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PLAN DESIGN: ECOSYSTEM SERVICES APPROACH METHODOLOGY. TYPOLOGICAL CLASSIFICATION. METHODOLOGY AND INDICATORS

Innovative materials and techniques for the conservation of 20th century concrete-based cultural heritage

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1 Executive Summary

This study develops a conceptual framework which adapts the ecosystem services approach to concrete cultural heritage, understood as a socio-ecological system. Heritage is analysed as a services provider for society. Whereas the biotic and abiotic units provide natural services, the artificial ones generate "anthropic services". The results obtained are part of the proposal of typological classification of the supporting, provisioning, regulating and cultural services, from the categorization agreed in the scientific literature and the proposal of an indicators system, organized by types: capacity, flow and benefits.

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2 Introduction

2.1 Background

The built heritage belongs to society as product, both in its original materialisation and its current contextualization [1]. However, society is not always aware of the value it possesses and, therefore, the role it plays in the welfare of human beings is not recognized. This link implies providing the relationship between heritage / society physical and intellectual accessibility and awareness of the concepts of fragility, durability and belonging which afflict the built heritage. The link effectiveness implies a direct and indirect way of working with society.

Directly, when it is managed through heritage institutions such us museums, archives, libraries, historical centers, archaeological sites, protected natural areas, botanical gardens, zoological gardens or reserves and all other public or private cultural agents whose work includes management of natural of cultural heritage.

Indirectly, when dissemination is included in plans or programs of training and / or professional dissemination; in relation to social media; in promotion programs and cultural information at a general level and / or in tourism strategies [2] or in research projects.

Since the 20th century, one of the most used materials for the construction of part of our current heritage is concrete, which in many cases is the architectural expression core. Due to its performances and ability to be modelled, but also for its infinite possibilities in terms of textures and colour, concrete has stimulated architectural innovation and creativity [3].

Many countries consider concrete architecture as cultural heritage, nevertheless this kind of monuments, which could seem "young" with respect to more ancient monuments, is decaying, due to a combination of lack of knowledge related to its real value and to environmental aggressive conditions in which they are exposed. One of the main consequences entailed is the lack of appreciation and awareness of these buildings, causing conservation problems. Some specific buildings and monuments of value made of concrete are not recognized as cultural heritage. Despite of this problematic, only a few specific scientific studies were dedicated to management to its value. In this sense, the mission of INNOVA-CONCRETE project, supported by the European Union's Horizon 2020, is to operate in technical aspects, combined with

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activities to promote and achieve social awareness and value creation linked to monuments and representative buildings.

This approach aims to overcome the concept of heritage as an object, historical and aesthetic treasure, and develop a broader conception which includes the geographical, physical-natural, social and cultural context and the heritage use's value recognition, all as a reference and understanding of the society's belonging and identity sense [4]. A new way of valuing both the patrimonial function of these buildings and concrete structures and their possible urban functions according to their characteristics and attributes is sought. All this from a multidimensional perspective: visual, functional, historical. In conclusion, it is intended to recognize that these concrete structures contribute to the general and particular social welfare.

The notion of heritage is linked to the passage of time, but as the poet T.S. Eliot affirmed, "the humblest of objects (...) is emissary of the culture from which it comes" [5]. For this reason, the human productions which have been identified by society as patrimonial goods are worthy to be conserved. The conservation of heritage without the recognition of its use (service) by the current society has no guarantee of continuity during time [6]. That is why it is necessary to design a tool that identifies and classifies the value of these services or uses that contribute to human well-being. Within the extended categorization of the heritage value in use, form and symbol, our tool focus on the tangible use of heritage [7].

2.2 Justification

The value proposal uses the ecosystem services (henceforth ES) approach, which has already proved useful for the natural heritage, and wich will be applied with the same methodology and the same procedure to anthropic heritage. This is a huge advantage, not only for the built heritage management, but also for the spatial and urban planning.

In this sense, the ES approach, since its beginnings in the seventies of the 20th century, has achieved an important position among academics, conservationists, development agencies, policy makers and governments, given its versatility as a theoretical framework, analytical tool, instrument for the management, political discourse and wareness [8]. Nowadays it has not only become an analyses instrument for academics, but also a powerful discursive tool for policymakers and conservationists [9]. The origin of the ES approach can be found in the late sixties and early seventies of the 20th century. Authors such as King [10], Heliwell [11], Hueting

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[12] and Odum [13] analyzed the way in which some "nature functions" carry out a job, provide a space and benefits to human beings and its social systems [14].

In 1977, Westman [15], [16] proposed that the social value of the benefits provided by ecosystems could be enumerated in order to help society make more informed management and policy decisions. These benefits were called "nature services". [17] However, the term ecosystem service per se, was used for the first time at the beginning of the 1980s by Ehrlich in 1987 [18], [19] and Ehrlich and Mooney in 1983 [20], [21]. These authors, coming from biology, proposed that the ecosystems' natural functions could be "services" that they provide to society, seeking to establish the biodiversity conservation as something necessary to maintain ES and not put at risk the life of humans being. In this way, a pedagogical use of the term ES [22] was made. According to Peterson [23], "the concept of ecosystem services was used to teach people that ecosystems provide services, demonstrating the value of ecosystem functions for humanity".

Conservationists were at the forefront in the use of the concept (ES) with the purpose of generating social awareness of the importance of ecosystems. Nevertheless, they saw the opportunity to use economic valuation as another way to show the importance of these services. The result which was derived from the introduction of economic analysis in the ES approach, was the pedagogical intention was quickly overcome during the nineties by the priority that was given to the ES's monetary valuation, promoted fundamentally by the neoclassical theory through environmental economics [24].

One of the most representative examples of the nature's monetary valuation was when Costanza et al. [25], assessed seventeen ecosystem services associated with sixteen biomes from all over the world. Although the same authors considered that the uncertainty associated with the exercise made this value only an approximation, the study became a historical milestone in the ES topic and strengthened new studies of monetary valuation (Table 1).

The use of the ecosystem services concept became widespread quickly. Especially since the 21st century, when some authors began to name it as the science of ecosystem services [26]. An evidence of this effort took place between the years 2000 and 2005, when around 1,300 scientists carried out the Millennium Ecosystem Assessment (EEM). This project made a clear call to generate more and better knowledge about the services provided by ecosystems [27].

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In March 2007, environment ministers from the G8+5 countries meeting in Potsdam (Germany) proposed to initiate the process of analyzing the global economic benefit of biological diversity, the costs of the loss of biodiversity and the failure to take protective measures versus the costs of effective conservation. In response to this proposal, the German Federal Ministry jointly initiated a global study that same year by for the Environment and the European Commission. The Economics of Ecosystems and Biodiversity project (TEEB), initiated by Germany and the European Commission and later adopted by UNEP, added more of the economic aspects of ecosystem services [28].

Table 1. Comparison of four of the main ecosystem services classification systems used worldwide and their differences and similarities

	Costanza et al., 1997	Millennium Ecosystem Assessment, 2005	TEEB, 2010	CICES (v. 2017)
Provisioning	Food production	Food	Food	Biomass-Nutrition
	Water supply	Fresh water	Water	Water
	Raw materials	Fibre, etc.	Raw materials	Biomass- Fibre, energy & other materials
	--	Ornamental resources	Ornamental resources	--
	Genetic resources	Genetic resources	Genetic resources	--
	--	Biochemicals and natural medicines	Medicinal resources	--
	--	--	--	Biomass-Mechanical energy
Regulating & Habitat	Gas regulation	Air quality regulation	Air purification	Mediation of gas & air flows
	Climate regulation	Climate regulation	Climate regulation	Atmospheric composition & climate regulation
	Disturbance regulation (storm protection & flood control)	Natural hazard regulation	Disturbance prevention or moderation	Mediation of air & liquid flows
	Water regulation (e.g. natural irrigation & drought prevention)	Water regulation	Regulation of water flows	Mediation of liquid flows
	Waste treatment	Water purification and waste treatment	Waste treatment (esp. water purification)	Mediation of waste, toxics, and other nuisances
	Erosion control & sediment retention	Erosion regulation	Erosion prevention	Mediation of mass-flows
	Soil formation	Soil formation [supporting service]	Maintaining soil fertility	Maintenance of soil formation and Composition
	Pollination	Pollination	Pollination	Life cycle maintenance (incl. pollination)
	Biological control	Regulation of pests & human diseases	Biological control	Maintenance of pest- and diseasecontrol
Supporting & Habitat	Nutrient cycling	Nutrient cycling & photosynthesis, primary production	--	--
	Refugia (nursery, migration habitat)	'Biodiversity'	Lifecycle maintenance (esp. nursery)	Life cycle maintenance, habitat, and gene pool protection
Cultural	Recreation (incl. eco-tourism & outdoor activities)	Recreation & eco-tourism	Recreation & eco-tourism	Physical and experiential Interactions

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	Cultural (incl. aesthetic, artistic, spiritual, education, & science)	Aesthetic values	Aesthetic information	--
	--	Cultural diversity	Inspiration for culture, art & design	--
	--	Spiritual & religious values	Spiritual experience	Spiritual and / or emblematic interactions
	--	Knowledge systems	Information for cognitive development	Intellectual and representative interactions
	--	Educational values		--

Source: Costanza et al. 2017.

The Common International Classification of Ecosystem Services (CICES) developed from the work on environmental accounting undertaken by the European Environment Agency (EEA). Supports their contribution to the revision of the System of Environmental-Economic Accounting (SEEA) which is currently being led by the United Nations Statistical Division (UNSD). The first fully operational version CICES (V4.3) was published in 2013. Based on the experience gained since then by the user community, its structure and scope has been reviewed (V5.1) [29].The idea of CICES is important because it was recognised that if ecosystem accounting methods were to be developed and comparisons were made, then some standardisation in the way we describe ecosystem services was needed. Standardisation was seen especially important where the link to economic accounting has to be made. Since the original proposal interest in CICES has grown. It has now become clear that in addition to the need for standardization in the context of environmental accounting, work on mapping and valuing ecosystem services and ecosystems assessments more generally would benefit from more systematic approaches to naming and describing ecosystem services.

The aim of CICES is not to replace other classifications of ecosystem services but to enable people to move more easily between them and to understand more clearly how people are measuring and analyzing information. Following common usage, CICES recognises that the main categories of ecosystem outputs to be provisioning, regulating and cultural services. However, it does not cover the so-called 'supporting services' originally defined in the MA. Rather these supporting services are treated as part of the underlying structures, process and functions that characterise ecosystems. Since they are only indirectly consumed or used, and may simultaneously facilitate many 'final outputs', it was considered that they were best dealt with in environmental accounts and mapping in other ways (https://cices.eu/).

In addition to providing a way to classify ecosystem services, CICES was also intended as a reference classification that would allow translation between different ecosystem service

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classification systems, such as those used by the Millennium Ecosystem Assessment (MA), The Economics of Ecosystems and Biodiversity (TEEB).

In CICES ecosystem services are defined, as the contributions that ecosystems make to human well-being, and distinct from the goods and benefits that people subsequently derive from them. These contributions are framed in terms of 'what ecosystems do' for people. Provisioning services are products obtained from ecosystems; regulating services are benefits obtained from the regulation of ecosystem processes; and cultural services. Services are the characteristics of elements of nature that provide opportunities for people to derive cultural goods or benefits.

The categorization and classification proposed in this report is associated with anthropic units that provide services. These must be compatible and comparable with the ecosystem services methodology, related to supply units from natural origin, in order to be able to use the same framework in the decision-making associated with the planning of the territory or in the natural and cultural heritage enhancement. The system developed by the European Union for the project "Mapping and Assessment of Ecosystems and their Services" (MAES) and the associated classification system The Common International Classification of Ecosystem Services (CICES) [30] will be taken as a reference.

2.3 Objectives

The point is to consider concrete-based cultural heritage as an important part of an urban (or geographic) ecosystem and to analyse the benefits (new ecosystems services) of its protection. This is not an easy task because, as far as we know, this methodology has only been used partially to assess the value of preserving the natural heritage. Hence, it is also a scientific challenge for Social Sciences and Humanities (SSH) disciplines within the InnovaConcrete project.

The main purpose is to develop a tool for valuing the concrete cultural heritage. To achieve it, a conceptual framework is designed which adapts the ecosystem services approach to concrete cultural heritage, understood as a socio-ecological system.

The following has been considered as specific objectives:

1. To perform a categorizaion and classification of heritage buildings.

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2. To carry out a categorization and a general classification of the services offered by buildings adapting the theoretical framework developed for ecosystem services. With special attention to:
    - Heritage buildings.
    - Heritage buildings made of reinforced concrete.
    - Heritage complexes in which reinforced concrete is a reference.
3. To validate the methodology developed to check that it offers useful information for a better value of the cultural heritage, with special attention to concrete buildings.
4. To establish a system of indicators to quantitatively measure the services provided by a building.

3 Methodology

The methodology carried out during the elaboration process of the study consisted of the following ten main steps:

1. Bibliographic search and background analysis on methods of cultural heritage value and urban management and planning.
2. Bibliographic search and background analysis on the ES methodology for the natural heritage valuation.
3. Construction of a conceptual framework and discussion for adapting the ES method to the requirements of the project, that is, the cultural heritage valuation with a simple and comprehensible methodology.
4. Development of the new classification of anthropic or socio-ecosystem services for the cultural heritage valuation, based on the ES theory and the classification carried out by CICES.
5. Testing and adjustment of the new classification with the analysis of databases on urban functions and activities (United Nations classification of economic activities, Spanish version thereof, article on urban functions).
6. Testing and adjustmet of the new classification with the analysis of real concrete heritage units: ICOMOs database with 222 concrete heritage buildings and monuments in Europe (Annex 1).

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7. Development of a *step-by-step* process for the implementation of the analysis and the valorisation of a patrimonial unit with respect to the systemic context where it is located.
8. Testing and adjustment of the new classification and methodology with in-depth analysis of a specific pilot case study, contrasting the traditional assessment systems and the proposal developed with a survey system related to the current assessment from respondents. Case of the Zarzuela hippodrome (Madrid).
9. Proposal of a system indicators for the monetary and non-monetary valuation of cultural heritage based on the anthropic service classification system.
10. Approach of its potential usefulness for decision making, heritage management, urban planning, territorial planning, etc.

Based on this methodology, the results achieved are described in the following sections.

4 Results

The results obtained can be summarized in two large blocks. Firstly, the construction of the conceptual base associated with the methodology or socio-ecological assessment tool. Secondly, the development of the application methodology itself through the *step-by-step* process.

Both results are summarized below:

1. Conceptual basis

   Conceptual aspects introduced and adapted / modified from the ES theory that have served to develop the methodology and which, being alterations, are really proposals and results that must be reflected and explained.

- Examples:

- Systems theory and its components.
- Anthropic units.
- Services and their basic classification with respect to CICES (support, etc.).
- Anthropic services classification: summary table with *CATEGORY* + *TYPE* and explanation of each type through the benefits that develop.

2. Application methodology: the *step-by-step* process.

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- Indicators system for enhancement and valuation of concrete heritage.

4.1 Conceptual basis for the methodology development to enhance the concrete cultural heritage value

The following epigraphs describe the main contributions that supports the methodological proposal of this work.

4.1.1 Systems theory: ecosystems and sociosystems

The ES methodology applies the general systems theory [31], in a sense that indicates that a system is understood as a group of elements that interact with each other through functions and processes (originated by such units), and that, also interact with their environment in turns. Ostrom [32] already referred to these systems as a socio-ecological system, composed of their own systems with different components and ecological and social processes interacting with each other. In fact, in nature there are hardly any spaces in where there is no human intervention at any level, with which the human being does not have any kind of direct or indirect relationship. That is why these methodologies assume that ecosystems are a combination of natural elements and processes, but anthropic as well [33]. Hence, in the ecosystem definition they include the human being as a component. However, the development of these methodologies has always focused on those "components" of purely natural origin (at most those mixed or slightly transformed).

These are only referred when we talk about the sytems' units (more or less complex) capable of supplyng some kind of service (key process), and that man can take advantage of his benefit.

Additionally, it is true that many works talk about agroecosystems (as a transformed ecosystem) or even the ecosystem services of the city, but in both cases referring to the services associated with the functions developed by natural units (e.g., urban parks).

Therefore, in this work it is considered that in the same way we can talk about ecosystems (as those units supplying services of natural origin), we can do the same with buildings and heritage infrastructures, such as reinforced concrete and others components / anthropic units, which could be understood as socio-systems. These components can be understood, thus, as anthropic systems that provide services for human welfare.

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4.1.2 Welfare services: ecosystem and anthropic services

It was said that CICES define ecosystem services as the contributions that ecosystems make to human well-being, and distinct from the goods and benefits that people subsequently derive from them. Hence, it is possible to think also about the contributions that socio-systems make to human well-being and talk about social services / anthropic services, going from a natural originated service to a human originated service. Thus, by linking the benefit that these human systems offer to people, society can easily understand its importance and its value, and it will also be possible to improve the perception for decision makers.

4.1.3 Types of delivery units of services in the socio-ecosystem

If the ecosystem definition already includes man and his anthropic elements and processes, the division above between ecosystems and socio-ecosystems loses its meaning.

In this case, this separation will be also applied to services, aims only to facilitate the understanding of a complex reality. In this regard, it would be more successful to talk about little altered or natural ecosystems, altered / transformed ecosystems, highly transformed ecosystems and anthropic or totally anthropic ecosystems.

In the first case (scanty altered or natural ecosystems), the services would have a more natural origin than in the latter, which would have a more anthropic origin. However, especially at the intermediate levels, there may be systems that supply both services categories (e.g., agro-ecosystems) or in which one prevails over the others (e.g., urban systems). In any case, the nomenclature described above will be maintained, to facilitate theoretical understanding for readers not used in the ecosystem services framework. In this way, the incorporation of anthropic units and services is not a normal discussion of the methodology, but rather an adaptation or complementation. With this, completing what Ostrom anticipated, it can be possible to think of a socio-ecological system or socio-ecosystem as a combination of units or subsystems developing functions, from a more or less complex interrelation between components and biotic processes (natural elements living, associated for example with fauna and flora), abiotic (natural not endowed with life, e.g., rocks, sands, atmospheric components), and anthropic (not natural, made by man, e.g., buildings, roads)

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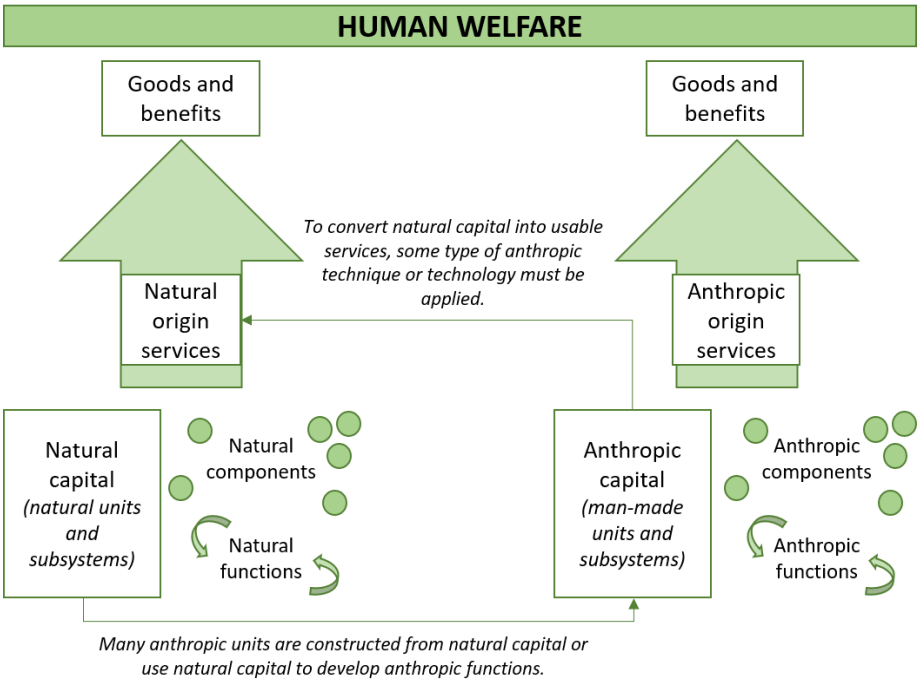
4.1.4 Services classification according to their origin

In this case, the proportion of the priority elements and functions is used to generalize and classify the services according to their origin. CICES already takes into consideration services of biotic and abiotic origin, when it classifies ecosystem services. Here it will be complemented with those originated (supplied) by anthropic units.

At the extremes we could talk about biotic services, such as those associated with units or systems formed mainly by living natural elements; abiotic services, such as those provided by units in which non-living natural elements stand out; and anthropic services, such as those associated with highly transformed or unnatural elements, built by man.

It should be noted that anthropic units, except in very exceptional cases, require the construction of services associated with natural units. Indeed, they use natural capital (e.g., material from abiotic origin for the buildings construction) to develop their anthropic functions, which, in many cases, also involves the transformation of another type of natural capital (eg, material from biotic origin for the textile industry). At other times they develop their own processes of purely human origin to produce benefits. Figure 1 schematizes this relationship between anthropic and natural processes and their influence on human welfare.

Figure 1: Relationship between services according to their origin and their relevance for human well-being



Source: Own elaboration

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For the ES ecosystem services, originated by natural processes, to be profitable for man, some technology or human capital must be applied (e.g., hunting, fishing, gathering systems), in order to allow their enjoyment and direct use. Other services need intermediate processing units to be able to offer some added benefit. In these anthropic units, adapted by man, transformation processes or adaptation of other products are carried out to convert them into third level services. These services offer an added value for their use or enjoyment (following the example, we would talk about the industrial by-products derived from fishing, aquaculture, agriculture, etc.).

Other anthropic units can also generate their own services originated by properly human processes. For instance, a soccer stadium or a theater offer direct cultural services (without the intermediation of natural systems); a court or a hospital offers regulatory services, direct as well. Likewise, services can be provided by simple systemic units or by more complex systems formed by a combination of units of different types. In the case of patrimonial elements, for example, we can talk about a building, as a simple unit, or an installation made up of built units' combinations (each with a function), but also of mixed systems, formed by a combination of constructed units (buildings), transformed spaces (squares or green spaces designed) and natural units or subsystems (less transformed leisure areas).

The classification of services will be carried out from the point of view of the beneficiary, since it is considered that the benefits can be obtained by the functions developed in a provider unit of services or a system made up of different units.

4.1.5 Four services categories

After discussion about the definition, it was analyzed if the methodology applied for ecosystem services fixes, with an adaptive effort for anthropic systems.

As previously noted, CICES classifies services into three categories: provisioning, regulating and cultural. In this work, we have taken advantage of this system, since it has been observed that it fits perfectly into the main urban functions developed by the different anthropic structures that can be found. Additionally, the CICES classification has had to be adapted to an important point: a function not valued in this classification is that associated with the space and physical support offered by certain anthropic structures.

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Table 2 try to resume the adaptation made, facing the categories developed by CICES and previously accepted in other efforts (TEEB, Millennium Ecosystems ...) with the definition of those categories adapted for anthropic systems.

Table 2. CICES and INNOVACONCRETE classification comparison

CATEGORY	CICES DEFINITION (for natural systems)	INNOVACONCRETE DEFINITION (for anthropic systems)
Provisioning services	Products obtained from ecosystems *(natural or mixed units)*	Products obtained from anthropic units (transformed and handmade / artificial units)
Regulating services	Benefits obtained from the regulation of ecosystem processes *(natural processes)*	Benefits obtained from the regulation of social processes *(human relations, activities...)*
Cultural services	The nature elements characteristics that provides *opportunities* for people to derive cultural goods or benefits *(visual, experiential, sensitive, emotional and cognitive benefits).*	The anthropic systems characteristics and elements that provide *opportunities* for people to derive cultural goods or benefits *(visual, experiential, sensitive, emotional and cognitive benefits)*
Spatial support	- Not considered -	Space and / or the physical support necessary to allow or sustain certain needs and functions

Source: Own elaboration

4.1.6 Considering space and spatial support

As seen in the previous section, a new category appeared: spatial support. This is a function associated with space and physical support offered by certain structures, in this case anthropic, is not valued in the analysed references for ecosystem services in relation to natural structures. It is considered here, following Onetti et al. [34], that these structures offer a series of benefits that should be considered. This is the reason why an additional services category has been incorporated in this report: spatial support service. It will be understood as the space and / or

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the physical support necessary to allow or sustain certain needs and functions. As those necessary services to produce the other services.

In this case, with the experience developed here, it is considered that space should be considered both in this classification of anthropic services and in the ecosystem services. This requires a deeper theoretical discussion process, which is not a goal of this work, but it can be done with enough solvency from Geography.

In CICES there are arguments associated with the old category support. In this sense, an option in a discusión is whether we must distinguish between intermediate services and more finalists, that is, all services, space services and support hardware, but in some cases, it is a more finalist function (e.g., warehouses). It is also under discussion if we can talk about space provision, that is, incorporate this service in the "Supply" section. Its definition has been considered as a separate category in the following arguments.

The benefit key associated with this category will be that it covers the needs by providing a specific surface or volume (quantitative aspect, associated for example with storage), in others cases it will be conveniently adapted and prepared to allow that physical support (qualitative aspect, for example, associated with the different means of transport, which require specific surfaces such as rails, asphalt ...).

In some cases, it will be a mixture of both aspects that will involve a very specific adaptations depending on the needs to cover (housing, for example, which requires optimal surface conditions and facilities, but there are also anthropic activities that require very special facilities with large surfaces, such as hippodromes ...). Therefore, the important is not the specific state of the unit that offers the service at a given moment (whether or not it allows the passage of something, for instance, that can be associated with the regulation of a flow), not the intensity or quality of the transported or displaced (more associated with the supply sections).

The relevant attribute is related to a passive quality: the availability of an useful space and the physical support facilitated in order to carry out the transportation (makes a space passable, circulable, navigable), storage or reception (makes a space have capacity to host), or to develop activities, operations or social functions. Also included the space reserved as an expansion area of anthropogenic units (e.g., for future infrastructures, industries, expansion of ports or urban areas) or security / buffer areas with restrictions (e.g., around buildings that work with dangerous substances).

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The provisioning service implies a process of supplying material elements, an active flow of material, supplies, people, vehicles, money, etc. It also includes the supply of information, knowledge or services, from a professional perspective (e.g., consulting services), that is, more oriented to the productive process than to intellectual growth (which would be part of the cultural services section).

4.1.7 Exceptional value of cultural services

Given the anthropic system nature, there is an intrinsic cultural value, since we always refer to cultural heritage. For this reason, in addition to the building's own functions, it will have (for its history and its past, for its architectural value, for its architect or for any other reason) a cultural function. That is, it will have a series of elements, processes and attributes (material or immaterial) to which a supply of cultural services can be associated. In fact, currently there are some rules for rehabilitation, maintenance, management, etc. of this type of buildings so that they do not lose or reduce their supply capacity. For this reason, we have to pay special attention to what has been developed in the framework of ecosystem services for cultural services, associated with the concept of heritage (in a natural or territorial case).

4.1.8 The importance of natural and cultural heritage conservation

When the theory of ecosystem services is used for the conservation of nature, it is assumed that, once the socio-ecological systems and their interactions are understood, the proper functioning of the natural heritage is the basis of human welfare that depends on it. Furthermore, for a system to adequately provide the services that are presupposed, it must be able to develop in a balanced and sustained manner to those functions that correspond to it. In this way, the alteration of the elements, functions and / or processes would imply an impact on human welfare due to an alteration in the flow services.

That is why one of the utilities of the methodology developed here lies in the ease of justifying the importance of conserving the anthropic heritage, beyond its cultural value, highlighting the functions that it develops or has developed up to the present.

4.1.9 Basic conceptual scheme

Next, Figure 2 summarize the conceptual construction developed or adapted from the ecosystem services methodology.

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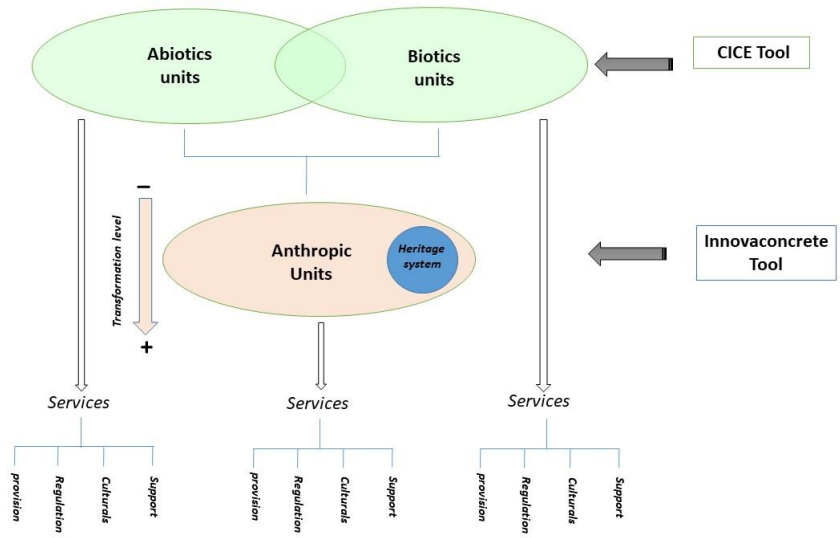
Figure 2: General scheme of the conceptual base developed



Source: Own elaboration

4.1.10 Anthropic services classification according to the associated benefits

Table 3 shows a summary of the developed classification, which starts from the advanced works by CICES [35]. Subsequently, in section 5, each category is defined and, in ANNEX 1, the table shows in which the service category is associated, the category developed, examples of the types of heritage buildings and the examples that fit in each category among the 222 analyzed throughout Europe.

Table 3: Classification of anthropic services

Category	ID	Type
1. Spatial support	1.1	Necessary space for resting and / or housing
	1.2	Operative space for the development of human activities
	1.3	Space to storage, deposit and / or reception
	1.4	Necessary support to allow movement and transport
2. Provisioning services	2.1	People supply to allow other anthropic activities
	2.2	Provider of goods and products to allow other anthropic activities
	2.3	Provider of basic urban services
	2.4	Provider of goods and products through the transformation, processing and handling of the materials
	2.5	Provider of monetary benefits by commercial activities or exchange (money, material or services)
	2.6	Provider of professional services, information and knowledge
3. Regulating services	3.1	Regulation of waste by urban or industrial process
	3.2	Regulation of the flow of people, vehicles, goods and materials

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	3.3	Regulation of conditions for habitability, security, social development, economic interactions and organization
	3.4	Regulation of basic physical and mental health
4. Cultural services	4.1	Physical and experiential interactions, active or passive, for leisure and tourism and / or personal enjoyment and development
	4.2	Intellectual interactions for cognitive development and training
	4.3	Spiritual, religious, symbolic, aesthetic, emblematic or ethic interactions
	4.4	Sociocultural relationships and material or economic exchange
	4.5	Nonuse value (For instance: value by mere existence, bequest value)

Source: Own elaboration

4.2 Methodology: *step-by-step* process

For the application of the methodological process, it will be necessary to perform four stages:

1. Distinguish whether the unit is part or not of a more complex system, and in that case, delimit the socio-ecological system.
2. Identify and categorize the unit or service provider system.
3. Identify the functions associated with the supplying unit.
4. Identify the services associated with that unit or system:

- As an individual building.
- As a whole system of which it is a part.

First, a distinction must be made between simple anthropic systems (for example, a building or monument) and complex anthropic systems. Complex systems are those that, in addition to providing the services for which they have been created, require a set of interrelated service provision units, which can be only anthropic units such as buildings or infrastructures or a combination of anthropogenic and natural Units. In this sense, it will be essential to delimit the socio-ecological system.

Second, to identify the units, and then, categorize each of them among the established categories. In this context, a first classification will have to do with the origin of the components and processes that dominate the system, being able to classify them as natural, mixed or anthropic or natural, transformed or highly transformed (anthropized). The next level of classification will depend on the categories that have been defined.

Third, the functions associated with these units or systems must be identified, and they will be responsible for the services. In this way, in order to facilitate the classification, different levels of detail could be used in the assignment of services, associated with the function or functions

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developed by the unit evaluated. In this sense, it will be necessary to propose the services for each of the following functions:

1. Main function for which it was created. It will have associated services that the building supplied in the past and that, in some cases, it could re-supply, but in any case, conditions the current supply.
2. Main function / s that are being developed at present. It will have associated a series of main services, which will be the most important when it comes to the identification and categorization of associated services.
3. Other complementary functions that the building or system develops. It will have associated other services, complementary to the main ones, which can also be observed (in general, they will be considered secondary in this process, although it will always depend on the objectives pursued).
4. Possible compatible potential functions. The associable services to these functions will help to look for new possible benefits to be generated by the building, as well as the search of "good practices" for the building type and that would allow to improve or expand the anthropic services provided by it or buildings that iat the moment have lost all use and are in a situation of abandonment or degradation.

Finally, all this process will allow, in a fourth step, an adequate allocation of the services that can be associated to the unit or system under study.

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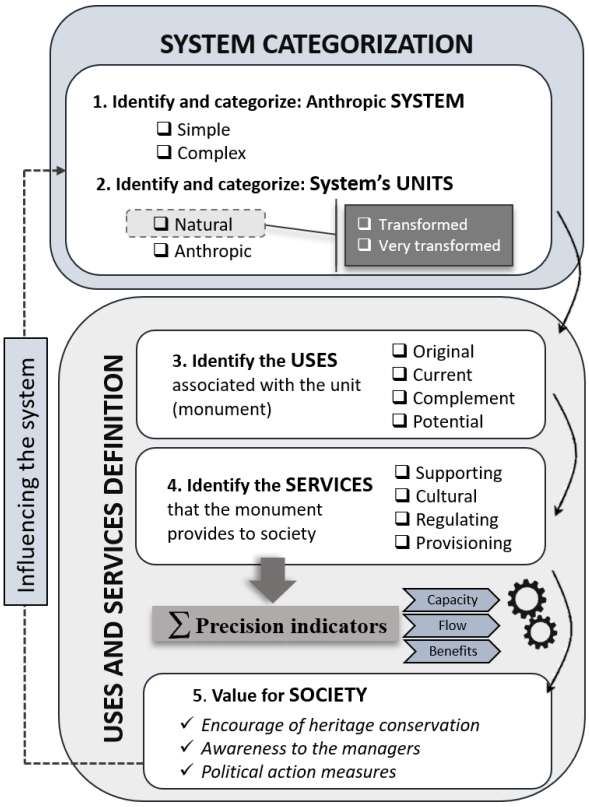
Figure 3: *Step-by-step* process scheme



Source: Own elaboration

As well as for ecosystem services, the concept of "anthropic disservices" can be exploited here, referred to those attributes that cause discomfort, rather than benefits [36]. For instance, a specific building with visual impact, may generate rejection which is considered a cultural disservice. Therefore, it represents the opposite of providing a service.

Valuing or quantifying services (indicators), could be considered that there are substitutable services (supply services generally are) and irreplaceable services (cultural services may be available in some cases). This could also be justified if we apply this methodology to heritage buildings.

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5 Classification proposal for the concrete heritage's ecosystem services

From the methodology applied, a classification proposal for the concrete heritage's ecosystem services has been obtained. This section is intended to show an organized classification based on services categories, being spatial support, provisioning, cultural and regulating services. This classification is an adaptation of the United Nations' proposal for the ecosystem evaluation. Each service category is briefly described from the benefits that can be generated in society, adding examples of buildings that could fulfill the associated functions. The distribution of the buildings selected by Docomomo and the service category to which it corresponds can be found in Annex 2.

5.1 Spatial support service

5.1.1 Necessary space for resting and / or housing

To allow getting a habilitated space for the adequate development of basic human needs and for people's housing.

- Examples: block or group of buildings; hotel; residence; house; village; orphanage.
- Example from Docomomo's selection: Unité d'Habitation de Marseille (France)

5.1.2 Operative space for the development of human activities

To allow getting space and / or essential physical support for the development of very specific activities (some primary, secondary and tertiary activities need a very specific physical support or an exceptionally large space). It also allows having a reserve of adaptable space for multiple activities, such as the exhibitions development, meetings, develop of human relationships or certain sports.

- Examples: Office blocks; multipurpose room; meeting center; social cultural center; center or pavilion of exhibitions or exhibitions; convention palaces; swimming pool; tennis club; hippodrome.
- Example from Docomomo's selection: Centennial Hall (Poland)

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5.1.3 Space for storage, deposit and / or reception

Based on the need to get space whereby to properly store goods, materials, a certain type of vehicle, equipment… At a very specific level, it allows, for example, to dispose of a proper space for the "rest" of our loved ones and, in general terms, for any deceased person.

- Examples: Storage installation; shed; garage; water tower; libraries; museums; zoo; cemeteries.
- Example from Docomomo's selection: Two hangars in Grimbergen (Belgium)

5.1.4 Necessary support to allow movement and transport

The main service is to adapts the surface in order to allow the necessary physical support for the transit of vehicles o (e.g., cars, tramway, trains, ships) or people. Therefore, it refers to infrastructures such as highway, roads, channel navigation, railway tracks, bridges… These infrastructures offer a "trafficability, pedestrianization and navigability" necessary for the human movement.

- Examples: Bridges, highway, roads, navigation channels, railway roads and other infrastructures.
- Example from Docomomo's selection: Kasari Bridge (Estonia).

5.2 Supply and provisioning service

5.2.1 People supply to allow other anthropic activities

To allow to the population to move from one place to another through several transport systems (e.g., bus, train, ship, on foot). In fact, this displacement "provides" to other anthropic unities/systems (urban areas, industrial parks, seaports…) the people they need to develop their activities (e.g., tourists, workers, customers).

- Examples: Bus station; train station; airports and other support units for many transport systems.
- Example from Docomomo's selection: Leipzig Main Station (Germany).

5.2.2 Provider of goods and products to allow other anthropic activities

To allow to citizens to obtain supplies of raw material, supplies or materials, (processed or not processed material), needed for the development of other anthropic activities (e.g., seaports or

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industries), through a multiply transport system (including highway, trains, ships, roads) and through other changing unities and distribution.

- Examples: Marketplace; grocery stores; stores; street market and infrastructures that provides it (e.g., roads, railway tracks).
- Example from Docomomo's selection: Schreiner Building (Germany).

5.2.3 Provider of basic urban services

To allow the supply of basic urban services (such as water, energy, telephony), for the development of the society's general activities, through multiple transport systems (e.g., gas pipeline, pipeline, wire and associated support unity).

- Examples: Energy plant, power transformers, pipeline systems, gas pipeline, wiring.
- Examples from Docomomo's selection: Københavns Højdevandbeholder (Denmark).

5.2.4 Provider of goods and products through the transformation, processing and handling of the materials

To allow society to dispose materials and adapted equipment from transformation, handling and / or raw material processing and supplies to improve / increase economic benefits, enjoyment and life quality. In a very specific level, it also allows to dispose a conveniently prepared food to consume.

- Examples: Industries; factories; processing or processed centers; pubs; cafeteria; restaurants.
- Example from Docomomo's selection: AEG_Turbinen Fabrik (Germany).

5.2.5 Provider of monetary benefits by commercial activities or exchange (money, material or services)

To allow improving the payment through spaces and anthropic units that make enable purchase and the goods, products and services exchange.

- Examples: Shops, shopping mall, marketplace, market, concert hall, cinema, theater, pubs, nightclub, racecourses... In addition, those infrastructures with an important commercial interest, including hotels, health resorts or spa centers.
- Example from Docomomo's selection: AEG_Turbinen Fabrik (Germany).

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5.2.6 Provider of professional services, information and knowledge

To allow the supply and distribution of information and the improvement of specialized knowledge, as well as the provision of technical and professional services (e.g., consulting), to support other necessities or social activities.

- Examples: Provision of information (e.g., radio station); of knowledge (e.g., research center, innovation, technologic center); professional services (e.g., consulting, repair shops).
- Example from Docomomo's seletion: Radio Kootwijk (The Netherlands).

5.3 Regulating services

5.3.1 Regulation of waste by urban or industrial process

To allow eliminating or reducing the waste's negative effects for human and nature (toxic residues and human discomfort, which cause smells, noise, visual impacts...) by general urban process (like solid waste disposal, urban effluent treatment, cleaning process and other urban cleaning services) or by industrial processes (p.e., control and management of industrial discharges or emissions of liquid or gaseous pollutants; filtration; storage; accumulation of pollutants).

- Examples: Treatment plants, dumps, waste storage.
- Example from Docomomo's selection: Gävle Crematorium (Sweden).

5.3.2 Regulation of the flow of people, vehicles, goods and materials

To allow the correct, orderly and / or safe distribution and movement / transit of vehicles (Traffic regulation and management and maintenance of transport routes on roads, railways, navigation channels), of people (access control and people influx through authorizations, specific controls and others, by operative or security reasons) and of goods and materials (Flux control and commercial goods circulations by operative, control and security reasons).

- Examples: Customs, tolls, control zones to building or infrastructure access, border areas, control towers, observation towers.
- Example from Docomomo's selection: Simon Stevin/Lorentz discharge sluices (The Netherlands).

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5.3.3 Regulation of conditions for habitability, security, social development, economic interactions and organization

To allow maintaining a general balance of a society or a specific activity, through order, control and administration tasks (offices, public administrations...), of general security (military centers, bunkers, naval bases, firefighters, civil protection, prisons), intervening in the relations and interactions among countries (embassies) and individuals, via legal support and / or regulating said interactions (court of justice, police, security services).

- Examples: Prisons, fire brigade buildings, police buildings and military structures, offices, public administrations (e.g., town halls or ministries), courts and tribunals, embassies.
- Example from Docomomo's selection: Court House of Livadia (Greece).

5.3.4 Regulation of basic physical and mental health

To allow maintaining the protection and / or recovery of health and basic physical and mental well-being of society.

- Examples: Health centers or hospitals and any living being in general (veterinarian center).
- Example from Docomomo's selection: Herlev Amts Sygehus (Denmark)

5.4 Cultural services

5.4.1 Physical and experiential interactions, active or passive, for leisure and tourism and / or personal enjoyment and development

To allow leisure and enjoyment through physical and experiential use of structures, elements and anthropic landscapes, in a more active way (e.g., practicing sports in pavilions, tourism in urban routes or with gastronomy in restaurants) or more passive (e.g., reading in libraries, enjoying visually in the cinema, the art of a museum, attending a soccer game, listening to music in concert halls, observing an urban landscape, etc.)

- Examples:

  Active activities: sports facilities (e.g., swimming pools, pavilions, athletic centers, etc.), bars, restaurants, nightclubs.

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Passive activities: museums, cinemas, concert halls, theaters.

- Example from Docomomo's selection: Olympic stadium (Finland).

5.4.2 Intellectual interactions for cognitive development and training

To allow personal or social growing through intellectual and representative interactions in / with structures, elements and anthropic landscapes, by means of different processes related to social sciences, culture and human questions, such as the knowledge production (research and science, innovation, technology development) and intellectual growing (education and training, including the cognitive development resulted from sensorial stimulus. E.g., go to a museum, contemplate heritage, know history, intellectual entertainment...).

- Examples: Schools, universities, technology development centers, research, innovation and development centers, libraries, museums.
- Example from Docomomo's selection: Eduardo Torroja Institute (Spain).

5.4.3 Spiritual, religious, symbolic, aesthetic, emblematic or ethic interactions

Facilitates mental / moral well-being of a person or a society, through the save of its faiths, rituals and / or spiritual symbology (e.g., churches, monasteries, other religious centers or spiritual elements), as well as through the save of its moral and / or ethical identity, as well as its cultural identity (sense of place and local identity, artistic representations, emblematic and / or symbolic elements or constructions, preservation of history and heritage, elements that allows greater social cohesion, etc.) It refers too to the well-being because of the senses and emotions exaltation by landscapes, structures or anthropic elements (including aesthetic design).

- Examples: Churches, convents, monasteries, cathedrals, burial grounds, monuments, memorials.
- Example from Docomomo's selection: Convento, teologado e Iglesia de San Pedro Mártir de los Padres Dominicos (Spain).

5.4.4 Sociocultural relationships and material or economic exchange

To allow a space or place for social meeting, development of relationships and social interactions and its intellectual expression, commercial (exchange and sale-purchase) and

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cultural (e.g., a big square in a city, local culture center, etc.), improving the social cohesion and cohabitation.

- Examples: Public squares, urban beaches, marketplaces.
- Example from Docomomo's selection: Park-Monument of the Bulgarian-Soviet Friendship (Bulgary).

5.4.5 Nonuse value (e.g., value by mere existence, legacy value)

To allow to society dispose spaces, structures... which, regardless of his actual interest, can be a known benefit or not for future generations or even if they don't produce a benefit by itself, specific or importantly enough, society decides to save it for a reason (e.g., a cultural representation, identity symbol or a unique o limited technique).

- Examples: Heritage buildings, libraries, urban areas without a specific purpose.
- Example from Docomomo's selection: Monument of the Bulgarian Communist Party (Bulgary).

6 Indicators proposal to measure the ecosystem services associated with heritage

Based on the typological classification proposal of the services offered by the concrete heritage presented in this report, an indicator system has been designed and organized in three large blocks: Capacity, flow and benefit. This model of distribution of indicator types has been used successfully in other works applied to natural ecosystems in coastal areas [37].

- Capacity: Referred to the capacity of an anthropic system to provide services. Those indicateros quantify, for example, the maximum production or storage capacity in relation to the used area. This initial capacity refers to the start up function of the building or monument analyzed. It would be particularly relevant to analyze the evolution of this capacity through time and to develop scenarios.

- Flow: Referred to the anthropic functions that ultimately contribute to human well-being (those values can never be greater than the capacity indicators). Those indicators inform about the level of uses and production, relativized with the maximum capacity. The evolution of this flow could be also analyzed.

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- Benefit: The flow may be translated into specific societal BENEFIT. Therefore, those indicators measure the possitive impact for human welfare caused by the anthropic activity carried out on the concrete heritage building, measured in economic or social benefits.

The concretion of the indicators will depend on the building or monument analyzed. In this way, if we use the example of Zarzuela hippodrome (one of the case studies in this project), we could conclude the following:

The hippodrome would be included in category 2.5, which is called "Provision of monetary benefits for commercial or exchange activities", even though we can associate cultural services. The adaptation of the capacity indicator would be the income from the maximum horse tickets and betting sales expected in the business plan divided by the occupied land surface of the racetrack. The proposed flow indicator would be the income from the sales of horse tickets and bets in a given year divided by the expected income in the business plan. Finally, the proposed benefit indicator would be the annual turnover divided by the number of racetrack workers in a given year and the degree of user satisfaction with the services offered. An important part of this information can be obtained at *https://www.hipodromodelazarzuela.es/informaci%C3%B3n-corporativa#portal-de-la-transparencia.*

Each indicator must have a tab model. This page includes all the information that the managers or technicians need to prepare and analyze the results. The proposed file can be seen in the following table:

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Table 4. Model of indicators sheet

Indicators data sheet			
SERVICE CATEGORY			**INDICATOR NAME:**
☐ Support spatial ☐ Provisioning ☐ Regulating ☐ Cultural			_____ _____
1. DESCRIPTION:			**Typology:** ☐ Capacity ☐ Flow ☐ Benefit
Units:	**Sources:**		
2. METHODOLOGY PROCESS:			
3. RESULTS:			
4. INDICATOR INTERPRETATION:			
DRIVERS			
EVALUATION			
5. SERVICE LEVEL:	**6. IMPROVEMENT OR DEGRADATION OF SERVICE:**		
OBSERVATIONS:			

Finally, the generic indicators proposal to each service categories has been designed. This proposal is presented in the following tables organized by services categories.

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Table 5. Proposal of indicators for Support Services

Type	Indicators		
	Capacity	*Flow*	*Benefit*
Necessary space for resting and / or housing	No. housing/Area surface	People who live/Total population	€/m2
	No. Rooms/floor surface	Occupancy rate / year	M2/people
	No. people/Area surface		
Operative space for the development of human activities	No. Offices/Area surface	No. business/Building or area surface	No. Total Workers/year
	Exhibition surface/Area surface (m2)	Occupied exhibition surface/total exhibition surface	Annual budget business/year
	People capacity/area Surface	No. Exhibitions/year	Sustainability certificates/No. Bussines
	No. sports tracks or swimming pools or rooms/area surface	Attending events/year	User satisfaction level
	Users capacity/area surface	Daily occupation /year	
		No. Users/year	
Space for storage, deposit and / or reception	Occupancy capacity per storage unit/area surface	Occupancy rate/year	Income by activity/year
	No. niches/area surface	No. users/year	Certificates of quality or sustainability/year
		No. visitors/year	No. workers/year
		No. funerals/year	
		No. busy niches/total niches	
Necessary support to allow movement and transport	km navigable/total area watershed	No. Ships/year	No. sales tickets/unit/year
	km railroads or roads/total population or surface	No. vehicles/year	Volumen mercancía /unidad/año
	Flow capacity or weight of the bridge or viaduct	No. passengers/year	Passengers/unit/year
		No. trains/year	Energy expenditure/unit/year

Source: Own elaboration

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Table 6. Proposal of indicators for the provisioning Services

Type	Indicators		
	Capacity	*Flow*	*Benefit*
People supply to allow other anthropic activities	No. train tracks or platforms/area surface	No. Services/area surface	No. Services/area Surface
		No. Passagers/area Surface/year	No. Passagers/area Surface/year
		No. transport companies/area Surface/year	No. transport companies/area Surface/year
Provider of goods and products to allow other anthropic activities	Maximum supply capacity area surface	No. kilos products sold / maximum supply capacity	Sales revenue / year
	Maximum number of retailers/surface area		Satisfaction degree facilities, services and products/year
	Capacity/surface area		No. bussines/year
Provider of basic urban services	Maximum supply capacity area surface	Real supply/maximum capacity/year	Population supplied/year
			Income supply/population/ year
			Degree of satisfaction services
Provider of goods and products through the transformation, processing and handling of the materials	Production capacity/area surface	Production/nº Workers/maximum capacity	Production benefits/year
	No. of seats or capacity establishment/area surface	No. users/maximum capacity/year	Average salary/worker
			invoicing/worker/y ear
			Degree of satisfaction services
Provider of monetary benefits by commercial activities or exchange (money, material or services)	Maximum expected revenue in business plan/area surface	Real income/year/expected income	Invoicing/worker/y ear
			Degree of satisfaction services

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Provider of professional services, information and knowledge	Maximun broadband coverage	Patents/No. workers/year	Patens benefits/No. workers
	No. Workers/area surface	Papers/workers (researchs, journalists...)/year	Average impact index published papers/year
	No. offices or laboratories/area surface	No. consulting agreement/Workers/year	No. companies related to centers/No. workers center
		listeners/year	Degree of satisfaction services

Source: Own elaboration

Table 7. Proposal of indicators for the Regulation Services

Type	Indicators		
	Capacity	***Flow***	***Benefit***
Regulation of waste by urban or industrial process	waste treatment capacity/area surface	waste treatment/year	Population area collection of waste/volume treated waste
			Waste generated/waste treated
Regulation of the flow of people, vehicles, goods and materials	No. checkpoints/area surface	No. people who cross borders/No. checkpoint/year	Kilos of caches shipment/registered persons
	No. Workers/area surface	No. checked elements (planes...)/workers/year	No. non-regular people identified/registered persons
			Degree of satisfaction services
Regulation of conditions for habitability, security, social	Maximum legal capacity of people/area surface	Actual occupation/maximum legal capacity	Crime rate
	No. offices/area surface	No. workers/offices	

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development, economic interactions and organization		No. intervention/population/year	Degree of satisfaction services
		No. looked persons/ population/year	
		No. of foreigners/embassy offices	
Regulation of basic physical and mental health	No. beds/area surface	Users/No. Beds or doctors/year	Degree of satisfaction services
	No. Workers/area Surface	Looked people/total population	Production benefits/year
	No. Centers/area Surface	Looked animals/total counted animals	Average salary/worker
			Billing/worker/year
			Life expectancy
			Patient recovery rate

Source: Own elaboration

Table 8. Proposal of indicators for Cultural Services

Type	Indicators		
	Capacity	Flow	Benefit
Physical and experiential interactions, active or passive, for leisure and tourism and / or personal enjoyment and development	Exhibition surface/Area surface)	Occupied exhibition surface/total exhibition surface	Income by activity/year
	People capacity/area surface	No. Exhibitions/year	Certificates of quality or sustainability /year
	No. sports tracks or swimming pools or rooms/area surface	Attending events/year	No. workers/year
	Users capacity/area surface	No. Users/year	Degree of satisfaction services
	No. seats or capacity establishment/area surface	No. visitors/year	Loading capacity

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Intellectual interactions for cognitive development and training	No. places offered for training/surface area	No. students/places offered	Patens benefits/No. Workers
	No. classrooms/area Surface	No. professors/offices	Average impact index published papers/year
	No. Offices/Area surface	No. visitors/year	No. companies related to centers/No. workers center
		No. users/year	No. students/total population
		No. degrees offered	Ranking de calidad formative
			Degree of satisfaction services
Spiritual, religious, symbolic, aesthetic, emblematic or ethic interactions	Occupancy capacity per storage unit/area surface	No, parishioners/religious ceremony	Billing visits/worker/year
	No. niches/area Surface	No. visitors/population	Donation/No, parishioners
		No. funerals/year	Degree of satisfaction services
		No. busy niches/total niches	
Sociocultural relationships and material or economic exchange	km beach/km total coast	users/area surface/year	Users/total population/year
	Surface of free spaces or green/area surface		Billing companies market/No. shops/year
	No. shops/area Surface		No. workers/shops/year
			Degree of satisfaction
Nonuse value (For instance: value by mere existence, bequest value)	Maximum occupation capacity per storage unit/area surface	No. Users/year	Degree of identification with space
		No. visitors/year	
		Preserved heritage	

Source: Own elaboration

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7 Conclusions

The main utility of the presented methodological framework resides in the possibility of making more visible the greater number of benefits that the cultural heritage offers to the human being. Once it becomes visible, it is easier to value it from the services it provides, following methodologies such as the use of quantification / qualification indicators or monetary and non-monetary valuation techniques, which are highly developed in the case of ecosystem services. Finding or enhancing services which are not valued or using conservation or maintenance prioritization criteria become results of this proposal.

Likewise, once the service classification system has been obtained for any building / monument built according to its function, it will be possible to consider what specific and detailed services are associated with their characteristic attributes. That is, for instance, between two buildings there will be constructive, architectural, contextual... elements that will provide greater benefits than others. In the case of concrete, the advantages offered by this material with respect to other materials, implies a greater flow of specific services, which could be getting more developed in future studies.

Another example of the proposal utility could be the identification of the heritage management problems, with the possibility of applying the causal framework DAPSI (W) R, (Driver, Activities, Pressures, State, Impact (on Welfare), Responses), widely used in the case of ecosystem services [38]- [39]. The associated conceptual framework would facilitate providing criteria to decision makers in order to prioritize some units over others, considering the services that each of them provides, and assessing the consequences of decisions made in urban planning on human well-being. This involves determining what anthropic and ecosystem services are gained or lost when a decision is made, from the units that are prioritized or from the units (also ecosystems) that are replaced by the new uses. Not in vain, there is heritage located in urban environments, but also in natural environments.

This classification system would also allow better cooperation between institutions and greater multidisciplinary / interdisciplinary collaboration in science and research and providing a logical discourse to create bridges between science and public management, between science and society and between public management and society. The use of the theoretical framework of ecosystem services allows to take advantage of a methodological development quite argued and consolidated in science. On the other hand, this approach is increasingly accepted in

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management, even to cross criteria for spatial planning, applicable to both more natural origin elements and systems as for those of more anthropic origin.

The main goal of this work is not to compare the importance between different services categories or to prioritize among them, but to make them visible, both for decision-making and for society. Subsequently, the different actors will apply their value and prioritization systems, which may require the support of other types of scientific work [40]. In the process is included the following difficulty: to associate services defined, benefits for society, since many are intangible. They are not material or monetary. An example of the difficulty of this association is that in some cases they depend on the principles, beliefs and values of each person. Others are not experiential but metaphysical. In other cases, they have to do with the transformation that a person can suffer when they perceive it, while others exist as a social commitment ("we as a society, we value") [41].

For an adequate application of this methodology, the following factors must be considered:

- Note that a unit can offer a supply of several services categories at the same time (just as ecosystems did). To remember also that we usually refer about anthropic systems composed of different units. The system's units can have different main services (but, for example, even if a university has a cafeteria, the main service would be cultural).
- Note that the spatial support service refers to the space and / or physical support necessary to allow or sustain certain needs. In some cases, the benefit key associated with this category will be that it covers the need by providing a specific surface or volume (quantitative aspect, associated for example with storage), in others cases it will be properly adapted and prepared to allow that physical support (qualitative aspect, for example, associated with the different means of transport, which require specific surfaces such as rails, asphalt ...).

  In some cases, it will be a mixture of both aspects and will involve very specific adaptations depending on the need to cover (housing, for example, which requires optimal surface conditions and facilities, but there are also anthropic activities that require very special facilities with large surfaces, such as hippodromes ...). Therefore, the importance is not the specific state of the unit that offers the service at a given moment (whether or not it allows the passage of something, for instance, that can be associated with the regulation of a flow), not the intensity or quality of the transported or displaced (more associated with the supply sections). The relevant attribute is

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related to a passive quality: the availability of an useful space and the physical support facilitated in order to carry out the transportation (makes a space passable, circulable, navigable), storage or reception (makes a space have capacity to host), or to develop activities, operations or social functions. Also included the space reserved as expansion areas of anthropogenic units (e.g., for future infrastructures, industries, expansion of ports or urban areas) or security / buffer areas with restrictions (p.e., around buildings that work with dangerous substances).

- The provisioning service implies a process of supplying material elements, an active flow of material, supplies, people, vehicles, money, etc. It also includes the supply of information, knowledge or services, from a professional perspective (e.g., consulting services), that is, more oriented to the productive process than to intellectual growth (which would be part of the cultural services section).

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9 Annex

9.1 Annex 1

Category	ID	Type	Examples	Examples from Docomomo's selection
1. Spatial support	1.1	Necessary space for resting and/or housing	Block or group of houses; hotel; home; orphanage	Unité d'Habitation de Marseille (France)
	1.2	Operative space for the development of human activities	Office blocks; multipurpose room; meeting center; social cultural center; center or pavilion of exhibitions or exhibitions; convention palaces; swimming pool; tennis club; Racecourses	Centennial Hall (Poland)
	1.3	Space for storage, deposit and/or reception	Storage installation; hangar; garage; water tower; libraries; museums; zoos; cemetery	Two hangars in Grimbergen (Belgium)
	1.4	Necessary support to allow movement and transport	Bridge, roads, navigation channels, train tracks and other infrastructures	Kasari Bridge (Estonia)
2. Provisioning services	2.1	People supply to allow other anthropic activities	Bus station; train station; airports and other support units for various transport systems	Leipzig Main Station (Germany)
	2.2	Provider of goods and products to allow other anthropic activities	Markets; supermarkets; slice; stores; markets and infrastructures that supply them (e.g., roads, train tracks)	Schreiner Building (Germany)
	2.3	Provider of basic urban services	Power plant; transformers; pipe systems, gas pipelines, wiring	Københavns Højdevandbeholder (Denmark)
	2.4	Provider of goods and products through the	Industries; factories; processing centers; pubs; coffee shops; restaurants	AEG_Turbinen Fabrik (Germany)

Category	ID	Type	Examples	Examples from Docomomo's selection
		transformation, processing and handling of the materials		
	2.5	Provider of monetary benefits by commercial activities or exchange (money, material or services)	Stores, shopping centers, markets, shops, concert halls, cinemas, theaters, pubs, nightclubs, racetracks and any facility with a high commercial interest	Schreiner Building (Germany)
	2.6	Provider of professional services, information and knowledge	Information (radio station); knowledge (research center, innovation, technology); professional services (consulting, workshop)	Radio Kootwijk (The Netherlands)
3. Regulating services	3.1	Regulation of waste by urban or industrial process	Treatment plants, landfills, storage of waste, crematoria …	Gävle Crematorium (Sweden)
	3.2	Regulation of the flow of people, vehicles, goods and materials	Customs, tolls, control zones for access to buildings or infrastructures, border areas, control towers, observation towers	Simon Stevin/Lorentz discharge sluices (The Netherlands)
	3.3	Regulation of conditions for habitability, security, social development, economic interactions and organization	Prisons, fire brigade buildings, police buildings, centers and structures for military use, offices, public administrations (such as town halls or ministries), courts and tribunals, embassies	Court House of Livadia (Greece)
	3.4	Regulation of basic physical and mental health	Hospitals, health centers, asylums, orphanages, veterinarians	Herlev Amts Sygehus (Denmark)
4.	4.1	Physical and experiential interactions, active or	More active nature: sports facilities (swimming pools, pavilions, athletics centers ...), bars,	Olympic stadium (Finland)

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Category	ID	Type	Examples	Examples from Docomomo's selection
Cultural services		passive, for leisure and tourism and / or personal enjoyment and development	restaurants, nightclubs. More passive: museums, cinemas, concert halls, theaters	
	4.2	Intellectual interactions for cognitive development and training	Schools, universities, training centers, higher education centers, research centers, technological development centers, R & D centers, libraries, museums ...	Eduardo Torroja Institute (Spain)
	4.3	Spiritual, religious, symbolic, aesthetic, emblematic or ethic interactions	Churches, convents, monasteries, cathedrals, cemeteries, monuments, memorials	Convento, teologado e Iglesia de San Pedro Mártir de los Padres Dominicos (Spain)
	4.4	Sociocultural relationships and material or economic exchange	Public squares, urban beaches, markets, urban or peri-urban parks	Park-Monument of the Bulgarian-Soviet Friendship (Bulgary)
	4.5	Nonuse value (For instance: value by mere existence, bequest value)	Heritage buildings, libraries, urban areas without assigned use	Monument of the Bulgarian Communist Party (Bulgary)

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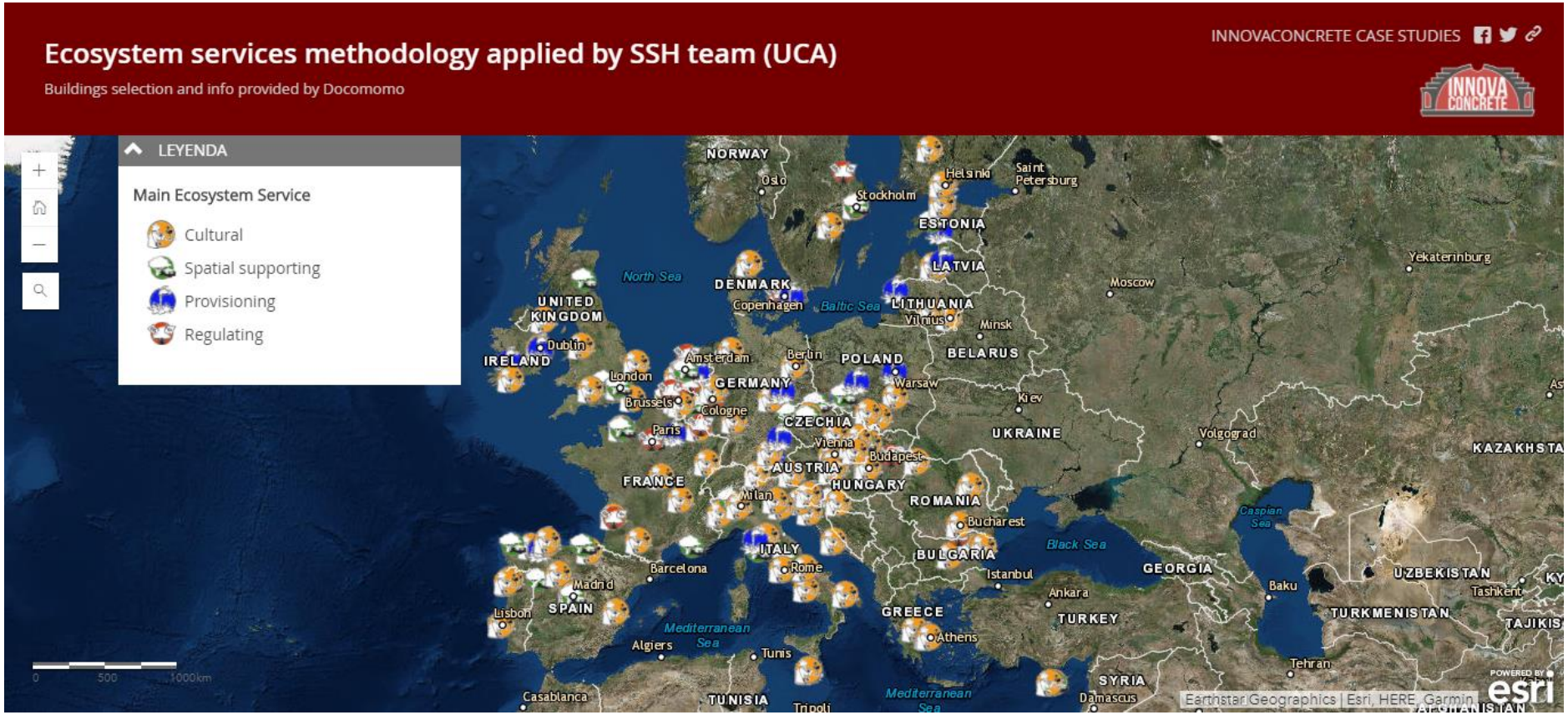
9.2 Annex 2

Geography Information System (GIS) with ecosystem services methodology applied



Link: *https://www.arcgis.com/apps/StoryMapBasic/index.html?appid=7687eb02c69f478baa6322585e24abbe*