PNUMA

COST– BENEFIT ANALYSIS OF

ADAPTATION TO CLIMATE CHANGE

PROJECTS IN URBAN AREAS OF **LATIN AMERICA**

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EUROCLIMA

CEPAL

IICA

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Guyana

CONTENT

1. Adaptation in urban environments in Latin America
2. Prioritization methodology
3. Multi-criteria analysis
4. Economic analysis
5. Case study
6. Final thoughts

1. Adaptation in urban environments in Latin America

1 CLIMATE CHANGE, LATIN AMERICA CONTEXT

Between 1990 and 2011, damages of **53 billion dollars** are estimated in 16 countries of the region.

All countries in the region have been affected by a disaster associated with climate change.

Economic losses are estimated in infrastructure in the Rio de la Plata in the period 2050 to 20100 **of between 5 and 15 billion dollars.**

Floods in Tabasco, Mexico, have provoked **between 60 and 100 thousand refugees** who have migrated to other states in search of work

Persistent phenomena such as **poverty, marginalization** and **irregularity** in **land** ownership throughout the region.

77% of the vulnerable population live in cities.

1.2 million people were affected due to the passage of Hurricane Mitch in 1998, which meant damages of **8.5 billion dollars.**

CLIMATE CHANGE, LATIN AMERICA CONTEXT

Table 1. Occurrence of natural disasters in Latin America and estimated costs (1990 - 2015)

Country	Occurrence (Natural disasters)	Deaths	Affected	Injured	Household	Total affected	Estimated cost (Thousands of USD)
Argentina	67	484	1,662,814	315	129,504	1,792,633	$6,409,410
Belize	14	64	232,600	570		233,170	$557,004
Bolivia	52	1,045	3,907,562	453	59,300	3,967,315	$1,839,500
Brazil	120	3,449	**50,232,423**	2,536	**716,235**	**50,951,194**	$14,436,670
Chile	51	648	1,058,916	750	136,305	1,195,971	$4,121,400
Colombia	83	3,002	10,490,748	2,238	208,963	10,701,949	$3,443,903
Costa Rica	36	182	1,372,087	62	35,127	1,407,276	$702,390
Ecuador	31	1,045	915,809	421	99,838	1,016,068	$1,811,500
The Savior	33	1,024	1,486,040	3	19,800	1,505,843	$3,024,710
French Guiana	2	10	SD	5	70,000	70,005	SD
Guatemala	49	3,003	6,149,176	799	55,370	6,205,345	$3,078,913
Guyana	7	34	1,243,974		10,000	1,253,974	$677,800
Honduras	46	15,605	4,616,668	12,049	58,712	4,687,429	$4,402,379
Mexico	**149**	4,331	13,521,923	1,467	693,401	14,216,791	**$36,939,610**
Nicaragua	42	3,876	2,915,069	264	15,872	2,931,205	$1,099,350
Panama	34	125	168,707	447	4,960	174,114	$235,850
Paraguay	32	151	2,995,475	202	14,500	3,010,177	$68,507
Peru	70	4,132	10,380,511	**1,827,473**	329,342	12,537,326	$442,000
Surinam	2	5	31,548	SD	SD	31,548	SD
Uruguay	24	26	173,726	12	14,300	188,038	$325,000
Venezuela	30	**30,383**	735,378	3,642	171,358	910,378	$3,497,500
TOTAL	974	72,624	114,291,154	1,853,708	2,842,887	118,987,749	$87,113,396

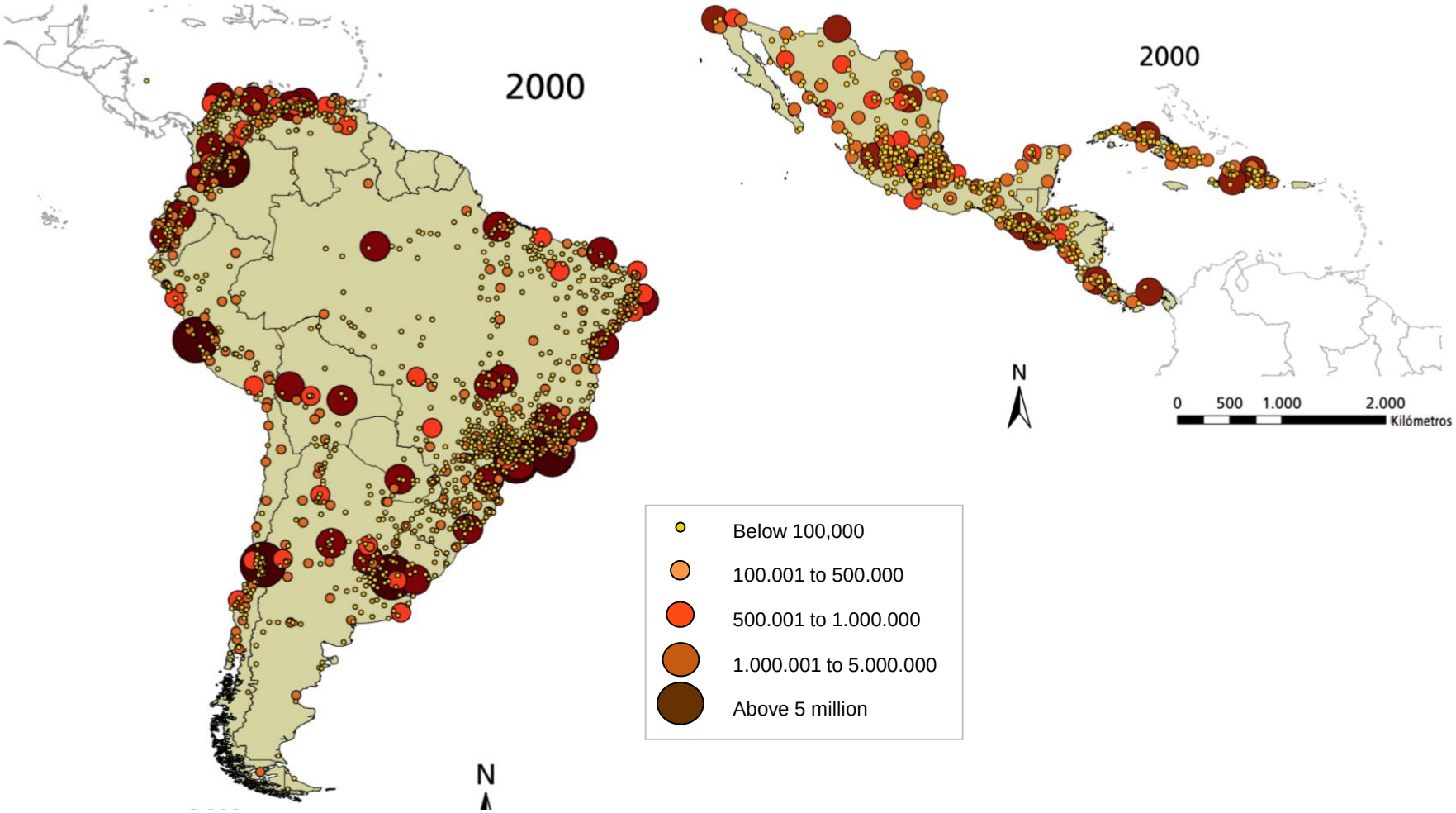
Source: The International Disaster Data Base. Http://www.emdat.be. Last query: June 9, 2016.

*** Note:** Natural disasters include weather events (extreme temperatures, storms), hydrological (flooding, landslides, erosion by sea), and climatological (drought, fire). It does not include biological events (epidemics and vector diseases) or geological events (volcanic activity).

SD: Without data

CLIMATE CHANGE, LATIN AMERICA CONTEXT

Illustration 1. Urban System of Latin America



Source: UN-Habitat, 2014.

1 CLIMATE CHANGE, LATIN AMERICA CONTEXT

Local governments face the need to choose between multiple options for climate action. Hence the usefulness of developing methods that allow them to make the best decision, by selecting the most cost-effective alternatives.

2. Prioritization Methodology

Prioritization Methodology

How to invest in adaptation?

First. From a social perspective, not all benefits and costs necessarily implies a transaction in the market; how much is worth protecting a life?... how much is it worth avoiding erosion? In general, how much is it worth to give public goods to a society?

Second. In the public sphere, there is a wide variety of actors involved who are affected or benefited by public decisions.

Third. The available human and financial resources may not be enough to carry out an economic efficiency analysis for all the alternatives that can be chosen.

Fourth. The effects of climate change are inherently uncertain.

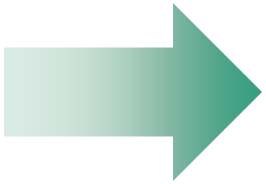
Prioritization Methodology

First. Externalities.

Second. Diversity of stakeholders.

Third. Limited resources for analysis.

Fourth. Uncertainty.



Economic Assessment of Ecosystem Services

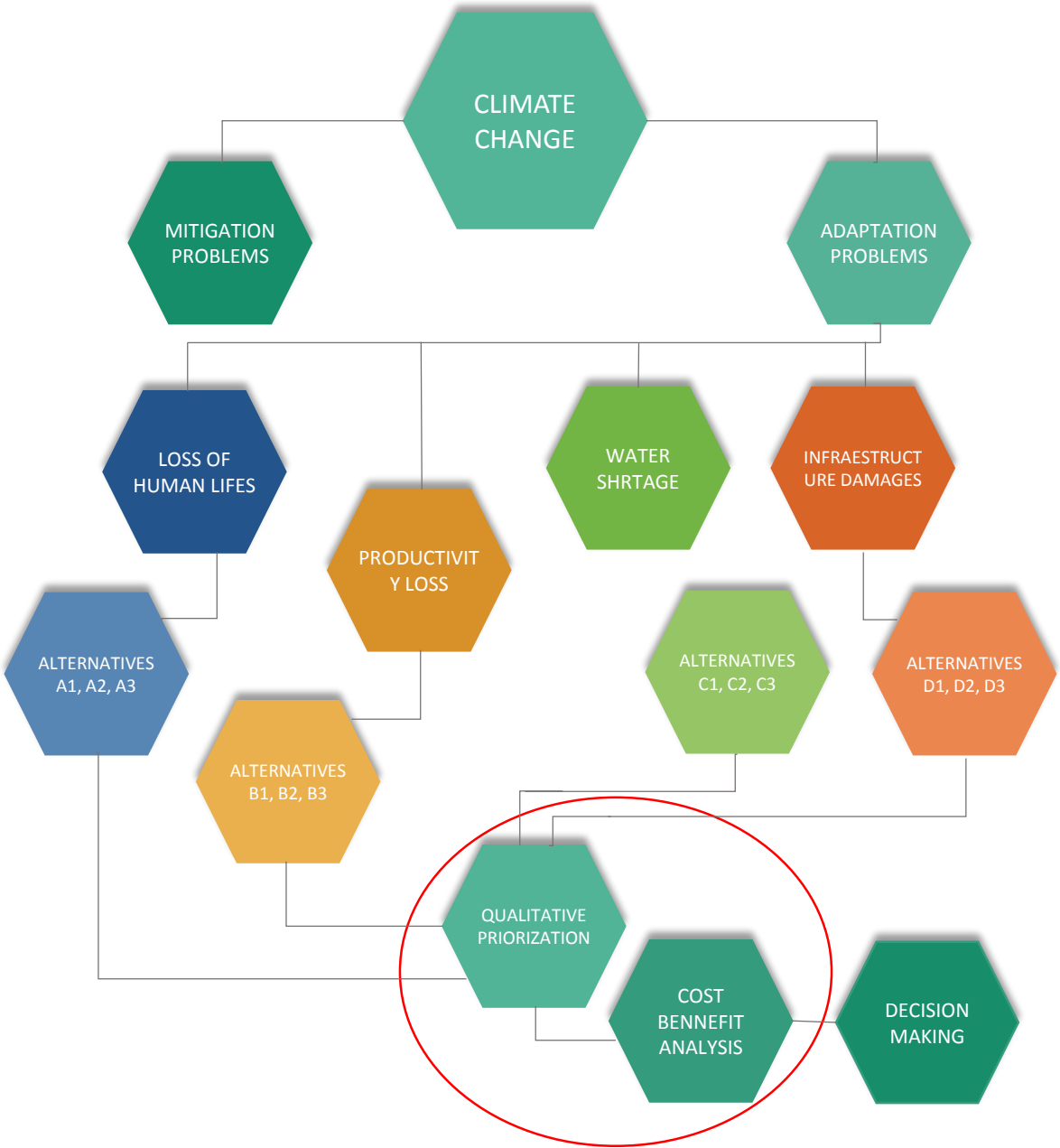
Qualitative analysis

Economic analysis to a small set of measures

Monte Carlo Analysis

2

Prioritization Methodology



3. Multi-criteria analysis

3 MULTI-CRITERIA ANALYSIS

GROUP OF CRITERIA	CRITERIA	RELATIVE WEIGHT (from 1 to 5, being 5 the largest weight)	DESCRIPTION OF CRITERIA	RATINGS OF RATING	MEASURES ARRANGED IN A PARTICIPATORY WORKSHOP				
					MEASURES 1	MEASURES 2	MEASURES 3	MEASURES 4	MEASURES 5
Ambiental	Conservation of ecosystems		The measure contributes to better adaptation to climate change through the ecosystem approach	Does not contribute: 0 Contributes moderately: 1-5 Contributes strongly: 6-10					
	Securing environmental services		The measure contributes to safeguard the environmental services on which the city depends	Does not contribute: 0 Contributes moderately: 1-5 Contributes strongly: 6-10					
Social	Care for the most vulnerable		The measure gives priority to the attention of the most vulnerable groups and exposed to phenomena associated with climate change.	No priority: 0 Give a medium priority: 1-5 Give priority strongly: 6-10					
	Participation		The measure has citizen support for its implementation.	Does not have citizen support: 0 Average account with citizen support: 1-5 Count heavily with citizen support: 6-10					
Economic	Cost-benefit		The measure brings higher explicit social benefits over implementation costs.	Does not provide social benefits: 0 Contributes moderately social benefits: 1-5 Provides strong social benefits: 6-10					
	Cost Effectiveness		The implementation of this measure is not expensive and is within the reach of the city budget.	The measure is expensive: 0 The measure is moderately expensive: 1-5 The measure is not expensive: 6-10					
Institutional and implementation	Feasibility		The measure is supported by other orders of government and is part of the priorities of the Government Program	It does not have the support of the central government: 0 Moderately supported by central government: 1-5 Strongly supported by central government: 6-10					
	Coordination		The measure induces processes of coordination and cooperation.	The measure does not induce cooperation and coordination processes: 0 Contributes moderately to cooperation and coordination processes: 1-5 Strongly contributes to cooperation and coordination processes: 6-10					

Space to define the rating of each measure based on the rating ranges previously agreed upon in a workshop with key stakeholders.

Examples:

Rank 1: 0 (Does not contribute)

Rank 2: 1 to 5 (Contribute moderately)

Rank 3: 6 to 10 (Contributes heavily)

MULTI-CRITERIA ANALYSIS

Example inspired by Uruguay (MVOTMA, 2015)

- M1. Implementation of a cooking oils recovery program for biodiesel generation.
- M2. Implementation of an organic waste separation program for the generation of compost and biogas.
- M3. Relocating social housing options to the most vulnerable neighborhoods to phenomena associated with climate change.
- M4. Dredging of canals and bodies of rainwater to the sewage system.
- M5. Implementation of a housing program on stilts in areas susceptible to flooding.
- M6. Decree a hydrological reserve area and reforest it with native species.
- M7. Planting 5000 trees on the Boulevard José Martí.
- M8. Elaboration of an Atlas of Risks of the Municipality.

MULTI-CRITERIA ANALYSIS

Table 2. Results of the workshop of prioritization of adaptation measures through the multicriteria analysis.

CRITERIA	RELATIVE WEIGHT (from 1 to 5, 5 being the highest weight)	DESCRIPTION OF THE CRITERIA	Rate from 1 to 10 where 1 is less and 10 is more important							
			M1	M2	M3	M4	M5	M6	M7	M8
It is a structural measure.	5	It attacks problems from their causes (illness) and not only their consequences (symptoms)	6	7	10	8	10	9	4	7
It generates co-benefits, is synergistic and transverse.	2	It solves problems of different sectors simultaneously, that is, the action or measure generates co-benefits and synergies in other sectors (transversality), including between mitigation and adaptation.	8	8	7	8	9	6	5	3
It is a long-term measure.	1	The action is long term and not just conjunctural.	4	5	10	8	10	10	5	4
It contributes to induce processes of environmental governance (interinstitutional and intergovernmental)	4	Induces political agreements that can materialize in the signing of interinstitutional and intergovernmental agreements or.	5	8	5	3	6	7	8	5
It has financial, technical and/or institutional support.	2	They have the human, technical and financial resources and specific areas that address the problem or can be developed.	8	8	8	8	8	8	8	8
It has an ecosystem-based approach to adaptation.	5	It uses the biodiversity and services provided by ecosystems as part of a broader adaptation strategy, as well as being economic actions and within the capacities of municipalities.	1	1	1	2	4	10	9	6
Solves a specific problem and is within the citizen's demands	3	It solves a problem identified by the community or it solves a specific problem, either to the citizen directly, or because the citizen is interested in solving it.	6	6	9	8	9	9	7	4
Sum of values	22									

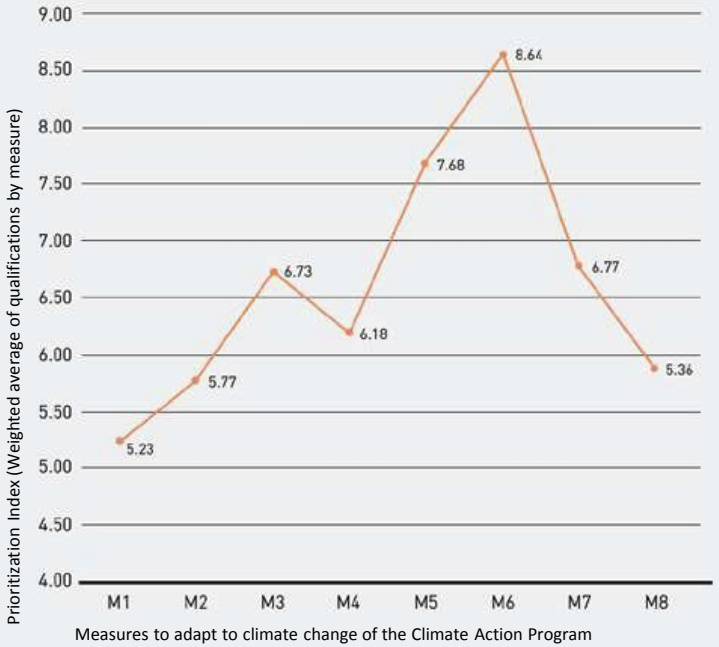
MULTI-CRITERIA ANALYSIS

Table 3. Weighted values of the prioritization exercise of adaptation measures according to weighted criteria.

CRITERIA	RELATIVE WEIGHT (from 1 to 5, 5 being the highest weight)	DESCRIPTION OF THE CRITERIA	Rate from 1 to 10 where 1 is less and 10 is more important							
			M1	M2	M3	M4	M5	M6	M7	M8
It is a structural measure.	5	It attacks problems from their causes (illness) and not only their consequences (symptoms)	1.36	1.59	2.27	1.82	2.27	2.05	0.91	1.59
It generates co-benefits, is synergistic and transverse.	2	It solves problems of different sectors simultaneously, that is, the action or measure generates co-benefits and synergies in other sectors (transversality), including between mitigation and adaptation.	0.73	0.73	0.64	0.73	0.82	0.55	0.45	0.27
It is a long-term measure.	1	The action is long term and not just conjunctural.	0.18	0.23	0.45	0.36	0.45	0.45	0.23	0.18
It contributes to induce processes of environmental governance (interinstitutional and intergovernmental)	4	Induces political agreements that can materialize in the signing of interinstitutional and intergovernmental agreements or.	0.91	1.45	0.91	0.55	1.09	1.27	1.45	0.91
It has financial, technical and/or institutional support.	2	They have the human, technical and financial resources and specific areas that address the problem or can be developed.	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73
It has an ecosystem-based approach to adaptation.	5	It uses the biodiversity and services provided by ecosystems as part of a broader adaptation strategy, as well as being economic actions and within the capacities of municipalities.	0.23	0.23	0.23	0.45	0.91	2.27	2.05	1.36
Solves a specific problem and is within the citizen's demands	3	It solves a problem identified by the community or it solves a specific problem, either to the citizen directly, or because the citizen is interested in solving it.	0.82	0.82	1.23	1.09	1.23	1.23	0.95	0.55
		Total (Priority Indices	4.95	5.77	6.45	5.73	7.50	8.55	6.77	5.59

3 MULTI-CRITERIA ANALYSIS

Results of prioritization of measures to adapt to climate change through multicriteria analysis



• M6. Decree a hydrological reserve area and reforest it with native species.

• M5. Implementation of a housing program on stilts in areas susceptible to flooding

• M7. Planting 5000 trees on the Boulevard José Martí.

• M3. Relocating social housing options to the most vulnerable neighborhoods to phenomena associated with climate change

• M4. Dredging of canals and bodies of rainwater to the sewage system

• M2. Implementation of an organic waste separation program for the generation of compost and biogas

• M8. Elaboration of the Atlas of Risks of the Municipality.

• M1. Implementation of a cooking oils recovery program for biodiesel generation

3 MULTI-CRITERIA ANALYSIS

To moderate the participation of actors in a group it is recommended to use the following techniques:

1

- Have the participants express their written opinions on cards and place them in a screen. The facilitator will categorize the cards and draw general conclusions from individual opinions.

2

- Numbered cards are distributed with a categorical scale (from 1 to 10 for example). Participants will be able to express the importance of a topic, criteria, etc. Based on this classification the facilitator will obtain the grading averages to give an order of importance to the object being graded.

3

- Assign a predetermined number in which an actor can intervene and set a time limit for those shares.

Note

- In these techniques, the facilitator's abilities to manage the group are fundamental, because on them depends that the exercise is really participatory, consensus is obtained and the validation of the actors involved. Also, prior to the participatory process, care must be taken that there is a representation of all the actors involved.

4. Economic Analysis

COST BENEFIT ANALYSIS

CONCEPT 1. Net Social Benefit:

It is the difference between total social benefits less total social costs of carrying out a project. It is a measure expressed in monetary units.

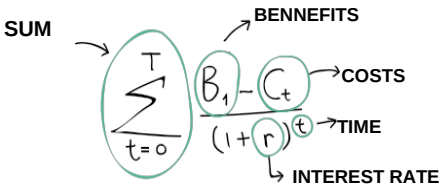
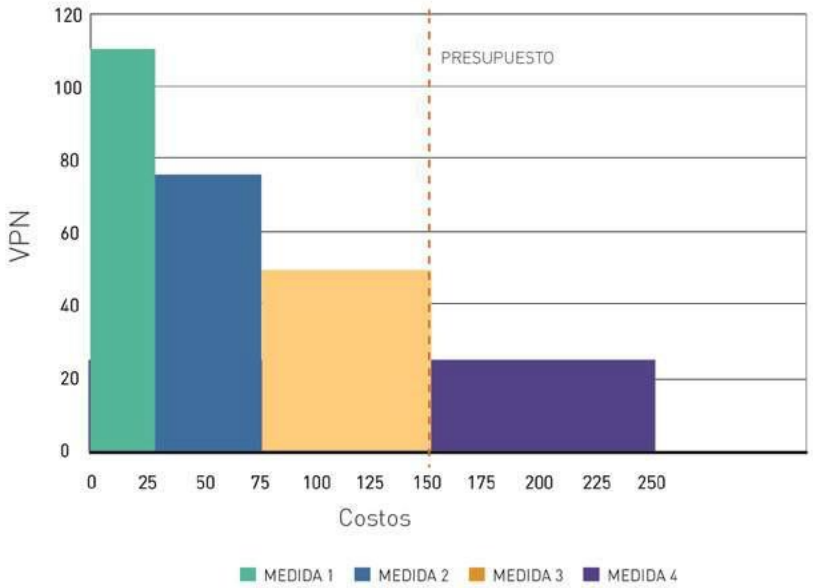


ILUSTRACIÓN 3 Priorización económica de alternativas



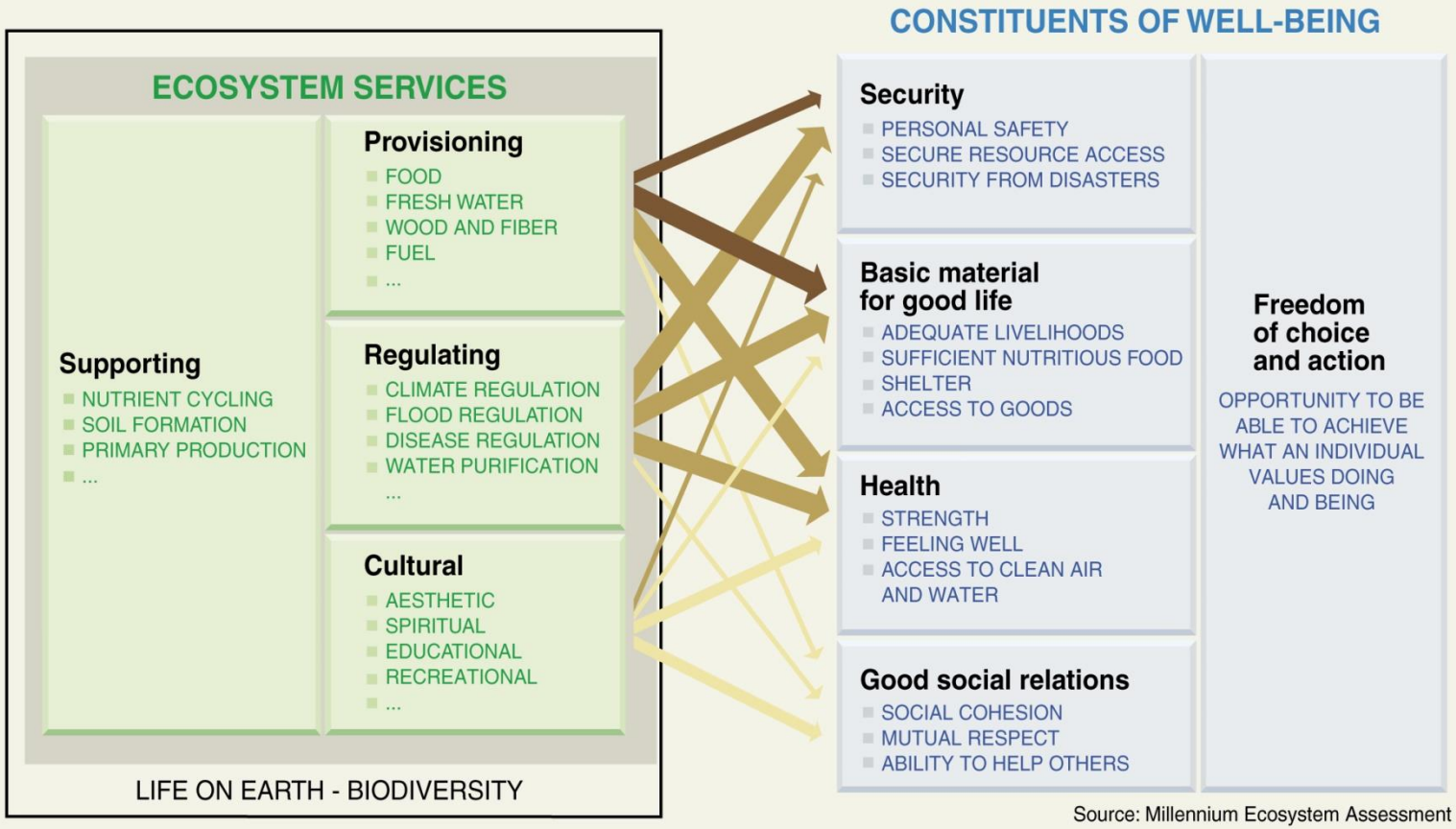
Fuente: Elaboración propia

TABLE 3 Online tool for social cost benefit analysis.

In a later section an example of a spreadsheet with which the user can perform a social cost-benefit analysis is presented, but we also invite the reader to visit http://financiamentosustentable.alianza-mredd.org/ where you can find an online tool to perform a social cost benefit analysis with very flexible functionalities.

The first version of this tool was developed in the Excel program and was funded by the German Cooperation in Mexico (GIZ). Later, the MREDD + Alliance in Mexico financed (with USAID resources) the development of the referred online version.

COST BENEFIT ANALYSIS



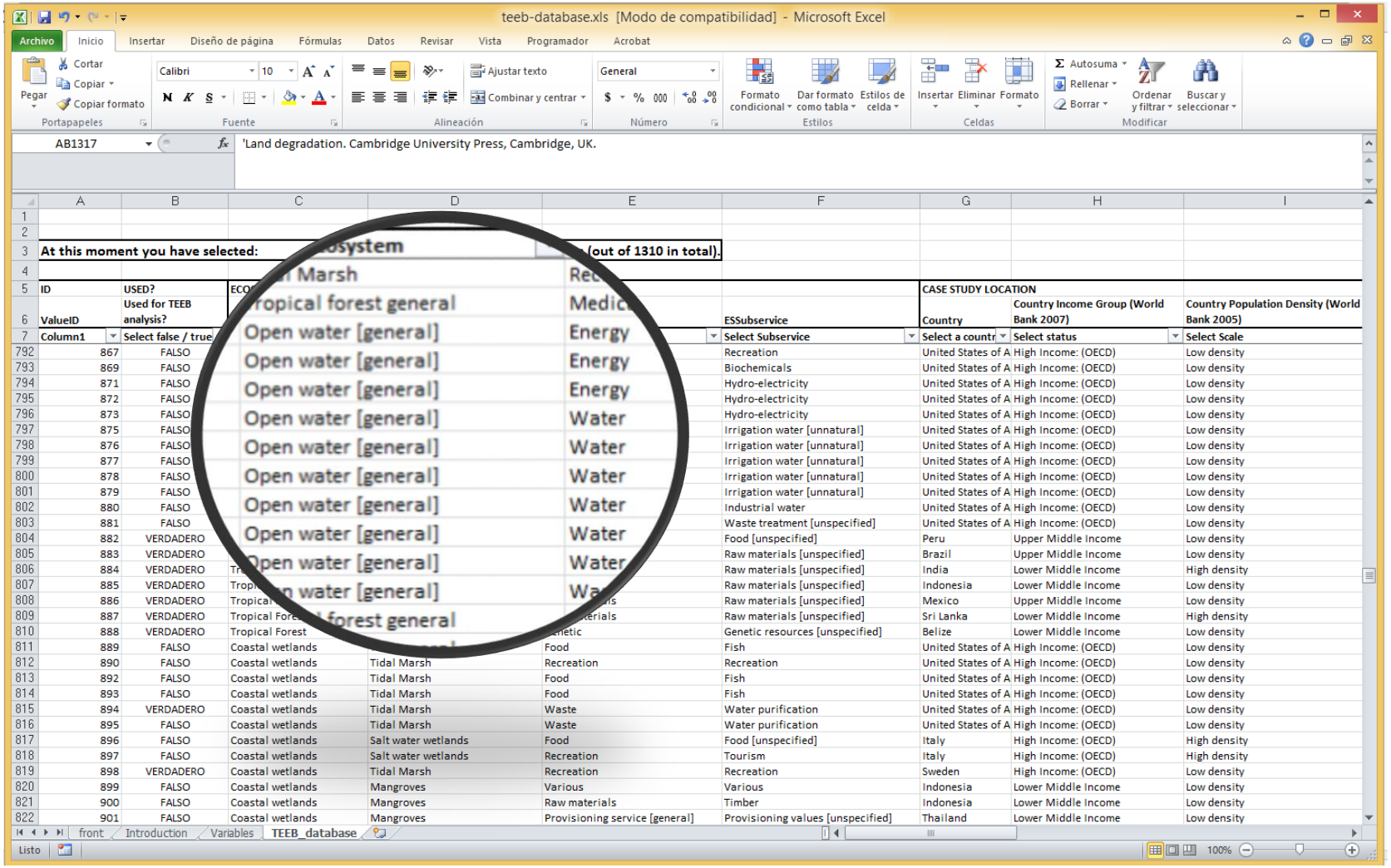
Source: Millennium Ecosystem Assessment

All SSEE should be considered

COST BENEFIT ANALYSIS

Economic valuation of SSEE

https://www.cbd.int/financial/gmr/**teeb-database**.xls



teeb-database.xls [Modo de compatibilidad] - Microsoft Excel

AB1317 'Land degradation. Cambridge University Press, Cambridge, UK.

At this moment you have selected: [illegible] (out of 1310 in total).

	ID	USED?					CASE STUDY LOCATION		
6	ValueID	Used for TEEB analysis?				ESSubservice	Country	Country Income Group (World Bank 2007)	Country Population Density (World Bank 2005)
7	Column1	Select false / true				Select Subservice	Select a countr	Select status	Select Scale
792	867	FALSO				Recreation	United States of A	High Income: (OECD)	Low density
793	869	FALSO				Biochemicals	United States of A	High Income: (OECD)	Low density
794	871	FALSO				Hydro-electricity	United States of A	High Income: (OECD)	Low density
795	872	FALSO				Hydro-electricity	United States of A	High Income: (OECD)	Low density
796	873	FALSO				Hydro-electricity	United States of A	High Income: (OECD)	Low density
797	875	FALSO				Irrigation water [unnatural]	United States of A	High Income: (OECD)	Low density
798	876	FALSO				Irrigation water [unnatural]	United States of A	High Income: (OECD)	Low density
799	877	FALSO				Irrigation water [unnatural]	United States of A	High Income: (OECD)	Low density
800	878	FALSO				Irrigation water [unnatural]	United States of A	High Income: (OECD)	Low density
801	879	FALSO				Irrigation water [unnatural]	United States of A	High Income: (OECD)	Low density
802	880	FALSO				Industrial water	United States of A	High Income: (OECD)	Low density
803	881	FALSO				Waste treatment [unspecified]	United States of A	High Income: (OECD)	Low density
804	882	VERDADERO				Food [unspecified]	Peru	Upper Middle Income	Low density
805	883	VERDADERO				Raw materials [unspecified]	Brazil	Upper Middle Income	Low density
806	884	VERDADERO				Raw materials [unspecified]	India	Lower Middle Income	High density
807	885	VERDADERO				Raw materials [unspecified]	Indonesia	Lower Middle Income	Low density
808	886	VERDADERO				Raw materials [unspecified]	Mexico	Upper Middle Income	Low density
809	887	VERDADERO				Raw materials [unspecified]	Sri Lanka	Lower Middle Income	High density
810	888	VERDADERO	Tropical Forest			Genetic resources [unspecified]	Belize	Lower Middle Income	Low density
811	889	FALSO	Coastal wetlands			Fish	United States of A	High Income: (OECD)	Low density
812	890	FALSO	Coastal wetlands	Tidal Marsh	Recreation	Recreation	United States of A	High Income: (OECD)	Low density
813	892	FALSO	Coastal wetlands	Tidal Marsh	Food	Fish	United States of A	High Income: (OECD)	Low density
814	893	FALSO	Coastal wetlands	Tidal Marsh	Food	Fish	United States of A	High Income: (OECD)	Low density
815	894	VERDADERO	Coastal wetlands	Tidal Marsh	Waste	Water purification	United States of A	High Income: (OECD)	Low density
816	895	FALSO	Coastal wetlands	Tidal Marsh	Waste	Water purification	United States of A	High Income: (OECD)	Low density
817	896	FALSO	Coastal wetlands	Salt water wetlands	Food	Food [unspecified]	Italy	High Income: (OECD)	High density
818	897	FALSO	Coastal wetlands	Salt water wetlands	Recreation	Tourism	Italy	High Income: (OECD)	High density
819	898	VERDADERO	Coastal wetlands	Tidal Marsh	Recreation	Recreation	Sweden	High Income: (OECD)	Low density
820	899	FALSO	Coastal wetlands	Mangroves	Various	Various	Indonesia	Lower Middle Income	Low density
821	900	FALSO	Coastal wetlands	Mangroves	Raw materials	Timber	Indonesia	Lower Middle Income	Low density
822	901	FALSO	Coastal wetlands	Mangroves	Provisioning service [general]	Provisioning values [unspecified]	Thailand	Lower Middle Income	Low density

Open water [general] Energy
Open water [general] Energy
Open water [general] Energy
Open water [general] Water
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Open water [general] Water

front | Introduction | Variables | TEEB_database

Listo

TABLE 6 Profitability indicators

Social Net Present Value (SNPV). It is equal to the discounted sum of total social benefits minus total social costs.

Private Net Present Value (PNPV). It is equal to the discounted sum of total private benefits minus total private costs.

The difference between SNPV and PNPV is that the former includes all identified costs and benefits, and the latter only considers the costs and benefits that directly affect the population or entity implementing the project. For example. Carbon capture is a social benefit because it benefits all humanity, or the reduction of local pollution is a benefit that benefits a geographic space that can go beyond the location where the project is done. The difference between private and social costs and benefits depend on the geographical delimitation in which the project is carried out.

Cost Benefit Index (CBI). It is the division of SNPV by the total costs and is interpreted as the net profit for each dollar invested in the project.

Annualized value (Equivalent Annual Annuity- AEE). It is an equivalent value to SNPV but of annual frequency. That is, it is a fixed amount per year that would have to be received over the life of the project and that is equivalent to receiving the entire SNPV today. This indicator is useful for showing the annual profitability of a project, and is comparable for projects that have a different life span.

Internal Rate of Return (IRR). It is the discount rate such that the SNPV is equal to zero. This rate indicates the profitability in percentage terms of the project. For example, if the IRR equals 10%, it means that each year the project has an average yield of 10%.

Term in which the cash flow is positive: It is the number of years in which the accumulated social benefits (undiscounted) are equal to the accumulated social costs (without discount). That is, it is the time frame in which the project begins to generate profits.

4 COST BENEFIT ANALYSIS

Costs and benefits of actions under analysis

ACTION	NO ACTION	DAM	MANGROVES
Benefits			
Avoided economical damages		X	X (Almost all)
Costs			
Construction costs.		X	
Maintenance costs.		X	X
Restoration costs.			X

Suppose there is a previous study that estimated economic damage per square meter in the population under study, that is directly exposed to flooding amounts to 5,000 USD / m2. This study also determined that the number of square meters exposed to floods in the area of greatest exposure is 2,000 m2. In addition, the study estimates that the probability of a flood causing these losses is 2% (2 events per 100 years). In this sense, the expected amount of infrastructure damage per year is 40 m2 (probability of damage x exposed area).

Hypothetical costs and bennefits

COST/BENNEFIT	QUANTITY	UNIT OF MEASUREMENT	VALUE (USD)	PERIODICITY
Avoided damage (Dam)	40	m^2	5000	Anual
Avoided damage (mangrove)	36	m^2	5000	Anual
Construction of the dam	1	km	1000000	Once
Mangrove restoration	2	hectare	200000	Once
Mantainance of the dam	1	km	20000	Anual
Mantainance of the mangrove	2	hectare	6000	Anual

Source: own elaboration.
Note: all values are arbitrary and were specified for expository porposes.

COST BENEFIT ANALYSIS

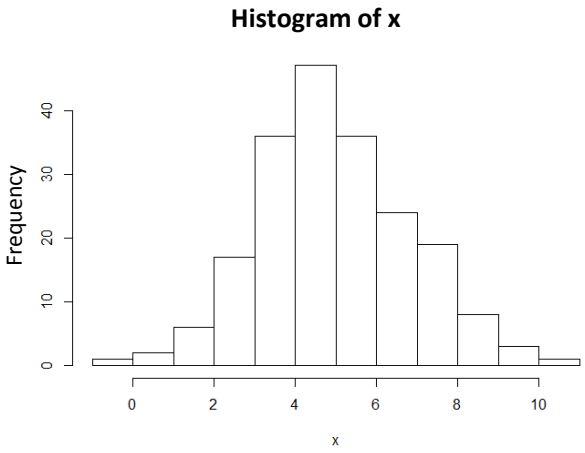
Results of the hypothetical exercise

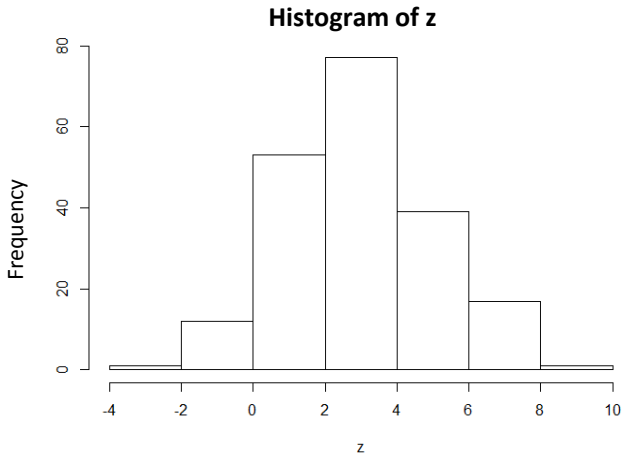
INDICATOR	DAM	MANGROVES
SNPV	$893,758.00	$1,312,962.00
PNPV	-$1,089,205.00	$471,705.00
CBI	0.82	2.78
Annual value (EAA)	$90,143.64	$132,424.22
IRR	22%	76%
Term (years)	6	3

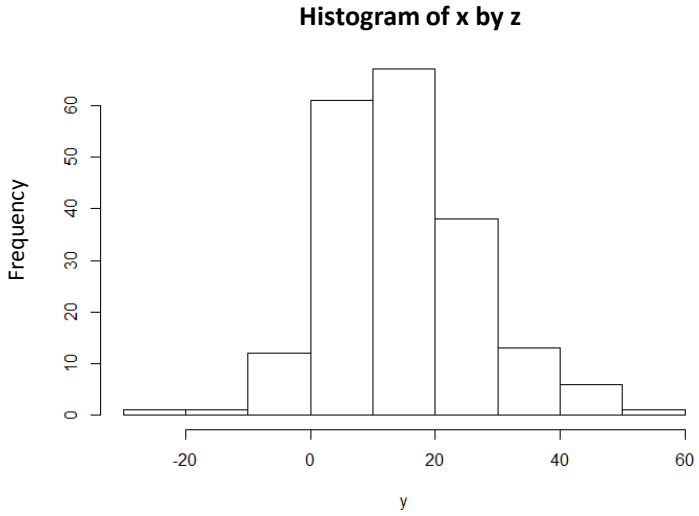
Source: Own elaboration

NOTE: To accede to the formulas used go to https://goo.gl/ExNER

Monte Carlo Analysis





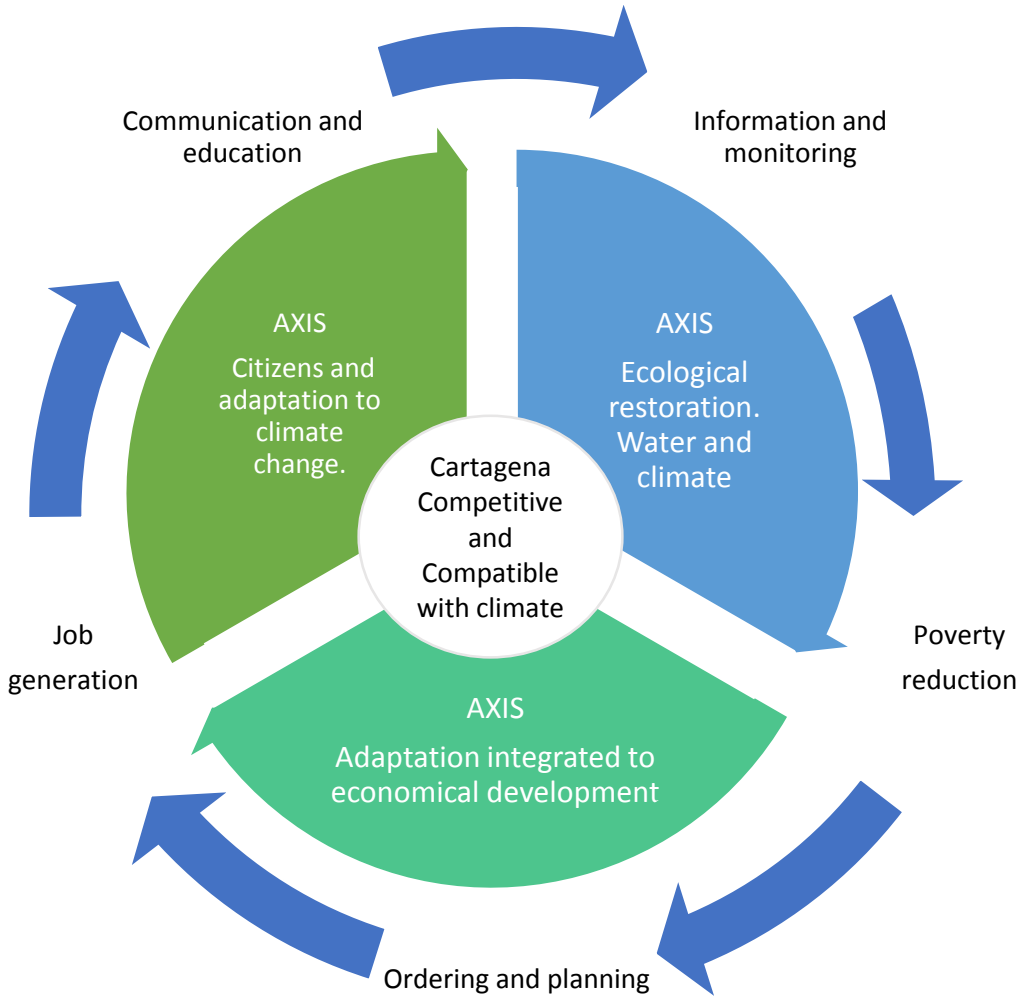


In the cost-benefit analysis, only information on minimum and maximum prices and quantities must be collected.
The tool does the rest

5. Case Study

5

CASE STUDY



Structural axis	Strategies	Program
1 Adaptation integrated to the economical development of the city	**Ports and industries compatible with climate change**	Energy efficiency
		Adaptable infrastructure
		Contribution to ecological integrity
		Comprehensive risk management
	Tourism sector committed with the adaptation to climate change	Hotel sector committed to climate change
		Tourism infrastructure adapted to climate change.
		Support system for the decision making process on climate change
		Education on climate change to tourism and service providers
		Marketing and promotion on climate change
	Protection of the historical patrimony	Protection of goods that have cultural meaning from climate change
		Greener historical centers and their influence areas
2 Citizens and adaptation to climate change.	**Neighborhoods adapted to climate change.**	Urban neighborhoods adapted to climate change
		Rural adaptation based on communities
3 Conservation and restoration of ecological patrimony	**Adaptation based on ecosystems**	Resilient ecosystems
		Promotion of ecological connectivity
		Habitat and emission reduction.
Transversal axis		
Information and monitoring		
Communication and education		
Ordering and planning		

Source: Alcaldía de Cartagena de In- dias-MADS-INVEMAR-CDKN-Cámara de Comercio de Cartagena (2014). Plan 4C.

CASE STUDY

1. Reef restoration
2. Green roofs
3. Permeable pavements (not in the 4C Plan)

1. Reef restoration

Costs and benefits considered in the analysis (prices in USD) (Coral reefs)

Details	Frec.	Unit	Quant.	Min quant.	Max quant.	Value	Low value.	High value.	Start date	End date
Provision	Annual	Ha	1	1	1	97.5	2.1	315.3	jan-17	dec-50
Coastal protection	Annual	Ha	1	1	1	1367	383.7	8485	jan-17	dec-50
Other regulation and support	Annual	Ha	1	1	1	101.3	4.81	1569	jan-17	dec-50
Tourism	Annual	Ha	1	1	1	1246	75.6	8466	jan-17	dec-50
Other cultural	Annual	Ha	1	1	1	55.3	1.36	762.9	jan-17	dec-50
Restoration costs	Annual	Ha	1	1	1	19150	207247	10000	jan-17	dec-50

Source: Own elaboration with information from UNEP-WCMC, WorldFish Centre, WRI y TNC (2010), Bayraktarov et al. (2016) y Spurgeon (2001)

2. Green roofs

TABLE 12 Costs and benefits considered in the analysis (prices in USD) (green roofs)

Details	Frec.	Unit	Amount	Minimum quant	Maximum quant	Value	Pessimistic Value	Optimistic Value	Start Date	Final Date
Water Capture	Anual	m^3	0.97	0.97	0.97	1.31	1.31	1.31	Jan-2017	Dec-2050
Carbon capture	Once	kCO_2e	1.375	1.375	1.375	0.01295	1295.00000	0.01295	Jan-2017	Dec-2050
Of them counted	Anual	m^2	0.4	0.4	0.4	2.14	4.87	1.12	Jan-2017	Dec-2050
Energy saving	Anual	kWh	5.40	2.2	8.6	0.13	0.13	0.13	Jan-2017	Dec-2050
Emission Reduction	Anual	kCO_2e	1.46	0.6	2.3	0.01295	0.01295	0.01295	Jan-2017	Dec-2050
Aesthetic value	Once	m^2	1	1	1	10	10	10	Jan-2017	Dec-2050
Costs of instatement	Once	m^2	1	1	1	67.8	136.9	37.7	Jan-2017	Dec-2050
Maintenance	Once	m^2	1	1	1	0.1	1.77	0.08	Jan-2017	Dec-2050

Source: own elaboration with insertion of White House (2010). Cornelissen or al. (2015). Getter et al. (2009). Millennium (2014). Perez and Salazar (2007) and WRI (2010).

3. Permeable pavements

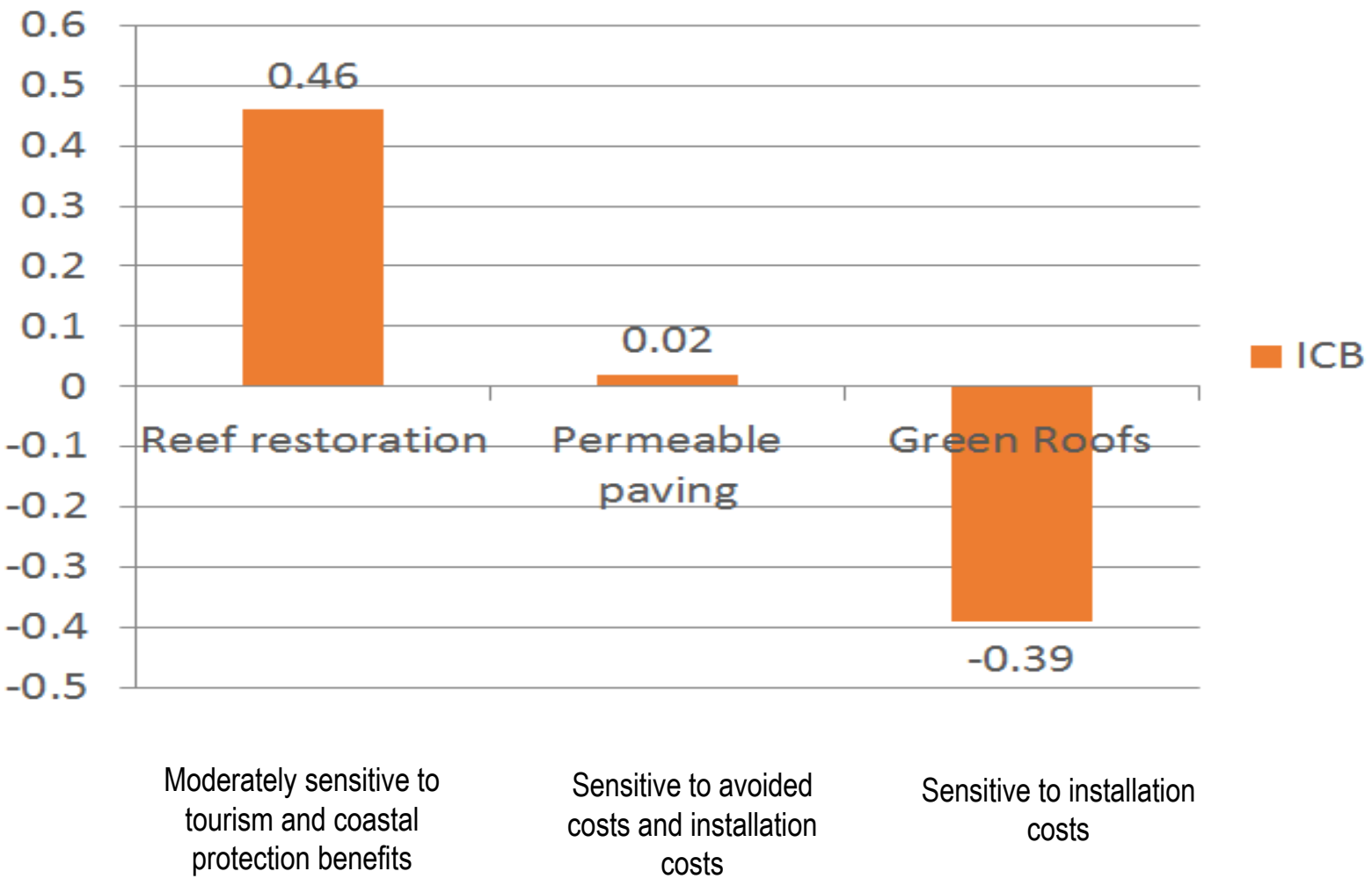
TABLE 15 Costs and benefits considered in the analysis (prices at USO) (permeable pavements)

Details	Frec.	Unit	Amount	Minimum quant	Maximum quant	Value	Pessimistic Value	Optimistic Value	Start Date	Final Date
Data avoided	Anual	m²	0.98	0.98	0.98	2.14	1.12	4.87	Jan•2017	dec•2050
Installation cost	Anual	m²	1.00	1.00	I	30.50	51.70	22.80	Jan•2017	dec•2050
Maintenance Costs	Anual	m²	1.00	1.00	1.00	0.15	0.99	0.04	Jan•2017	dec•2050

Source: Own elaboration with information from WRI (2010) and the CNT website.

CASE STUDY

Results



Moderately sensitive to tourism and coastal protection benefits

Sensitive to avoided costs and installation costs

Sensitive to installation costs

6. **Final Thoughts**

5 Final Thoughts

1. Our proposal is a hybrid version between qualitative and quantitative analysis. First, the measures are qualitatively prioritized and then a cost-benefit analysis of the measures with the highest score in the multicriteria analysis is done.

2. Multicriteria analysis allows the integration of non-economic dimensions in prioritization.

3. The cost-benefit analysis allows estimating the social profitability of carrying out a project.

From the case study:

- Carry out a qualitative analysis of the coastal protection function with InVEST.
- Carry out an analysis of the tourist potential of the Cartagena reefs.
- Carry out a green roof pilot program in coordination with the private sector.
- It is profitable to use permeable pavements but special attention must be paid to direct costs.

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