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AMUVAM Model for the Valuation and Prioritization of the Environmental Assets of the Ecosystem of the Pacucha Lagoon, Andahuaylas, Peru.

Abel Isaias Barrial Lujan, Maria del Carmen Delgado Laime, Mary Luz Huamán Carrión, Fidelia Tapia Tadeo, Yalmar Ponce Atencio and Yobana Rodrigo Cabezas

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1st Abel Isaías Barrial Lujan*
Faculty of Engineering
Universidad Nacional José María Arguedas
Andahuaylas, Apurímac, Peru
abarrial@unajma.edu.pe
*Corresponding author

2nd Maria del Carmen Delgado
Faculty of Engineering
Universidad Nacional José María Arguedas
Andahuaylas, Apurímac, Peru
mcdelgado@unajma.edu.pe

3rd Mary Luz Huamán Carrión
Faculty of Engineering
Universidad Nacional José María Arguedas
Andahuaylas, Apurímac, Peru
mhuaman@unajma.edu.pe

4th Fidelia Tapia Tadeo
Faculty of Engineering
Universidad Nacional José María Arguedas
Andahuaylas, Apurímac, Peru
ftapia@unajma.edu.pe

5th Yalmar Ponce Atencio
Faculty of Engineering
Universidad Nacional José María Arguedas
Andahuaylas, Apurímac, Peru
yalmar@unajma.edu.pe

6th Yobana Rodrigo Cabezas
Faculty of Engineering
Universidad Tecnologica de los Andes
Andahuaylas, Apurímac, Peru
jhobanarc95@gmail.com

***Abstract*—Currently there is a consensus in the scientific community that many of the goods and services generated by environmental assets aren´t detected by the market due to they are intangible asset as tangible, it is difficult, and in some cases impossible. For this reason, the objective of the present work was the economic valuation and to know the prioritization of the environmental assets of the ecosystem of the Pacucha lagoon and, through the AMUVAM model made up of AHP and the method of updating income, through the survey of a group of experts (46 people) in the judgment of the researcher, it was possible to determine the total economic value amounting to $ 20,793,456.81, whose prioritization gives the direct use value with a weight (29.57%), followed by existence value (18.28 %), indirect use value 18.23% legacy value (17.66%) and option value (16.26%). In addition, in the interest of knowing the existence value, the economic value is $ 3,801,788.67 to this component of the VET, experts prioritize the biodiversity subcomponent (51.41%), followed by cultural heritage and visual landscape (27.07% and 21.52%) respectively. Obtaining this economic value would turn out to be a very important tool that allows us to evaluate and compare the different benefits of said asset for conservation and sustainability in a way that improves the management of its resources.**

Keywords*—*Ecosystem; multi-criteria method; Pacucha lagoon; environmental asset and economic valuation

I. INTRODUCTION

The natural ecosystem provides society with a large number of flows of goods and services that contribute to social welfare directly and indirectly. Furthermore, these flows represent the support of sustainability in the trade and economy of the countries. However, in the market society in which we find ourselves, the importance of all kinds of goods or assets is fundamentally understood through the expression of their monetary value [1]. Therefore, one of the best ways to demonstrate and transmit the importance of an environmental asset will be by determining the economic value of the goods and services they provide.

When referring to economic valuation in the environmental field, it is evident that we are talking about assigning a monetary value to the goods and services that environmental systems provide us in a defined geographical environment. This fact is controversial for some researchers, since they argue that it does not make sense to define a value for a good that has no market and that will never be the subject of a transaction. On the other hand, in other social sectors, fundamentally environmentalists, it is thought that obtaining the value of an environmental space is the first step on the road to its privatization [2]. However, different authors who have contributed to the study of economic valuation and consider that valuing the environment economically means being able to have an indicator of its importance in the well-being of society, which allows it to be compared with other components of this well-being. [3] express this idea in a similar way: "In order to compare, you need a common denominator, and this is money." [4] and [5] also justify the valuation of these assets in order to better use public resources. For both authors, estimating the value of environmental assets can serve to justify and enable the distribution of the public budget among the different alternatives for public investment, as well as among the different initiatives for the conservation, preservation or restoration of environmental assets. Thus, knowledge of this economic value is key for government intervention to improve market efficiency, in a Pareto sense, since it allows justifying and prioritizing administrative decisions regarding the use of its resources.

In environmental valuation there are already a series of methods used in a large number of works that, using different approaches, seek to determine a monetary value of either the asset considered or the services that asset produces. The best

known are the cost of the trip [6], the contingent valuation method [7]; [8] and the hedonic value method [9] within the focus of Environmental Economics. On the other hand, and from an Ecological Economics perspective, the most representative are the Energy Analysis [10] and the Emergetic Analysis [11].

This work, a methodology different from the previous ones is presented with the dual purpose of increasing the instruments available to obtain the value of environmental assets and to provide a new valuation perspective. It includes multi-criteria evaluation systems, where multiple valuation languages take place, which take into account ethnic and cultural specificities. Biophysical indicators are as important, or more, than the prices generated by the market. In this sense, we fundamentally consider the economic valuation and prioritization of the environmental assets of the ecosystem of the Pacucha lagoon, Andahuaylas - Peru. Applying the AMUVAM model (analytical multi-criteria valuation method) that is based on the Analysis of the Theory of Multicriteria Decision such as The Hierarchical Analytical Process (AHP) and income update rate [2]. For this purpose, it is necessary to arrive at the estimation of an Indicator of Total Economic Value (TEV); which in turn, is made up of the components of direct use value (DUV), indirect use value (IUV), option value and / or Co-option (OV), existence value (EV) and legacy or future value (LV). The prioritization of the components of environmental assets is achieved by means of the weighting that indicates the importance of each of the criteria (in this study it becomes the components of the TEV). This weighting using the AHP methodologist is extracted from the survey that was carried out on a group of experts of 46 people with qualities that possess a vast knowledge of the asset to be valued, being representatives of the different sectors, whose institutional function and professional work is linked to the Pacucha lagoon. For this, the fundamental table of paired comparisons was used, where each of the respondents indicated the relative importance according to the criteria they initially identified. In order to find the final weight of each criterion, the importance of each expert was first calculated according to the experience studies registered in the survey in each category. In the case of the rent update rate method, the calculations considered the economic benefits derived from agriculture, livestock, fishing and recreation (tourism) activities; that is, the value of an economic good that becomes equal to the present value of the sum of future rents or Gains (Income-Expenses) that a good can generate for its owner. Despite this, we are aware that expressing some of the components of the value of an environmental asset through a monetary unit may be debatable.

This way, the valuation of an environmental asset of an economic type means being able to have an indicator of its importance in the well-being of society, which allows it to be compared with other components of this well-being, the total economic value (TEV). Thus, knowledge of this economic value is key for government intervention to improve market efficiency, in a Pareto sense, since it allows justifying and prioritizing administrative decisions regarding the use of its resources. Lack of valuation of these resources can lead to economic actions and activities that lead to inappropriate use or overexploitation, causing a negative change in the condition and care of natural resources.

II. MATERIALS AND METHODS

2.1. Scope of the study

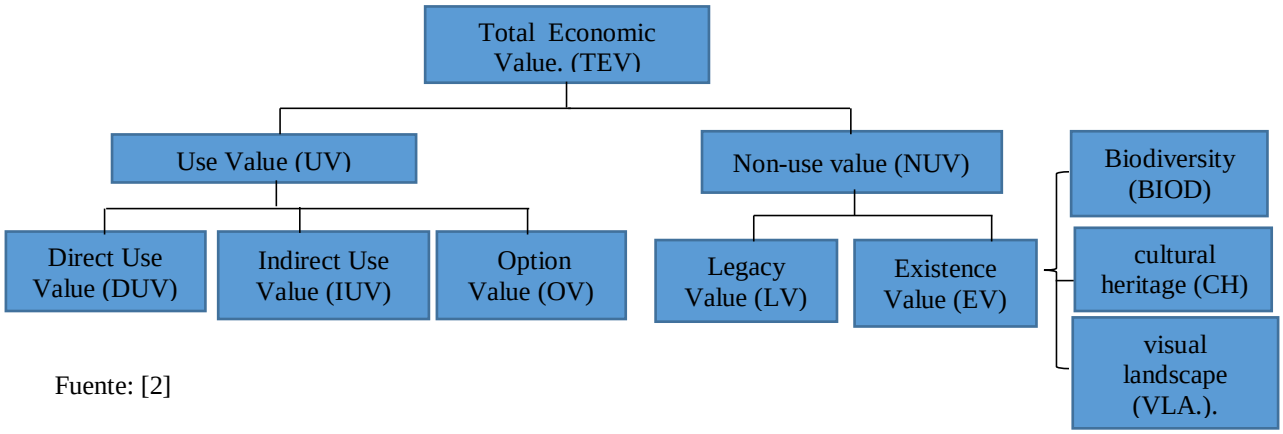
For the present study, the environmental assets of the ecosystem of the Pacucha lagoon have been considered. This lagoon is located in the Pacucha district, which is located 16.1 km from the capital of the Andahuaylas province, at an altitude of 3,125.00 meters above sea level. Located between the coordinates: 13 ° 36´27´´ south latitude and 79 ° 19´30´´ west longitude, it has an extension of 728.00 has [12]. Its dimensions are, maximum length 3,970.00 m on the east-west axis; maximum width 2,680.00 m; maximum depth 30.00 m, water volume 118,010,495.00 m3. [13], and the environmental asset of this resource is delimited in detail with the different components of the total economic value (TEV).

The Pacucha lagoon is considered one of the largest and most beautiful lagoons in Peru. In addition to being a tourist place, it is the source of the most important agricultural system within the economic corridor of the Apurímac region. Its importance lies in the fact that its water volume and nutritional components of its waters are productive. Currently, different fish species such as trout, lake silverside and common carp have been exploited [14]. The lagoon water resources are used to agricultural activities, mainly for the production of potatoes of various varieties, corn and vegetables; and in livestock activities for raising cattle, sheep, pigs, and minor animals such as guinea pigs and chickens, which provides food sources and economic resources for the benefit of people living in the surrounding communities. Another primary characteristic of the water in the Pacucha lagoon is its temperature, which ranges between 15 ° C in June and July and a maximum of 19 ° C in March and April [13], which allows to house on its banks plants such as totora, species of adapted and endemic flora, for instance, Atajo, Molle, Fennel, parsley, aloe, marcco, artemiza, amor seco, santa maría, llaulli, cedroncillo, Ajenjo, mutuy, dandelion, turnip, broom, manayupa, alfalfa, clover, hierba buena, oregano, wild mallow, llantén, sweet grass, lengua de vaca, romanza, ruda, totora, aguaymanto, eucalyptus, cypress, pine, kishka, yahuarchoncca ayaczapatilla and nettle. On the other hand, birds such as: Rayador negro, Yanavico, Garza bueyera, Garcita Blanca, Bandurria, Rascón, Ave fría andina, Playerito de Baird, Sandpiper, Faláropo Tricolor, Playero coleador, Andean Gull, Junquero, Neotropical Cormorant, Wild Duck , Andean coot, Barcino duck, Jergón duck, Sambullidor and moorhen. In addition, in this natural space activities such as the famous boat rides are carried out as a tourist activity.

2.2. Methodology of economic valuation of the environmental asset using AMUVAM

The economic value of environmental goods and services were quantified using the AMUVAM method described by [2]. This is a method of valuation of environmental assets which is composed of two techniques, the AHP (Analytic Hierarchy Process) developed by [15], that includes the selection of alternatives based on a series of criteria or variables, and the Income Update Method established by (Ramsey, 1928) and updated by [2]. Follow, the Direct Use Value (DUV) will be calculated. The DUV is the only component of the TEV that can calculate your income because it includes the activities that the market detects. Subsequently, your total income will be updated to the social rate of time preference calculated for Peru. Using the DUV as the pivot value, the value of the rest of the components will be calculated. Finally, adding the values of all the components, the TEV is obtained. The diagram of the Figure 1 shows it in a clearer way:

Figure 1 Diagram of the Total Economic Value and EV components compared during the survey.



Fuente: [2]

It is important to define of the TEV component the VET

a) Use values

a1) DUV usually refer to the values derived from the goods that can be extracted, consumed or enjoyed directly. In this work, they correspond to the goods that involve the consumption of natural resources and have a market value. [16]. In this case, the study considered agricultural production (potato, corn, alfalafa and horalizas), livestock, fishing and others that regulate the market.

a2) IUV are mainly derived from the services ecosystems produce. This work, together with flood control, groundwater recharge, retention of nutrients and support to other ecosystems, included in the classification of wetlands by [17], natural areas of stabilization and recreation have been considered. The socio-environmental system of the pacucha lagoon. In terms of recreation, cycling, bird watching, walking, boating, swimming, and sunbathing are some of the main recreational activities in this area. These latter recreational activities, which could be connected with tourism, are not considered as a direct use of a non-consumptive good [18], since the income is supposed to be related to the services provided by the tourist companies that take advantage of the natural benefits.

a3) OV It the one obtained by guaranteeing that in the future the benefits of an asset will be available or enjoyed, even if it is not currently being enjoyed [19]. It is related to the importance assigned to maintaining the option of taking advantage of the value of resource use. hydric in the future, even if it seems unimportant now. It is related to the expected value of the information derived from the delay in use. [20]. That is, there is some speculation with technological advance, believing that perhaps in the future it will be profitable or beneficial.

b) Non-use values

b1) EV is the value of an asset as it is an essential resource for the conservation of tangible assets, such as flora or fauna or unique for the conservation of cultural values, landscapes, etc. [19]. BIOD, CH and VLA. In this case, all the resources present in the pacucha lagoon (species of plants, grasses, birds, fish and others).

b2) VLA also called Inheritance Value is the value that a active to bequeath the benefits that it offers to future generations that have the opportunity to enjoy it. [19].

Table 1 Comparison between TEV components.

Comparison	Scores
DIRECT USE/INDIRECT USE values	/
DIRECT USE/OPTION, QUASI-OPTION values	/
DIRECT USE/EXISTENCE values	/
DIRECT USE/BEQUEST values	/
INDIRECT USE/OPTION, QUASI-OPTION values	/
INDIRECT USE/EXISTENCE values	/
INDIRECT USE/BEQUEST values	/
OPTION, QUASI-OPTION VALUES/EXISTENCE values	/
OPTION, QUASI-OPTION VALUES/BEQUEST values	/
EXISTENCE/BEQUEST values	/

Which is considered more important by society with respect to the general value of the pacucha lagoon? Second, they express the intensity of importance, using the scale of comparisons shown in Table 4. According to the proximity of the elements compared in importance, the different values of the fundamental scale can be used. Their answers are used to obtain the comparison matrices. There are as many matrices as consulted stakeholders. Then the consistency ratios (CR) are verified and the eigenvalues are calculated. Finally, the geometric mean of the eigenvalues is calculated to obtain the weights of the various TEV and EV components. For this study, the group of experts included local and external actors representing the key issues in the area, in terms of exploitation and conservation of natural resources. The selected and interviewed experts were representatives of the decentralized institutions in the province of Andahuaylas table 2

Table 2 Collective group surveyed

N°	PARTICIPATING INSTITUTIONS/ REPRESENTATIVES
5	: Subregional Agricultural Directorate
3	: Sub Regional Production Directorate
2	: Chamber of Commerce, Industry and Tourism
3	: Foreign Trade and Tourism Directorate
2	: Pacucha District Local Economic Development Office
3	: Biologist, from the José María Arguedas National University
2	: Microbiologist, from the José María Arguedas National University
3	: Agroindustrial Engineer from the José María Arguedas National University
2	: Engineers in food industries from the José María Arguedas National University
5	: Agricultural Engineer from the Technological University of the Andes
6	: Engineer in Environmental and Natural Resources of the Technological University of the Andes
3	: Licensed Tourism and Hospitality from the ISTEPSA
4	: Representative of the Association of Fish Farmers of Pacucha
3	: Representative of the most important residents of the Pacucha District

2.2.1. Analytic Hierarchy Process (AHP).

The AHP method updated by [15] allows a set of possible alternatives, to prioritize them, using the pairwise comparison between elements using a fundamental scale which is described in the Table 1 in relation to Table 3.

Table 3 The fundamental scale for pairwise comparisons.

Valu e	*Verbal scale*	*Explicatión*
1	Equal importance	Criterion A is just 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 criterion B
9	Extreme importance	Extreme importance A over B.The evidence favouring one activity over another is of the highest possible order of affirmation
2,4,6 y 8	Intermediate values between the above, when it is necessary to qualify	

Note: [1]Reciprocal values to the previous ones: If alternative *i* has one of the previous non-null numbers assigned to it, when compared to activity *j*, then *j* has the reciprocal value when compared to *i*. Comparing alternatives two by two according to a criterion and using the scale of the paired comparison table, we obtain square matrices; $A = a_{ij}$, which must comply the properties of reciprocity, homogeneity and consistency [2].

The consistency of the paired comparison matrices of the survey to the collective group, is known through the consistency ratio and is calculated as follows:

The Consistency Index (CI)

$$CI = \frac{\lambda max - R}{R-1} \quad (1)$$

where R is the rank of the matrix. Knowing the Consistency Index the Consistency Ratio is calculated (CR) as

$$CR = \frac{CI}{Consistencia\ aleatoria} \quad (2)$$

, being the random consistency, for a matrix M_{5x5}, equal to 1.11, CR ≦10 %, and for a matrix M_{3x3} equal to 0.52, CR ≦ 5% [2].

For the application of the AHP method, by means of non-probability sampling in the judgment of the researcher, a collective group of individuals with extensive knowledge of the asset to be valued was considered. A total of 46 people were considered, the selection criteria being representatives of the different sectors, whose institutional function and professional work is linked to the Pacucha lagoon. For this, the fundamental table of paired comparisons was used (see Table 3) with the group of selected local and external actors.

2.2.2. Rent asset update method

According to the analytical method, the value of an economic good is equal to the present value of the sum of

the future rents or Earnings (Income-Expenses) that a good can generate for its owner.

In this way, the usual Value formula (V) is computed as follow:

$$V = \sum_{i=1}^{n} \frac{Ri}{(1-R)\hat{}i} = \frac{R}{(1-R)} + \frac{R}{(1-R)\hat{}1} + \frac{R}{(1-R)\hat{}2} + \frac{R}{(1-R)\hat{}3} + \cdots + \frac{R}{(1-R)^i} = \frac{\frac{R}{(1+r)}}{1-\frac{1}{(1+r)}} = \frac{R}{r} \quad (3)$$

, where,
V = Value of the environmental asset for its functions (DUV),
Ri = Future income generated by the property in year *i* for its owner,
r = Update rate that expresses the preference for money in the owner's time (Social Rate of temporary preference),
n = Period during which the good will generate benefits.

2.2.3. Pivot value calculation

As update rate (r), we will take the Social Discount Rate r = 3.77, calculated for Peru [21] and [22], calculated from the [23] formula (individual or pure time preference rate (0.88%); which represents the elasticity of the marginal utility curve of consumption.

$$DUV\ Value = \frac{Cash\ flow\ of\ the\ services\ provided\ by\ DUV}{Discount\ rate} \quad (4)$$

2.2.4. Total Economic value (TEV) calculation and its related components.

The underlying hypothesis of the TEV is the sum of its partial components which are implicit in this assessment. This approach has been argued by different authors [24]. However, if the TEV is not considered as a market value, but as an indicator of the value of an environmental asset, the sum of its partial values can be seen as an estimate of its real value [25] y [26].

Once the pivot value of equation (4) is known, the values for the other TEV components (IUV, OV, EV, LV) are estimated [16]. This is done by using the eigenvectors determined through the AHP method, so that the relative the weights of the TEV components are defined (see equations 5 - 8). The TEV of the environmental asset is determined by adding all the partial values (see equation 9). Thus the obtained value indicates the TEV of the environmental asset of the ecosystem service of the Pacucha lagoon. Then, the value of each component of existence value (biodiversity, cultural heritage and visual landscape) is derived from its weights and the known economic value (see equations 10 - 12).

$$VUI = \frac{DUV}{DUV\ weight} * IUV\ weight \quad (5)$$

$$OV = \frac{DUV}{DUV\ weight} * OV\ weight \quad (6)$$

$$EV = \frac{DUV}{DUV\ weight} * EV\ weight \quad (7)$$

$$LV = \frac{DUV}{DUV\ weight} * LV\ weight \quad (8)$$

$$VET = DUV + IUV + OV + EV + LV \quad (9)$$

$$BIOD = EV * BIOD\ weight \quad (10)$$

$$CH\ value = EV * CH\ weight \quad (11)$$

$$VLA\ value = EV * VLA\ weight \quad (12)$$

III. RESULTS AND DISCUSSIONS

The assessment incorporates psychological connotations (hedonic, ethical, cultural, theological, among others) [27]. However, it can be a useful political instrument for decision-making in environmental planning and management in general, because it brings the discussion to the monetary field, since our valuation of a good and service is in a market society [28] in such a way that, having an indicator expressed in economic terms, it allows evaluating and comparing the different benefits that this environmental asset provides and improving the management of its resources as a very useful tool, important for the conservation, protection and sustainability of said asset [29].

A. Obtaining the values that compose the social value using AHP

According on the AHP methodology, the order of priority of the TEV was got, based on the contributed Social Value of the interdisciplinary people group, on the environmental asset of SE of the Pacucha lagoon. In order to determine the relative weighting in each case, the paired comparisons have been proposed in the questionnaire so that the 5X5 matrices (DUV, IUV, OV, EV and LV) and 3X3 (BIOD, VLA and CH) respectively were constructed; obtaining, after verifying its consistency, the eigenvectors that are detailed for each case in the following points and that are added by means of the geometric mean. The same that are contrasted by the criterion of reciprocity, homogeneity and consistency, which is subsequently calculated by the geometric mean (M.G.) of all the respondents.

Table 4 TEV eigenvectors and EV component eigenvectors

N	*DUV*	*IUV*	*OV*	*EV*	*LV*	*BIOD.*	*CH*	*VLA.*
1	0.4685	0.2873	0.1248	0.0665	0.0530	0.6370	0.2583	0.1047
2	0.0472	0.1219	0.1902	0.5006	0.1401	0.6716	0.2654	0.0629
3	0.4673	0.2542	0.1627	0.0834	0.0324	0.2426	0.0879	0.6694
4	0.4265	0.3013	0.0843	0.1145	0.0734	0.1047	0.2583	0.6370
5	0.6076	0.0597	0.1481	0.1466	0.0381	0.1047	0.2583	0.6370
6	0.5489	0.0338	0.0983	0.2207	0.0983	0.6370	0.2583	0.1047
7	0.6134	0.1991	0.0362	0.0945	0.0567	0.1140	0.4806	0.4054
8	0.6243	0.1898	0.0966	0.0428	0.0465	0.6370	0.2583	0.1047
9	0.5744	0.1520	0.0388	0.0766	0.1581	0.6586	0.1562	0.1852
10	0.4357	0.0466	0.1511	0.1129	0.2536	0.6694	0.2426	0.0879
11	0.1293	0.0708	0.4266	0.0634	0.3098	0.1562	0.6586	0.1852
12	0.0373	0.0918	0.1464	0.2582	0.4663	0.7471	0.1194	0.1336
13	0.0507	0.0629	0.1524	0.3265	0.4075	0.6586	0.1562	0.1852
14	0.1532	0.0528	0.0889	0.2413	0.4638	0.1852	0.1562	0.6586
15	0.5281	0.2053	0.1409	0.0491	0.0766	0.7471	0.1194	0.1336
16	0.5260	0.2301	0.1082	0.0897	0.0460	0.7471	0.1194	0.1336
17	0.5176	0.2423	0.0286	0.1535	0.0580	0.6586	0.1562	0.1852
18	0.4622	0.2593	0.1375	0.0680	0.0730	0.6370	0.2583	0.1047
19	0.0928	0.1554	0.3357	0.3619	0.0542	0.7471	0.1194	0.1336
20	0.0569	0.0891	0.2316	0.1393	0.4831	0.6370	0.2583	0.1047
21	0.4938	0.0828	0.0464	0.1492	0.2277	0.1140	0.4054	0.4806
22	0.4543	0.1076	0.0483	0.3472	0.0426	0.6694	0.2426	0.0879
23	0.1503	0.0422	0.0993	0.2529	0.4553	0.4806	0.4054	0.1140
24	0.4438	0.2654	0.1523	0.0579	0.0806	0.1140	0.4054	0.4806
25	0.0512	0.1361	0.2281	0.4981	0.0865	0.2583	0.1047	0.6370
26	0.0478	0.1111	0.4775	0.2127	0.1510	0.6370	0.2583	0.1047
27	0.0531	0.0847	0.4959	0.1831	0.1831	0.6941	0.1315	0.1744
28	0.0361	0.1104	0.1238	0.2395	0.4903	0.7514	0.1782	0.0704
29	0.0251	0.0757	0.3912	0.2299	0.2781	0.0778	0.4869	0.4353
30	0.5469	0.0326	0.1559	0.0584	0.2063	0.6694	0.2426	0.0879
31	0.5325	0.2324	0.0700	0.1161	0.0490	0.6370	0.1047	0.2583
32	0.5257	0.2385	0.0302	0.1461	0.0594	0.6694	0.2426	0.0879
33	0.2864	0.5134	0.1109	0.0445	0.0448	0.6370	0.1047	0.2583
34	0.3603	0.3344	0.0689	0.0836	0.1528	0.7514	0.0704	0.1782
35	0.0502	0.0723	0.1996	0.1670	0.5109	0.0879	0.6694	0.2426
36	0.5117	0.2891	0.0999	0.0562	0.0431	0.6370	0.2583	0.1047
37	0.3233	0.3821	0.0991	0.0393	0.1562	0.7695	0.1265	0.1040
38	0.0502	0.1756	0.1052	0.3859	0.2831	0.4353	0.4869	0.0778
39	0.0507	0.0843	0.1755	0.1567	0.5329	0.4869	0.4353	0.0778
40	0.6277	0.1656	0.0420	0.0824	0.0824	----	----	----
41	0.5173	0.1027	0.0610	0.1659	0.1532	----	----	----
M. G.	0.2140	0.1319	0.1177	0.1323	0.1278	0.4151	0.2186	0.1738

Note: [2] The number of questionnaires carried out was to 46 people, of which 41 valid surveys have been used for VET and the others are not valid since CR presented greater than 10% and have been discarded. For EV, 39 valid questionaires were used, since the rest presented CR greater than 5% and have been discarded.

On the other hand, it is stated that the weight of each expert is governed by ethical, cultural, and professional codes, among others. These ethical, cultural and professional codes are not the same for the whole set of experts, and as a consequence there are different points of view when weighing the different components that compose the TEV. Hence the importance of assigning the value of environmental assets not regulated by the market.

B. *Valuation of direct use by using the income update method*

The Pacucha Lagoon is distinguished from other natural areas because the primary use of its natural resources is especially intense. We have defined the value of Direct Use as the economic value that environmental goods and services have, due to the exploitation of their resources, for the satisfaction of human needs. The economic benefits

considered are derived from agriculture, livestock, fishing and recreation services.

Table 5 Cash flow from agricultural activity

Agricultural activity	*Incomes*	*Expenditures*	*Net Margin*	*N° Of Farm*	*Benefit ($/year)*
Potato production	2,182.14	2,119.14	63.00	610	38,430.86
Corn production	641.87	562.55	79.32	580	46,005.16
Alfalfa production	3,161.31	2,841.44	319.87	68	21,751.30
Vegetables	367.80	340.15	27.66	78	2,157.14
Total					$ 108,344.46

Note: [3]In 2018, the potato production has represented 35%, surpassed by corn production that represented 42%, alfalfa represented 20% and vegetables 2%, of the annual production campaign utility.

Table 6 Cash flow from livestock activity

Livestock activity	*Incomes*	*Expenditures*	*Net Margin*	*N° unid/year*	*Benefit ($/año)*
Cattle	680.00	380.00	300.00	260	78,000.00
Porcine-pig	62.00	43.00	19.00	230	4,370.00
Ovine	40.00	27.00	13.00	117	1521.00
Minor animals (guinea pig)	7.00	3.00	4.00	1200	4,800.00
Total					$ 88,691.00

Note: Table 6 indicates the order of utility generated in livestock activity, cattle represents 88%; of utility, pigs and smaller animals 5% and sheep 2%, respectively.

Table 7 Cash flow from fishing

Activity	*Incomes*	*Expenditures*	*Net Margin*	*act./year*	*Benefit ($/year)*
Artisanal fishing	680	213	467	24	$ 11,208.00

Note: Data about of fish catches in the Pacucha lagoon. It is worth mentioning that the activity is 7 months of capture and 5 months of closure included in the period 1/1/2018 to 31/12/2018.

Table 8 Cash flow from recreational activity on boats

Activity	*Incomes*	*Expenditures*	*Net Margin*	*Num of associations*	*Benefit ($/year)*
Recreational activities (boats)	7671.43	2959.38	4712.05	5	$ 23,560.27

Nowadays, the recreational activity on boats in the Pacucha lagoon is an increasing demand on weekends and holidays. Families and groups of friends are the ones that demand the boat ride service the most. Thus, the sum of the productive activities (agricultural, livestock, fishing and recreation) achieved, as an economic benefit in 2018, was of $ 231,803.73.

C. Calculation of the total economic value indicator

Known the DUV of the Pacucha lagoon that represents $ 231,803.73 as the PIVOT value, the weight of each of the values is calculated in economic terms. In this way, the TEV Indicator is deduced as well as each of the partial values. In this calculation, the Table 4 was used with the aggregation of the eigenvectors of the geometric mean of the experts, which results in the final weight as indicated in Table 9. Being the higher weighing, of TEV pair comparison, the DUV followed by IUV and EV, and of minor prioritization the OV and LV, respectively.

Table 9 Total economic value of the pacucha lagoon according to the aggregate weights assigned by the experts.

TEV	*Geometric mean*	*Aggregation*	*Final weighting*	*value US$*
DUV	0.2140	0.2957	29.57%	6,148,640.04
IUV	0.1319	0.1823	18.23%	3,789,717.34
OV	0.1177	0.1626	16.26%	3,381,738.35
EV	0.1323	0.1828	18.28%	3,801,788.67
LV	0.1278	0.1766	17.66%	3,671,572.41
total				US$ 20,793,456.81

The differences in the weight allocation of the TEV components by paired comparison of the respondents and, therefore, the final weight can be attributed to the existence of different interests and attitudes towards the valued asset.

This finding is in agreement with the reports of authors working in the field of ecosystem resource management who have reported differences in weight allocation between different expert groups. Hence, the Indicator of the Total Economic Value of Laguna de Pacucha amounts to US $ 20,793,456.81 / year for 728 hectares, equivalent to $ 28,562.44 / year in one hectare. Despite the lack of consensus on the importance of the different components of the TEV, it is observed that some of the components receive similar weights as the IUV and EV. However, the highest weight is the direct use value DUV that reaches 29.57%, the value of bequest and option are lower percentage by weight between 16 and 17.7% respectively.

The knowledge of the environmental situation of the ecosystem benefits of the "Laguna de los Padres" wetland in Argentina, allowed us to express in economic terms an approximate measure possibly undervalued amounting to more than 138 million pesos / year. [28]. While in Peru, the estimated annual economic values of the Llancahue estuary water production ecosystem service reached between 11 and 25 US $ per m3; which is equivalent between US$ 83,742,593 and US$ 190,324,075 in total [30]. Likewise, they found US $ 320,580.78 as the annual value of enjoying the Sausacocha lagoon in the La Libertad region. However, in the case of the Pacucha lagoon, it is equivalent to US$ 176.20 per m3 and US $28,562.44 as annual value per hectare, as described above.

On one side, the work of. [20] indicates that the average value is of 3,274 US $ / ha / year, derived from 200 wetland studies. His study is a synthesis of work. developed by [31] and [32]. This value does not take into account services such as ornamentals and medicinal resources, historical and spiritual values, or sediment control [16]. On the other side, [33] provide an average value of $ 3,463 / ha / year for the non-commercial benefits of the coastal area of Catalonia, based on a transfer of spatial value assessment, also show the average value by county. For the Ebro river delta counties, a Ramsar wetland, the evaluation of which was the use of human land, estimates a range of values between US $ 3,672 and US $ 4,123 / ha / year. The illustrated data of the aforementioned authors is significantly different from the estimated economic values for the Pacucha lagoon. This is due to the fact that they used traditional valuation methods whose disadvantage of considering both their intangible and tangible aspects is difficult, and in some cases impossible to grasp of the components of the TEV, as indicated [16]. However, for the present work, the AMUVAM model was used, which allows estimating a TEV, using direct and indirect economic variables and social variables.

Next, the relative weighing of the Existence value, according to Table 10, is known. The relative weighing according to the order of priority by the respondents is the biodiversity component, followed by cultural heritage and finally visual heritage. This is the value that experts assign to ecosystems and in particular to biological diversity for the mere existence and the possibility of maintaining them for future generations.

Table 10 Components of Existence Value (EV)

EV	*Geometric mean*	*Aggregatio*	*Final weighting*	*Value en US$*
Biodiversity	0.4151	0.5141	51.41%	1,954,455.89
Cultural heritage	0.2186	0.2707	27.07%	1,029,027.81
Visual Landscape	0.1738	0.2152	21.52%	818,304.97
Total				3,801,788.67

The components of the existence value reach the sum of US$ 3,801,788.67. Whose components were characterized with the following weighting, 51.41% of biodiversity, the valuation for cultural aspects represents 27%, and finally, the valuation for the enjoyment of the visual landscape is equivalent to 21.52%. In the case of the environmental assessment of the vineyard in the municipal area of Requena-Spain, the weighting of the value of existence was made known, with 15% of biodiversity, landscape 35% and population fixation of 50% [34]. Likewise, in the valuation and prioritization of the Valencia-Spain lagoon, we have a relative weight, through the experts, of biodiversity 55%; 20% cultural heritage and 25% visual landscape [35]. In this context, the value found for the Pacucha lagoon has a greater preponderance than the biodiversity component, very similar to the prioritization of the Valencia lagoon. In that sense, the collective group surveyed, opts for the characteristics of the existence of species of flora and fauna and these are preserved for future generations.

IV. CONCLUSIONS

The need for economic valuation responds to the fact that in the market society, in which we are, the importance of environmental assets is fundamentally manifested through their economic value.

The total economic value of the Pacucha lagoon amounts to US $ 20,793,456.81, that includes the value of direct use by agricultural, livestock, fishing and recreation services, carrying the most valued utility US$ 6,148,640.04; followed by the stock value US$ 3,801,788.67; indirect use value US$ 3,789,717.34; legacy value US$ 3,671,572.41 and option value US$ 3,381,738.35. Likewise, the prioritization of the components of the VET was evaluated, whose weight reaches (29.57%) for direct use value and the lowest weight is the option value (16.26%). Under this result, it is understood that the respondents tend to a philosophy of valuation in tangible aspects. Furthermore, in the interest of knowing the existence value, the economic value is $ 3,801,788.67. of which, experts prioritize the biodiversity subcomponent (51.41%), followed by cultural heritage and visual landscape (27.07% and 21.52%) respectively

When calculating the environmental value of the Pacucha lagoon in monetary units, it allowed us to have an indicator of its importance for social welfare, due to the unpaid positive externality (direct and indirect benefits) to third parties. This parameter, in the face of restitution for possible damages, is compared with other components of well-being, improving society's awareness of its real importance, and serve the public administration and collaborate in the design of policies and decision-making to prioritize its actions.

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