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An economic valuation of ecosystem services provided by the River Turia Natural Park (Valencia)

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ABSTRACT: The objective of this paper is to obtain the monetary value of ecosystem services provided by the Turia Natural Park (TNP). This paper proposes the use of the Analytic Multicriteria Valuation Method (AMUVAM) by replacing the Analytical Hierarchy Process (AHP) with the Analytic Network Process (ANP), since the ANP method allows to analyze interdependence relationships between the services provided by a system. The results express that the economic value of the ecosystem services associated to the TNP ranges between 163,946,752 € and 481,549,597 €. The results reveal distinct patterns in the valuation of the existing services due to ethical issues.

KEYWORDS: AMUVAM, ANP, ecosystem services, multi-criteria decision methods, valuation of environmental systems.

Valoración económica de los servicios ecosistémicos asociados al Parque Natural del Turia (Valencia)

RESUMEN: El objeto de este trabajo es la obtención de un intervalo de valor de los servicios ecosistémicos proporcionados por el Parque Natural del Turia (PNT). La metodología empleada ha sido el método analítico de valoración multicriterio (Analytic Multicriteria Valuation Method, AMUVAM) sustituyendo el Proceso Analítico Jerárquico por el proceso analítico en red (Analytic Network Process, ANP), dado que este permite analizar relaciones de interdependencia entre los servicios del sistema. El valor económico de los servicios ecosistémicos asociados al PNT oscila entre 163.946.752 € y 481.549.597 € en función de las diferentes sensibilidades éticas de los expertos.

PALABRAS CLAVE: AMUVAM, ANP, servicios ecosistémicos, métodos de decisión multicriterio, valoración de activos ambientales.

JEL classification/Clasificación JEL: Q57 Q29, C52, H43.

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1. Introduction

There is an increasing awareness about environmental goods. The main factors which make society more sensitive to these goods are: income rise, increased leisure time, ease of movement, urbanization of the population and evidences about the potential effects of chemical inputs on human health and the environment (MEA, 2005a; Slangen, 1994). All these circumstances have led to an increasing demand of environmental goods alongside the growing importance of natural areas. Consequently, in the recent years the interest towards the analysis and valuation of environmental services has risen (Bateman *et al.,* 2013; Díaz *et al*., 2015). As a result, consumer preferences have evolved towards a greater appreciation of environmental goods and towards the emergence of *environmentalism* as a powerful ethical and political force. Accordingly, the importance of protected areas such as the wetlands, which have traditionally been less valued, has been enhanced (Juffe-Bignoli, 2014; Palomo *et al.,* 2014).

Despite the importance of environmental services and the benefits they generate for society, as the market does not capture them, society fails to perceive their true value (Aznar and Estruch, 2015) and therefore, they weakly weigh in political decisions (Constanza *et al.,* 1997). This is principally due to market failures, a consequence of the existence of inexhaustible externalities which refer to the non-rivalry in the consumption of many environmental externalities (Baumol and Oates, 1989). This causes the market not to consider all the benefits that society obtains from ecosystems. The result from a social point of view is the inefficient use of natural resources which contributes to the loss and degradation of our natural capital (GBO3, 2010; MEA, 2005a).

The concept of environmental economic valuation can be understood as "an instrument to serve the environmental policy which is intended to attribute economic values to environmental goods and services" (Herruzo, 2002). The concept can be also considered as the determination of the value of a good taking into account its characteristics and its economic-temporal context by using a contrasted method of calculation and allowing to incorporate objective knowledge and quantitative variable as well as subjective knowledge and qualitative variables (Aznar and Guijarro, 2012).

Some authors express their views about the importance of environmental valuation and the need to value natural spaces. Kriström (1995) considers that, with the valuation of environmental assets, goods that are not considered by the market will be more efficiently used. In the same way, Azqueta (1994) points out that the valuation of environmental assets is useful to improve the use of public resources and encourages conservation, preservation and restoration. The importance of environmental valuation also lies in allowing society to become involved in public decision-making processes (Mooney *et al.,* 2005). Furthermore, communicating the economic value of goods and services contributes positively to society, since it shows the costs that would be caused by the loss of biodiversity and the degradation of ecosystems (TEEB, 2010). Herruzo (2002) states that "economic valuation is necessary to achieve two priority economic objectives in any economic system: economic efficiency and sustainable growth.” Finally, Ramsar (2007) considers valuation important in order to “ensure more balanced decision-making”. Therefore, the need to value natural spaces is the first step to consider the benefits generated by ecosystems, ergo to be considered it is necessary to define their value.

In summary, the relevance of estimating the value of the environment lies in being able to transmit to a society, which trusts on market forces, the monetary value of the services provided by an environmental asset so that it can be perceived. Nevertheless, as a sector of society does not want to commodify the environment, the purpose of the value that is sought is not to privatize the environmental asset (Aznar and Estruch, 2015). The objective is to determine the magnitude of the benefit that the asset provides in order to support effective informed decisions. In this way this process can be useful for the public administration, since it allows them to justify the investments and actions (Aznar and Estruch, 2015). This encourages a more efficient management which allows a better conservation and protection of environmental assets and prevents their degradation.

This paper aims to obtain the economic value of the ecosystem services provided by the Turia Natural Park. The purpose is to obtain an indicator of the economic value which allows society to capture its value, as well as providing the public administration a reference to justify its investments and prioritize their actions.

The Turia Natural Park is a riverside park with an area of 4.736 hectares. It is located in the Community of Valencia, specifically, west of the City of Valencia. The natural site was declared Natural Park in 2007 by the Generalitat Valenciana. The river acts as a backbone of the Park, as well as a first-order biological corridor. It is a space of great ecological interest, essentially for its biodiversity due to the presence of endemism (Generalitat Valenciana, 2015). The Park is an ecosystem located in a large metropolitan area around the City of València and neighbouring districts. As for the method for environmental valuation, our research makes use of an adaptation of the AMUVAM multicriteria valuation method (Aznar *et al.,* 2014) that applies Analytic Network Process (ANP) as a procedure to select alternatives. In the next pages, Section 2 makes deals with ethical considerations of environmental valuation and Section 3 introduces ecosystem services according to the Millennium Ecosystem Assessment (MEA). Section 4 details the methodology used, based on multicriteria valuation methods, in particular the adaptation of the Analytic Multicriteria Valuation Method (AMUVAM). The two final sections present the main findings and the article’s conclusions.

2. Environmental ethics

Moral considerations have great relevance in environmental valuations. There are environmental ethics which address the complexity of the valuation towards the human species and its relationship with the different elements that make up the biosphere. The anthropocentrism is considered the “conventional posture, according to a cultural tradition that places the human being at the cosmos centre”. This environmental philosophy states that “precisely the human species is the one who gives value to the rest of its components, therefore, the human being is the only subject with fundamental right" (Azqueta, 1994). On the contrary, there is another vision regarding animal and living beings rights, which considers that anthropocentrism is an unjustified discrimination and professes that a "path towards a more just society will be to break down the barrier that separates the human species of the rest of the biosphere species" (Azqueta, 1994).

Anthropocentrism does not consider the environment as an individual. Instead, the environment is only taken into consideration when the personal interests of the human species are compromised. Within anthropocentrism, although it considers that human beings are the only ones who possess immanent value, individuals differ with respect to the importance given to the intrinsic value that nature possesses. This implies that the importance given to different ecosystem services by individuals may differ even if their assessment is consistent. Therefore, it is reasonable to establish a range of values as a result of the assessment (Azqueta, 1994).

Consequently, anthropocentrism could be more appropriate for environmental valuations as it can be better understood by an individualist and capitalist society like the present one. Animalists, in turn, do not consider only human beings as the only subjects of value and present a holistic vision regarding animals and living beings. However, the complexity towards the valuation of environmental services is much higher; even within anthropocentrism there are also individuals whose welfare is affected by the welfare of the rest of nature (Azqueta, 1994). To consider this combination of visions, the experts interviewed in the present research were divided into two groups according to their similarities in terms of the given answers. This was accomplished through a cluster analysis so that the different approaches can be reflected. That is to say, there is a range of values based on the ethical positioning of the valuator which shows the gradation between the different positions. For that reason, there is not a single value but a range of values for the ecosystem services provided by the Natural Park.

3. Ecosystem services and their classification and the Millennium Ecosystem Assessment

Introducing ecosystem services as a concept allows us to express the benefits provided by nature into economic terms, as well as to transfer the importance of natural ecosystems to society and generate social interest in the conservation of biodiversity (Valdéz and Ruiz, 2011). It is important to contextualize and understand the concept in order to value the Turia Natural Park.

First of all, in order to define the concept of ecosystem services, the notion of ecosystem needs to be established. According to Millennium Ecosystem Assessment (MEA), an ecosystem is "a dynamic complex of plants, animal and microorganisms communities and the non-living environment interacting as a functional unit". Once the concept of ecosystem is defined, the concept of ecosystem services can be defined as "the benefits that human beings obtain from ecosystems produced by interactions within the ecosystem" (MEA, 2005a).

There is a consensus on the definition of what ecosystem services are, but some debate exists on how to classify them. Classifications are based on factors related to their diversity, functionality, processes and structure (Valdéz and Ruiz, 2011). Daily *et al*. (2000) classified the services that derive from an ecological community in which a type of vegetation dominates, called a biome; for example, the steppe. The quoted author focuses on the conditions within the ecosystems as well as on the related processes and biotic components (Valdéz and Ruiz, 2011).

Other authors, together with Constanza *et al., op.cit. (*1997), classify ecosystem services according to the benefits that society perceives from them, distinguishing between tangible physical objects and intangible processes (Valdéz and Ruiz, 2011). Costanza *et al., op.cit* (1997) proposes a list that defines 17 ecosystem services associated to the functions of ecosystems which generate goods or services (Valdéz and Ruiz, 2011).

In 2002, De Groot *et al.* presented a classification aiming at creating a general framework focused on the functions and services provided by ecosystems. The framework is based on the functional groups of ecosystems and their interrelations to define what they call goods and services. This classification consists of 23 basic functions associated in four categories (regulation, habitat, production and information) where its potential is considered in relation to the satisfaction of human needs (Valdéz and Ruiz, 2011).

Another classification was proposed in 2008 by Fisher and Turner, based on the division between intermediate services and final services (Valdéz and Ruiz, 2011). This classification makes the complexity of ecosystems visible and establishes a connection between ecosystem processes and services. The objective of the authors is to implement payments for ecosystem services as a strategy to protect and restore natural spaces through a valuation with a multifunctional approach.

Between 2001 and 2005, the United Nations (UN) undertook a scientific report about the consequences of changes in ecosystems with the participation of scientists from 95 countries. The MEA initiative (MEA, 2005a and 2005b) defined the social benefits provided by ecosystem services and disseminated a classification based on four types of services: supporting services, provisioning services, regulating services and cultural services. The aim of MEA was to integrate ecological sustainability, conservation and well-being, as well as to support decision-making (Valdéz and Ruiz, 2011). This classification is one of the most widespread and accepted classifications. Several works on environmental assessment use the classification of the Millennium Ecosystem Assessment. Rewitzer *et al.* (2017), Mendoza-González *et al.* (2012) and Tudela-Mamani *et al.* (2011) adopt the classification of MEA for the valuation of ecosystem services.

There are authors like Valdéz and Ruiz (2011) who consider that the classification proposed by MEA has a weak ecological basis due to its anthropocentric perspective. The concept emphasizes the utilitarian character that humans attribute to natural processes and elements, focusing the assessment on them (Schröter *et al.,* 2014), based on anthropocentrism, which was discussed in the previous section. In spite of this, for the valuation of the Turia natural space, we opted for using the classification derived from MEA, because it adapted well to the Turia case, as for its simplicity, accessibility and applicability to public decision-making (Valdèz and Ruiz, 2011). Also, as mentioned above, it is a classification widely approved because of its multi-disciplinary approach.

From the general list proposed by the MEA classification MEA (2005a and 2005b) and interviews with experts from the Natural Park, the ecosystem services existing in the site were obtained. MEA considers four categories of ecosystem services: supporting services, provisioning services, regulating services and cultural services.

- Supporting services are those services that are necessary for the production of all other ecosystem services. They form the basis of all ecosystems, as well as for their services, eg. recycling of nutrients, soil formation and photosynthesis.
- Provisioning services are the products that people obtain from ecosystems such as food, water and fiber; these are divided into market and non-market services.
- Regulating services are the benefits people obtain from the regulation of ecosystem processes that affect climate or water quality.
- Cultural services are the non-material benefits that people obtain from ecosystems through spiritual enrichment, recreation and aesthetic experiences.

4. Methods

4.1. Multicriteria models and the Analytic Multicriteria Valuation Method

Multicriteria methods have been proposed to optimize decision making based on ecosystem valuation (Castro and Urios, 2017). The multicriteria models (MCDM - *Multiple Criteria Making Decision*) are intended to help in decision-making when there are several criteria that are not simultaneous (Aznar and Guijarro, 2012), due to the existence of criteria to which society attach different values, and cannot be aggregated in the same variable. The demand for these tools has increased due to changes in the way environment is understood. Factors present in society are of social, political, technological, economic and environmental nature. The economic criterion is not the only one to be taken into consideration.

The standard AMUVAM method is a valuation method of environmental assets which consists of two phases: the Analytical Hierarchy Process (AHP) and the discount cash flow (Aznar *et al.,* 2014). The first phase is based on assessing the comparative importance to be given to each of the ecosystem services provided by the considered asset, in this case the Park. The second phase aims to obtain the total economic value of the assets. The standard method assumes that there is no interdependence between services. In our case we consider that ecosystem services are interdependent so the prioritization is obtained by using Analytic Network Process (ANP) instead of AHP. For the second part, the income update method is used to transform the annual income generated by ecosystem services into the value of the asset.

Therefore, for the enviromental valuation, we use a modified AMUVAM method. The procedure follows the same scheme as the standard AMUVAM method, except that the importance of each elements is obtained through ANP instead of AHP. We thus assume that the estimated services are dependent on each other: supporting services, provisioning services, regulating services and cultural services.

To avoid double accounting, the supporting services can be considered as inputs of the rest of the services and, therefore, they are not considered for the valuation. Only the provisioning services, regulation services and cultural services are valuated. With this operation, the total value of ecosystem services and the other three final ecosystem services can be obtained, but it is not possible to know what part of the value of ecosystem services comes from support services. Therefore, we only value the final production of the ecosystem services.

The valuation presents several limitations. In order to address them, we opted not to work with a single value but to work with a range of values, thus avoiding ethical problems. The issue of double accounting was dealt with by removing the inputs that are not adding value to each ecosystem service. The data obtained can not be contrasted but the reliability of the study is based on the consistency ratios (CR), provided by the AMUVAM method, which is a parameter that verifies the coherence of the obtained data.

4.2. Analytic Network Process Method

The Analytic Network Process is a generalization of Analytical Hierarchy Process. It is a method of selecting alternatives based on a series of criteria or variables. In our case there are no alternatives, but we use this method to be able to quantify the importance of each of the ecosystem services in the total value provided by the total ecosystem services. Thomas L. Saaty published the method in 1996 (Saaty, 1996). Unlike the AHP, the ANP method considers all interrelationships, influences and feedback between all elements of the system (Aznar and Guijarro, 2012). This process is based on the several phases, which are described below:

Identification of the elements of the network and construction of the network. Based on the classification proposed by MEA in 2005, and on the interviews with the experts from the Natural Park, the existing ecosystem services were identified. The ecosystem services were grouped in different clusters. In this specific case, there are three clusters: C1, provisioning services; C2, regulating services; and C3, cultural services.

Analysis of the network of influences: matrix of interfactorial domination. Once the clusters and their components were defined, the influence that the elements exert on each other and the feedback between them were determined. For this, the matrix of interfactorial domination or influence matrix was used (Table 1). This matrix is formed by ones and zeros:

TABLE 1

Scale of the influence matrix

Symbology	Influence between elements
1	Influence between the elements exists
0	No influence exists between the elements

Source: Aznar and Guijarro (2012).

Considering the scale of influences, the matrix of interfactorial domination is obtained (Table 2). The matrix is constructed by determining if each of the elements or services that form the cluster influences the other elements. In the example above, cluster C1 is made up of three ecosystem services: e_{11}, e_{12} and e_{13}. In the matrix, the vector obtained is (0,1,1) which means that the ecosystem services e_{12} and e_{13} have influence over the service e_{11} and that they have no influence over itself. To complete the matrix of interfactorial domination, the same methodology is used to determine the influences of the elements of C1, as well as those of the other clusters (C2).

TABLE 2

Interfactorial domination matrix

		C1			**C2**		
		e_{11}	e_{12}	e_{13}	e_{21}	e_{22}	e_{23}
C1	e_{11}	0	1	0	1	0	1
	e_{12}	1	0	1	1	0	1
	e_{13}	1	1	0	0	1	1
C2	e_{21}	0	1	1	0	0	0
	e_{22}	1	1	1	0	0	0
	e_{23}	1	0	1	0	0	0

Source: Aznar and Guijarro (2012).

Calculation of the priorities between elements: original supermatrix. Once the influences are identified, they must be transformed into quantitative percentages, through paired comparison matrices. In order to quantify these influences, it is necessary to determine which element has the most influence and how much influence it has. Following the example, the questions would be: "over e_{11}, which element has more influence, e_{12} or e_{13}? And how much more influence does it have?" The paired comparison matrix is constructed by comparing the elements of the network in pairs and quantifying the comparison using a fundamental scale (Table 3) proposed by Thomas L. Saaty in 1980 (Saaty, 1980).

TABLE 3

Fundamental comparison scale by pairs

Value	Definition	Observations
1	Equal importance	Criterion A is as important as criterion B
3	Moderate importance	Experience and judgment slightly favor criterion A over B
5	Strong importance	Experience and judgment strongly favor criterion A over B
7	Very strong importance	Criterion A is much more important than the B
9	Extreme importance	The evidence favouring criterion A over criterion B is of the highest posible order of affirmation
2, 4, 6 y 8	Intermediate values when compromise is needed	
Reciprocals of above	If criterion A has strong importance over criterion B: Criterion A over criterion B 5/1 Criterion B over criterion A 1/5	

Source: Saaty (1980).

The matrices constructed must fulfil three properties: reciprocity, homogeneity and consistency. Consistency is one of the strengths of the method, which is one of the few methods with an objective parameter that verifies the coherence of the obtained data. For this, consistency ratio (CR) indicates if the information is consistent. The ratio must be lower than previously determined percentages depending on the matrix range (Table 4).

TABLE 4

Percentages limits of the consistency ratio

Matrix range	Consistency ratio (%)
3	5
4	9
5 o more	10

Source: Aznar and Guijarro (2012).

Considering the proposed example, if over the element e_{11}, e_{12} had more influence than e_{13}, and this influence was an intermediate value between moderate importance and equal importance, the quantification of the influences would be as Table 5 shows:

TABLE 5

Influences of e_{12} and e_{13} over e_{11}

	E_{12}	E_{13}	Eigenvector
e_{12}	1	2	0.667
e_{13}	1/2	1	0.333
CR (%)	0	0	1.000

Source: Aznar and Guijarro (2012).

These quantifications from experts are transferred to the matrix of interfactorial domination substituting the ones, which indicated the existence of influence. We thus obtain a matrix of interfactorial domination.

To quantify the influences of the remaining network elements, the same procedure must be repeated, considering the corresponding matrices for each cluster and obtaining the original supermatrix formed by eigenvectors and zeros.

Calculation of priorities between clusters: weighted supermatrix. The original supermatrix must be transformed into a stochastic matrix by columns (a matrix where all columns add up one) until the successive powers of the supermatrix converge. To carry out this transformation, a paired comparison matrix with the clusters is proposed to determine the weight of these according to their importance.

Considering the previous example, the question to be asked in this phase would be: "between cluster C1 and C2, which has the greatest influence over the elements of C1? And how much more influence does it have?" With this, we obtain a matrix like this (Table 6):

TABLE 6

Influences of C1 and C2 over C1

	C1	C2	Eigenvector
C1	1	1/3	0.250
C2	3	1	0.750
CR (%)	0	0	1.000

Source: Aznar and Guijarro (2012).

Once the weights are obtained, they are multiplied by the weights of the elements of each cluster to obtain the stochastic matrix. That is, if the value of the service e_{11} was 0.667, this must be multiplied by the weighting of the corresponding cluster, in this case 0.250. For Cluster C1, the operation would be:

$$0,667 \text{ x } 0.250 = 0.167 \qquad [1]$$

Therefore, we can obtain the influence of each element in relation to the importance given to the clusters (Table 7).

TABLE 7

Weighted supermatrix of C1 and C2 over C1

		C1			**C2**		
		e_{11}	e_{12}	e_{13}	e_{21}	e_{22}	e_{23}
C1	e_{11}	0	1	0	1	0	1
	e_{12}	0.667 x 0.25	0	1	1	0	1
	e_{13}	0.333 x 0.25	1	0	0	1	1
C2	e_{21}	0	1	1	0	0	0
	e_{22}	0.167 x 0.75	1	1	0	0	0
	e_{23}	0.833 x 075	0	1	0	0	0

Source: Aznar and Guijarro (2012).

Calculation of the limit supermatrix. The limit supermatrix is obtained by multiplying the weighted supermatrix by itself as many times as necessary until obtaining a matrix where all the columns converge to a certain value. All the columns of this matrix will be the same, indicating the global priority of the elements of the network.

4.3. Expert interviews

First of all, we must know the main environmental services provided by the Turia Natural Park. We start from the general list of the Millennium Ecosystem Assessment. Experts establish which of the ecosystem services are significant and which are not. In order to do so, the interviews must be carried out with Park's experts who have extensive knowledge about the area of study and its ecosystem services.

The model of survey adopted for the present paper is based on that formulated by De la Hera *et al.* in 2017. This questionnaire is based on three sections: Existence of the environmental service, importance of the service and factors that influence the change of services. Our case only relied on two of the interview's sections: the existence and importance of the ecosystem service, without considering the factors that influence the change in services, since this section is not relevant for the valuation of the ecosystem services associated with the Turia Natural Park. Therefore, only the existence of the service and its importance within the Park were considered. The experts had to determine if the service existed or not, and in the case that it existed, its importance making use of a colour scale. Green, for services with strong importance, amber for moderate importance, and red for weak importance.

Once the questionnaire was designed, the interviews were carried out with the collaboration of experts with different profiles associated to the Natural Park: the director of the Turia Natural Park, the former director of the Turia Natural Park, a member of the general board of the Turia Natural Park, municipal environmental officers and a member of an NGO.

As the objective of the first phase of the interviews was to determine which of the ecosystem services were associated to the Park and which were not, a frequency analysis was carried out for the interpretation of the interviews with the experts. The frequency analysis is used to determine the services that are important within the Natural Park. The frequency of the services was classified as of a strong, medium or weak importance. This procedure allowed us to discard those services that only have weak importance and, according to the experts, are not representative in the Park. It was decided that, in order to be considered representative, the service must be regarded as of strong importance by at least four of the experts.

The second phase of interviews applied the ANP method, previously explained, once the existing ecosystem services in the Natural Park had been determined. Once the survey was designed, the meetings with the experts associated with the Turia Natural Park were arranged so that they could determine the importance of the existing services. It is not necessary for these experts to be the same ones as in the first phase. Other experts who are equally closely related to the Turia Natural Park and its ecosystem services can be interviewed. This second phase of interviews included the director of the Turia Natural Park, the former director of the Turia Natural Park, a member of the general board of the Turia Natural Park, a forestry engineer, an agroforestry holder and an arable land holder.

4.4. Obtaining the economic value of the ecosystem services of the Park

As the interviews with the experts were completed and the supermatrix limit was obtained, the pivot value was calculated. This calculation can be carried out in parallel with the interviews. The pivot value is the value of the ecosystem services that have a market and therefore their monetary value can be known. Based on this value, the value of ecosystem services that do not have a market can be quantified.

First of all, experts define which of the services entail economic activity for the Park. Then, the value of direct use is calculated through the activities that do have a market and therefore have income associated with them. The value of an economic good with a market is equal to the current value of the sum of its related incomes, so we calculated its gross margin.

These incomes are updated with the actual revenue method, since with the valuation method applied we obtain the value through the annual value of the incomes provided by the ecosystem services. In this particular case we used the social discount rate (SDR) instead of a financial rate as the use of the market discount rate does not incorporate all the objectives pursued by the company, since such rate is the result of individual decisions, and society is not the mere aggregate of its individuals (Aznar and Estruch, 2015), therefore its use is not adequate for social issues. The SDR reflects to what extent, from the point of view of a society, a present benefit is more valuable than the same benefit obtained in the future (Boardman *et al.,* 2008; Correa, 2006; Moore *et al.,* 2004).

Based on the calculated value of the market services, the pivot value and the weight of the influences of the remaining services, the value of the ecosystem services can be determined. This procedure allows us to determine the economic value for the ecosystem services of the Turia Natural Park.

5. Results and discussion

5.1. Results: first phase of interviews

As previously explained, the frequency analysis identified the relevant services provided by the Park. Likewise, it allowed us to discard non-significant services. A table indicating the frequency was obtained according to the importance of ecosystem services. The relevant services of the Turia Natural Park are listed in Table 8. For the provisioning services, as there are market and non-market services, the importance of the market and non-market services is determined separately.

TABLE 8

Services provided by the Turia Natural Park

Ecosystem services		
Provisioning services (PS)	**Regulating services (RS)**	**Cultural services (CS)**
Agriculture (MS)	Climate regulation (CR)	Recreational and tourist activities (RA)
Hunting (MS)	Regulation of erosion and conservation of fertility (ER)	Didactic and educational activities (DA)
Water (NMS)	Regulation of water flows and their quality (WR)	Aesthetic value (AV)
	Pest regulation and biological pest control (PR)	Research activities and knowledge system (RKA)
	Regulation of water purification (WPR)	
	Regulation of air quality (AR)	
	Waste and wastewater treatment (WT)	
	Carbon capture and storage (CCS)	
	Pollination (P)	

Source: Compiled by authors based on interviews with experts from the first phase.

5.2. Results: second phase of interviews

Once the relevant ecosystem services in the Natural Park are determined, the ANP methodology can be applied. Subsequently, the results of the interviews with the experts associated with the Natural Park are presented. The experts were grouped according to their similarities, as explained previously. The experts were divided into two groups. The first group was composed of experts 1 (forestry engineer), 2 (agroforestry owner) and 5 (arable land owner); and the second group was formed by experts 3 (director), 4 (former director) and 6 (member of the general board).

The experts were grouped according to the similarities of their feedback, the calculation of the weighting of the ecosystem services was carried out from the eigenvectors provided by experts' responses. The geometric mean of the eigenvectors provided by the experts interviewed was calculated. Later on, these geometric means were standardized by addition, with the value 1 for the addition of all the ecosystem services; consequently, the weights of the services associated with the clusters were calculated, and with them, the weight that these ecosystem services have globally.

The aggregation reflects a logical division of groups sharing common ideas, where Group 1 was formed by the forestry engineer and the owners, while the Group 2 was formed by the experts related to the direction and management of the Park, that is, the director, the former director and the member of the governing board.

The main differences between the groups lie on the weights that they attach to ecosystem services. Experts 1, 2 and 5 (Group 1) give priority to provisioning services and regulation services, and grant less importance to cultural services. Experts 3, 4 and 6 (Group 2) provide greater relative weight to regulatory services, leaving provisioning services and cultural services in the background. However, despite prioritizing regulatory ecosystem services, Group 2 grants the Park's cultural services greater importance than Group 1.

TABLE 9

Eigenvectors provided by the experts interviewed and absolute value

		Experts: Group 1					Experts: Group 2				
		E 1	**E 2**	**E 5**	**G.M**	**S.A**	**E 3**	**E 4**	**E 6**	**G.M**	**S.A**
Ecosystem services	**PS**	0.447	0.389	0.405	0.413	0.414	0.110	0.138	0.181	0.140	0.144
	RS	0.450	0.488	0.484	0.474	0.475	0.608	0.767	0.733	0.699	0.720
	CS	0.104	0.123	0.110	0.112	0.112	0.283	0.095	0.087	0.133	0.136
Total value		-	-	-	**0.998**	**1.000**	-	-	-	**0.971**	**1.000**

		Experts: Group 1						Experts: Group 2					
		E1	**E2**	**E5**	**G.M**	**S.A**	**Weight**	**E3**	**E4**	**E6**	**G.M**	**S.A**	**Weight**
Provisioning services	**MS**	0.243	0.219	0.228	0.230	0.556	0.230	0.060	0.073	0.100	0.076	0.545	0.078
	NMS	0.204	0.170	0.177	0.183	0.444	0.184	0.049	0.065	0.081	0.064	0.456	0.066
Total value		-	-	-	0.413	1.000	-	-	-	-	0.140	1.000	-
Regulating services	**CR**	0.082	0,091	0.087	0.087	0.524	0.248	0.137	0.174	0.166	0.158	0.729	0.525
	ER	0.041	0.043	0.043	0.042	0.255	0.121	0.052	0.064	0.061	0.059	0.270	0.194
	WR	0.064	0.068	0.068	0.066	0.400	0.190	0.080	0.102	0.097	0.093	0.427	0.307
	PR	0.041	0.045	0.045	0.044	0.263	0.125	0.047	0.059	0.056	0.054	0.246	0.177
	WPR	0.034	0.036	0.035	0.035	0.210	0.100	0.050	0.063	0.058	0.056	0.260	0.187
	AR	0.033	0.036	0.035	0.035	0.209	0.099	0.054	0.069	0.066	0.063	0.288	0.207
	WT	0.042	0.045	0.045	0.044	0.266	0.126	0.060	0.076	0.072	0.069	0.316	0.227
	CCS	0.040	0.045	0.043	0.043	0.258	0.122	0.075	0.096	0.090	0.086	0.398	0.286
	P	0.074	0.079	0.083	0.079	0.477	0.226	0.054	0.066	0.068	0.062	0.286	0.206
Total value		-	-	-	0.166	1.000	-	-	-	-	0.217	1.000	-
Cultural services	**RA**	0.054	0.069	0.062	0.061	1.223	0.137	0.137	0.058	0.053	0.075	1.343	0.183
	DA	0.016	0.019	0.017	0.018	0.351	0.039	0.038	0.013	0.012	0.018	0.323	0.044
	AV	0.018	0.018	0.015	0.017	0.335	0.037	0.068	0.011	0.010	0.019	0.349	0.048
	RKA	0.015	0.017	0.015	0.016	0.315	0.035	0.040	0.013	0.012	0.018	0.328	0.045
Total value		-	-	-	0.050	1.000	-	-	-	-	0.056	1.000	-

Source: Author´s calculations.

Note: ***PS****: Provisioning service;* ***RS****: Regulating services;* ***CS****: Cultural services;* ***MS****: Agriculture and Hunting;* ***NMS****: Water;* ***CR****: Climate regulation;* ***ER****: Regulation of erosion and conservation of fertility;* ***WR****: Regulation of water flows and their quality;* ***PR****: Pest regulation and biological pest control;* ***WPR****: Regulation of water purification;* ***AR****: Regulation of air quality;* ***WT****: Waste and wastewater treatment;* ***CCS****: Carbon capture and storage;* ***P****: Pollination;* ***RA****: Recreational and tourist activities;* ***DA****: Didactic and educational activities;* ***AV****: Aesthetic value;* ***RKA****: Research activities and knowledge system.*

5.3. Economic value

At this stage, the objective is the calculation of the pivot value, which refers to the value of the ecosystem services that have a market. The ecosystem services which are captured by the market are, in our case study, the provisioning services: Agriculture and hunting.

5.3.1. Agriculture

It is necessary to know what crops the Park has and the area they occupy, as well as the income generated and costs associated with these crops. We have taken this information from interviews with experts related to the agricultural sector of the Park and from public databases.

TABLE 10

Crops in the Turia Natural Park

Crop type	Area (ha)	Total area (%)
Fruit	907.51	19.16
Olive grove	35.40	0.75
Vineyard	27.86	0.59
Arable land	179.99	3.80

Source: Institut Cartogràfic Valencià (Generalitat Valenciana, 2016).

The arable land in the studied area is mainly constituted by horticultural crops such as: watermelon, melon, pumpkin, cucumber, zucchini, onion, artichoke, tomato, beans and lettuce. The most common crop rotations in Valencia are melon or watermelon, potato, onion or artichoke. As for the fruit trees, the most widespread crop is citrus.

In order to estimate the economic value of agriculture in the Park, it is necessary to know the total revenue received by the farmer and the productions costs, and thus estimate an approximate gross margin. Revenues were calculated from average yields and farm gate prices. With an estimate of variable costs, the net gross margin was calculated. The required information was provided by the experts interviewed in June 2018. These interviews were conducted with experts closely related to the farming sector in the studied area. In the same way, data were reviewed and complemented by officers in charge of the Park´s administration and management. With the collected data, the economic value of the agricultural sector of the Park was estimated (Table 11 and Table 12). According to the described procedure, the estimated monetary value of agriculture in the Turia Natural Park is approximately 1,096,412 €.

TABLE 11

Estimation of gross margin generated by crops (estimate per hectare)

Crops	Citrus	Olive grove	Vineyard	Horticultural
Revenue (€/ha)	5,888	1,112	1,176	5,497
Costs (€/ha)	4,900	1,019	1,055	4,424
Gross margin (€/ha)	988	93	121	1,073

Source: Compiled by authors based on Generalitat Valenciana (Generalitat Valenciana, 2015) and interviewed experts.

TABLE 12

Estimation of gross margin generated by crops in the Turia Natural Park

Crops	Citrus	Olive grove	Vineyard	Horticultural	Total
Cultivation area Natural Park (ha)	907.51	35.40	27.86	179.99	1,150.76
Gross margin Natural Park (€)	896,620	3,292	3,371	193.129	1,096,412

Source: Compiled by authors based on Generalitat Valenciana (Generalitat Valenciana, 2015) and interviewed experts.

From the obtained results, citrus fruit finds considerable difficulties to continue in production. Consequently, as abandonment of production emerges because of low market prices it is possible that not all hectares accounted are actually in production. The horticultural sector in Valencia is well-known as a part de L'Horta de València, an area characterized by very small plots where crop rotation is very common. Our calculations try to estimate the gross margin as close as possible considering the diversity of crops. It is necessary to highlight that both yields and prices oscillate considerably from one season to another.

5.3.2. Hunting

As in the farming sector, it is necessary to know the revenue and variable costs associated with the hunting activities, as well as the area of hunting reserves of the Park. To obtain the required information, the experts were interviewed during June of 2018. A total of 3,246 ha of the Natural Park are used for hunting, and they correspond to 68.55 % of the Park. Once the area is determined, we must know the revenue and the variable costs associated with the hunting activities. With all the information, we proceed to calculate the gross margin that the hunting sector generates in the Natural Park (Table 13). The total monetary value generated by the hunting activity in the Turia Natural Park was estimated at 2,175 €. This value can be very variable since it is closely related to the maintenance of the areas and eventual improvements including fauna repopulation, formation of artificial water points and food supply.

TABLE 13

Gross margin estimation by hunting activities in the Turia Natural Park

Revenue (€/ha)	Costs (€/ha)	Gross margin (€/ha)	Hunting area (ha)	Gross margin of the Natural Park (€)
2,85	2,18	0.67	3,246	2,175

Source: Compiled by authors based on Generalitat Valenciana (Generalitat Valenciana, 2012) and interviewed experts.

5.3.3. Pivot value and total economic value

Based on the results obtained from the market, agriculture and hunting services, we can estimate the pivot or economic value of these services in the Turia Natural Park. This value is 1,098,587 € (Table 14). This income was converted into actual values with the Spanish SDR 2016, as this is the most recent year for which we have official data (Table 15). The value obtained for the TDS is 2.91 %: this value has been calculated with the data provided by WBG (World Bank Group, 2018) and OECD (2018). As a result, the annual value of the market services of the Park is 37,727,565 €. Finally, from the calculated value of the market services and the weights of the ecosystem services, the economic value of the ecosystem services of the Natural Park can be determined. As a conclusion, the economic value of the ecosystem services associated to the Turia Natural Park ranges between 163,946,752 € and 481,549,597 € (Table 16).

TABLE 14

Pivot value or economic value of the market ecosystem services

Gross margin of the Natural Park (€)		Total gross margin of the Natural Park (€)
Agriculture	Hunting	
1,096,412	2,175	1,098,587

Source: Compiled by authors.

TABLE 15

Social discount rate Spain 2016 (%)

Temporary pure rate (p)	Marginal utility rate of consumption (e)	Growth rate per capita consumption (g)	SDR (p +eg)
0.868	1.760	1.162	2.91

Source: Compiled by authors based on World Bank Group (World Bank Group, 2018) and OECD (2018).

TABLE 16

Economic value of the ecosystem services of the Turia Natural Park

		Experts: Group 1		**Experts: Group 2**	
Ecosystem services	**PS**	0.414	67,810,696	0.144	69,293,893
	RS	0.475	77,785,757	0.720	346,567,165
	CS	0.112	18,350,298	0.136	65,688,538
	Total (€)	**163,946,752**		**481,549,597**	
Provisioning services	**MS**	0.230	37,727,565	0.078	37,727,565
	NMS	0.184	30,083,130	0.066	31,566,328
	Total (€)	**67,810,696**		**69,293,893**	
Regulating services	**CR**	0.248	14,240,236	0.525	78,464,560
	ER	0.121	6,930,104	0.194	29,025,859
	WR	0.190	10,882,726	0.307	45,940,006
	PR	0.125	7,146,755	0.177	26,524,359
	WPR	0.100	5,721,433	0.187	27,952,815
	AR	0.099	5,669,424	0.207	30,984,643
	WT	0.126	7,234,100	0.227	34,017,824
	CCS	0.122	7,002,086	0.286	42,843,468
	P	0.226	12,958,888	0.206	30,813,627
	Total (€)	**77,785,757**		**346,567,165**	
Cultural services	**AR**	0.137	10,096,052	0.183	37,657,600
	DA	0.039	2,894,158	0.044	9,057,265
	AV	0.037	2,761,212	0.048	9,771,902
	RKA	0.035	2,598,876	0.045	9,201,768
	Total (€)	**18,350,298**		**65,688,538**	
Total ecosystem services (€)		**163,946,752**		**481,549,597**	

Source: Compiled by authors.

Note. ***PS****: Provisioning service;* ***RS****: Regulating services;* ***CS****: Cultural services;* ***MS****: Agriculture and Hunting;* ***NMS****: Water;* ***CR****: Climate regulation;* ***ER****: Regulation of erosion and conservation of fertility;* ***WR****: Regulation of water flows and their quality;* ***PR****: Pest regulation and biological pest control;* ***WPR****: Regulation of water purification;* ***AR****: Regulation of air quality;* ***WT****: Waste and wastewater treatment;* ***CCS****: Carbon capture and storage;* ***P****: Pollination;* ***RA****: Recreational and tourist activities;* ***DA****: Didactic and educational activities;* ***AV****: Aesthetic value;* ***RKA****: Research activities and knowledge system.*

6. Conclusions

The economic value of the ecosystem services associated to the Turia Natural Park ranges between 163,946,752 € and 481,549,597 €. This range of values takes into account diverse approaches and experts' views, all of them consistent despite their different visions. Although the prioritization was similar for both groups of experts, the order of quantification was not. Both groups attach more value to the regulating services although the weighting is different. The most important services are market and environmental services, specially the second type of services that are essential for the balance of ecosystems. As for the cultural services, there are not clear differences and the main differences appear in the provisioning and regulating services, probably due to ethical issues which justify having a range of values and not a single value. Despite this, cultural services are relevant for recreational activities, which are very significant since the Park is located nearby the Metropolitan area of Valencia, so citizens can make use of this site to enjoy nature.

If we focus on each of the services individually, the importance falls mainly on agriculture and hunting, climate regulation and recreational activities in relation to provisioning, regulation and cultural services, respectively. So, in case of allocating public expenditure or prioritizing some actions, these services could be part of reasonable choices since they receive higher social values.

To conclude, our main research finding is our estimation of the economic value of the Natural Park by expressing the value of ecosystem services in the context of a market society.

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