructures in the European Union and carried out in the article consists of the following steps:

1. Define the baseline scenario or without the project.
2. Define the scenario with the project.
3. Determine the period of analysis.
4. Cost estimation.
5. Adjustment of costs using shadow price coefficients.
6. Valuation of social benefits (Section 3).
7. Calculation of the social net present value (ENPV).
8. Calculation of the social internal rate of return (IRR).
9. Calculation of the discount rate (i).

The cost–benefit analysis applies the "incremental approach" whereby only the difference between the trend flows or those without a project and flows with a project is considered. In this way, the economic and financial indicators are estimated based on the incremental cash flows.

Therefore, it was necessary to clearly define the two possible scenarios of the project:

- Trend scenarios or scenarios without the project: In this scenario, the Vega Baja Nature Plan is not executed. Therefore, the territory would maintain its current exposure to the risk of flooding, not taking advantage of the potential water resources from the urban superficial run-off for its reuse, mainly in agriculture.
- Scenario with the project: In the scenario in which the Vega Baja Nature Plan is carried out, a series of infrastructures are implemented that have the capacity to increase the resilience of the territory to floods, eliminating or mitigating their effects on the urban environment, recovering rainwater for its subsequent reuse and creating new green and gardened zones which can be enjoyed by the residents of Vega Baja.

The economic or social evaluation was conducted by allocating the increase in social costs and benefits generated by the project, which are listed in this section. To achieve this, the net present value (ENPV) was calculated. This is the difference between the total social costs and benefits, updated with the social discount rate.

The ENPV is obtained through the following expression:

$$\text{ENPV} = \sum_{t=0}^{T} \frac{\text{ABS}_t}{(1+i)^t}, \quad (1)$$

where:

ENPV = economic or social net present value;
ΔBSt = increase in social benefits (Benefits − Costs);
i = economic discount rate (3%);
t = period of time;
T = time horizon.

In order to determine the profitability of the investment, the social internal rate of return (IRR) was calculated, finding the discount rate (i) obtained when the ENPV is zero.

In methodological terms, with respect to the period of analysis, according to the Guide to Cost–Benefit Analysis of Investment Projects [12], hydraulic projects, such as this one, should have a period of useful life, including the phase of construction, of 30 years. Furthermore, it is estimated that the execution of the works has a duration of three years.

Therefore, if the execution of the actions established in the master plan with respect to floods in the municipalities of Vega Baja is expected to begin in the year 2023, the period considered will span from 2023 to 2052, with the works finishing in 2025.

The estimated execution, maintenance and exploitation costs of the project should be included in the economic or social cost–benefit analysis. For this study, the data were obtained from the municipal master plans in the area of the Vega Baja—VEGA RENHACE Regeneration Plan project, drawn up by HIDRAQUA, a company in the water and environment sector whose work has been carried out through concessions and mixed companies in 79 towns in the Autonomous Community of Valencia.

The execution costs should be taken as the budget of implementing the actions through contracts, estimated at EUR 841.74 M + VAT. Meanwhile, the maintenance costs were estimated at EUR 10.3 M, while the residual value of the infrastructure at the end of the useful life period was estimated at EUR 231.48 M [19].

In the case of the economic cost–benefit analysis, the costs included in the project—that is, the costs involved in executing and maintaining the actions—were adjusted through shadow price coefficients. These coefficients were also applied to the price of the land and residual value included at the end of the period of analysis.

These coefficients were used to express the social opportunity cost instead of the prices observed in the market. In this way, according to the aforementioned Guide to Cost–Benefit Analysis, correction factors must be applied to transform the financial costs into economic costs [12]. Therefore, the following coefficients were applied (Table 1), obtained from similar projects recently undertaken in Spain:

Table 1. Shadow price coefficients for the Spanish case. Own elaboration, based on [20,21].

Shadow Price Coefficients	
Land	1.30
Execution	0.90
Maintenance	1.00
Residual Value	0.92

Next, the three blocks mentioned in the introduction as those that will generate the greatest environmental and social impact were analysed in depth.

4. Socio-Economic Impact of the Vega Baja Nature Plan

As previously mentioned, this project will substantially transform the 27 municipalities of Vega Baja, generating a series of impacts that are grouped into three large strategic areas and discussed below: benefits for health and well-being, environmental and territorial protection benefits, and benefits for the enhancement of the value of the properties.

4.1. Benefits for Health and Well-Being

This block includes the impacts related to the improvement in health conditions and quality of life resulting from the actions carried out in this plan for protecting against floods and sustainable drainage.

This project will add a series of assets to the territory that will enormously enhance the quality of life of the residents in the district, beyond the logical reduction in the danger of flooding, such as floodable parks, rain gardens and landscape actions in many parts of the district.

The creation of natural spaces in urban areas generates a series of benefits for the residents, such as the use and enjoyment of these areas for recreation, favoured by the mild climate conditions during a large part of the year and the high number of sunlight hours, together with the thermal regulatory factor of the green areas during the months of the most extreme temperatures.

To this, we should also add that the green areas help to reduce noise, increase the feeling of well-being of the residents and contribute to restoring and giving continuity to the unique landscape of the traditional Mediterranean orchard, which is becoming lost in Spain.

Next, the main impacts of the recovery of traditional natural spaces and the impact on gender equality will be discussed.

4.1.1. Recovery of Natural Spaces with a Recreational Value

This impact included in the Guide to Cost–Benefit Analysis is related to the recovery or preservation of natural spaces with recreational value, such as beaches, natural parks or protected areas, where outdoor leisure activities are carried out: hiking, cycling, bathing, fishing, etc.

This project contemplates a series of landscape actions, which, apart from fulfilling the objective of helping to mitigate the risk of flooding, will enable the restoration of the recreational value of certain places with a high ecological value in Vega Baja. Some of the most relevant landscape interventions that will be undertaken thanks to the project are:

- Dredging the mouth of the river Segura (Guardamar del Segura). The mouth of the river Segura has been affected by a clogging process due to the sediments carried by the river itself, which generates problems relating to the minimum depth for vessels and an increase in the erosion of the coast due to the acceleration of the water as the section of the river diminishes. For this reason, a total thickness of 40 cm will be dredged from the artificial course and the former river course and canes will be removed. This measure will favour water sports tourism and recreational activities such as fishing and bathing.
- Landscape restoration in the "La Sierra" Municipal Natural Park (Algorfa). This natural park with high ecological value, located in the Sierra de Algorfa, is affected by floods due to its sparse vegetation. Therefore, the project proposes reforestation actions and the planting of autochthonous plant species in the area around the Ermita de la Virgen de la Salud, which will improve the environmental and landscape quality of the area, transforming it into an area with recreational value for the inhabitants of this municipality.
- A floodable park and green zone close to the Salinas de Torrevieja (San Miguel de Salinas). Actions for adapting the Rambla lo Masera to prevent run-off and the contamination of crops include a lamination-seepage park with an area of 36,000 m^2. A new green area will also be created, favoured by its proximity to the Salinas de

Torrevieja, which will enable its recreational and leisure use within an environment of high-quality landscapes.

In order to quantify the recreational benefit of these interventions in monetary terms, the Guide to Cost–Benefit Analysis of the European Commission suggests using the travel cost method. This comprises the quantification of the costs incurred in the recreational activity such as transport, activities, consumption in the destination, etc.

Therefore, for the case of dredging the mouth of the river Segura, according to the White Paper of Tourism of the Region of Valencia, it is estimated that the mooring of each vessel in a sports marina or yachting club has a daily economic impact of EUR 150, of which around 25%, that is, EUR 37.50/day, corresponds to mooring and port services [22].

Given that the Marina de Guardamar has 495 moorings, establishing the hypothesis of an annual average occupancy of 50% derived from this intervention, it is estimated that the annual cost generated by this infrastructure is EUR 3,387,656.

However, it should be noted that the dredging of the river Segura will not definitively eliminate the problem of the excess of sediments carried by the river in successive floods, and that this measure does not include any points regarding its maintenance. Therefore, the hypothesis that the action will enable a normal operation of this sports marina for 15 years is adopted, as this is the period considered in the subsequent cost–benefit analysis.

In order to quantify the recreational value of the other two actions in Algorfa and San Miguel de Salinas, it is assumed that, given the characteristics of these natural spaces, the cost per visitor is limited to the cost of displacement.

As the visitors to these spaces will mainly be local residents, an average value of EUR 3 per visitor is adopted (possible cost of fuel and displacement time for return journeys). On the other hand, in accordance with the visitor figures of some of the natural spaces of the areas, a hypothesis is established of 10,000 visitors per year to each of the aforementioned natural spaces.

Multiplying the average cost by the total estimated annual visitors to these natural spaces, the quantification of the benefit from recreational use will be EUR 30,000 per year for each of the spaces. In total, for the two actions, a positive impact of EUR 60,000 per year will be included in the cost–benefit analysis.

4.1.2. Impact on Gender Equality

Based on a comprehensive perspective, the project presented seeks to meet both hydraulic demands and also environmental and social demands. Therefore, it contemplates policies and actions that favour gender equality. These actions taken throughout the design, execution and useful life of the works are described below. Particular emphasis is placed on those actions related to the aforementioned green, recreational areas, etc., and their insertion into the existing urban fabric.

From the beginning of the last century to the present day, the global population has grown three-fold, and the thirty-year forecast indicates that by the middle of this century, the world will have almost 10 billion human inhabitants. This is causing the uncontrolled expansion of the population, giving rise to irreversible changes, the modification of ecosystems and the consumption of global resources [23].

The economic crisis caused by COVID-19 and the development of technological innovations are increasing the contradictions and gaps between countries, territories, and people. Reflecting these complex urban changes, but on a lower scale, cities are replete with barriers producing spatial and social fragmentation and segregation, with major social, economic, and cultural inequalities. Within this context, women are those who suffer more, according to the report "Turning promises into action: Gender equality in the 2030 Agenda for Sustainable Development" [24].

Furthermore, in modern cities, there is historical urban fragmentation, where each function (living, working, recreating, and moving) usually corresponds to its own particular space. In this way, the functionalist city has created an extremely structured urban order based on the productive organisation of the working man, which only takes into account

the time that can be monetised, ignoring the time that women invest in reproducing and caring [23].

In this respect, the NUA [3], approved in the UN Habitat III Conference on Housing and Sustainable Urban Development, addresses, among other aspects, the gender inequalities in urban areas. To do this, it calls for the planning of inclusive urban spaces, providing accessibility to basic services and, in this way, managing the urbanisation process to improve the life of both men and women.

The NUA sets out gender commitments, guaranteeing the full participation of women and equal rights in cities. It acknowledges the gap between the contribution of women to cities and the benefits that they obtain, and underlines the importance of addressing gender inequalities throughout the urban management and development process.

In this way, in order to better integrate the gender perspective in the planning and management of transport, the mobility of care concept has arisen [4]. This new concept of mobility is related to homemaking and care activities, such as looking after dependent people, either children or the elderly, which are unpaid in most cases. This mobility includes all of the journeys undertaken to carry out the daily tasks for these purposes.

As a result, the lack of equipment and places where these care tasks are undertaken can imply significant barriers in the lives of people and, most of all, of women, statistically the most impacted in these cases [25]. Some priority issues with respect to urbanisation related to the gender perspective are [26]:

- The integration of uses and proximity: in today's cities, the spaces are separated by uses, but daily life requires the contrary.
- Public space and safety: the quality and safety of the public space is important for women, the elderly and children, who most use the street to move about, play in the open air or socialise, and they are basically the most vulnerable to conditions of inaccessibility and insecurity.
- Economic activity: there is a need to balance productive tasks (work) with reproductive tasks (family). Again, in this case, women are the most affected, having to apply for reduced working hours with the consequent loss of earnings.
- Amenities, shopping, and leisure facilities: the actual use of amenities as opposed to accompanying other people who use them is a variable that explains the differences in gender with respect to the access to and use of amenities, as use through accompanying others multiplies the number of trips, frequencies, and fixed timetables.

Bearing these points in mind, the different administrations contributed to the elaboration of guidelines for gender equality, such as the Conselleria de Vivienda, Obras Públicas y Vertebración del Territorio de la Generalitat Valenciana through SET to introduce the gender perspective in the urban planning process [27], which proposes a series of objectives, goals and examples of actions.

In this way, the new green urban zones and recreational spaces proposed in this project will take these gender perspective guidelines into account so that these spaces promote the quality of life and well-being of women. One way of ensuring that these guidelines are ultimately followed is to favour the full participation and equality of women in the planning of cities and the adoption of decisions, drawing from their own experiences.

Therefore, as well as the Equality Plans, equal opportunity policies are also promoted, not only between women and men but also between generations, in the authorship of projects commissioned to professionals [28]. In this respect, work is being done to achieve greater parity and diversity in the elaboration of construction projects and in the design phase with the contribution of women.

Below are two examples of floodable parks (Figure 3) which are analysed in terms of social integration and incorporating a gender perspective.

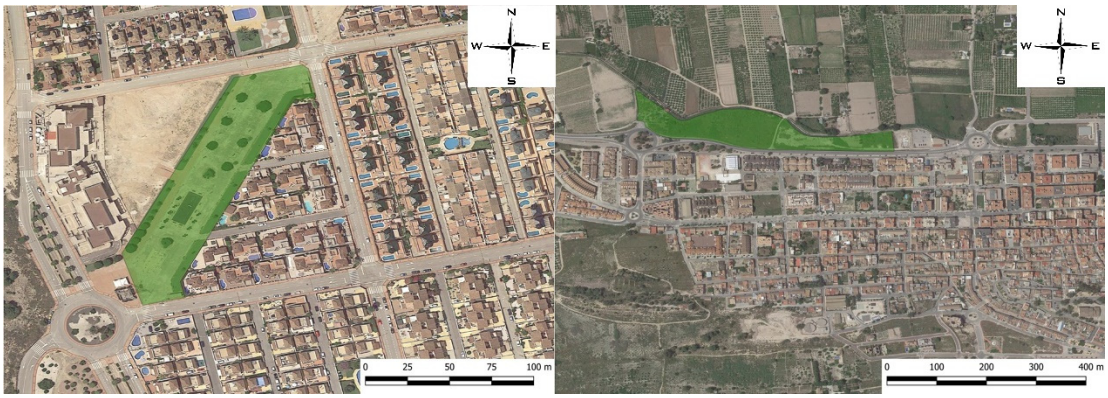


Figure 3. Examples of floodable parks analysed. Own elaboration based on [29] and Google Maps.

Therefore, after analysing all of the actions, we can observe that the majority of the parks are located in urban centres, although some are situated on the outskirts due to the hydrological constraints. Consequently, and fundamentally in these cases, efforts will be made so that these floodable parks fulfil the previously described objectives, and particularly with the following criteria:

- Adequate accessibility and signs without steps, gentle slopes, and handrails.
- The elimination of the feeling of insecurity inside the parks and the surrounding areas through adequate lighting and maximum visibility.
- Equipping these areas with amenities for the provision of care, such as toilets, hygiene and nursing facilities, and urban furniture.
- Involvement of women in the design process, as they are more vulnerable than men. Likewise, since gender is ageless, older people are also included. Women are provided with high representation to put forward their ideas. The guarantee of safety, lighting, and accessibility from the urban centre is provided in order to ensure an adequate integration with the existing urban fabric.

It should be noted that this perspective is aligned with the recommendations in the "Guidelines for incorporating the gender perspective in the actions eligible to finance within the framework of the Plan for Recovery, Transformation and Resilience" elaborated by the Women's Institute of the Ministry of Equality in July 2021 [30].

These guidelines refer to the stages of development of the projects eligible for finance with this plan. First, the public administrations call for projects with fixed objectives and criteria. In the next phase, the perspective sought with these guidelines is addressed in detail and the private/public-private entities design and present projects that respond to the set objectives and criteria. In the third phase, the public administration selects the projects, and in the fourth phase, the entities selected implement their projects with the corresponding monitoring [30].

4.2. Environmental Benefits

Climate change is generating serious problems related to water stress and water quality due to the recurring episodes of drought. Furthermore, the floods derived from torrential rain phenomena aggravate the negative impacts due to the deterioration in the quality of the water and crop damage.

Within this framework, in recent years, highly ambitious initiatives have been developed by government bodies to mitigate and slow down the evolution of climate change. Proof of this is the 2030 Agenda approved by the United Nations, which establishes 17 sustainable development goals (SDGs) to, among other goals, fight against climate change and improve access to water resources [31]. Furthermore, in 2016, the Paris Agreement was signed. This is a legally binding international treaty on climate change with the objective of limiting global warming much below 2 °C, comparable to pre-industrial levels [32].

Of late, the European Union has been making resolute efforts to lead the economic transformation towards a sustainable use of resources and a drastic reduction in greenhouse gas emissions. It has united this change with the recovery from the COVID-19 pandemic, dedicating a third of the 1.8 billion euros of investments of the Next Generation EU plan for this purpose [33].

In this aspect, and in line with the objectives of the Vega Baja Renhace Plan, this project focuses on reproducing and restoring the hydrological processes prior to the urban development of Vega Baja, integrating them into the environment and generating new natural areas to be used and enjoyed by the residents. Below, several of these environmental benefits are discussed. They will arise thanks to the following planned actions: the preservation of the ecosystem and biodiversity, the reduction in greenhouse gases and the reuse of water.

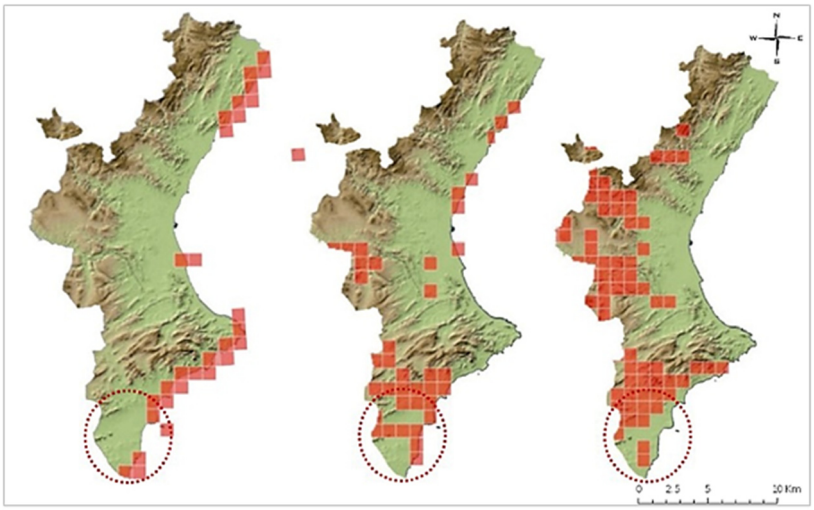
4.2.1. Preservation of the Ecosystem and the Biodiversity

The creation and regeneration of green spaces, thanks to a greater availability and quality of water resources, will positively affect the recovery and preservation of the autochthonous flora and fauna of Vega Baja.

Specifically, the positive impact of this project will be visible in the regenerated green zones on the banks of the river Segura, thanks to the improvement in the quality of the water as a result of the implementation of the SUDS, which will greatly affect the preservation of the habitat.

The benefits generated from preserving the ecosystem and the biodiversity will be estimated through the "willingness to pay" for the preservation and conservation of the ecosystem and biodiversity. In this respect, in 2013, the European Commission conducted a study to quantify the benefit derived from the protection of the habitat, setting values for each of the nine groups of different habitats established in "Red Natura 2000".

With respect to the protected habitat existing in Vega Baja, according to the "Manual de identificación de los hábitats protegidos en la Comunidad Valenciana" (Manual for identifying protected habitats in the Region of Valencia) [34], which specifies the presence of the different locations of the nine habitats, their types of vegetation, and their characteristics throughout the territory of Valencia, we can observe that in the surroundings of the course of the river Segura as it passes through Vega Baja, there are only protected species classified in Group 1 of "Coastal Habitats and Halophytic Vegetation" (Figure 4).



(**a**) (**b**) (**c**)

Figure 4. Location of the coastal habitats and halophytic vegetation in Vega Baja (Autonomous Community of Valencia). (**a**) Distribution of vegetated cliffs on Mediterranean coasts, with endemic Limonium spp; (**b**) distribution of Mediterranean salt steppes (Limonietalia); (**c**) distribution of the Iberian gypsiferous vegetation (Gypsophiletalia). Own elaboration based on [34].

According to the Manual, the habitat of Group 1 includes coastal habitats and halophytic vegetation, including the following sub-groups of protected species existing in Vega Baja:

- Cliffs with Mediterranean coastal vegetation, with endemic *Limonium* spp.
- Mediterranean salt steppes (Limonietalia).
- Iberian gypsum vegetation (Gypsophiletalia).

Therefore, as a reference to quantify the benefit of preserving the ecosystem and biodiversity, the average value of the coastal habitats and halophytic vegetation was taken. For the Spanish case, this was quantified at EUR 2449.38/ha/year (EUR 2020), after conducting a series of adjustments in accordance with the per capita gross domestic product (GDP) and the economic evolution from the publication of the European study to the present day [5,35].

According to the Segura Hydrographic Confederation, the section of the river Segura that runs through the province of Alicante is 38.5 km long. The green corridor within which the course and copses of the river are found covers an area of 511 hectares [36]. Applying the benefit value per hectare obtained to the area in which this measure is implemented generates an estimated benefit of EUR 1,251,633/year for the whole of the useful life of the project.

Furthermore, we should also note the positive impact on the marine environment due to the improvement in the quality of the water resources [37,38]. Although it not will be quantified in monetary terms due to its complexity, this latter positive impact should be incorporated in the cost–benefit analysis, and, in any case, should be acknowledged as another environmental benefit of this project on a qualitative level.

4.2.2. Reduction in Greenhouse Gases

This impact refers to the reduction in greenhouse gases, again thanks to the creation of new green zones. The vegetation in these spaces will help to neutralise part of the emissions of these gases that are harmful to the planet.

As already mentioned, in recent years, public administrations are accelerating their measures to mitigate the consequences of climate change. In November 2018, the European Commission presented its Long-Term Strategy for 2050 for a climatically neutral future, in line with the Paris Agreement to maintain the increase in temperature below 2 °C. In tune with this, in November 2020, in Spain, the Long-Term Decarbonisation Strategy was approved, which defines the path to reach climatic neutrality in 2050 [39,40].

Climate change and the current urbanisation trends have led to the resilience of cities becoming a priority. The risks to health and the environment are expected to increase, due to the climate conditions in urban areas, most of all in developing cities which are experiencing rapid population growth [41,42].

To prevent this, the execution of green zones in urban areas represents an alternative for the effective mitigation of climate change [6] due to their capacity to reduce the greenhouse effect. This phenomenon arises due to the fact that the vegetation captures the carbon dioxide from the atmosphere and converts it into oxygen during photosynthesis. Therefore, the significant number of green spaces in an area will enable a greater volume of carbon dioxide to be captured, which should be quantified as a positive impact.

The methodology to economically evaluate this reduction in greenhouse gases is aligned with the Guide to Cost–Benefit Analysis, and is made up of the following steps:

- The quantification of the volume of emissions not released into the atmosphere due to the new green zones as a result of the implementation of the SUDS (tonnes of CO_2/year).
- Calculation of the externality: total tonnes of CO_2 emissions, multiplied by their unit cost (EUR/tonne).

For the quantification of the volume of emissions saved, the carbon sequestration provided by the new green zones is taken into account. In this sense, the Research Cen-

tre of the European Commission recently published an article on the climate benefits of the urban green zones. It estimates a carbon sequestration value of these areas of 0.98 kg CO_2/m^2 year [6,7], which will be taken as a reference for this study. Applying this value, thanks to the creation of the new green zones proposed in this project, it is estimated that 2511 t of CO_2 will be neutralised each year.

On the other hand, with respect to the unit cost, the Guide to Cost–Benefit Analysis suggests increasing its price gradually from 25 EUR/tonne CO_2 in 2010 to 45 EUR/tonne CO_2 in 2030 [12] (p. 63). Consequently, these price increase parameters will be followed from the start of the benefit in 2024—39 EUR/tonne CO_2—until 2030, where it will be set at a price of 45 EUR/tonne CO_2 until the end of the analysis period in 2052.

4.2.3. Reuse of Water

Following the principles of the circular economy, based on the reuse of non-renewable resources and the reduction in waste generation, the positive impact produced by the reuse of water is analysed in this project. This is particularly important, as this area suffers from a structural water deficit.

This project will discharge the water collected from the rainwater network into a network of gullies, which are pipelines that transport the irrigation surpluses to lower areas for its reuse and/or discharge into the sea.

As illustrated in Figure 5, the effects of climate change on the hydrometeorological variables affect the territorial and time distribution of the precipitations with an intensification of extreme phenomena, such as floods and droughts [8].

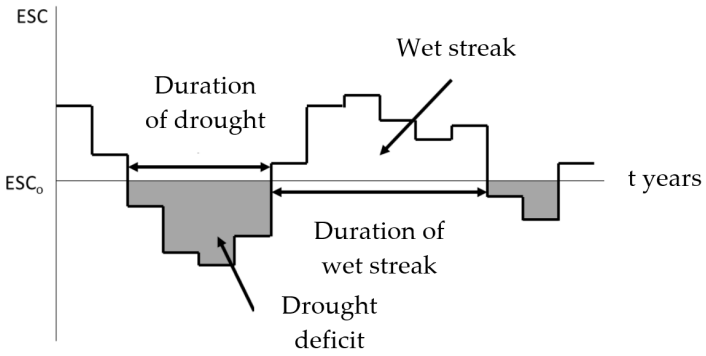


Figure 5. Concept and definition of droughts. Own elaboration based on [43].

The district of Vega Baja lies within the scope of the Segura Hydrographic Confederation (SHC). Annex 13 of the Segura Basin Hydrological Plan 2022–2027, entitled "Risks associated with Climate Change and Adaptation", mentions that an overall reduction in run-off is expected, together with an increase in extreme episodes (droughts and floods).

These effects are already perceived, as the average annual rainfall in the period between 1980 and 2011 in the Segura Basin did not reach 400 L/m^2, being even lower in the Vega Baja area (below 300 L/m^2 in some parts) (Figure 6) [44].

In order to adequately meet the demands and overcome drought events, greater flexibility in the sources of supply and a boost to non-conventional resources are required. In addition, the efficiencies of the supply networks must also be improved [8]. In other words, the territory needs to become more resilient to extreme hydrological phenomena.

Specifically, one of the main objectives of this project, Vega Baja Nature, is to increase the resilience of the territory of the district, thanks to the implementation of the SUDS, which will enable part of the urban run-off water to be recovered for its subsequent reuse in both agriculture, which will increase the benefits in this sector due to the increase in hectares irrigated, and in urban use (street cleaning, irrigation of green areas, etc.), which will give rise to a saving in drinking water.

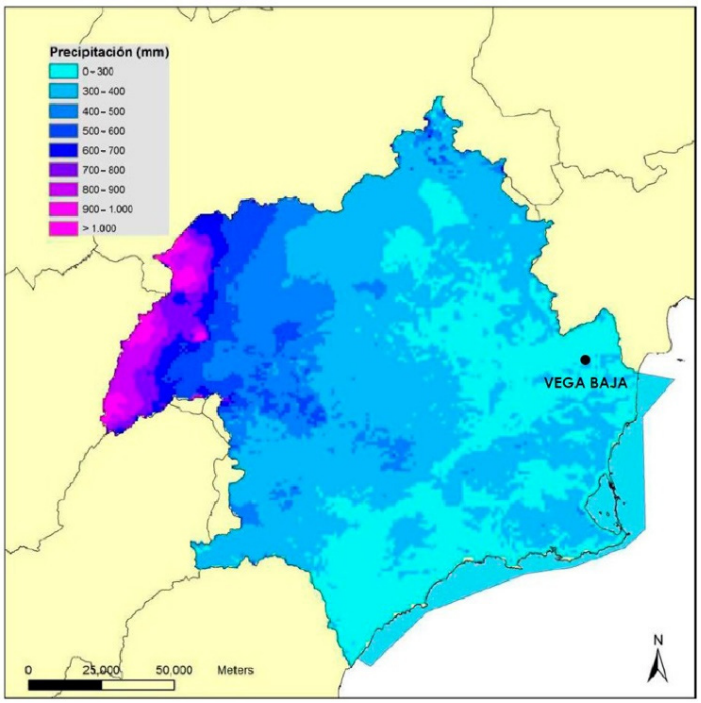


Figure 6. Annual average rainfall, period 1980–2011 [44].

According to the information provided by HIDRAQUA, thanks to the flood protection actions taken through the different municipal master plans of Vega Baja, with the implementation of rain tanks, lamination ponds, etc., the total recovered area will be:

- 7.6 Hm^3/year for agriculture.
- 3.5 Hm^3/year for urban uses.

In other words, a total of 11.1 Hm^3 of water per year will be recovered, constituting a new provision of water resources for the district.

The benefits for agriculture can be estimated in accordance with the productivity per hectare of crop in the area. In this respect, the Segura Basin Hydrological Plan 2022–2027 indicates the net profit margin per irrigated hectare in each of the irrigated areas, called units of agricultural demand (UADs) [8]. Specifically, there are seven UADs in the area of Vega Baja.

After analysing the size, demands and net margins of each of the UADs published in the Segura Basin Hydrological Plan 2022–2027, a weighting of these figures was carried out and a net margin of EUR 3746.55 per hectare of crop on average was obtained. Given that over 1257 hectares will be irrigated, thanks to the 7.6 Hm^3/year that are recovered for this use, the estimated profit for this concept is EUR 4.71 M per year.

On the other hand, the action will generate significant savings in drinking water amounting to 3.5 Hm^3 per year. Given that the average price of the cubic metre of drinking water is around EUR 1.71 in the municipalities of Vega Baja, the savings in drinking water can be estimated at almost EUR 6 M for the municipalities of the district. On the other hand, they must pay a price for the regenerated water, which is estimated at a cost of EUR 339,500 per year.

As a result, the net profit for the regeneration of water for urban uses will be approximately EUR 5.64 M per year.

Overall, the benefit for regenerated water is estimated at EUR 10.35 M per year, which will be included in the economic cost–benefit analysis.

4.3. Protection of the Territory and the Enhancement of the Value of the Property

As mentioned throughout the article, the Vega Baja Nature Plan seeks to significantly transform the Vega Baja del Segura in order to increase its resilience to phenomena that are adverse for the territory, such as floods. In this district, over the last 40 years, seven episodes of floods have been recorded, in 1986–1989, 2012, 2016, and 2019, all of which generated significant material damage [45].

Undoubtedly, thanks to this project, important economic benefits will be gained throughout Vega Baja due both to the reduction in damage and adaptation of the territory to future adverse phenomena and to the enhancement of its value, thanks to the creation and preservation of many environmental resources of the district. These aspects will be analysed in detail below.

4.3.1. Reduction in Damage to Property

Floods incur social, environmental and economic damage of varying severity depending on the intensity and duration of the rainfall. These may include substantial direct damage derived from the impact on infrastructures and properties and from controlling the flood, evacuations and the provision of emergency supplies.

In this project, thanks to the mitigation of the rainwater floods generated through the implementation of the SUDS, designed for a period of return of 15 years, the damage caused to property in the urban areas will be reduced drastically and should be quantified and included as a benefit in the subsequent cost–benefit analysis.

In order to quantify the damage to property, the most relevant parameter in determining the vulnerability to floods is the maximum depth reached by the water. Therefore, for any land use, a theoretical curve could be determined for the percentage of damage over the total value depending on this depth [11].

As illustrated in Figure 7 and in general, the percentage of damage is small if the depth is less than 60–70 cm, but increases exponentially when the depth exceeds this limit, and can become catastrophic [11]. This highlights the notable positive impact of reducing the depth of a flood, particularly if the depth is reduced below thresholds where the damage is minimal, around 15 cm.

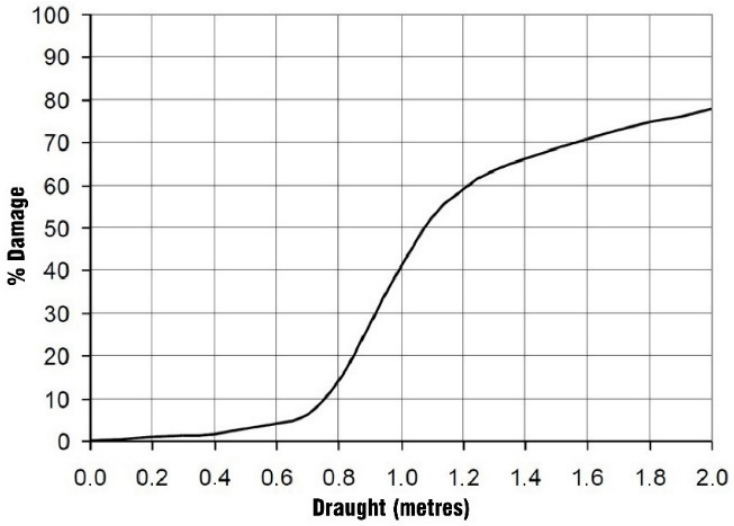


Figure 7. Evolution of the percentage of damage depending on the maximum depth for generic use. Own elaboration based on [11].

The rainwater network, the SUDS and other defence mechanisms enable the negative effect of the waterproofing derived from urbanisation processes to be reversed, increasing the permeability of the soil. In this way, the peak flows are reduced and, therefore, there is a considerable reduction in the damage caused by a flood.

In order to quantify this benefit, the "incremental approach" should be applied, considered as the final benefit of the measure of the difference between the trend flows or flows without a project (the current situation) and the flows with a project (the future situation). To do this, the depth–damage curves or vulnerability curves will be used, which enable the modelling of the possible material losses caused by a flood.

Recently, research was published in Spain which developed a series of depth–damage curves for different types of uses of property in the city of Barcelona [9]. Moreover, regional and time adjustment indices were obtained to transfer the curves elaborated for Barcelona to other municipalities of Spain which also suffer frequent flood episodes, to facilitate the estimates of damage in these areas.

One of the municipalities which the researchers considered in their analysis was precisely Orihuela, in Vega Baja, calculating different factors to be able to transfer the depth–damage curves obtained from Barcelona to this case. Therefore, these depth–damage curves were applied and adjusted to estimate the reduction in damage to property derived from the actions of the Vega Baja Nature Plan.

Based on these considerations, first, the area affected by flooding was determined for a scenario without the project under the period of return contemplated, in this case, 15 years. The municipal master plans for flooding list the areas at risk, establishing three levels; low floods—depths between 0 and 15 cm; medium floods—depths between 15 and 60 cm; and high floods—depths of over 60 cm.

After determining the area affected by floods for each of the levels of risk in the return period of 15 years in the trend scenario, this was compared with the area affected by flooding after implementing the flood protection actions proposed in the municipal master plans, which will be reduced due to the reduction in the depth.

The following land uses were considered: housing (residential use), tertiary, industrial and dotacional, with different depth-damage curves in each case. These draught–damage curves were obtained in 2020 [9] for the case of Orihuela, the capital of the Vega Baja district and one of the two most important municipalities in the region, and are therefore directly applicable. Using these curves, the benefits were obtained after reducing the level of potential range of damage due to draught reduction for each land use analysed (Table 2). As shown in Table 2, the greatest benefit in terms of damage reduction is obviously obtained when the draught is reduced from "High" to "Low" since, as explained above, if the draught exceeds 60–70 cm, the percentage of damage increases exponentially, and the consequences can be catastrophic.

Table 2. Estimate of the benefits due to a reduction in the damage to property according to land use in Vega Baja, in euros per square metre. Own elaboration based on [9].

Reduction in the Depth	Housing	Tertiary	Industry	Dotacional
From "High" (>60 cm) to "Low" or without risk (<15 cm)	EUR 135/m^2	EUR 156/m^2	EUR 273/m^2	EUR 196/m^2
From "High" (>60 cm) to "Medium" (15–60 cm)	EUR 59/m^2	EUR 74/m^2	EUR 133/m^2	EUR 81/m^2
From "Medium" (15–60 cm) to "Low" or without risk (<15 cm)	EUR 77/m^2	EUR 82/m^2	EUR 141/m^2	EUR 115/m^2

Through geographic information systems (GIS), the area affected by flood risk benefited by this project was estimated. Specifically, this area is where the risk of flooding is reduced. After these areas were calculated, the benefit gained from reducing the damage was obtained by multiplying these areas by the estimated values in Table 2.

In total, it is estimated that the benefit from reducing damage in Vega Baja thanks to the project over a return period of 15 years is EUR 193.9 M.

However, the master plans contemplate actions that would implement both the monitoring and sensing systems and the warning and extreme event management system of the "Smart River Basin" programmes. They will generate benefits, as danger and vulnerability data will be provided in real time with early warnings in the different municipal authorities.

With these early warnings, the population will be able to take appropriate action to protect, where possible, their properties, businesses and industries from extreme flood

episodes. Therefore, the benefits gained from a reduction in damage are greater in net terms than those estimated.

For this reason, it is considered reasonable to increase the benefit gained from a reduction in damage by 10%, estimated for rainfall with a return period (T) of 15 years, amounting to EUR 213.3 M.

Furthermore, given that the period of study of the cost–benefit analysis will be 30 years, it is probable that rainfall episodes will occur with a return period of 15 years in this time. Therefore, this benefit will be included twice.

On the other hand, and for the same reason, during the useful life of the installation, a rainfall episode will occur with a return period of 25 years. In this respect, according to the publication "Máximas lluvias diarias en la España Peninsular", published by the Dirección General de Carreteras (General Directorate for Roads) (1999), the rainfall in Vega Baja for a return period of 25 years would be higher than that with a return period of 15 years by 10% to 15%.

Therefore, in the case of a precipitation of a return period of 25 years, much of the potential damage caused would be absorbed by the project, with an estimated benefit of 90% of those obtained with a precipitation with a return period of 15 years of EUR 191.9 M, which will also be included in the subsequent cost–benefit analysis.

When including these benefits in the analysis, they are homogeneously distributed throughout the period of analysis in year seven (T = 15), fifteen (T = 25) and twenty-two (T = 15).

Under the principle of prudence in calculating the benefits, it should be remembered that the cost–benefit analysis will not include rainfall episodes with a return period of less than 15 years or over 25 years.

The future effects of climate change on the increase in extreme rainfall episodes are not taken into account. This is because, according to the recent report by the Intergovernmental Panel on Climate Change (IPCC) of the United Nations, the south and south-east of Spain are among the most affected areas of Europe in terms of rainfall variation and extreme episodes [46]. In other words, with the increase in the frequency of extreme phenomena, the benefits gained from the reduction in damage will tend to be significantly greater. Therefore, these estimates of benefits are conservative in net terms.

4.3.2. Increase in the Value of Properties

The increase in the resilience to the effects of climate change and the improvement of the quality of life and well-being, thanks to the actions carried out in urban environments, should be transferred to the property market of the district. Therefore, a potential increase in the value of properties is expected as a consequence of the actions contemplated in this project.

In this respect, it should be noted that Vega Baja is the district in the province of Alicante and the Region of Valencia with the greatest dynamism in the property market. Therefore, this benefit directly affects one of its most important economic sectors.

In 2017, a total of 14,721 property transactions were registered in the district. That is, 36.7% of the total transactions for the province and 18.6% of the autonomous region. These percentages are very high in relative terms, taking into account that the population of the district only accounts for 7.1% of the residents of the Region of Valencia. In the case of new properties, the weight of Vega Baja is even greater. In 2017, a total of 2852 new properties were sold, 57% of the total number in the province and 38.2% in the region [47].

In an efficient property market, an increase in the value of the properties would be expected, thanks to the reduction in flood risk and to the existence of a difference in sale prices between those properties located in floodable areas and those that are not [48].

However, recent studies show that, in general terms, there are no such differences. The disparities in price of the properties located in areas of risk with respect to those that are not are only visible after a flood episode, when an isolated or temporary reduction in the

price of the property is generated which, according to the results of different researchers, can last from a few months to six or seven years [49–51].

Different reasons explain this inefficiency in the property market, such as the lack of awareness of society about flood risk, the unawareness of buyers with respect to the potential danger existing in a certain area due to this risk, or the lack of communication of these dangers by the different actors involved [50].

Considering these possible reasons and given that the actions of the Vega Baja Nature Plan refer to a low return period (15 years), which, in turn, implies a moderate reduction in depth, it is considered that the impact is negligible, and is somewhat conservative when formulating the cost–benefit analysis and its social profitability.

However, and on the contrary, the actions will generate new green spaces in the different municipalities, such as gardens or floodable parks. These newly created green areas will increase the value of those properties located nearby, generating a new social benefit which, as a result, should be incorporated in the cost–benefit analysis, according to the Guide.

With respect to the quantification of the enhancement of the value of the property market thanks to urban green spaces, although it is true that both in the United States and in Europe, different studies on a local and metropolitan level have been carried out on the increase in the value of properties close to green areas [52,53], the individual circumstances of each property market analysed make it difficult to extrapolate the results from one specific area to another. Therefore, in order to conduct this evaluation, a regional or national analysis is required which takes into account the impact in green zones of different areas and environments, given that there are not sufficient data to undertake this study ad hoc.

Within this framework, in its Guide to Cost–Benefit Analysis, the European Commission considers that this impact should be estimated through a hedonic price approach, which, in the case at hand, consists of comparing the price of the properties located close to urban green areas with respect to those that are not in order to observe the variation in the price related to this factor.

This approach has been chosen for many years by the British government to estimate the impact of green areas on the property market in England and Wales, in a joint study conducted by the Department for Environment, Food and Rural Affairs and the Office for National Statistics of this government [54–57].

After initially analysing the sale of a million properties in England and Wales between 2009 and 2016, with subsequent updates to the present day, the analysts found that those properties located close to green areas experienced an increase in price, which rose as the size of the green zone and the proximity to it increased [10]. Therefore, the greatest increase is found in those properties located less than 200 m from a green space, although slight price rises are detected in properties located within a radius of up to 500 m (Figure 8).

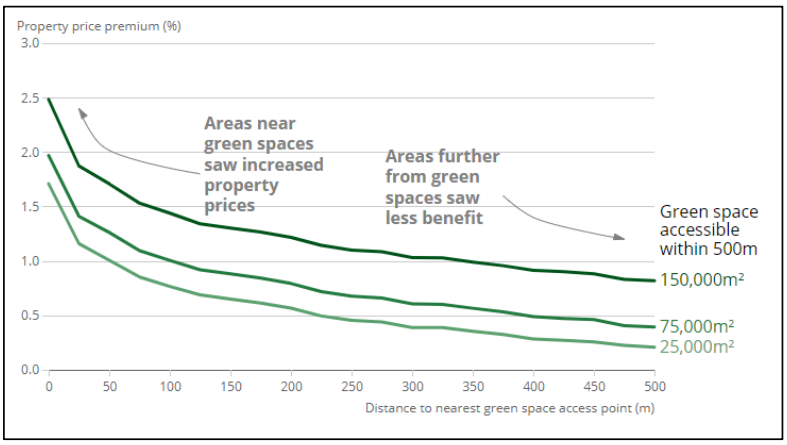


Figure 8. Percentage increase in the price of properties in accordance with their closeness to green spaces depending on the size of the green area and their distance from it [10].

As we can observe in the figure, the greatest price increases occur in those properties that are located less than 100 m from the green spaces, where these properties increase their value by between one and two per cent, depending on the size of the park or garden. The impact of the increased value of properties logically reduces as the distance from the green area increases with price increases of 0.2–0.8% in properties located 500 m away.

To this increase in value we should add the increase in price observed in those properties with views of the green areas. This factor is highly rated by buyers, who are willing to pay above market value for views of green areas. According to the Office for National Statistics of the UK government, the increase in price for this factor is 1.8% [10].

Although the sample of this research is sufficiently representative, with one million transactions, it is possible that the increase in value of a property with views of a green landscape on the property market in south-east Spain is slightly higher due to its scarcity with respect to Great Britain. However, given that there are no studies in Spain with sufficient representativeness, the results obtained in the British study will be applied. Therefore, the hypothesis is conservative with respect to the cost–benefit analysis and its social profitability.

Therefore, based on Figure 8, a hypothesis is formulated regarding the increase in value of properties, thanks to the existence of green areas depending on their size and the proximity of the properties to them. To do this, first, the actions proposed in all of the municipalities were reviewed in detail. Those that involve the creation of new green spaces and are located in areas close to the urban centres or in the existing fabric were chosen. New green spaces with an area of less than 5000 m^2 were eliminated from the analysis, as it is considered that their impact on the property market is negligible.

Given the heterogeneity of the size of these actions, and in accordance with the studies conducted by the British government in this respect, as previously mentioned, the price increase curves of Figure 8 are applied as follows:

- In new green areas of between 100,000 and 400,000 m^2, the upper curve indicated in the graph is applied (150,000 m^2 curve).
- In new green areas of between 50,000 and 100,000 m^2, the middle curve indicated in the graph is applied (75,000 m^2 curve).
- In new green areas of between 5000 and 50,000 m^2, the lower curve indicated in the graph is applied (25,000 m^2 curve).

Based on these curves, the following percentage increases are established and applied in accordance with the distance of the property from the new green area (Table 3):

Table 3. Increase in the value of properties by range. Own elaboration based on [10].

Increase in the Value of Properties	0–50 m	50–200 m	200–500 m
150,000 m^2 curve (from 100,000 to 400,000 m^2)	2%	1.50%	1%
75,000 m^2 curve (from 50,000 to 100,000 m^2)	1.60%	1%	0.60%
25,000 m^2 curve (from 5000 to 50,000 m^2)	1.40%	0.80%	-

As shown in Table 3, there is a greater increase in property values in dwellings close to large green areas. Thus, the largest increase in property values occurs in properties located 0–50 m from green areas of between 100,000 and 400,000 m^2, which will increase in value by 2%. In contrast, the smallest increase to be taken into account in this analysis will be for dwellings located within 200–500 m of green areas of between 50,000 and 100,000 m^2, which will increase in value by 0.6%. It should be noted that the dwellings with the smallest increase would be those located 200–500 m from green areas of between 5000 and 50,000 m^2, with an increase in value of approximately 0.2%, an insignificant figure in the total benefit, while it would also take an enormous number of hours to find the surface area of dwellings located 200–500 m away from these green areas, which is why it is not taken into account.

In order to obtain the benefit, the residential constructed area within each of the three distance ranges for each of the green areas selected is calculated. That of the 200–500 m range is not included for the smaller-sized areas because the increase in price is not significant. The measurements of the constructed area were obtained from the land registry and the property portal Idealista with the support of the GeoNet viewer of the Provincial Government of Alicante.

An additional price increase of 1.8% is also included for those properties which, after the actions, will have views of green areas, specifically, those close to these new green spaces.

After calculating the area of each range of proximity, the value of the price increase of the properties is estimated in accordance with the municipality where the green area is located, based on the average prices per square metre published on the portal Idealista.

Then, applying the percentages of Table 3 to the price of the properties by range of each municipality, it is estimated that the total benefit from the increase in the value of the properties will be EUR 29.7 M.

It should be noted that other benefits for the properties derived from the green spaces, such as the reduction in the "the urban-heat-island effect" in the municipalities are not included in this cost–benefit analysis due to their complexity. This aspect can give rise to significant social benefits in the future, taking into account the climate change forecasts carried out. Similarly to the benefit of the previous section, again these benefit estimates are conservative in net terms.

4.3.3. Recovery of the Productivity of the Land

According to the Guide to Cost–Benefit Analysis of Investment Projects of the European Union, this impact is related to the potential use of the land after the implementation of measures for preventing and reducing natural risks. In other words, before the execution of the corresponding actions, certain land uses were restricted due to their risk of flooding. Therefore, with the application of these actions, in our case the flood protection works and the SUDS, the land could be reclassified as residential, industrial or commercial, etc.

Therefore, this impact should not be considered on the land classified as urban land or sectored and urbanised developable land, but on its area, as the protection measures necessary to mitigate the risk of flooding will have been adopted.

However, in the case of non-delimited developable land (land reserved for future developments but not urbanised), the SUDS can play a very important role.

In order for the non-delimited developable land to become sectorised, it must fulfil the provisions of the PATRICOVA regulations, particularly Article 19 "Limitations on developable land without an approved integrated action programme, affected by flood risk", which indicates that flood protection works will be carried out on this land in order for it to be developed. Additionally, Article 23 referring to "The management of the Green Infrastructure against flood risk" indicates that the use of SUDS will be promoted to increase the resilience of the territory to these phenomena.

In this way, the protection works and the implementation of the SUDS with the subsequent reduction in depth will reduce the risk of flooding, enabling its future use as sectorised and urbanised developable land.

As a result, this section includes as a principal benefit of the measure the non-delimited developable land affected by flood risk, as indicated by the PATRICOVA.

Through the joint use of the Visor del Sistema de Información Urbana (Urban Information System Viewer) [58] and the Visor del Instituto Cartográfico Valenciano (Valencian Cartographic Institute Viewer) [59], it may be observed that the municipalities of Benijófar, Daya Vieja, Dolores and Orihuela have non-delimited developable land at risk of flooding.

In total, over 300 ha of non-delimited developable land at risk of flooding are identified in different parts of the four municipalities mentioned (Table 4).

Table 4. Municipalities with non-delimited developable land at risk of flooding. Own elaboration based on [58–62].

Municipality	Area (ha)	Potential Use
Benijófar	2.5	Tertiary
Daya Vieja	25.1	Industrial
Dolores	27.2	Tertiary
Orihuela	249.8	Residential-Tertiary-Industrial

After locating these areas, an assessment should be made of whether, thanks to the actions of the different municipal master plans, this land would be protected against future floods, because, as it is developable land that has not yet been developed, it may be the case that the actions to carry out do not directly reduce this risk and, therefore, these areas do not benefit.

After the analysis, the developable plots of Dolores and Benijófar that are at risk of flooding would not benefit directly. However, the potentially dangerous situation of 213,400 m^2 in Daya Vieja and of 1,285,400 m^2 in Orihuela would be reversed after the implementation of the actions.

After determining the areas benefiting from the actions of this plan, their positive impact has to be quantified and then included in the cost–benefit analysis. According to the Guide elaborated by the European Union on this aspect, land that has been converted into developable land can be quantified based on the market value, given that it is an appropriate estimate of its opportunity cost. Consequently, the benefit should be calculated by multiplying the benefited area by the market value per m^2, for land used for both residential and industrial purposes.

In this way, these market values are estimated using as a reference the current sales price of urban land for residential and industrial use, based on the sales values of dozens of plots located in the district of Vega Baja as indicated in specialised portals such as Idealista, Fotocasa or Habitaclia. After obtaining these values, the average market price is calculated as EUR 224.18/m^2 for residential land and EUR 146.53/m^2 for industrial land.

Applying these values to the plots benefiting from the Vega Baja Nature Plan, it is estimated that the recovery of productivity of the land gives rise to benefits of EUR 264.84 M, derived from the actions proposed in the Plan.

5. Results

After the evaluation of all the impacts developed above, the following summary table is obtained (Table 5):

Specifically, the three greatest benefits of the project are related to the recovery of the productivity of the land (EUR 265 M), the reduction in damage to property (EUR 620 M) and the reuse of water (EUR 280 M).

The final result of the economic cost–benefit analysis of the Vega Baja Nature Plan generates positive ENPV amounting to EUR 92.4 M. Furthermore, the social profitability or social IRR of the project over 30 years is estimated at 4.3%, showing that the project is socially feasible—that is, beneficial for society.

Therefore, from the analysis conducted in this study, it may be concluded that the municipal master plans to address floods in Vega Baja are socially beneficial and, therefore, fulfil this essential requisite for opting for European finance.

In this respect, it is an ideal candidate for the Recovery and Resilience Facility of the "Next Generation EU" programme [33]. This is a large recovery fund aimed at palliating the economic and social damage caused to the member states by the COVID-19 pandemic.

Specifically, this project was designed taking into account the objectives defined by the "Next Generation EU" programme, which seek the transformation of Europe towards a more ecological, resilient territory, better adapted to current and future challenges.

As previously indicated, this finance is compatible with other European funds derived from the Multiannual Financial Framework 2021–2027 (Structural Funds) and the potential of the Spanish Public Administrations or those derived from the public-private participation contracts.

Table 5. Summary of benefits assessed in the study. Own research.

	Recovery of Natural Spaces	Preservation of Ecosystem Amd Biodiversity	Reduction in Greenhouse Gases	Reuse of Water	Reduction in Damage to Property	Increase in the Value of Properties	Recovery of Land Productivity
2023	-	-	-	-	-	-	-
2024		EUR 417,211	EUR 32,643				
2025		EUR 834,422	EUR 66,960				
2026	EUR 3,447,656	EUR 1,251,633	EUR 102,951	EUR 10,357,135		EUR 29,750,877	EUR 264,840,338
2027	EUR 3,447,656	EUR 1,251,633	EUR 105,462	EUR 10,357,135			
2028	EUR 3,447,656	EUR 1,251,633	EUR 107,973	EUR 10,357,135			
2029	EUR 3,447,656	EUR 1,251,633	EUR 110,484	EUR 10,357,135	EUR 213,282,986		
2030–2036	EUR 3,447,656	EUR 1,251,633	EUR 112,995	EUR 10,357,135			
2037	EUR 3,447,656	EUR 1,251,633	EUR 112,995	EUR 10,357,135	EUR 191,954,687		
2038–2040	EUR 3,447,656	EUR 1,251,633	EUR 112,995	EUR 10,357,135			
2041–2043	EUR 60,000	EUR 1,251,633	EUR 112,995	EUR 10,357,135			
2044	EUR 60,000	EUR 1,251,633	EUR 112,995	EUR 10,357,135	EUR 213,282,986		
2045–2052	EUR 60,000	EUR 1,251,633	EUR 112,995	EUR 10,357,135			
TOTAL	EUR 52,434,840	EUR 35,045,724	EUR 3,125,358	EUR 279,642,645	EUR 618,520,659	EUR 29,750,877	EUR 264,840,338

6. Discussion and Conclusions

The objective of this article is to estimate the socio-economic impact of the investment and social efficiency of implementing the municipal master plans to address flooding in Vega Baja (Vega Baja Nature Plan).

This project will generate a profound territorial transformation for each of the 27 municipalities of Vega Baja del Segura, significantly increasing the quality of life and well-being of their inhabitants, thanks to the many green urban areas and regenerated spaces for their use and enjoyment which incorporate gender equality policies and actions in their design to favour social cohesion.

In addition, the actions generate many environmental benefits, such as the preservation of the ecosystems and biodiversity, the reduction in greenhouse gas emissions and the better use of water resources, an essential aspect for this district.

Furthermore, these flood protection measures will lead to a significant decrease in the risk of these extreme phenomena, reducing the potential damage to property, recovering the productivity of the land in certain areas and increasing the value of the properties, thanks to their proximity to the new urban green spaces.

It is worth mentioning that the most noteworthy benefits obtained are those related to the recovery of the productivity of the land, the reduction in the damage to property and the reuse of water, as together they account for 91% of the total monetised value.

Thus, the cost–benefit analysis requires a great deal of work to analyse all the impacts, and it is therefore advisable to start the analysis with those impacts that are considered most relevant. Thus, if these main benefits barely manage to amortise the investment and maintenance, it can be concluded in advance that the investment will not be socially positive. Similarly, if these impacts generate a positive IRR or very close to it, it can be assumed that the investment is socially positive and may be worth pursuing in order to determine the final profitability of the project and the subsidy required, if any.

The final result of the economic cost–benefit analysis generates positive ENPV amounting to EUR 92.4 M. Furthermore, the social profitability or social IRR of the project over 30 years has been estimated at 4.3%, showing that the project is beneficial for society.

In short, it is a plan that has a high social profitability for the whole of Vega Baja based on an integrated approach which complies with the SDGs and the 2030 Agenda: the flood risk is mitigated, it favours the circular economy through the reuse of water, improving the quality of its discharge into the different collectors, greenhouse gas emissions are reduced and it favours social cohesion through the generation and enhancement of value of many recreational spaces, incorporating the gender perspective, among many other social benefits.

Finally, the SIRR or social profitability of the project could be slightly higher than the result of 4.3% obtained, as there are several impacts of complex quantification for which there is no defined methodology, and which are considered methodological limitations.

The first limitation relates to the positive impact on the marine environment—specifically on Posidonia—due to the improvement of the quality of the water resources [37,38] of the Segura riverbed in the municipality of Guardamar del Segura.

The future effects of climate change due to increased extreme precipitation events have also not been taken into account since, according to the recent report of UN's Intergovernmental Panel on Climate Change (IPCC), the south and south-east of Spain—where the Vega Baja region is included—are among the most affected areas in Europe in terms of rainfall variation and extreme events [46], i.e., with an increase in the frequency of extreme events, the damage reduction benefits over 30 years will tend to be significantly higher than those estimated in this research.

Finally, the impact on gender equality has only been taken into account qualitatively, because it has not been possible to quantify it in monetary terms.

Therefore, in view of the limitations indicated above, these new lines of research are opened up so that they can be included quantitatively in the cost–benefit analysis and obtain even more precise results.

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