Commissioned by:	UN Environment, CTCN, Adaptation Fund
Project Title:	Building up integrated monitoring and early warning forest fires detection system in the Borjomi - Kharagauli National Park by innovative remote sensing tools, in Georgia
Implemented by:	International Business and Economic Development Center
Country:	Georgia
Deliverable:	2.5.a. Detailed cost analysis of the designed integrated monitoring and early warning forest fires detection system for the Borjomi - Kharagauli National Park

Cost-benefit analysis of the Integrated Forest Fire and Smoke Detection Monitoring and Early Warning System in the Borjomi - Kharagauli National Park

The economic value of the Protected Natural Area Borjomi - Kharagauli National Park

Contents

ABBREVIATIONS

BAU	-	Business as Usual
EIRR	-	Economic Internal Rate of Return
ENPV	-	Economic Net Present Value
ES	-	Ecosystem Services
GHGs	-	Greenhouse Gases
NPV	-	Net Present value
PA	-	Protected Area
SDR	-	Social Discount Rate
SEM	-	Sustainable Ecosystems Management

The study presents the main economic and social arguments justifying the choice of the optimal scenario for monitoring and early warning of forest fires and smoke detection in Borjomi - Kharagauli National Park.

1. Methodology

The method used is that of the cost-benefit analysis at the level of each of the proposed technical options that were detailed in the benchmarking, i.e.:

1. Video / Thermo Cameras

2. Wireless Sensor Networks

3. Surveillance drones.

For each of the technical scenarios, the cost-benefit analysis was carried out by comparing two scenarios, the scenario in which "nothing is done" (economic activities are carried out as for the time being, without any contribution of monitoring and early warning of forest fires and smoke detection) and the scenario in which the contribution of monitoring and early warning of forest fires and smoke detection systems is taken into account in the development of economic activities.

The study goes beyond the established principles of cost-benefit analysis by demonstrating, alongside its financial indicators, the contribution to employment and poverty reduction through increased individual incomes, employment, increased productivity, food security, increased tax revenues and the positive effects on low incomes and marginalized populations.

Thus, the study is not limited to identifying the net present value of the sum of the economic activities studied at the level of each of the analyzed scenarios, but also shows the influence on a social level.

The economic activities studied in the analyzed site are: tourism and recreation, forestry, hunting, agriculture, traditional crafts and water resources. The net present value of the sum of the economic activities analyzed is calculated as the difference between the scenario in which the economic activities are carried out as such in the target area, , and

the scenario in which there is a sustainable surveillance and a system of early warning of forest fires at the level of the target area.

The analysis includes an assessment of how the sustainable surveillance and early warning of forest fires offered by the three technical options contribute to the creation of benefits in

- tourism and leisure

- logging associated with active forest management

- non-timber forest products and hunting in the target area

- carbon sequestration

- supply of food (milk and meat) through the pastures of the protected area

- water supply for both bottled water industry and water supply to communities

The disaster mitigation analysis focuses on the costs of avoided damages due to erosion control and water regulating services in the protected area.

The analysis interval is a 20 – year projection.

2. Conceptual framework

The conceptual framework is based on the Ecosystem Services Approach. The ecosystem that overlaps the target area is considered as a natural unit made up of living things and their environment. Ecosystem services (ES) refer to a flow of resources or services from the environment that people directly or indirectly benefit from.

The Millennium Ecosystem Assessment[1] represents a framework that helps identify SEs by classifying them into the following four categories:

- Supply services refer to the tangible goods provided by ecosystems

- Regulating services refer to the natural processes of an ecosystem, such as carbon sequestration and water regulating, which contribute to social well-being;

[1] https://www.millenniumassessment.org/en/index.html

- Cultural services refer to the non - material benefits obtained from ecosystems (e.g. tourism);

- Adjacent services necessary to achieve the other ecosystem services (such as, soil formation or nutrient recycling). These services are different from other services because their effects on people is either indirect (through supply, regulating or cultural services) or occur after a very long period of time.

The Ecosystem Services approach explicitly recognizes that ecosystems and the biological diversity contribute to individual and social well-being. The economic evaluation is focused on the "ultimate benefits" obtained by the community in the target area from the services provided by the ecosystem that exists in the target area. The assessment did not take into consideration the services and functions that contribute to these benefits in order to avoid double counting.

The benefits that are generated by adjacent services were not monetized as such as they are intermediate benefits that contribute to obtaining a series of final benefits. The value of the intermediate benefits is included in the monetization of the end results associated with the services they support. Health is also not explicitly listed as an ecosystem service, as health benefits are considered to be provided by a range of services such as flood protection and a clean environment for recreation. The health cost associated with a decline in these services can be used to monetize the benefits provided by an ecosystem. Biodiversity is also considered interdisciplinary because its benefits can be associated with a range of other services.

The Millennium Ecosystem Assessment emphasizes that Protected Areas provide essential ecosystem services that support the prosperity and survival of the population, such as clean water, flood and storm risk reduction, and carbon sequestration. Conceptually, viable ecosystems, with a high degree of biodiversity, generate over time larger quantities of higher quality products and more stable ecosystem service flows.

The objective of the method is to identify evidence of the economic benefits, both direct and indirect, generated by the ecosystems of the protected area that is the target area of the analysis. The analysis looks at these benefits from the perspective of the possible decline in productivity caused by the degradation of ecosystems, due to not taking measures or making changes (the "do nothing" scenario) and comparing this decline with the productivity from the "sustainable ecosystem management" scenario. The two scenarios are generic scenarios, used as a basis for assessing the economic values of ecosystem services (ES).

The Financial Analysis

There is no need to carry out a financial analysis of the fire detection system investment because the investment does not generate a financial income. It generates only investment and operating costs.

The Economic Analysis

An economic analysis of the investment will be carried out in order to demonstrate that **the project has a net positive contribution for society and deserves to be co-financed from public funds.**

For the selected scenario, the benefits of the project must exceed the costs of the project. Especially, the present value of the economic benefits of the project must exceed the present value of the economic costs of the project.

Such a situation is expressed as:

- a positive ENPV (Economic Net Present Value)

- a Benefit/Cost (B/C) ratio greater than 1

- the EIRR (Economic Internal Rate of Return) of the project is bigger than the discount rate used to calculate the NPV.

A social discount rate[2] of 3% was used.

The costs of the economic project (compared to the financial one) are measured from the point of view of 'resource' or 'opportunity' costs. They represent the benefit that can be predetermined (loss of opportunity) by the society by using the limited economic resources in the project compared to an alternative use of the funds for other purposes.

The economic benefits of the project were measured from the point of view of avoided costs as a result of project implementation, or from the point of view of external benefits resulting from project implementation and which are not included in the financial analysis.

[2] The social discount rate (SDR) is used in the economic analysis of investment projects to discount economic costs and benefits, and reflects the opportunity cost of capital from an inter-temporal perspective for society as a whole. In other words, it reflects the social view of how future benefits and costs are to be valued against present ones. In this sense, every discount rate entails a judgement concerning the future and it affects the weight attributed to future benefits or costs.

The starting point in the economic analysis was the cash flow calculated for the financial analysis to which two types of corrections are introduced. These corrections are reflected in economic cash flows:

- fiscal correction and price conversion

- monetization of externalities.

The preparation of the economic analysis began by identifying the externalities.

The inclusion of externalities in the economic analysis was done by transforming them into economic terms by assigning them a "price" or a "cost".

The externalities that were analysed were those for which a solid economic argument could be presented and for which a monetization or estimation is realistically possible.

Such monetized externalities are:

- income from milk production

- income from meat production

- value of food provided by pastures in the long term

- revenues generated by forestry

- ecosystem benefits of carbon sequestration

- Benefits for society determined by labour cost corrections

- value of tourism and leisure activities

- reduction of the cost of drinking water treatment meant for the public water supply system because of preventing soil erosion and regulation of water flow and quality.

3. The contribution of the protected natural area to different economic sectors

The following table presents the link of ES in the protected area with the economic sectors.

Table 1 – ES and economic sectors

Type of ES	Services	Benefit / Result	Sectors supported by ES
Supply services	food	milk, meat, venison, berries, mushrooms	Households, tourism, agriculture
	wood	Wood for processing, fire wood	Households, industry
	water	Public water supply, bottled water, water for use in industry and agriculture	Agriculture, industry, tourism
	medicinal plants	Herbal medicine	Households, pharma
	Ornamental resources	Ornamental resources	Industry
Regulating services	Regulating of greenhouse gas emissions (GHGs)	Carbon sequestration	All sectors
	Microclimate stabilization	Air quality	All sectors
	Water regulating (storage and retention)	Protection against storms and floods	All sectors
	Water treatment	Water quality	Tourism, industry, households, agriculture
	Nutrients retention	Increased water quality	Agriculture tourism
Cultural services	Cultural and religious heritage	Environment used for publicity and promotion	Tourism, households
	Education	Young people understanding biological processes	Households
	Ecotourism and leisure	Bird watching, hiking	Tourism
	Landscaping and leisure	High rates	Tourism, households
	Biodiversity conservation	Altruistic motivations	All sectors

Within the present study, the benefits / results are analysed from the point of view of their intensity in the two scenarios: the "do nothing" scenario compared to the "sustainable management of the ecosystem" scenario. The economic value of an area is the result of increasing the benefits of the two management scenarios.

The following table shows how ecosystem services can contribute to various economic sectors.

Table 2 – ES and current issues and solutions

Economic Sector	**Ecosystemic Service**	**Current issues / Solutions**
Agriculture	A sustainable source of high-quality water supply depends on the ecosystems preserved within the PA	In the case of the “do nothing “ scenario, the rates are low (the services is provided almost free) which leads to over usage. In the case of “sustainable ecosystem management” scenario, feasible rates are sustained by the reduction of costs with water treatment (thus the final cost is not increased).
	The whole water sources are located in the target area	There is a lack of information regarding the link between water quality and the management of the ecosystems.
	Forests host wild varieties of cultivated plants and species that are pollinators and or help with pest control	The importance of biodiversity is not known to the public and young people. It is important that schools provide information about such topics.
Forestry	Intact forest ecosystems are located in the PA	In the case of the “do nothing “ scenario, danger of illegal logging is high. Income form forestry is

	The protected area provides significant carbon sequestration services. Income from compensation for carbon sequestration may become an important resource.	rather low as compared to management costs. Taxes for forestry activities should have a reasonable level to give incentives to the forest managers to take proper measures and protect forests against illegal activities.
Nature oriented tourism	The PA is important for nature – oriented tourism due to wild plants and animals, non-polluted air and water, wild landscape. Activities in healthy ecosystems are considered as more enjoyable and satisfying.	In the case of the "do nothing " scenario, the protected area is affected by insufficient investment to sustain nature -oriented tourism which determines negative external costs. In a SEM scenario, nature – oriented tourism is supposed to generate bigger income.
Settlements	There are benefits for settlements due to the PA in terms of access to unpolluted water, or natural mitigation of climate changes	Conservation of watersheds can increase the quality and quantity of water thus reducing the cost of water treatment

The following table shows the differences between the two administration methods of BAU and SEM according to Bovarnick[3].

Business as Usual (BAU) is a more conventional set of management practices that optimizes short-run gain without consideration of ecosystems or to externalized costs. Sustainable Ecosystem Management (SEM) focuses on long-term output, being inclusive of all impacts and costs.

Table 3 – BAU vs SEM

BAU (Business as Usual)	**SEM (Sustainable Management of Ecosystems)**

[3] Bovarnick, A., F. Alpizar, C. Schnell, Editors. The Importance of Biodiversity and Ecosystems in Economic Growth and Equity in Latin America and the Caribbean: An economic valuation of ecosystems, United Nations Development Programme, 2010.

- the management plans of the protected natural area are not based on the assessment of dangers and needs for mitigation; - the tourism infrastructure in PA does not meet the expectations; - PA investments in tourism infrastructure are below the basic level; - essential ecosystems that support tourism are at risk; - visiting is unregulated; - the tourism sector does not support the development of tourism infrastructure and tourism programs in the PA; - there are no water treatment stations; - waste water from food processing and tourism development causes eutrophication; - carbon sequestration objectives are not included in forest management and logging.	- the management plans of the protected natural area are based on the evaluation of dangers and the needs for mitigation; - the tourism infrastructure in the PA meets the expectations; - PA investments in tourism infrastructure meet the requirements; - government agencies in the tourism sector support tourism in PA and programs to protect the ecosystems; - the tourism sector supports the development of tourism infrastructure and the programs to protect the ecosystems; - essential ecosystem conservation programs are fully funded and the dangers are minimal; - pollution taxes are high; - water treatment stations are installed and taxes are introduced; - external environmental aspects are included in the water tariff and tourism service fees; - carbon sequestration objectives are included in forest management models.

4. Detalied analisys of main technical options

Option 1: Early smoke and fire detection system in forest areas with Video / Thermo Cameras

Total investment costs: 212.00 thousand USD;

Total operating and maintenance costs USD 3.90 thousand/year

Socio- economic analysis and cost – benefit analysis for the consolidated effects of the investment

"Do nothing" scenario - BAU -

-	Y 0	Y 1	Y 2	Y 3	Y 4	Y 5	Y 6	Y 7	Y 8	Y 9	Y 10
Value of tourism and leisure activities in the "do nothing" scenario – ('000) $	561	566	572	578	583	589	595	601	607	613	619
Value of food sources from pastures on short term - ('000) $/year	43,913	43,913	43,913	43,913	43,913	43,913	43,913	43,913	43,913	43,913	43,913

Revenue from forestry	2,769	2,769	2,769	2,769	2,769	2,769	2,769	2,769	2,769	2,769	2,769
Value of ES of carbon sequestration in BAU scenario – ('000) $	7,511	7,511	7,511	7,511	7,511	7,511	7,511	7,511	7,511	7,511	7,511
Total benefits and revenue	**54,754**	**54,759**	**54,765**	**54,771**	**54,776**	**54,782**	**54,788**	**54,794**	**54,800**	**54,806**	**54,812**

Implemented Project scenario - SEM -	Y 0	Y 1	Y 2	Y 3	Y 4	Y 5	Y 6	Y 7	Y 8	Y 9	Y 10
Value of tourism and leisure activities in the SEM scenario - ('000) $	561	566	583	601	619	637	657	676	696	717	739
Value of food sources from pastures on long term - ('000) $/year	43,913	44,352	44,795	45,243	45,696	46,153	46,614	47,080	47,551	48,027	48,507
Revenue from forestry	2,769	2,796	2,847	2,848	2,849	2,850	2,851	2,855	2,859	2,863	2,867
Value of ES of carbon sequestration in SEM scenario – ('000) $	7,511	7,511	7,549	7,568	7,587	7,606	7,625	7,644	7,663	7,682	7,701
Total benefits and revenue		**55,226**	**55,775**	**56,261**	**56,751**	**57,247**	**57,747**	**58,256**	**58,770**	**59,289**	**59,814**

Socio- economic analysis and cost – benefit analysis for the consolidated effects of the investment

"Do nothing" scenario - BAU -										
-	Y 11	Y 12	Y 13	Y 14	Y 15	Y 16	Y 17	Y 18	Y 19	Y 20
Value of tourism and leisure activities in the "do nothing" scenario – ('000) $	626	632	638	645	651	657	664	671	677	684
Value of food sources from pastures on short term - ('000) $/year	43,913	43,913	43,913	43,913	43,913	43,913	43,913	43,913	43,913	43,913
Revenue from forestry	2,769	2,769	2,769	2,769	2,769	2,769	2,769	2,769	2,769	2,769
Value of ES of carbon sequestration in BAU scenario – ('000) $	7,511	7,511	7,511	7,511	7,511	7,511	7,511	7,511	7,511	7,511
Total benefits and revenue	**54,818**	**54,825**	**54,831**	**54,837**	**54,844**	**54,850**	**54,857**	**54,864**	**54,870**	**54,877**

Implemented project scenario - SEM -	Y 11	Y 12	Y 13	Y 14	Y 15	Y 16	Y 17	Y 18	Y 19	Y 20
Value of tourism and leisure activities in the SEM scenario - ('000) $	761	784	807	832	857	857	857	857	857	857
Value of food sources from pastures on long term - ('000) $/year	48,992	49,482	49,977	50,477	50,981	51,491	52,006	52,526	53,051	53,582
Income from forestry	2,871	2,875	2,879	2,883	2,887	2,893	2,899	2,905	2,911	2,917
Value of ES of carbon sequestration in SEM scenario – ('000) $	7,720	7,739	7,758	7,777	7,796	7,815	7,834	7,853	7,871	7,890
Total benefits and revenue	**60,344**	**60,880**	**61,421**	**61,968**	**62,521**	**63,056**	**63,596**	**64,141**	**64,691**	**65,246**

('000) $		Years									
	CF	1	2	3	4	5	6	7	8	9	10
Fiscal corrections		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Revenue from profit tax, local taxes, labour taxes		123.90	128.41	133.13	138.05	143.19	148.57	154.20	160.09	166.26	172.72
Revenue generated by the multiplier effect of ecotourism		67.96	70.00	72.10	74.26	76.49	78.78	81.15	83.58	86.09	86.09
Benefits for society determined by labour cost corrections		227.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benefits of ES of carbon sequestration		37.90	56.86	75.81	94.76	113.71	132.66	151.62	170.57	189.52	208.47
Benefits of ES following a reduction of costs with water treatment		74.30	74.30	74.30	74.30	74.30	74.30	74.30	74.30	74.30	74.30
Benefits of ES regarding the reduction of damages due to floods		40.75	41.97	43.23	44.53	45.86	47.24	48.66	50.12	51.62	53.17
Revenue from additional wages		40.20	43.42	46.89	50.64	54.69	59.07	63.79	68.90	74.41	80.36
Total external benefits		**612.77**	**414.95**	**445.45**	**476.54**	**508.25**	**540.62**	**573.71**	**607.55**	**642.19**	**675.10**
Revenue due to increased tourist flow		0.00	11.33	23.11	35.35	48.08	61.31	75.06	89.33	104.15	119.54
Revenue due to increased food produced by pastures – ('000) $/year		439.13	882.65	1,330.60	1,783.04	2,239.99	2,701.52	3,167.67	3,638.47	4,113.98	4,594.25
Additional income from forestry		27.69	78.69	79.69	80.69	81.69	82.69	86.69	90.69	94.69	98.69
Total revenue		**466.81**	**972.66**	**1,433.39**	**1,899.07**	**2,369.76**	**2,845.52**	**3,329.41**	**3,818.49**	**4,312.82**	**4,812.48**
Forestry taxes		2800.00	2800.00	2800.00	2800.00	2800.00	2800.00	2800.00	2800.00	2800.00	2800.00
Total external costs		**2800.00**	**2800.00**	**2800.00**	**2800.00**	**2800.00**	**2800.00**	**2800.00**	**2800.00**	**2800.00**	**2800.00**
Total running and maintenance costs		0.00	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90
Total investment costs	212.00	127.20	50.88	0	0	0	0	0	0	0	0
Total costs		**127.20**	**54.78**	**3.90**	**3.90**	**3.90**	**3.90**	**3.90**	**3.90**	**3.90**	**3.90**
Net cash flow		**-1,847.61**	**-1,467.17**	**-925.06**	**-428.29**	**74.11**	**582.24**	**1,099.21**	**1,622.13**	**2,151.11**	**2,683.68**
Economic Internal Rate of Return (ERR)	**%**	**25.07%**									
Economic Net Present Value (ENPV)	**('000) $**	**37352.93**									
Benefit / Cost ratio		**1.89**									
Update factor	**3%**										

('000) $		Years									
	CF	11	12	13	14	15	16	17	18	19	20
Fiscal corrections		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Revenue from profit tax, local taxes, labour taxes		179.49	186.59	194.05	201.87	210.10	213.84	217.88	222.24	226.96	226.96
Revenue generated by the multiplier effect of ecotourism		86.09	86.09	86.09	86.09	86.09	86.09	86.09	86.09	86.09	86.09
Benefits for society determined by labour cost corrections		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benefits of ES of carbon sequestration		227.42	246.37	265.33	284.28	303.23	322.18	341.13	360.09	379.04	397.99
Benefits of ES following a reduction of costs with water treatment		74.30	74.30	74.30	74.30	74.30	74.30	74.30	74.30	74.30	74.30
Benefits of ES regarding the reduction of damages due to floods		54.76	56.41	58.10	59.84	61.64	63.49	65.39	67.35	69.37	71.45
Revenue from additional wages		86.79	93.73	101.23	109.33	118.08	127.52	137.72	148.74	160.64	160.64
Revenue due to increased tourist flow		**708.85**	**743.49**	**779.09**	**815.71**	**853.43**	**887.41**	**922.51**	**958.81**	**996.39**	**1,017.43**
Revenue due to increased food produced by pastures – ('000) $/year		135.52	152.09	169.29	187.13	205.64	199.13	192.55	185.91	179.21	172.43
Additional income from forestry		5,079.32	5,569.24	6,064.06	6,563.83	7,068.60	7,578.41	8,093.32	8,613.38	9,138.65	9,669.16
Total revenue		102.69	106.69	110.69	114.69	118.69	124.69	130.69	136.69	142.69	148.69
Forestry taxes		**5,317.52**	**5,828.02**	**6,344.04**	**6,865.65**	**7,392.92**	**7,902.23**	**8,416.56**	**8,935.98**	**9,460.54**	**9,990.28**
Total external costs		2800.00	2800.00	2800.00	2800.00	2800.00	2800.00	2800.00	2800.00	2800.00	2800.00
Total running and maintenance costs		**2800.00**	**2800.00**	**2800.00**	**2800.00**	**2800.00**	**2800.00**	**2800.00**	**2800.00**	**2800.00**	**2800.00**
Total investment costs		3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90	3.90
Total costs	212.00	0	0	0	0	0	0	0	0	0	0
Net cash flow		**3.90**	**3.90**	**3.90**	**3.90**	**3.90**	**3.90**	**3.90**	**3.90**	**3.90**	**3.90**
Revenue due to increased tourist flow		**3,222.47**	**3,767.61**	**4,319.23**	**4,877.46**	**5,442.44**	**5,985.74**	**6,535.17**	**7,090.89**	**7,653.03**	**8,203.80**

Economic Internal Rate of Return (ERR)	**%**	**25.07%**
Economic Net Present Value (ENPV)	**('000) $**	**37352.93**
Benefit / Cost ratio		**1.89**
Update factor	**3%**	

Option 2: Early smoke and fire detection system in forest areas with Surveillance drones

Total investment costs: 550.00 thousand USD;

Total operating and maintenance costs 21 thousand USD/year

Socio- economic analysis and cost – benefit analysis for the consolidated effects of the investment

"Do nothing" scenario - BAU -

	Y 0	Y 1	Y 2	Y 3	Y 4	Y 5	Y 6	Y 7	Y 8	Y 9	Y 10
Value of tourism and leisure activities in the "do nothing" scenario – ('000) $	561	566	572	578	583	589	595	601	607	613	619
Value of food sources from pastures on short term - ('000) $/year	43,913	43,913	43,913	43,913	43,913	43,913	43,913	43,913	43,913	43,913	43,913
Revenue from forestry	2,769	2,769	2,769	2,769	2,769	2,769	2,769	2,769	2,769	2,769	2,769
Value of ES of carbon sequestration in BAU scenario – ('000) $	7,511	7,511	7,511	7,511	7,511	7,511	7,511	7,511	7,511	7,511	7,511
Total benefits and income	**54,754**	**54,759**	**54,765**	**54,771**	**54,776**	**54,782**	**54,788**	**54,794**	**54,800**	**54,806**	**54,812**

Implemented project scenario - SEM -	Y 0	Y 1	Y 2	Y 3	Y 4	Y 5	Y 6	Y 7	Y 8	Y 9	Y 10
Value of tourism and leisure activities in the SEM scenario - ('000) $	561	566	583	601	619	637	657	676	696	717	739
Value of food sources from pastures on long term - ('000) $/year	43,913	44,352	44,795	45,243	45,696	46,153	46,614	47,080	47,551	48,027	48,507
Revenue from forestry	2,769	2,796	2,847	2,848	2,849	2,850	2,851	2,855	2,859	2,863	2,867
Value of ES of carbon sequestration in SEM scenario – ('000) $	7,511	7,511	7,549	7,568	7,587	7,606	7,625	7,644	7,663	7,682	7,701
Total benefits and revenue		**55,226**	**55,775**	**56,261**	**56,751**	**57,247**	**57,747**	**58,256**	**58,770**	**59,289**	**59,814**

Socio- economic analysis and cost – benefit analysis for the consolidated effects of the investment

"Do nothing" scenario - BAU -

	Y 11	Y 12	Y 13	Y 14	Y 15	Y 16	Y 17	Y 18	Y 19	Y 20

Value of tourism and leisure activities in the "do nothing" scenario – ('000) $	626	632	638	645	651	657	664	671	677	684
Value of food sources from pastures on short term - ('000) $/year	43,913	43,913	43,913	43,913	43,913	43,913	43,913	43,913	43,913	43,913
Revenue from forestry	2,769	2,769	2,769	2,769	2,769	2,769	2,769	2,769	2,769	2,769
Value of ES of carbon sequestration in BAU scenario – ('000) $	7,511	7,511	7,511	7,511	7,511	7,511	7,511	7,511	7,511	7,511
Total benefits and revenue	**54,818**	**54,825**	**54,831**	**54,837**	**54,844**	**54,850**	**54,857**	**54,864**	**54,870**	**54,877**

Implemented project scenario - SEM -	Y 11	Y 12	Y 13	Y 14	Y 15	Y 16	Y 17	Y 18	Y 19	Y 20
Value of tourism and leisure activities in the SEM scenario - ('000) $	761	784	807	832	857	857	857	857	857	857
Value of food sources from pastures on long term - ('000) $/year	48,992	49,482	49,977	50,477	50,981	51,491	52,006	52,526	53,051	53,582
Revenue from forestry	2,871	2,875	2,879	2,883	2,887	2,893	2,899	2,905	2,911	2,917
Value of ES of carbon sequestration in SEM scenario – ('000) $	7,720	7,739	7,758	7,777	7,796	7,815	7,834	7,853	7,871	7,890
Total benefits and revenue	**60,344**	**60,880**	**61,421**	**61,968**	**62,521**	**63,056**	**63,596**	**64,141**	**64,691**	**65,246**

('000) $		Years									
	CF	1	2	3	4	5	6	7	8	9	10
Fiscal corrections		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Revenue from profit tax, local taxes, labour taxes		123.90	128.41	133.13	138.05	143.19	148.57	154.20	160.09	166.26	172.72
Revenue generated by the multiplier effect of ecotourism		67.96	70.00	72.10	74.26	76.49	78.78	81.15	83.58	86.09	86.09
Benefits for society determined by labour cost corrections		227.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benefits of ES of carbon sequestration		37.90	56.86	75.81	94.76	113.71	132.66	151.62	170.57	189.52	208.47
Benefits of ES following a reduction of costs with water treatment		74.30	74.30	74.30	74.30	74.30	74.30	74.30	74.30	74.30	74.30
Benefits of ES regarding the reduction of damages due to floods		40.75	41.97	43.23	44.53	45.86	47.24	48.66	50.12	51.62	53.17
Revenue from additional wages		40.20	43.42	46.89	50.64	54.69	59.07	63.79	68.90	74.41	80.36
Total external benefits		**612.77**	**414.95**	**445.45**	**476.54**	**508.25**	**540.62**	**573.71**	**607.55**	**642.19**	**675.10**
Revenue due to increased tourist flow		0.00	11.33	23.11	35.35	48.08	61.31	75.06	89.33	104.15	119.54

Revenue due to increased food produced by pastures – ('000) $/year		439.13	882.65	1,330.60	1,783.04	2,239.99	2,701.52	3,167.67	3,638.47	4,113.98	4,594.25
Additional income from forestry		27.69	78.69	79.69	80.69	81.69	82.69	86.69	90.69	94.69	98.69
Total revenue		**466.81**	**972.66**	**1,433.39**	**1,899.07**	**2,369.76**	**2,845.52**	**3,329.41**	**3,818.49**	**4,312.82**	**4,812.48**
Forestry taxes		2,800.00	2,800.00	2,800.00	2,800.00	2,800.00	2,800.00	2,800.00	2,800.00	2,800.00	2,800.00
Total external costs		**2,800.00**	**2,800.00**	**2,800.00**	**2,800.00**	**2,800.00**	**2,800.00**	**2,800.00**	**2,800.00**	**2,800.00**	**2,800.00**
Total running and maintenance costs		0.00	20.91	20.91	20.91	20.91	20.91	20.91	20.91	20.91	20.91
Total investment costs	550	330.00	132.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total costs		**330.00**	**152.91**	**20.91**	**20.91**	**20.91**	**20.91**	**20.91**	**20.91**	**20.91**	**20.91**
Net cash flow		**-2,050.41**	**-1,565.30**	**-942.07**	**-445.30**	**57.10**	**565.23**	**1,082.20**	**1,605.12**	**2,134.10**	**2,666.67**
Economic Internal Rate of Return (ERR)	**%**	**24.05%**									
Economic Net Present Value (ENPV)	**('000) $**	**36843.03**									
Benefit / Cost ratio		**1.87**									
Update factor	**3%**										

('000) $		Years									
	CF	11	12	13	14	15	16	17	18	19	20
Fiscal corrections		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Revenue from profit tax, local taxes, labour taxes		179.49	186.59	194.05	201.87	210.10	213.84	217.88	222.24	226.96	226.96
Revenue generated by the multiplier effect of ecotourism		86.09	86.09	86.09	86.09	86.09	86.09	86.09	86.09	86.09	86.09
Benefits for society determined by labour cost corrections		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benefits of ES of carbon sequestration		227.42	246.37	265.33	284.28	303.23	322.18	341.13	360.09	379.04	397.99
Benefits of ES following a reduction of costs with water treatment		74.30	74.30	74.30	74.30	74.30	74.30	74.30	74.30	74.30	74.30

Benefits of ES regarding the reduction of damages due to floods		54.76	56.41	58.10	59.84	61.64	63.49	65.39	67.35	69.37	71.45
Revenue from additional wages		86.79	93.73	101.23	109.33	118.08	127.52	137.72	148.74	160.64	160.64
Total external benefits		**708.85**	**743.49**	**779.09**	**815.71**	**853.43**	**887.41**	**922.51**	**958.81**	**996.39**	**1,017.43**
Revenue due to increased tourist flow		135.52	152.09	169.29	187.13	205.64	199.13	192.55	185.91	179.21	172.43
Revenue due to increased food produced by pastures – ('000) $/year		5,079.32	5,569.24	6,064.06	6,563.83	7,068.60	7,578.41	8,093.32	8,613.38	9,138.65	9,669.16
Additional income from forestry		102.69	106.69	110.69	114.69	118.69	124.69	130.69	136.69	142.69	148.69
Total revenue		**5,317.52**	**5,828.02**	**6,344.04**	**6,865.65**	**7,392.92**	**7,902.23**	**8,416.56**	**8,935.98**	**9,460.54**	**9,990.28**
Forestry taxes		2,800.00	2,800.00	2,800.00	2,800.00	2,800.00	2,800.00	2,800.00	2,800.00	2,800.00	2,800.00
Total external costs		**2,800.00**	**2,800.00**	**2,800.00**	**2,800.00**	**2,800.00**	**2,800.00**	**2,800.00**	**2,800.00**	**2,800.00**	**2,800.00**
Total running and maintenance costs		20.91	20.91	20.91	20.91	20.91	20.91	20.91	20.91	20.91	20.91
Total investment costs	550.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total costs		**20.91**	**20.91**	**20.91**	**20.91**	**20.91**	**20.91**	**20.91**	**20.91**	**20.91**	**20.91**
Net cash flow		**3,205.46**	**3,750.60**	**4,302.22**	**4,860.45**	**5,425.43**	**5,968.73**	**6,518.16**	**7,073.88**	**7,636.02**	**8,186.79**
Economic Internal Rate of Return (ERR)	**%**	**24.05%**									
Economic Net Present Value (ENPV)	**('000) $**	**36843.03**									
Benefit / Cost ratio		**1.87**									
Update factor	**3%**										

Option 3: Early detection of smoke and fires in forest areas with Wildfire Sensors

Total investment costs: 460.00 thousand USD;

Total operating and maintenance costs 9.53 thousand USD/year

Socio- economic analysis and cost – benefit analysis for the consolidated effects of the investment

"Do nothing" scenario - BAU -											
-	Y 0	Y 1	Y 2	Y 3	Y 4	Y 5	Y 6	Y 7	Y 8	Y 9	Y 10

Value of tourism and leisure activities in the "do nothing" scenario – ('000) $	561	566	572	578	583	589	595	601	607	613	619
Value of food sources from pastures on short term - ('000) $/year	43,913	43,913	43,913	43,913	43,913	43,913	43,913	43,913	43,913	43,913	43,913
Income from forestry	2,769	2,769	2,769	2,769	2,769	2,769	2,769	2,769	2,769	2,769	2,769
Value of ES of carbon sequestration in BAU scenario – ('000) $	7,511	7,511	7,511	7,511	7,511	7,511	7,511	7,511	7,511	7,511	7,511
Total benefits and income	**54,754**	**54,759**	**54,765**	**54,771**	**54,776**	**54,782**	**54,788**	**54,794**	**54,800**	**54,806**	**54,812**

Implemented project scenario - SEM -	Y 0	Y 1	Y 2	Y 3	Y 4	Y 5	Y 6	Y 7	Y 8	Y 9	Y 10
Value of tourism and leisure activities in the SEM scenario - ('000) $	561	566	583	601	619	637	657	676	696	717	739
Value of food sources from pastures on long term - ('000) $/year	43,913	44,352	44,795	45,243	45,696	46,153	46,614	47,080	47,551	48,027	48,507
Revenue from forestry	2,769	2,796	2,847	2,848	2,849	2,850	2,851	2,855	2,859	2,863	2,867
Value of ES of carbon sequestration in SEM scenario – ('000) $	7,511	7,511	7,549	7,568	7,587	7,606	7,625	7,644	7,663	7,682	7,701
Total benefits and revenue		**55,226**	**55,775**	**56,261**	**56,751**	**57,247**	**57,747**	**58,256**	**58,770**	**59,289**	**59,814**

Socio- economic analysis and cost – benefit analysis for the consolidated effects of the investment

"Do nothing" scenario - BAU -

_	Y 11	Y 12	Y 13	Y 14	Y 15	Y 16	Y 17	Y 18	Y 19	Y 20
Value of tourism and leisure activities in the "do nothing" scenario – ('000) $	626	632	638	645	651	657	664	671	677	684
Value of food sources from pastures on short term - ('000) $/year	43,913	43,913	43,913	43,913	43,913	43,913	43,913	43,913	43,913	43,913
Revenue from forestry	2,769	2,769	2,769	2,769	2,769	2,769	2,769	2,769	2,769	2,769
Value of ES of carbon sequestration in BAU scenario – ('000) $	7,511	7,511	7,511	7,511	7,511	7,511	7,511	7,511	7,511	7,511
Total benefits and revenue	**54,818**	**54,825**	**54,831**	**54,837**	**54,844**	**54,850**	**54,857**	**54,864**	**54,870**	**54,877**

Implemented project scenario - SEM -	Y 11	Y 12	Y 13	Y 14	Y 15	Y 16	Y 17	Y 18	Y 19	Y 20
Value of tourism and leisure activities in the SEM scenario - ('000) $	761	784	807	832	857	857	857	857	857	857
Value of food sources from pastures on long term - ('000) $/year	48,992	49,482	49,977	50,477	50,981	51,491	52,006	52,526	53,051	53,582
Revenue from forestry	2,871	2,875	2,879	2,883	2,887	2,893	2,899	2,905	2,911	2,917
Value of ES of carbon sequestration in SEM scenario – ('000) $	7,720	7,739	7,758	7,777	7,796	7,815	7,834	7,853	7,871	7,890
Total benefits and revenue	**60,344**	**60,880**	**61,421**	**61,968**	**62,521**	**63,056**	**63,596**	**64,141**	**64,691**	**65,246**

('000) $ | Years

	CF	1	2	3	4	5	6	7	8	9	10
Fiscal corrections		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Revenue from profit tax, local taxes, labour taxes		123.90	128.41	133.13	138.05	143.19	148.57	154.20	160.09	166.26	172.72
Revenue generated by the multiplier effect of ecotourism		67.96	70.00	72.10	74.26	76.49	78.78	81.15	83.58	86.09	86.09
Benefits for society determined by labour cost corrections		227.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benefits of ES of carbon sequestration		37.90	56.86	75.81	94.76	113.71	132.66	151.62	170.57	189.52	208.47
Benefits of ES following a reduction of costs with water treatment		74.30	74.30	74.30	74.30	74.30	74.30	74.30	74.30	74.30	74.30
Benefits of ES regarding the reduction of damages due to floods		40.75	41.97	43.23	44.53	45.86	47.24	48.66	50.12	51.62	53.17
Revenue from additional wages		40.20	43.42	46.89	50.64	54.69	59.07	63.79	68.90	74.41	80.36
Total external benefits		**612.77**	**414.95**	**445.45**	**476.54**	**508.25**	**540.62**	**573.71**	**607.55**	**642.19**	**675.10**
Revenue due to increased tourist flow		0.00	11.33	23.11	35.35	48.08	61.31	75.06	89.33	104.15	119.54
Revenue due to increased food produced by pastures – ('000) $/year		439.13	882.65	1,330.60	1,783.04	2,239.99	2,701.52	3,167.67	3,638.47	4,113.98	4,594.25
Additional income from forestry		27.69	78.69	79.69	80.69	81.69	82.69	86.69	90.69	94.69	98.69
Total revenue		**466.81**	**972.66**	**1,433.39**	**1,899.07**	**2,369.76**	**2,845.52**	**3,329.41**	**3,818.49**	**4,312.82**	**4,812.48**
Forestry taxes		2800.00	2800.00	2800.00	2800.00	2800.00	2800.00	2800.00	2800.00	2800.00	2800.00
Total external costs		**2800.00**	**2800.00**	**2800.00**	**2800.00**	**2800.00**	**2800.00**	**2800.00**	**2800.00**	**2800.00**	**2800.00**
Total running and maintenance costs		0.00	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53
Total investment costs	460,00	276.00	110.40	0	0	0	0	0	0	0	0
Total costs		**276.00**	**119.93**	**9.53**	**9.53**	**9.53**	**9.53**	**9.53**	**9.53**	**9.53**	**9.53**
Net cash flow		**-1,996.41**	**-1,532.32**	**-930.69**	**-433.92**	**68.48**	**576.61**	**1,093.58**	**1,616.50**	**2,145.48**	**2,678.05**
Economic Internal Rate of Return (ERR)	**%**	**24.39%**									
Economic Net Present Value (ENPV)	**('000) $**	**37074.07**									

Benefit / Cost ratio		**1.88**
Update factor	**3%**	

('000) $		Years									
	CF	11	12	13	14	15	16	17	18	19	20
Fiscal corrections		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Revenue from profit tax, local taxes, labour taxes		179.49	186.59	194.05	201.87	210.10	213.84	217.88	222.24	226.96	226.96
Revenue generated by the multiplier effect of ecotourism		86.09	86.09	86.09	86.09	86.09	86.09	86.09	86.09	86.09	86.09
Benefits for society determined by labour cost corrections		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Benefits of ES of carbon sequestration		227.42	246.37	265.33	284.28	303.23	322.18	341.13	360.09	379.04	397.99
Benefits of ES following a reduction of costs with water treatment		74.30	74.30	74.30	74.30	74.30	74.30	74.30	74.30	74.30	74.30
Benefits of ES regarding the reduction of damages due to floods		54.76	56.41	58.10	59.84	61.64	63.49	65.39	67.35	69.37	71.45
Revenue from additional wages		86.79	93.73	101.23	109.33	118.08	127.52	137.72	148.74	160.64	160.64
Total external benefits		**708.85**	**743.49**	**779.09**	**815.71**	**853.43**	**887.41**	**922.51**	**958.81**	**996.39**	**1,017.43**
Revenue due to increased tourist flow		135.52	152.09	169.29	187.13	205.64	199.13	192.55	185.91	179.21	172.43
Revenue due to increased food produced by pastures – ('000) $/year		5,079.32	5,569.24	6,064.06	6,563.83	7,068.60	7,578.41	8,093.32	8,613.38	9,138.65	9,669.16
Additional income from forestry		102.69	106.69	110.69	114.69	118.69	124.69	130.69	136.69	142.69	148.69
Total revenue		**5,317.52**	**5,828.02**	**6,344.04**	**6,865.65**	**7,392.92**	**7,902.23**	**8,416.56**	**8,935.98**	**9,460.54**	**9,990.28**
Forestry taxes		2800.00	2800.00	2800.00	2800.00	2800.00	2800.00	2800.00	2800.00	2800.00	2800.00
Total external costs		**2800.00**	**2800.00**	**2800.00**	**2800.00**	**2800.00**	**2800.00**	**2800.00**	**2800.00**	**2800.00**	**2800.00**
Total running and maintenance costs		9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53	9.53
Total investment costs	460.00	0	0	0	0	0	0	0	0	0	0
Total costs		**9.53**	**9.53**	**9.53**	**9.53**	**9.53**	**9.53**	**9.53**	**9.53**	**9.53**	**9.53**
Net cash flow		**3,216.84**	**3,761.98**	**4,313.60**	**4,871.83**	**5,436.81**	**5,980.11**	**6,529.54**	**7,085.26**	**7,647.40**	**8,198.17**

Economic Internal Rate of Return (ERR)	**%**	**24.39%**
Economic Net Present Value (ENPV)	**('000) $**	**37074.07**
Benefit / Cost ratio		**1.88**
Update factor	**3%**	

5. Conclusions

Based on the availability of data, three scenarios were compared in more detailed financial terms, i.e. Wireless sensors networks (wild fire sensors), Video / Thermo Cameras and surveillance drones system.

		Scenarios		
		Wildfire Sensors	**Video / Thermo Cameras**	**Surveillance drones**
Investment	('000) $	**460**	**212**	**550**
Total running costs	('000) $	**9.53**	**9.53**	**20.91**
Rate of internal economic return on investment (ERR)	%	**24.39%**	**25.07%**	**24.05%**
Economic Net Present Value (ENPV)	('000) $	**37074.07**	**37352.93**	**36843.03**
Benefit - cost ratio (BCR)		**1.88**	**1.89**	**1.87**
Update factor	3%	**3%**	**3%**	**3%**
Reference period	years	**20**	**20**	**20**
Expected external benefits	('000) $	**10105.94**	**10105.94**	**10105.94**
Discounted future earnings	('000) $	**69129.65**	**69129.65**	**69129.65**
Expected external costs	('000) $	**41656.93**	**41656.93**	**41656.93**

Expected total costs	('000) $	**504.60**	**225.73**	**735.64**

Based on the economic analysis, the best value of main indicators, i.e. Economic Net Present Value (ENPV) and Internal rate of economic return on investment (ERR) belongs to the Video / Thermo Cameras scenario.