forests

MDPI

Article

Linking Spatialized Sustainable Income and Net Value Added in Ecosystem Accounting and the System of National Accounts 2025: Application to the Stone Pine Forests of Andalusia, Spain

Pablo Campos [1], José L. Oviedo [2,*], Alejandro Álvarez [2] and Bruno Mesa [2]

[1] Spanish National Research Council (CSIC), Institute for Public Goods and Policies (IPP), C/Albasanz, 26–28, E-28037 Madrid, Spain; pablo.campos@csic.es
[2] Spanish National Research Council (CSIC), Institute of Marine Sciences of Andalusia (ICMAN), Campus Universitario Río San Pedro s/n, E-11519 Pto. Real-Cádiz, Spain; alejandro.alvarez@cchs.csic.es (A.Á.); bruno.mesa@cchs.csic.es (B.M.)
* Correspondence: jose.oviedo@csic.es

Abstract

This research objective is to overcome the shortcomings of the updated values added of the System of National Accounts 2025 (SNA 2025) in order to measure the spatialized total sustainable social income from forest ecosystems through an experimentally refined System of Environmental-Economic Accounting (rSEEA). Sustainable income measured at observed, imputed, and simulated market transaction prices is defined as the maximum potential consumption of products generated in the forest ecosystem without a real decline in the environmental asset and manufactured fixed capital at the closing of the current period, assuming idealized future conditions of stable real prices and dynamics of institutional and other autonomous processes. A key finding of this research is that sustainable income extends the SNA 2025 net value added by incorporating the omissions by the latter of environmental net operating surplus (or ecosystem service in the absence of environmental damage), ordinary changes in the environmental asset condition and manufactured fixed capital adjusted according to a less ordinary entry of manufactured fixed capital plus the manufactured consumption of fixed capital. Sustainable income was measured spatially for 15 individual products, the area units being the map tiles for Andalusia, Spain, Stone pine forest (*Pinus pinea* L.) canopy cover was predominant, covering an area of 243,559 hectares. In 2010, the SNA 2025 gross and net values added accounted for 24% and 27%, respectively, of the Stone pine forest sustainable income measured by the rSEEA. The ecosystem services omitted by the SNA 2025 made up 69% of the rSEEA sustainable income.

Keywords: gross operating income; ecosystem service; ordinary revaluation of capital; environmental asset; environmental income; biological sustainability

check for updates

Academic Editor: Peter Elsasser

Received: 27 June 2025
Revised: 6 August 2025
Accepted: 13 August 2025
Published: 25 August 2025

Citation: Campos, P.; Oviedo, J.L.; Álvarez, A.; Mesa, B. Linking Spatialized Sustainable Income and Net Value Added in Ecosystem Accounting and the System of National Accounts 2025: Application to the Stone Pine Forests of Andalusia, Spain. *Forests* **2025**, *16*, 1370. https://doi.org/10.3390/f16091370

Copyright: © 2025 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

1. Introduction

1.1. Background to Economic Accounts of Sustainable Social Income from Forest Ecosystems

There is consensus among policy makers and academic experts that the management of nature must be based on the best available scientific knowledge on the lasting contributions of the biophysical factors and ecosystem services to people's consumption [1] (p. 457). The positive contribution of nature to the exchange value of a natural-based consumed product is denoted in ecosystem accounting as an ecosystem service, while if the contribution is negative, it is denoted as environmental damage (or disservice).

Natural area management is often undertaken without having access to specialized environmental–economic accounting data from national statistical offices, leading public policies for natural areas to be designed and implemented with limited availability of environmental–economic statistical data [2] (p. 137). The standard values added of the updated System of National Accounts 2025 (henceforth SNA) presents an incomplete measurement of the total sustainable social income (henceforth sustainable income) generated by a product at any scale, national or subnational scale [3].

The sustainable income from a natural area means the potential total-product economic contribution derived from the human services (labor cost), manufactured capital (manufactured capital income), and environmental asset (environmental income) production factors that would allow the physical endowments and economic transaction values of single product capital to remain unchanged at the closing of the accounting period, assuming idealized future conditions of constant prices and the absence of changes in institutional and other autonomous processes. The total environmental asset contribution of a nature-based product to sustainable income is denoted as environmental income [4] (pp. 49–50).

Reference [5] (p. 779) was a pioneer in incorporating the non-market passive use values of nature's service existence value into people's incomes. The environmental income of a natural product shows that the necessary contribution of nature to sustainable income is biophysical, and since the transaction price of a product depends on the institutional conditions and economic rationales of the owners of the production factors, it can be either positive (ecosystem service) or negative (environmental damage). The price of an ecosystem service, by definition, will be a positive amount, since a negative price for the environmental net operating surplus of a product is denoted as environmental damage (or disservice). The environmental income of a consumed natural-based product is the virtual exchange value of its ecosystem service, the value of its opening environmental asset remaining the same at the closing of the accounting period, as long as there are no changes in the autonomous (external) factors of its production function. The environmental income of an individual product dependent on the natural environment can present either positive or negative exchange values. Both variables are estimated by assuming the idealized future conditions of real price stability and the absence of change in the dynamics of institutional and other autonomous (external) processes affecting the production functions of the products.

Sustainable income is a key economic ecosystem accounting variable for informing and guiding the management of consumed and accumulated products in progress dependent on the ecosystem's natural production factors. The academic experts and national statistical offices recognize the consistency of the sustainable income concept, although there is no proposed measurement of it under the SNA [6] (p. 34), [7] (p. 87), [8] (p. 192).

Reference [8] (pp. 187–193) developed the conceptualization of sustainable income by extending the SNA net value added (or net domestic product) to include the environmental net operating surplus and revaluation of capital omitted by the SNA. However, the accounting record of autonomous revaluation as a component of sustainable income and the capital balance account has long been the subject of debate. The uncertainty regarding the future dynamic of the autonomous factors of the production function (e.g., "windfall") is one of the main reasons why mainstream experts exclude them from the sustainable income of the current period [9] (pp. 177–179).

The United Nations Statistics Commission (UNSC) expert working group for the reform of the SNA recommended that its central framework be expanded to include the omitted contribution of economic services of nature in a novel expanded gross value added [10] (p. 43). The UNSC expert working group was skeptical as regards the meaning of the satellite system of environmental–economic accounting when the aim is to consistently

broaden the SNA values added. From the perspective of satellite ecosystem accounts, the monetary System of Environmental-Economic Accounting—Ecosystem Accounting (SEEA EA) guide in progress has reviewed the state of the art of the valuation of ecosystem services and environmental assets omitted in the System of National Accounts [11] (chapters 8–11). The SEEA EA recommended that active use consumed products without market prices be valued through consumers' willingness to pay marginal prices (or exchange price), according to the stated and revealed preferences, among other valuation techniques. The SEEA EA also rejects the valuation of sustainable and environmental incomes. The proposed advances to the monetary SEEA EA could lead to a satellite of the SNA without integrating its values added in sustainable income ("Building the understanding and capacity for using the SEEA EEA may then be best accomplished by building protocols as a complementary accounting framework, rather than seeking full economic integration within the SNA" [12] (p. 27).

Inclusive wealth accounting seeks to estimate the contribution of the ecosystem asset to consumer well-being through the consumption of a natural-based product. Inclusive wealth replaces the SEEA EA valuation of the ecosystem asset at the observed or simulated market transaction price of the discounted resource rent (or ecosystem service) of a natural-based product with a marginal accounting price (or shadow price) that reflects a social price. Reference [13] showed the possible matching of the market price of the resource rent and the social accounting price by adjusting the former according to the correction for market externalities to reflect a social price. Reference [14] applied the inclusive wealth approach to market resource rents of timber and other forest products from Ethiopia assuming that they were appropriate surrogates for accounting prices, matching market and shadow prices.

Reference [15] estimated ecosystem services and environmental assets in 2020 for a group of products consumed from forests in more than a hundred countries following the recommendations of the SEEA EA to apply observed and simulated transaction prices [11]. The active use products considered were recreational (including recreation, hunting, and fishing), non-wood forest products, and water regulation services. Although rejected by the SEEA EA, [15] estimated the passive use product ecosystem services of habitat and species protection. Reference [16] expanded the ecosystem service valuations of active use products of forests based on [15] by valuing ecosystem services from extracted timber.

We are not aware of applications of the SEEA EA that incorporate non-SNA ecosystem services in the spatial measurement of the sustainable income from single active and passive use products consumed from forest ecosystems.

From both a conceptual and an empirical perspective, the Agroforestry Accounting System (AAS) has advanced in the integration of the SNA gross value added into the sustainable income from the forest ecosystem in the application to the forests of the Andalusian region [17]. Among the innovations in [17], the inclusion in the final products of both the natural growth of woody products valued at discounted resource rent price and carbon sequestration net of emission valued at imputed market price (or basic price) should be highlighted. An additional innovation in [17] is the inclusion of depletion (harvested woody products) in the intermediate consumption. The SNA includes the hidden depletion in the gross value added, and for this reason, the latter differs from the concept of gross operating income (GOI).

The final products of the natural growth of woody products and net carbon sequestration, as well as the intermediate consumption (including depletion) registered by the AAS, lead to multiple instrumental adjustments in the entries and withdrawals in the capital balance account of environmental assets, which are intended to avoid double counting in the measurement of sustainable income.

With the aim of contributing to the scientific debate on the sustainable income accounting framework for a forest ecosystem, this research proposes to denote the simplified AAS as a refined System of Environmental-Economic Accounting (rSEEA). The rSEEA omits woody natural growth and net carbon sequestration variables in the production account, but they are incorporated into the estimate of the ordinary revaluation of the environmental asset condition. Another difference introduced in the rSEEA with respect to the AAS is the redefinition of sustainable income, omitting the autonomous capital revaluation (Supplementary Text S3.1).

The rSEEA refines the ongoing SEEA EA monetary guidelines by incorporating the ecosystem services embedded in passive use products without market prices (e.g., landscape conservation and preservation of threatened wild biodiversity species). The rSEEA also differs from the SEEA EA by incorporating ordinary capital revaluation into sustainable income.

The rSEEA applies transaction prices (or exchange prices) of products and capital that give rise to the measurements of values added and sustainable incomes. Reference [18] applied the SNA and rSEEA at the scale of 12 large publicly owned *Pinus* forest farms situated in protected areas in Eastern Andalusia and estimated that the SNA ecosystem service (ES_{SNA}) accounted for 25% of the environmental income under the rSEEA in 2010. Reference [19] applied the rSEEA to value the biodiversity existence value of threatened wild flora and fauna in the Stone pine forest (SPF) of Andalusia. The latter publication evidences the fact that the ecosystem service of the threatened wild biodiversity product in the Stone pine forest is recognized by the passive consumers of the Andalusian adult population.

1.2. The Research Objective

The objective of this research is to develop and apply a consistent spatialized integration of the SNA values added in the sustainable income of a forest ecosystem measured by an operative refined System of Environmental-Economic Accounting (rSEEA).

The SNA and the rSEEA are applied in those spatial tiles of the Spanish Forest Map [20] in which the canopy cover is predominantly Stone pine forest and to single tree data modelling from the Spanish third National Forest Inventory [21] in the region of Andalusia, covering a total of 243,559 hectares (Supplementary Text S1: Table ST1).

The measurement of sustainable income from Stone pine forest by the rSEEA is applied to the 15 single economic products corresponding to the landowner and the government ecosystem trustee. This research applies the SNA, which measures 12 products (timber, cork, firewood, pine cones, grazing, residential, conservation forestry, firefighting, mushrooms, recreation, landscape conservation, and biodiversity preservation) and a rSEEA that adds three additional products (private amenity, water, and carbon) (Supplementary Text S2).

This application to the Andalusian Stone pine forest presents a regional case study where provisioning services are minor products valued at observed, imputed, and simulated market prices, with the major final product consumptions being the regulating–maintenance and cultural services. The latter services guide the biological sustainability (Supplementary Text S1.2: Table ST2) and economic management of Andalusian Stone pine forests.

1.3. Innovations

This research develops three main advancements in the sustainable income concept and application. The first advancement is the integration of SNA gross values added for single products into sustainable income measured by the rSEEA. This innovation is derived from measuring sustainable income by extending the SNA gross value added

to include the SNA omitted environmental net operating surplus and ordinary change in capital less ordinary entry of manufactured fixed capital. The second advancement is the exclusion of autonomous revaluation of capital from the measurement of sustainable income. Thus, this innovation avoids the incorporation into sustainable income of the changes in capital that are exogenous to the production functions of individual products. The third advancement applied is the measurement of the sustainable income of the Stone pine forests from Andalusia in 2010 at forest tiles and regional scales.

1.4. Economic Data Sources

National statistical offices do not provide data on products and economic costs which are georeferenced according to the tiles (or plots) of the predominant forest tree species. The experimental application of the rSEEA to the map-tiles of the Stone pine forests of Andalusia was possible thanks to the availability of primary georeferenced data from 2010 from the application of the AAS methodology to the forests of the Andalusia region provided by the RECAMAN project [17]. The autonomous region of Andalusia has a similar size to that of Austria. Thus, this research can be considered a pioneering experiment similar to a national-scale case of a forest ecosystem species. It also has the additional characteristic that regional scale results are derived by aggregating the data from the tiles with a greater than 50% predominance of the Stone pine species. The time elapsed means that the economic values of income and capital must be considered as illustrative. There are no economic data on Stone pine subsequent to those from the RECAMAN project and it may be that the current results for provisioning products would have declined significantly compared to those estimated in 2010.

There are no published economic studies involving managed Stone pine forests in economic publications from other Mediterranean countries.

1.5. Research Structure

Section 2 briefly describes the SNA gross value added and rSEEA sustainable income and capital concepts and methods applied in the Andalusian Stone pine case study. Section 3 develops the equations for the consistent integration of the SNA values added into the sustainable income of the rSEEA. The results Section 4 presents the sustainable income and capital figures derived from the applications of the SNA and rSEEA to Stone pine forests (SPF). The discussion Section 5 highlights the sustainable income figures along with the meaning, strengths, weaknesses, and policy implications of the hypothetical implementation of a sustainable income environmental–economic accounting framework for forest ecosystems. The conclusions Section 6 restates the objectives and highlights the results attained through this research. Supplementary Text S1 details the Stone pine forest institutional setting, area covered, data sources, and physical flows and stocks of the Andalusian Stone pine forest case study. Supplementary Text S2 describes the single products concept and valuation methods applied to the Stone pine forest. Supplementary Text S3 presents a detailed description of the sustainable income and capital concepts and applications of the rSEEA in the 15 economic products valued from the Stone pine forests. The supplementary materials conclude with five tables and a figure.

2. Conceptual Issues on Sustainable Income

2.1. Biological and Environmental–Economic Sustainability Concepts of a Natural Area

Biological sustainability is defined as the maintenance and/or reduction in the stock of wild species of fauna and flora threatened with the risk of extinction in the ecosystem accounting area at the closing of the current period and in the future up to a given time horizon [22].

Environmental–economic sustainability is defined as the maintenance and/or increase in the real ecosystem asset condition dependent on natural biological factors of the ecosystem accounting area, all else being equal.

There may be an asymmetry between biological and economic sustainability due to the differences in physical and monetary metrics, respectively. Biological sustainability may require management that results in the loss of sustainable income, with the government being the collective institution that must consider the loss of sustainable income tolerable by the affected population of the ecosystem accounting area.

2.2. Products and Capital Valuations at Transaction Prices

It is recognized that a natural-based product can be produced by one or more of the production factors of labor, manufactured capital, and natural capital. There may also be consumed products with negative exchange values. From the perspective of the production function of a natural-based product, the contributions of the factors of production to the generation of its sustainable income depend on local biophysical endowments and institutional and other autonomous conditions.

The concept of transaction price originates in the visible and invisible exchanges of products and capital ownerships among the natural persons or collective institutions, the latter in representation of the former, exclusive of third-party property rights [23].

The product transaction prices under the SNA and rSEEA applied to the Stone pine forest (SPF) coincide (1) at observed market prices for the products of timber, cork, firewood, pine cones, grazing, and residential, (2) at the total cost plus imputed competitive manufactured net operating surplus for the intermediate products of conservation forestry and firefighting, and (3) at the total cost for final products of own account manufactured gross fixed capital formation.

The SNA and rSEEA differ in their valuations of the consumed final products of recreation, mushrooms, landscape conservation, and threatened wild biodiversity preservation. These consumed products are valued at the total cost plus competitive manufactured net operating surplus under the SNA. Meanwhile, the rSEEA values mushrooms at imputed market prices, and recreation, landscape conservation, and threatened wild biodiversity preservation at simulated market prices based on the marginal willingness to pay stated by the final consumers.

The SNA omits the SPF consumed final products of private amenity, water, and carbon. The rSEEA values amenity at simulated transaction prices and water and carbon at imputed market prices (Tables 1 and S1, Supplementary Texts S2–S3).

Table 1. Observed, imputed, and simulated market transaction prices for intermediate and final products applied by accounting frameworks to Stone pine forests of Andalusia.

Class	Abbreviation	Slightly Refined System of National Accounts (SNA)	Refined System of Environmental-Economic Accounting (rSEEA)	Reference
Landowner				
Consumed final product of timber	FPcti	Observed market price: farm gate price	Observed market price: farm gate price	[7]
Consumed final product of cork	FPcco	Observed market price: farm gate price	Observed market price: farm gate price	[7]
Consumed final product of firewood	FPcfi	Observed market price: farm gate price	Observed market price: farm gate price	[7]

Table 1. *Cont.*

Class	Abbreviation	Slightly Refined System of National Accounts (SNA)	Refined System of Environmental-Economic Accounting (rSEEA)	Reference
Consumed final product of pine cones	FPcpc	Observed market price: farm gate price	Observed market price: farm gate price	[7]
Intermediate product of grazing	IPgr	Observed market price: resource rent price	Observed market price: resource rent price	[7]
Consumed intermediate product of residential accommodation	ISSac/FPcac	Imputed market price: farm gate rental price	Imputed market price: farm gate price	[3]
Consumed final product of private amenity	FPcam	na	Simulated market price: contingent valuation method: private non-industrial landowner average willingness to pay	[24]
Intermediate product of conservation forestry service	ISScf	Imputed market price: market total cost plus competitive manufactured net operating surplus hidden in the general government production account	Imputed market price: market total cost plus competitive manufactured net operating surplus.	[3,17]
Ecosystem trustee				
Intermediate product of firefighting service	ISSff	Imputed market price: market total cost plus competitive manufactured net operating surplus hidden in the general government production account	Imputed market price: market total cost plus competitive manufactured net operating surplus hidden in the general government production account	[3,17]
Consumed final product of mushrooms	FPcmu	Imputed market price: market total cost plus competitive manufactured net operating surplus hidden in the general government production account	Imputed market price: farm gate price	[3,17]
Consumed final product of economic water runoff stored in public dams	FPcwa	na	Imputed market price outside the Stone pine forest: resource rent measured by 3% rate of environmental asset of water from applying hedonic price method to irrigated land market price in Guadalquivir Valley	[17,25]

Table 1. *Cont.*

Class	Abbreviation	Slightly Refined System of National Accounts (SNA)	Refined System of Environmental-Economic Accounting (rSEEA)	Reference
Consumed final product of carbon sequestration net of emission	FPcca	na	Imputed market price: market price from other industries outside the Stone pine forest	[26]
Consumed final product of open access active use recreation	FPcre	Imputed market price: market total cost plus competitive manufactured net operating surplus hidden in the general government production account	Simulated market price: active consumer median willingness to pay measured by contingent valuation	[17]
Consumed final product of landscape conservation passive use	FPcla	Imputed market price: market total cost plus competitive manufactured net operating surplus hidden in the general government production account	Simulated market price: passive consumer marginal willingness to pay measured by choice experiment and simulated exchange value	[17]
Consumed final product of threatened wild specie passive use	FPcbi	Imputed market price: market total cost plus competitive manufactured net operating surplus hidden in the general government production account	Simulated market price: passive consumer marginal willingness to pay measured by choice experiment and exchange value methods	[19]
Own account manufactured gross fixed capital formation	GFCF	Market price: total cost hidden in the general government production account	Market price: total cost	[3]

Abbreviations: na is not applicable; FPcac is consumed final product of residential accommodation service.

Wild mushrooms are gathered by free-access recreational visitors with no opportunity cost at the time of the visit and no manufactured capital investment. The price of threatened wild biodiversity corresponds to the average for the existence value service (passive use) of the 104 species inventoried in the Stone pine forest [19]. The resource rent and the farm-gate prices coincide with the products of water and carbon. This coincidence in prices is due to the fact that these products do not incur labor costs and manufactured capital investment. The prices applied in the valuations of the consumed products of the Stone pine forest correspond to those of the resource rent in 12 products, the stumpage price in 3 products, and the farm-gate price in 15 products (Table S1).

Ecosystem services are valued which are at residual prices for consumed products which are generated by products dependent on labor cost and manufactured capital investment (e.g., timber, cork, firewood, pine cones, grazing, amenity, mushrooms, recreation, landscape, and biodiversity) [27] (Equation (1)) and at imputed market prices for products that depend only on environmental asset production factors (e.g., water and carbon) [27] (Equation (2)).

The results for environmental assets without market prices are subjective because they depend on the chosen discount rate, which cannot be verified from transactions of these

assets in formal markets. The environmental assets are valued by applying a real discount rate of 3%, except in the cases of private amenity and water, which are estimated from the prices in the Stone pine forest land market, as stated by landowners, and from the hedonic price for irrigated land, respectively.

Inanimate manufactured fixed capital is estimated according to the current market replacement price for the same type of new durable good or another equivalent substitute multiplied by an assumed technical coefficient of future loss in physical productivity.

2.3. Subjective Meaning of Gross Values Added of Natural Area

The SNA incorporates the change in inventory less purchases of domestic animals in the final product. Thus, the inclusion of the SPF ordinary change in the carbon inventory as the carbon final product consumed from the forest ecosystem woody product natural growth less harvested product is not a conceptual innovation of the refined System of Environmental-Economic Accounting (rSEEA).

The SNA valuation of a consumed final product without market price at the total cost of production means that its implicit transaction price is ignored, although it can be made visible using marginal willingness to pay methods according to the revealed/stated preferences of final consumers. Thus, the SNA total cost criterion as the consumed final product is a subjective convention. Another subjective convention of the SNA is the exclusion of consumed final products without labor cost and/or manufactured capital investment incurred, but with observed or imputed market prices after their appropriation by the government ecosystem trustee (e.g., water and carbon). The total cost of the production of a product without a market price in the SNA contains intermediate consumption, remuneration of labor, depreciation (or consumption of manufactured fixed capital), and the imputed competitive net operating surplus of manufactured capital [3] (para 7.142).

The rSEEA accepts that since the hypothetical valuation derived from the final consumers' marginal willingness to pay is uncertain, the sustainable income derived from the simulated and imputed market prices is conceptually consistent and may be more accurate than the SNA gross value added with regard to reflecting the sustainable income from the forest ecosystem enjoyed by society as a whole.

The subjective conventions of the SNA described above mean that the extensions of the SNA gross and net values added, which give rise to the rSEEA sustainable income, are not completely novel. The measurements of both SNA values added and sustainable income are conditioned by the agreed subjective assumptions of the SNA and rSEEA [7] (p. 84), [9] (p. 177).

2.4. Preferential Remuneration Order of Production Factors

In this research, the SNA and rSEEA assume the preferential remunerations of intermediate consumption, labor cost, manufactured gross operating surplus, and ecosystem disservice of an intermediate or consumed final product. The environmental gross operating surplus is the residual value that can be derived after the preferential remunerations of the above mentioned production factors of a consumed product (Supplementary Text S3; Table 2). However, the environmental gross operating surplus is preferentially paid in the event that it comes from the first transaction of a product (e.g., grazing, water). When the payment of the environmental gross operating surplus is preferential, in this case, the residual (balancing item) value of the consumed product corresponds to the manufactured gross operating surplus.

Table 2. Economic indicator definitions and equations under rSEEA applied to Stone pine forests of Andalusia.

Class	Abbreviation	Definition	Refined System of Environmental-Economic Accounting (rSEEA)
Production function	P	P shows the factors that contribute to the generation of total product as input (I) of intermediate consumption (IC), labor force (L), manufactured fixed capital (FCm), and environmental asset (EA), in the current period.	$P \equiv F(I, LC, FCm, EA)$
Total product	TP	Total product (TP) contening the intermediate (IP) and final product (FP). The FP includes final product consumed (FPc) and accumulated product denoted as own account manufactured gross fixed capital formation (GFCF), in the current period.	$TP = IP + FP$ $FP = FPc + GFCF$
Gross value added	GVA	GVA is estimated by subtracting from the total product (TP) at observed, imputed and simulated market (before taxes and subsidies linked to production) transaction price less purchased and own intermediate consumption (IC) valued at market price. GVA represents the remunerations of labor cost (LC) and gross operating surplus (GOS) embedded in the total product (TP). The GVA contains the GVA_{SNA} plus the ecosystem service omitted by the SNA ($ES_{NON\text{-}SNA}$).	$GVA = TP - IC$ $GVA = LC + GOS$ $GVA = GVA_{SNA} + ES_{NON\text{-}SNA}$
Labor cost	LC	LC is gross remuneration for employees that includes social charges.	$LC = LCe$
Gross operating surplus	GOS	GOS components are the manufactured gross operating surplus (GOSm) and the environmental gross operating surplus (GOSe) embedded in the total product (TP). GOSe and environmental net operating surplus (NOSe) coincide. GOSe includes ecosystem service (ES) and ecosystem disservice (ED).	$GOS = GOSm + GOSe$ $GOSe = ES + ED$ $GOSe = NOSe$ Being ED = 0: $GOS = GOSm + ES$
Net value added	NVA	NVA under the rSEEA is gross value added (GVA) less consumption of manufactured fixed capital (CFC), with the latter item denoted as depreciation by the SNA. NVA contains the net added value of the SNA (NVA_{SNA}) plus the ecosystem service omitted by the SNA ($ES_{NON\text{-}SNA}$) less the ordinary change in the SNA environmental asset condition ($CEAco_{SNA}$).	$NVA = GVA - CFC$ $NVA = NVA_{SNA} + ES_{NON\text{-}SNA} - CEAco_{SNA}$
Environmental net operating surplus	NOSe	The environmental net operating surplus embedded in a consumed product may contain an ecosystem service (ES) or an ecosystem disservice (ED).	$NOSe = ES + ED$
NON-SNA environmental net operating surplus	$NOSe_{NON\text{-}SNA}$	$NOSe_{NON\text{-}SNA}$ includes environmental net operating surplus without market prices ($NOSenmp_{NON\text{-}SNA}$) and the environmental net operating surplus with market prices ($NOSemp_{NON\text{-}SNA}$) embedded in consumed final products that are omitted in the SNA.	$NOSe_{NON\text{-}SNA} = NOSenmp_{NON\text{-}SNA} + NOSemp_{NON\text{-}SNA}$

Table 2. *Cont.*

Class	Abbreviation	Definition	Refined System of Environmental-Economic Accounting (rSEEA)
Ecosystem service	ES	Ecosystem service is a positive exchange value contribution to the forest ecosystem individual total product estimated by the market price in the first observed transaction and/or the residual exchange value after having remunerated the services of labor and the immobilized manufactured capital. The ecosystem services contain the extraction of the provisioning opening environmental asset used (EAwu) and the net return on environmental asset (NREA).	ES = TP − IC − LC − GOSm − ED Being ED = 0: ES = EAwu + NREA
Environmental net operating income	NOIe	NOIe is estimated by subtracting EAwu from the environmental net operating surplus (NOSe). NOIe contains NREA and ED.	NOIe = NOSe − EAwu NOIe = NREA + ED Being ED = 0: NOIe = NREA
Gross operating income	GOI	GOI contains the gross operating remunerations on production factors of human labor and total capital investment. It is estimated according to the gross value added less the environmental opening extraction cost (EAwu). GOI contains labor remuneration (LC), gross operating surplus (GOSm) of immobilized manufactured capital, and environmental net operating income (NOIe).	GOI = GVA − EAwu GOI = LC + GOSm + NOIe
Sustainable income	SI	SI contains gross operating income (GOI) and ordinary revaluation of capital (Cro). SI represents the remunerations for the production factors of labor (LC), manufactured capital income (CIm), and environmental income (EI). SI extends the gross value added of the SNA (GVA_{SNA}) by incorporating the latter's omissions from the ecosystem service ($ES_{NON\text{-}SNA}$), the ordinary change in the condition of the environmental asset (CEAco), and the ordinary revaluation of manufactured fixed capital nominal price (FCmrpo). SI contains the net value added of the SNA (NVA_{SNA}) and the latter's omissions of the ecosystem service ($ES_{NON\text{-}SNA}$), the ordinary change in the condition of the environmental asset ($CEAco_{NON\text{-}SNA}$) and the ordinary change in manufactured fixed capital (CMFCo), less the ordinary entry of fixed capital (FCeo) and plus depreciation (CFC). The latter two items avoid double counting.	SI = GOI + Cro SI = GVA + CCo − FCmeo SI = LC + CIm + EI Being ED = 0: $SI = GVA_{SNA} + ES_{NON\text{-}SNA} + CEAco + FCmrpo$ $SI = NVA_{SNA} + ES_{NON\text{-}SNA} + CEAco_{\ NON\text{-}SNA} +$ CMFCo – FCmeo + CFC
Ordinary revaluation of total capital	Cro	Cro is estimated by the revaluation of total capital (Cr) minus the autonomous (extraordinary) revaluation (Cra) of total capital caused by changes in the dynamics of institutional and other autonomous (exogenous) factors. Cro contains the ordinary revaluation of the environmental asset condition (EArco) and the ordinary revaluation of manufactured fixed capital (FCmrpo).	Cro = Cr − Cra Cro = EArco + FCmrpo

Table 2. *Cont.*

Class	Abbreviation	Definition	Refined System of Environmental-Economic Accounting (rSEEA)
Ordinary revaluation of environmental asset condition	EArco	EArc is estimated by the total revaluation (EAr) less the autonomous revaluation (EAra) of the environmental asset. EArco contains the ordinary change in the condition of the environmental asset (CEAco) plus the extraction of the environmental work in progress (EAwu) inventoried at the opening of the period.	EArco = EAr − EAra EArco = CEAco + EAwu
Ordinary revaluation of manufactured fixed capital	FCmro	FCmrpo is revalued due to the effects of degradation due to normal use and the unanticipated change in nominal price.	FCmrpo = CMFCo − FCmeo
Environmental income	EI	EI contains the contribution of the environmental net operating income (NOIe) and the ordinary revaluation of environmental asset condition (EArco) to total sustainable social income. As the ecosystem disservice (ED) is absent, EI represents the ecosystem services (ES) plus the ordinary change in environmental asset condition (CEAco).	EI = NOIe + EArco EI = ES + CEAco
Manufactured capital income	CIm	CIm contains manufactured gross operating surplus (GOSm) plus ordinary revaluation in manufactured fixed capital (FCmrpo) used during the current period in the generation of total sustainable social income.	CIm = GOSm + FCmrpo

2.5. Measurement of Standard Net Value Added and Sustainable Income of Forest Ecosystem Under Idealized Conditions

The changes in capital are classified separately in the rSEEA into ordinary and autonomous changes. Ordinary changes in capital are attributed to the services of the production factors that affect the production function of a product. Autonomous changes in capital are due to factors exogenous to the productive biota management of economic products. Autonomous factors are due to variations in the discount rate, technological changes, extraordinary capital destructions, new discoveries of wealth, changes in property rights, extraordinary price changes, changes in land uses, and other autonomous factors that affect the capital value at the closing of the current period.

When valuing sustainable income in this Stone pine forest case study, it is expected that it will be subject to indefinite productive biota sustainability management at the close of the period in which sustainable income is measured (see Supplementary Text S1: Table ST2).

Controversy with regard to sustainable income measurement is mainly associated with the dynamics of institutional and other autonomous factors. In addition, there is a lack of data regarding the modeling of future biological productivities of products dependent on the environmental assets of the natural area.

This research application of sustainable income incorporating ordinary revaluation of capital requires idealized modeling of future ecosystem services and assumptions of exclusions from the dynamics of institutional and other autonomous factors that affect the valuation of capital at the closing of the current period [9] (p. 179). These idealized assumptions are, among others, that (1) unforeseen entries and withdrawals from the capital balance account do not occur, (2) the expected ordinary entries and withdrawals are the manufactured fixed capital investments and those of ongoing environmental woody

products used (depletion), respectively, and (3) there are no changes in the dynamics of the institutional and other autonomous factors that affect the capital value at the closing of the current period, with the exception of the autonomous revaluation of the environmental asset of the private amenity.

2.6. Intermediate Product and Own Intermediate Consumption

The omission of own intermediate consumption of pastures and the differences in the recording of residential service explain why in the Stone pine forest (SPF) case study, the intermediate product differs from own intermediate consumption in both the SNA and rSEEA and between the SNA and rSEEA compared. In the case study of the SPF in Andalusia, the products of livestock and game activities are omitted. In this case study, the SNA records the residential service self-consumed by non-institutional private owners as a final product. In the rSEEA, this service is recorded doubly as an intermediate product of residential activity and its counterpart as intermediate consumption of private amenity activity.

3. Accounting Methods to Consistently Integrate Values Added into Sustainable Income

3.1. SNA Values Added Equations

3.1.1. SNA Gross Value Added

The *Instituto de Estadística y Cartografía de Andalucía* (IECA) applies a SNA that in practice only explicitly estimates the landowners' Economic Account for Forestry (EAF) at the regional scale of Andalusia and, therefore, the SNA does not measure the gross value added for the tiles of the Stone pine forest [28]. The SNA applied in this research to the Stone pine forest (SPF) estimates the gross value added for the landowner and government ecosystem trustee.

The SNA applied in the SPF estimates gross value added (GVA_{SNA}) at market price as the residual value from the total product (TP_{SNA}) less intermediate consumption (IC_{SNA}) and their factorial allocation between labor cost and gross operating surplus. In this Stone pine research case study, the gross operating surplus (GOS_{SNA}) of the SNA is classified into its components of manufactured gross operating surplus ($GOSm_{SNA}$) and environmental gross operating surplus ($GOSe_{SNA}$). Given the omission in the SNA of ecosystem disservice (ED), the GOSe and the ecosystem service (ES_{SNA}) coincide:

$$GVA_{SNA} = TP_{SNA} - IC_{SNA}, \quad (1)$$

$$GVA_{SNA} = LC_{SNA} + GOS_{SNA}, \quad (2)$$

$$GOS_{SNA} = GOSm_{SNA} + GOSe_{SNA}, \quad (3)$$

$$GOSe_{SNA} = ES_{SNA}, \quad (4)$$

The lightly refined SNA production and generation of income account applied by this research to the SPF makes the SNA gross value added for the single economic products of the landowner and of the government ecosystem trustee visible.

The SNA registers the single products of the landowner (timber, cork, firewood, pine cones, grazing, residential, and conservation forestry) and the government ecosystem trustee hidden in the standard SNA general government production account (firefighting, recreation, mushrooms, landscape conservation, and threatened wild biodiversity).

The lightly refined SNA economic products register the commercial intermediate products (grazing, conservation forestry, and firefighting) and their counterparts of own commercial intermediate consumptions, consumed final product (timber, cork, firewood,

pine cones, residential, recreation, mushrooms, landscape, and biodiversity) and accumulated final products (own account manufactured gross fixed capital formation).

3.1.2. SNA Net Value Added

The SNA considers that "the calculation of depreciation [manufactured consumption of fixed capital] requires that statisticians estimate the present value of the stock of the relevant assets, [...]. There may be similar concerns when it comes to the estimation of depletion" [3] (para 3.143). The net value added (NVA_{SNA}) of the SNA is obtained by subtracting from the gross value added the consumption of manufactured fixed capital (CFC) and depletion (D_{SNA}):

$$NVA_{SNA} = GVA_{SNA} - CFC - D_{SNA}, \quad (5)$$

Rearranging Equation (5) makes the factorial attribution of net value added (NVA_{SNA}) explicit:

$$NVA_{SNA} = LC + NOS_{SNA}, \quad (6)$$

$$NOSe_{SNA} = GOS_{SNA} - D_{SNA}, \quad (7)$$

$$NOS_{SNA} = NOSm_{SNA} + NOSe_{SNA}, \quad (8)$$

$$NOSe_{SNA} = ES_{SNA} - D_{SNA}, \quad (9)$$

$$NVA_{SNA} = LC + NOSm_{SNA} + NOSe_{SNA}, \quad (10)$$

where NOS_{SNA} is net operating surplus, $NOSm_{SNA}$ is the manufactured net operating surplus, and $NOSe_{SNA}$ is the environmental net operating surplus. The $NOSe_{SNA}$ includes ecosystem service minus depletion (D_{SNA}).

The depletion corresponds to the "decline in future economic benefits, due to extraction in excess of its growth, which can be earned from a resource, the value of which is based on the physical flows of depletion using the price of the natural resource in situ" [3] (para 7.286).

Idealized conditions are assumed in which there are no future changes in real prices or in the institutional conditions and other autonomous processes that affect the calculation of the closing environmental assets of the products recorded by the SNA. Given these idealized conditions assumed in the future and the absence of unanticipated ordinary entries and withdrawals at the end of the current period, the ordinary revaluation of the environmental asset condition ($EArco_{SNA}$) is due to the effect of the discount for the timing at the end of the current period of the provisioning products produced and those expected to be produced in the future ("Depletion is not recorded when there is a reduction in the quantity of an environmental asset owing to unexpected events such as losses due to extreme weather or pandemic outbreaks of disease" [3] (para 7.293); "In the case of biological resources depletion may be positive or negative, depending on whether or not the extraction of the resources is higher or lower than (net) natural growth" [3] (para 7.297).

In this study, the depletion (D_{SNA}) of a single product environmental asset from the SPF is estimated by the ordinary change in the environmental asset condition with a negative sign ($-CEAco_{SNA}$). $CEAco_{SNA}$ is derived from $EArco_{SNA}$ less the extraction of product in progress used (EAwu), thus avoiding double counting in the net value added (NVA_{SNA}) and $CEAco_{SNA}$ records. A positive $CEAco_{SNA}$ is denoted as an enhancement (or negative depletion). In this case, the NVA_{SNA} may have a meaning close to that of the sustainable income of the individual provisioning product recorded by the SNA.

The equations that estimate the NVA_{SNA} applied in the SPF are shown below.

$$CEAco_{SNA} = EAc_{SNA} - EAo_{SNA} - EAra_{SNA}, \quad (11)$$

$$CEAco_{SNA} = EArco_{SNA} - EAwu_{SNA}, \quad (12)$$

$$D_{SNA} = EAwu_{SNA} - EArco_{SNA}, \quad (13)$$

$$D_{SNA} = -CEAco_{SNA}, \quad (14)$$

$$NVA_{SNA} = GVA_{SNA} - CFC + CEAco_{SNA}, \quad (15)$$

where EAc_{SNA} is the SNA closing environmental asset, EAo_{SNA} is the SNA opening environmental asset, and $EAra_{SNA}$ is the current period unanticipated autonomous revaluation of environmental asset.

3.2. rSEEA Sustainable Income Equations Under Idealized Conditions

The sustainable income (SI) of a product generated in a natural/cultural ecosystem area is defined as the maximum consumption of the product that can occur indefinitely without decreasing its capital, at the end of the accounting period, given the idealized conditions of stable future real prices and the absence of institutional changes or of the dynamics of other autonomous processes

Table 2 describes in detail the sequences of equations that lead to the estimate of the sustainable income of an individual product, applied to the SPF under the rSEEA. To facilitate the fluidity and understanding of the text, the equations for calculating the rSEEA sustainable income, which is derived from the estimates of gross operating income (or main balancing item of the production/income generation account) and the ordinary capital revaluation (or balancing item of the total capital revaluation net of the autonomous revaluation of the capital balance account), are briefly described.

The sustainable income (SI) of an economic product is estimated through aggregating the gross operating income (GOI) and the ordinary revaluation of total capital (Cro) in the current period. Although it is assumed that the autonomous revaluation of capital (Cra) does not form part of the sustainable income for the current period, the changes in the dynamics of the autonomous factors can affect the sustainable income of future periods:

$$SI = GOI + Cro \quad (16)$$

The factorial distribution of the sustainable income comprises the labor cost (LC), the manufactured capital income (CIm), and the environmental income (EI). The manufactured capital income contains the manufactured gross operating surplus (GOSm) and the ordinary revaluation of the manufactured fixed capital nominal price (FCmrpo). The environmental income comprises the environmental net operating income (NOIe) and the ordinary revaluation of the environmental asset condition (EArco):

$$SI = LC + CIm + EI \quad (17)$$

Under the idealized conditions of the Stone pine forest (SPF) capital balance account entries and withdrawals, the equations for sustainable income are simplified without losing generality as the aggregated values of gross value added (GVA) plus ordinary change in total capital (CCo) adjusted according to the ordinary entry of manufactured fixed capital (FCmeo):

$$SI = GVA + CCo - FCmeo \quad (18)$$

The SI extends the SNA gross value added (GVA_{SNA}) to include the elements omitted by the SNA of environmental net operating surplus ($NOSe_{NON\text{-}SNA}$) and the ordinary change in capital (CCo) less ordinary entry of manufactured fixed capital (FCmeo):

$$SI = GVA_{SNA} + NOSe_{NON\text{-}SNA} + CCo - FCmeo \quad (19)$$

The integrations of the SNA net value added into the rSEEA sustainable income (SI) are shown in the following equations:

$$SI = NVA_{SNA} + NOSe_{NON\text{-}SNA} + CEAco_{NON\text{-}SNA} + CMFCo - FCmeo + CFC \quad (20)$$

$$\text{Where ED in the rSEEA} = 0: \quad SI = NVA_{SNA} + ES_{NON\text{-}SNA} + CEAco_{NON\text{-}SNA} + CMFCo - FCmeo + CFC \quad (21)$$

3.3. Ordinary Cash Flow

The ordinary cash flow (CFo) is an indicator aimed at revealing the formal market self-finance of the economic products at the closing of the accounting period. The main aim of the CFo is to draw attention to the inconsistency which can arise from substituting the gross operating income for the ordinary cash flow at the closing of the current period.Among the multiple economic variables recorded in SNA and rSEEA methodologies, the ordinary CFo can be measured as the balancing item of the monetary formal market revenues (R) less expenditures (E). In order to avoid the effect of extraordinary manufactured fixed capital investment purchases in the current period, the depreciation of manufactured fixed capital (CFC) is considered a monetary payment and is assumed to be equivalent to the annualized ordinary purchase of manufactured fixed capital in the period (Supplementary Text S3; Table 2).

$$CFo = R - E, \quad (22)$$

4. Andalusian Stone Pine Forest Capital and Income Results Under SNA and rSEEA

Applying the authors' refined System of Environmental-Economic Accounting (rSEEA) and the System of National Accounts (SNA) to the SPF of Andalusia allowed to measure the SNA gross (GVA_{SNA}) and net (NVA_{SNA}) values added, the environmental net operating surplus ($NOSe_{NON\text{-}SNA}$) of consumed products with and without market prices omitted by SNA, the ordinary change in capital (CCo), and the ordinary entry of manufactured fixed capital (FCmeo). The sustainable income was measured for the 15 products valued in the SPF, while the sustainable income and capital from other SPF products (e.g., livestock, hunting) was omitted.

For the sake of simplicity, the tables showing the economic results omit the carbon ecosystem disservice component because it is not present in the case study of the Stone pine forests in 2010.

4.1. Total Capital Under rSEEA

The environmental assets made up 95% of the Stone pine forest opening total capital in 2010 (Table 3). The environmental assets of the landowners and ecosystem trustee institutional sectors make up 26% and 74% of the opening environmental asset, respectively.

Table 3. Capital balance account under refined System of Environmental-Economic Accounting for stone pine forests of Andalusia (2010: €÷ha).

Class	Opening of Capital	Manufactured Fixed Capital Entries	Environmental Asset Withdrawals Used	Revaluation of Capital				Closing of Capital
				Ordinary Revaluation of Capital		Autonomous Revaluation of Environmental Asset	Revaluation of Capital	
				Ordinary Condition Revaluation of Environmental Asset	Ordinary Price Revaluation of Manufactured Fixed Capital			
	Co	FCme	EAwu	EArco	FCmrpo	EAra	Cr	Cc
1. Environmental asset (EA)	8753.4		13.7	63.6		−42.7	21.0	8760.7
1.1 Landowner (EA_{LO})	2290.8		13.7	46.3		−42.7	3.7	2280.8
Timber	725.7		13.4	41.3			41.3	753.5
Cork	28.0		0.2	1.6			1.6	29.4
Firewood	9.5		0.0	0.5			0.5	10.1
Pine cones	78.3			2.6			2.6	81.0
Grazing	680.7			0.3			0.3	681.0
Amenity	768.5					−42.7	−42.7	725.8
1.2 Ecosystem trustee (EA_{ET})	6462.6			17.3			17.3	6479.9
Recreation	737.1							737.1
Mushrooms	370.4							370.4
Carbon	639.0			17.3			17.3	656.3
Landscape	3702.0							3702.0
Biodiversity	263.2							263.2
Water	750.9							750.9
2. Manufactured fixed capital (FCm)	422.0	25.3			−14.8		−14.8	432.5
2.1 Landowner (FCm_{LO})	292.3	16.5			−4.3		−4.3	304.5
Plantation	115.3	16.5			4.4		4.4	136.2
Construction Equipment	177.0				−8.7		−8.7	168.2
2.2 Ecosystem trustee (FCm_{ET})	129.7	8.8			−10.4		−10.4	128.1
Plantation		0.0			0.0		0.0	0.0
Construction	110.7	6.1			−8.4		−8.4	108.4
Equipment	4.6	0.4			0.0		0.0	5.0
Others	14.4	2.2			−2.0		−2.0	14.6
Capital (C)	9175.4	25.3	13.7	63.6	−14.8	−42.7	6.2	9193.3

Landscape conservation accounts for 42% of the ecosystem trustee environmental asset. Pine cones contribute less than 1% of the value of the environmental asset. The private amenity and landscape make up 34% and 57% of the landowner and ecosystem trustee environmental assets, respectively.

The capital balance account flows are the ordinary withdrawal of the environmental asset of environmental products (or works) in progress used (EAwu) and the ordinary entries of manufactured fixed capitals (FCmeo). Ordinary revaluations of environmental asset condition (EArco) are positive and those of manufactured fixed capital are slightly negative (FCmrpo). The ordinary revaluation of capital (EUR 49÷ha) comes from the positive revaluations of the environmental asset condition (EArco) of EUR 64÷ha and the negative ordinary revaluation of the nominal price of the manufactured fixed capital (FCmrpo) of EUR −15÷ha (Table 3).

Closing total capital increases slightly as the positive ordinary revaluation of capital (Cro) exceeds the negative autonomous revaluation (Cra) of the private amenity environmental asset. The application of the SNA in the SPF provides an $EArco_{SNA}$ of EUR 46.3 per hectare for timber, cork, firewood, pine cones, and grazing and an EAwu of EUR 13.7 per hectare for woody products (timber, cork, and firewood), resulting in an ordinary change in the environmental asset condition ($CEAco_{SNA}$) of EUR 32.6 per hectare. Thus, the estimated depletion (D_{SNA}) is a negative value (or enhancement) of EUR −32.6 per hectare.

4.2. Values Added Under SNA

The lightly refined System of National Accounts (SNA) applied to the Stone pine forest (SPF) estimates a SNA gross value added (GVA_{SNA}) of EUR 119.6÷ha in 2010, with labor cost being EUR 259.8÷ha, while the gross operating surplus is a significant negative value of EUR −140.2÷ha (Table 4).

The SNA manufactured gross operating surplus and the ecosystem service are hidden in the SNA gross operating surplus. The SNA consumed final products with market prices dependent on environmental production factors implicitly incorporate ecosystem services at an amount of EUR 31.8÷ha.

The physical extractions of timber, cork, and firewood in 2010 were notably lower than the natural growth (Supplementary Text S1: Table ST2). The physical yields and stocks of the Andalusian Stone pine forest products valued show that the quantities remain constant or increase at the closing of the current period (2010) (Supplementary Text S1: Table ST2).

The spatialized results for pine cones in SPF are presented in Figure ST1 at the scale of the tiles of the Spanish Forest Map [20]. The yield of pine cones harvested by the landowners is estimated at 25% of the 25,000 tons of average annual biological yield in the tiles with a predominance of either pure or mixed SPF in Andalusia (Supplementary Text S1: Table ST2, Figure ST1). The landowner perceives a notably negative net operating surplus of EUR -49.3÷ha for pine cones (Table S2).

Assuming that potential illegal harvesting of pine cones does not incur significant manufactured intermediate consumption and/or manufactured fixed capital user costs, the "stolen" pine cones will approximate their gross and net values added. The hypothetical incorporation of the pine cones harvested by "thieves" would increase the values added of the pine cone product from the SPF, although the landowners would continue to obtain the same negative gross and net operating surpluses.

The net value added (NVA_{SNA}) of the SNA exceeds the value of the GVA_{SNA}. This counterintuitive result arises because the SNA denotes the enhancement of ordinary change in the environmental asset condition ($CEAco_{SNA} > 0$) as negative depletion ($D = -CEAco_{SNA}$). The negative value of depletion (D_{SNA}) exceeds the value of depreciation (CFC) in absolute terms (Table 4).

Table 4. Gross and net values added under the lightly refined System of National Accounts for the Stone pine forests of Andalusia (2010: €÷ha).

Class	Landowner (LO)	Ecosystem Trustee (ET)	Stone Pine Forest (SPF)
1. Total product (TP)	101.4	154.1	255.5
1.1 Intermediate product (IP)	53.4	38.2	91.6
Grazing of livestock	13.9		13.9
Grazing of game species	8.0		8.0
Conservation forestry	31.5		31.5
Fire fighting		38.2	38.2
1.2 Final product (FP)	48.0	112.6	160.5
1.2.1 Final product consumption (FPc)	31.4	107.1	138.5
Timber	21.5		21.5
Cork	0.3		0.3
Firewood	*		*
Pine cones	4.8		4.8
Residential	4.9		4.9
Recreation		20.0	18.9
Mushrooms		0.1	0.1
Landscape		77.5	77.5
Biodiversity		8.5	8.5
1.2.2 Manufactured gross fixed capital formation (GCF)	16.5	8.8	25.3
2. Intermediate consumption (IC)	44.0	91.8	135.8
2.1 Purchase of intermediate consumption (ICp)	44.0	22.2	66.2
2.2 Own intermediate consumption (ICo)		69.6	69.6
3. Gross value added (GVA)	57.4	62.3	119.7
3.1 Labor cost (LC)	208.2	51.6	259.8
3.2 Gross operating surplus (GOS)	−150.8	10.7	−140.1
3.2.1 Manufactured gross operating surplus (GOSm)	[−182.6]	10.7	[−171.9]
3.2.2 Ecosystem service (ES)	[31.8]		[31.8]
4. Depreciation of manufactured fixed capital (CFC)	8.6	7.4	16.0
5. Depletion (D)	−32.6		−32.6
6. Net value added (NVA) (3 – 4 − 5)	81.4	54.9	136.3
7. Net operating surplus (NOS) (6 − 3.1)	−126.8	3.3	−123.5
8. Manufactured net operating surplus (NOSm) (3.2.1 − 4)	[−191.4]	3.3	[−91.7]
9. Ordinary cash flow (CFo)	[−217.8]	[−53.2]	[−271.0]

Notes: variables in brackets are not shown explicitly by the SNA; ET is ecosystem trustee of government; * is value less than EUR 0.05÷ha.

4.3. Gross Operating Income Under rSEEA

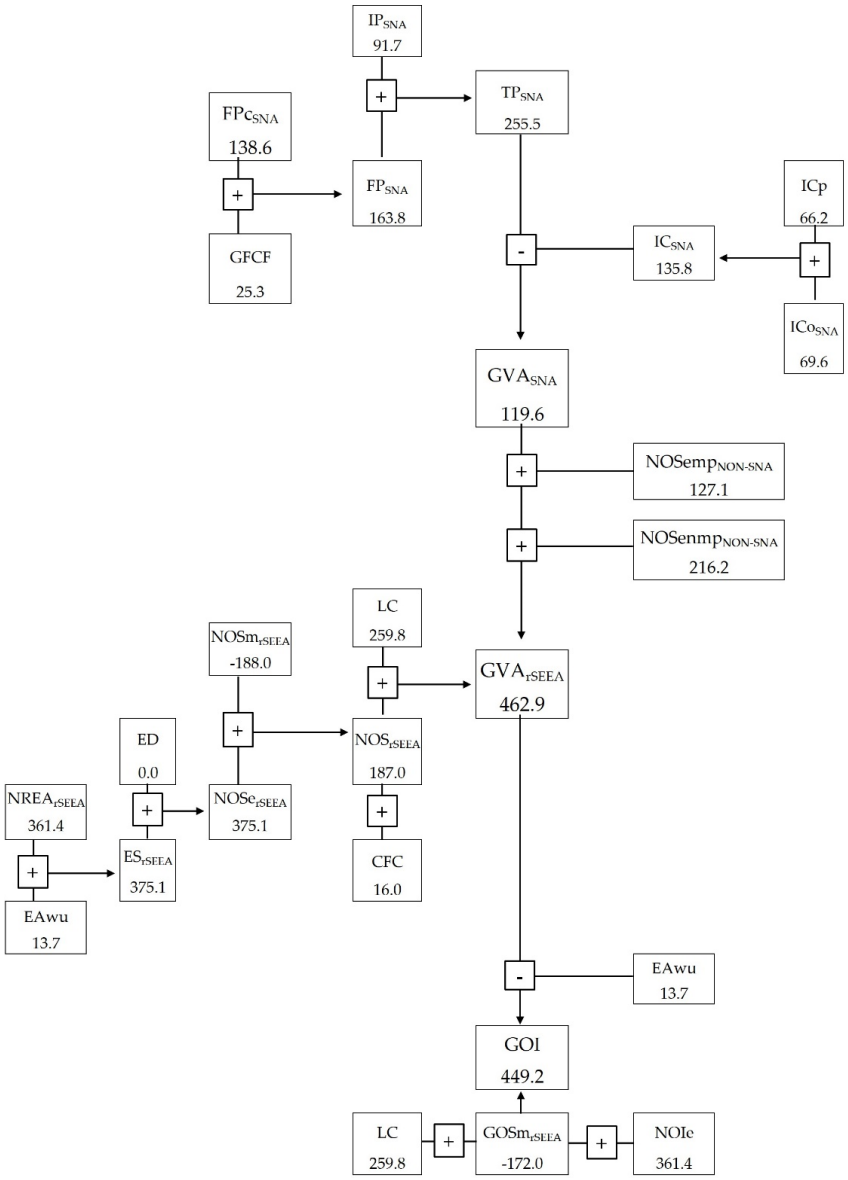
Figure 1 shows the sequence of linked results leading from SNA gross value added to rSEEA gross value added and gross operating income.

The scarce relative contribution of the woody products extracted (EAwu) explains why the gross operating income accounts for 97% of the gross value added (Table 5). The gross operating income (EUR 449÷ha) comprises the labor cost (EUR 259.8÷ha), the negative manufactured gross operating surplus (EUR −172.0÷ha), and the net return on environmental asset (EUR 361.4÷ha). The gross operating income of the ecosystem trustee is 2.7 times that of the landowner (Table 5).

Table 5. Stylized sequence of measuring sustainable income under refined System of Environmental-Economic Accounting for Stone pine forests of Andalusia (2010: €÷ha).

Class	Landowner LO	Ecosystem Trustee ET	Stone Pine Forest SPF
1. Total product (TP)	184.9	418.8	603.8
1.1 Intermediate product (IP)	58.3	38.3	96.6
1.1.1 Intermediate product of raw material (IRM)	21.9		21.9
Livestock grazing	13.9		13.9
Game species grazing	8.0		8.0
1.1.2 Intermediate service product (ISS)	36.4	38.3	74.6
Conservation forestry	31.5		31.5
Residential	4.9		4.9
Firefighting		38.3	38.3
1.2 Final product (FP)	126.6	380.6	507.2
1.2.1 Final product consumed (FPc)	110.1	371.8	481.9
Timber	21.5		21.5
Cork	0.3		0.3
Firewood	0.0		0.0
Pine cones	4.8		4.8
Amenity	83.6		83.6
Recreation		38.4	38.4
Mushrooms		11.3	11.3
Landscape		189.7	189.7
Biodiversity		16.5	16.5
Water		41.8	41.8
Carbon		74.1	74.1
1.2.2 Manufactured gross fixed capital formation (GFCF)	16.5	8.8	25.3
2. Intermediate consumption (IC)	48.9	91.9	140.9
2.1 Purchase of intermediate consumption (ICp)	44.0	22.2	66.2
2.2 Own intermediate consumption of service (ICo)	4.9	69.7	74.6
3. Gross value added (GVA)	136.0	326.9	462.9
3.1 Labor cost (LC)	208.2	51.6	259.8
3.2 Gross operating surplus (GOS)	−72.2	275.3	203.1
3.2.1 Manufactured gross operating surplus (GOSm)	−182.7	10.7	−172.0
3.2.2 Environmental gross operating surplus (GOSe)	110.5	264.6	375.1
4. Consumption of manufactured fixed capital (CFC)	8.6	7.4	16.0
5. Net value added (NVA)	127.4	319.5	446.9
5.1 Labor cost (LC)	208.2	51.6	259.8
5.2 Net operating surplus (NOS)	−80.9	267.9	187.0
5.2.1 Manufactured net operating surplus (NOSm)	−191.3	3.3	−188.0
5.2.2 Ecosystem service (ES)	110.5	264.6	375.1
Opening environmental asset withdrawal used (EAwu)	13.7		13.7
Net return on environmental asset (NREA)	96.8	264.6	361.4
6. Capital income (CI)	−43.9	282.2	238.3
6.1 Manufactured capital income (CIm)	−187.0	0.3	−186.8
6.1.1 Manufactured gross operating surplus (GOSm)	−182.7	10.7	−172.0
6.1.2 Ordinary revaluation of manufactured fixed capital (FCmrpo)	−4.3	−10.4	−14.8
6.2 Environmental income (EI)	143.2	281.9	425.1
6.2.1 Environmental net operating income (NOIe)	96.8	264.6	361.4
6.2.2 Ordinary revaluation of environmental asset (EArco)	46.3	17.3	63.6
7. Ordinary change in environmental asset (CEAo)	32.7	17.3	50.0
8. Sustainable income (SI)	164.4	333.8	498.1
8.1 Gross operating income (GOI)	122.3	326.9	449.2
8.2 Ordinary revaluation of capital (Cro)	42.0	6.9	48.9
9. Ordinary cash flow	−217.8	−53.2	−271.0

Note: As environmental damage (or ecosystem disservice) is not present in the Stone pine forest, environmental gross and net operating surpluses and ecosystem service coincide.



Abbreviations: IPSNA is SNA intermediate product; TPSNA is SNA total product; FPSNA is SNA final product, FPcSNA is SNA final product consumed, GFCF is own account manufactured gross fixed capital formation, ICSNA is SNA manufactured intermediate consumption; ICp is purchase of manufactured intermediate consumption, ICoSNA is SNA own manufactured intermediate consumption; GVASNA is SNA gross value added, NOSempNON-SNA Non-SNA Environmental net operating surpluses with market prices; NOSenmoNON-SNA is Non-SNA environmental net operating surplus without market prices; GVArSEEA is rSEEA net value added; LC is labor cost; NOS is net operating surplus; CFC is consumption of fixed capital; NOSm is manufactured net operating surplus, NOSe is environmental net operating surplus; ED is ecosystem disservice; ESrSEEA is rSEEA ecosystem services; NREA is net return on environmental assets; EAwu is extractions of environmental work in progress inventoried at opening of current period; GOI is gross operating surplus and GOSmrSEEA is rSEEA manufactured gross operating surplus.

Figure 1. Stylized sequences of the integration of gross value added under the System of National Accounts into the net value income under the refined System of Environmental-Economic Accounting applied to the Stone pine forest of Andalusia (2010: €÷ha).

4.4. Ecosystem Service Under rSEEA

The net operating return on environmental asset (NREA) makes up 96% of the ecosystem services (Table 5, Figure 2). The ecosystem services of the ecosystem trustee are

2.4 times those of the landowner. The ecosystem services of the single products of the landowners are made up of amenity (71%), grazing (17%), and timber (12%) (Figure 2; Table S3). The contribution of cork and firewood accounts for less than 0.5% of the ecosystem services of the landowner. The pine cone ecosystem service is less than EUR 0.1÷ha.

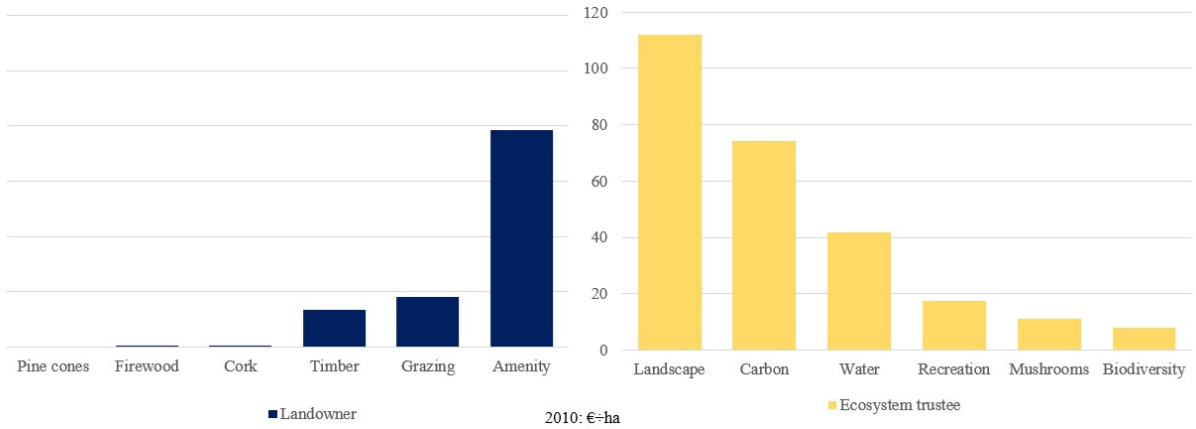


Figure 2. Ecosystem services single products allocation under refined System of Environmental-Economic Accounting.

The main ecosystem services of the ecosystem trustee are landscape, carbon, and water, accounting for 42%, 28%, and 16%, respectively. The other ecosystem services of the ecosystem trustee, namely, recreation, mushrooms, and biodiversity, account for the remaining 14%. As regards the ecosystem services, 52% correspond to regulating–maintenance, 26% to cultural, and 22% to provisioning (Table S4). Figure 3 shows the spatialized Stone pine forest ecosystem services at tile-scale ecosystem area units.

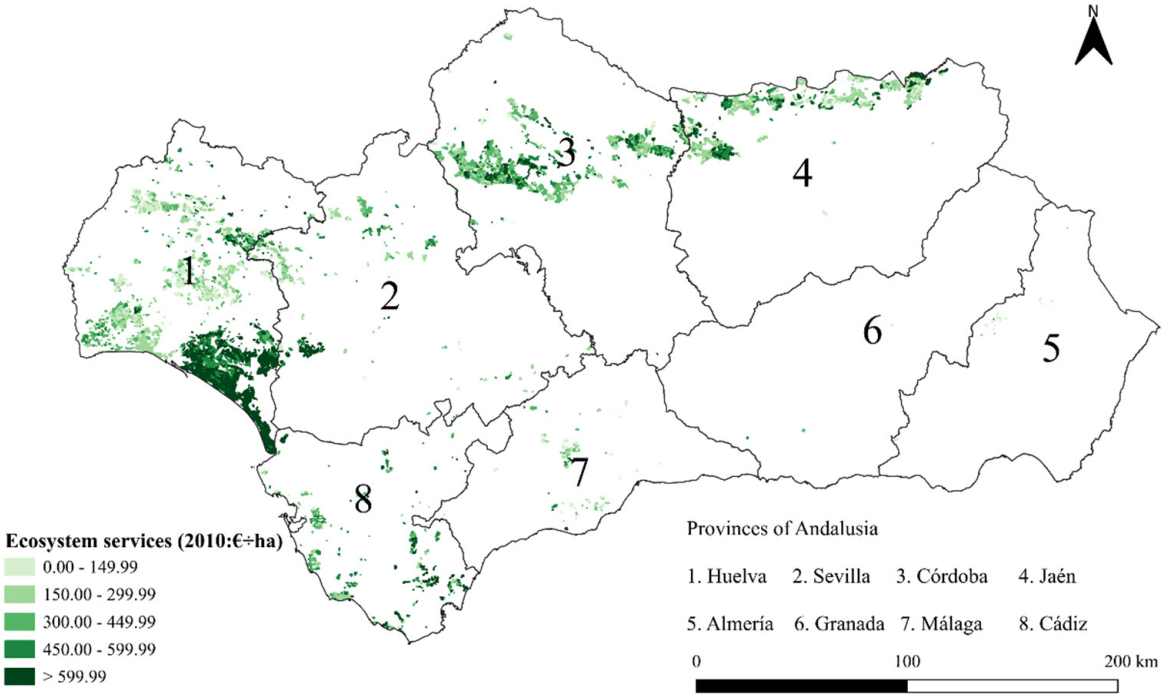
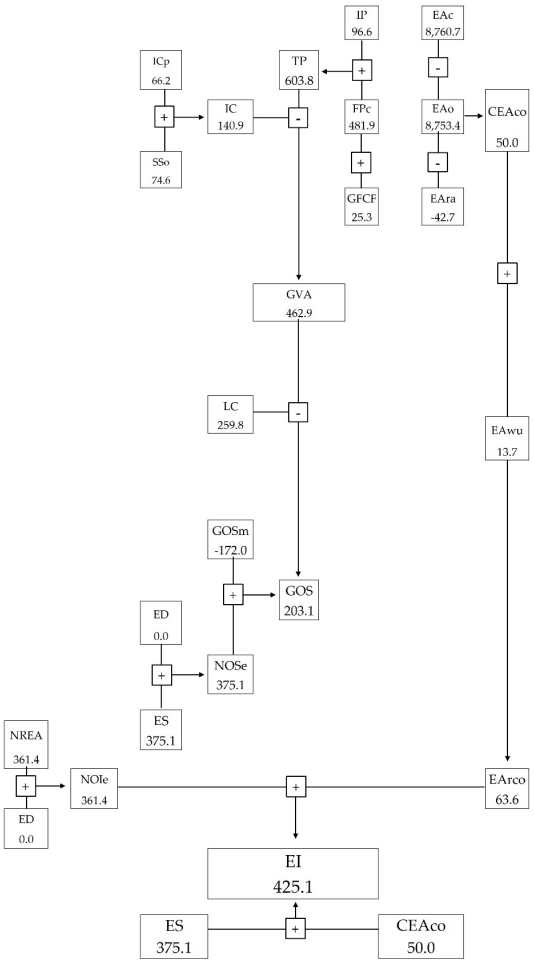


Figure 3. Spatialized Stone pine forest ecosystem services at tile-scale ecosystem area units.

4.5. Environmental Income Under rSEEA

Figure 4 presents the sequences of accounting records which lead to the rSEEA environmental income (EI) estimation of EUR 425÷ha. The environmental net operating income

(NOIe) and ordinary revaluation of environmental assets condition (EArco) account for 85% and 15% of the environmental income (Table 5), respectively.



Abbreviations: TP is total product; IP is intermediate product; FPc is final product consumed; GFCF is manufactured gross fixed capital formation; IC is intermediate consumption; ICp is purchase of intermediate consumption; SSo is own intermediate consumption of services; GVA is gross valued added; LC is labor cost; GOS is gross operating surplus; GOSm is manufactured gross operating surplus; NOSe is environmental net operating surplus; ED is ecosystem disservice; ES is ecosystem services; EAwu is ordinary withdrawal of environmental asset used of work in progress inventoried at the opening of current period; NREA is net operating return on environmental assets; NOI is net operating income; EAc is closing of environmental asset; EAo is opening of environmental asset; EAra is autonomous revaluation of environmental asset; CEAco is ordinary change in environmental asset condition; EArco is ordinary revaluation of environmental asset condition; EI is environmental income.

Figure 4. Stylized sequence of environmental income measurements under the refined System of Environmental-Economic Accounting for the Stone pine forest of Andalusia (2010: €÷ha).

The products of amenity, landscape, and carbon make up 66% of the environmental income (Figure S1, Table S5). Pine cones contribute only a minor value to the environmental income. The distribution of environmental income among the provisioning, regulating–maintenance, and cultural services is similar to that of ecosystem services, with moderate variations in the form of an increased weight of provisioning services and a decrease in cultural services (Table S5).

4.6. Sustainable Income Under rSEEA

The rSEEA estimates a sustainable income of EUR 498÷ha for the Stone pine forest (Table 5). Sustainable income comprises 52% for labor and 48% for capital income (Table 6). The sustainable income comes mainly from the products of landscape, amenity, and carbon (Figure 5, Tables 6 and S5). The relative weights of these products decrease slightly in relation to the factorial distribution of the environmental income due to the incorporation of the economic products without environmental income, namely, residential, conservation forestry, and firefighting. The sustainable income from the pine cones product contributes a slightly negative value to the sustainable income for Stone pine forest. It should be noted that the harvested pine cones product is not generally profitable at observed market prices and that theft/donation of pine cones is widespread. Hence, as the amount harvested and the economic rationale of the illegal harvesters are unknown, the gross operating income for pine cones appropriated by either free-access collectors or illegal harvesting was not estimated.

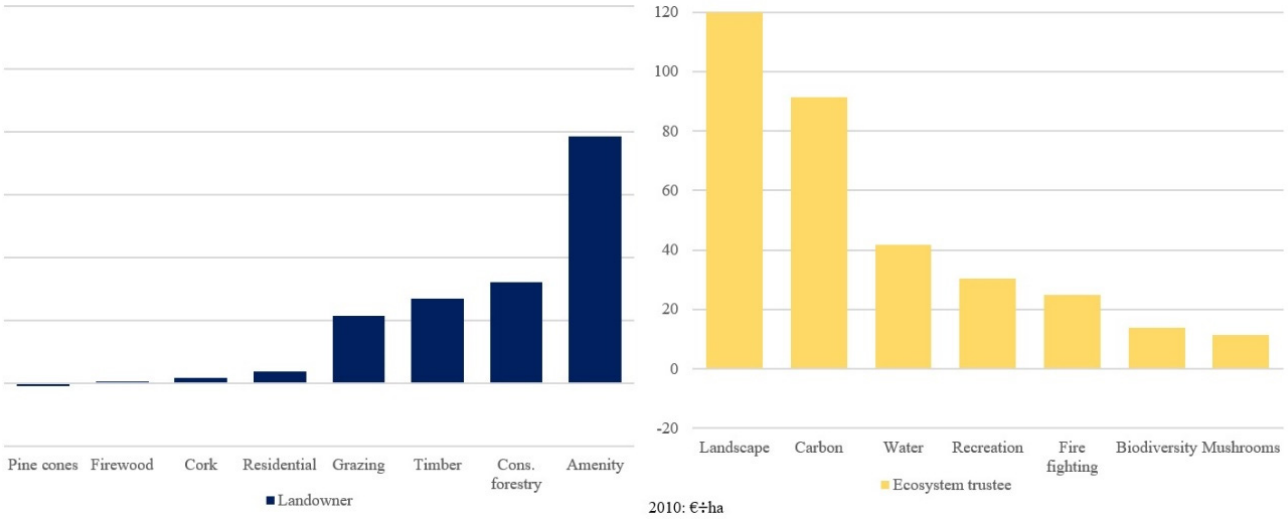


Figure 5. Sustainable incomes from the single products under the refined System of Environmental-Economic Accounting for the Stone pine forest of Andalusia.

In total, 89% of labor income corresponds to the products of timber, pine cones, conservation forestry, and firefighting (Table 6). The manufactured capital income (CIm) results are notably negative for timber and pine cones. These CIm negative results are not offset by the modest positive values of other products. The manufactured capital income for the 15 Stone pine forest (SPF) products as a whole is negative, at EUR −187÷ha (Table 6). Landscape provides the main single income and accounts for 24% of the sustainable income. The economic products of the landowners make up 36% of the sustainable income (Table 6). Figure 6 shows the spatialized Stone pine forest sustainable incomes at tile-scale ecosystem area units.

The rSEEA sustainable income (SI) extends the SNA gross value added to include the omitted environmental net operating surplus (or ecosystem services) of the ecosystem trustee consumed final products with market prices (mushrooms, water, and carbon) with an amount of EUR 127÷ha (Figure 1, Table 7). The SI also incorporates the ecosystem services of the consumed products dependent on labor cost and/or manufactured capital investment with and without market prices (amenity—the SNA records as a consumed final product the residential housing accommodation service self-consumed by the non-industrial landowner where this corresponds to a natural person, recreation, landscape, and biodiversity), all of which are registered by the SNA although their ecosystem services,

with a value of EUR 216÷ha, are omitted (Figure 1; Table 7). The rSEEA considers the landowner's residential service as an intermediate service product that is used as own intermediate consumption of the private amenity activity. The SNA and the rSEEA also imputed a competitive manufactured net operating surplus of EUR 3.4÷ha as a return on manufactured capital investment of consumed products without market prices (Figure 1; Table 7). The gross value added under the rSEEA is 4.0 times that of the SNA (Table 8).

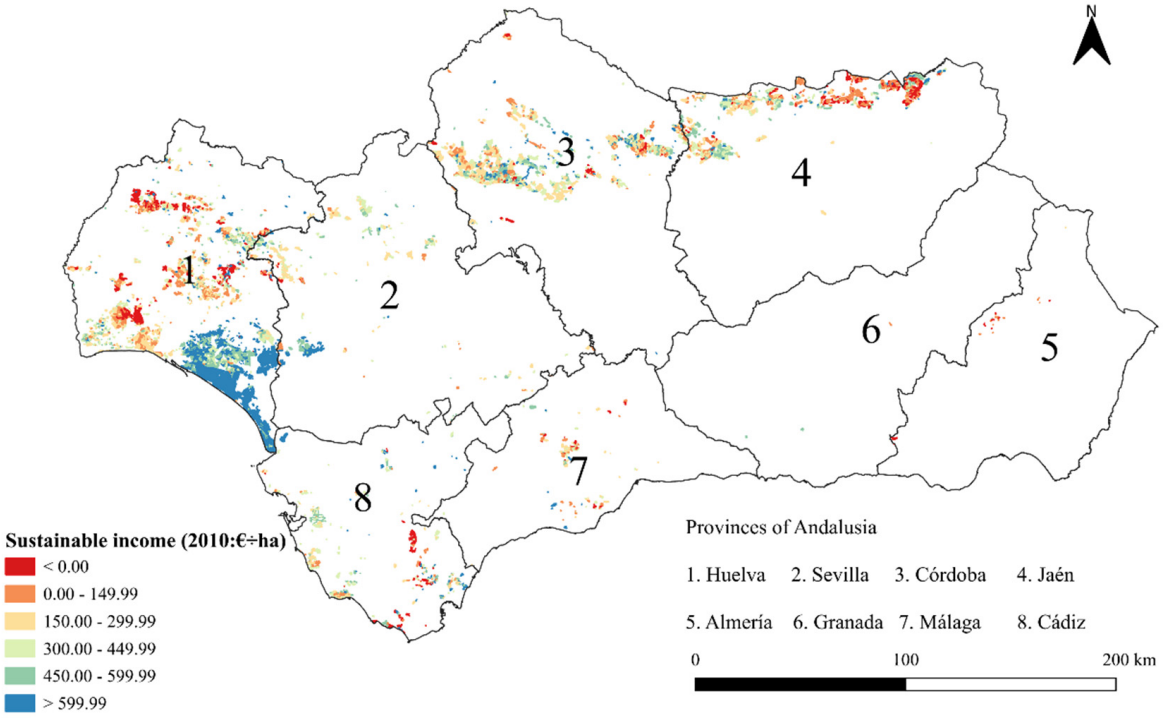


Figure 6. Spatialized Stone pine forest sustainable incomes at tile-scale ecosystem area units.

The sustainable income under the rSEEA is 2.3 times the gross value added under the SNA. The sustainable incomes of the landowner and the ecosystem trustee are 2.9 and 5.7 times their respective gross values added under the SNA, respectively (Table 7).

The SI incorporations of NVA_{SNA} income omissions include ecosystem services (EUR 343.3÷ha), ordinary changes in environmental assets condition (EUR 17.3÷ha), ordinary changes in manufactured fixed capital (EUR 10.6÷ha), and adjustments that avoid double counting of less ordinary entries of manufactured fixed capital (EUR 25.3÷ha), plus depreciation of manufactured fixed capital (EUR 16.0÷ha). In the SPF case study, the NVA_{SNA} accounts for 27.4% of the SI (Table 8).

The results from the application of the authors' refined System of Environmental-Economic Accounting (rSEEA) to the Stone pine forest showed that sustainable income was 3.7 times the net value added measured under the SNA. The factorial attribution of the sustainable income of EUR 498.1÷ha corresponds to labor income of EUR 259.8÷ha, a negative manufactured capital income of EUR −186.8÷ha, and an environmental income of EUR 425.1÷ha. The sum of the two latter capital incomes gives a total capital income of EUR 238.3÷ha, which accounts for 48% of the sustainable income of the Stone pine forest. The SPF results for labor cost and manufactured consumption of fixed capital under the SNA and the rSEEA coincide (Table 9).

Table 6. Factorial allocations of sustainable incomes under the refined System of Environmental-Economic Accounting for the Stone pine forest single products of Andalusia (2010: €÷ha).

Class	Manufactured Gross Operating Surplus GOSm 1.1	Ordinary Revaluation of Manufactured Fixed Capital FCmrpo 1.2	Manufactured Capital Income CIm 1 = 1.1 + 1.2	Environmental Net Operating Income NOIe 2.1	Ordinary Revaluations of Environmental Asset EArco 2.2	Environmental Income EI 2 = 2.1 + 2.2	Labor Cost LC 3	Sustainable Incomes SI 4 = ∑ 1 − 3
Landowner	−182.7	−4.3	−187.0	96.8	46.3	143.2	208.2	164.4
Timber	−137.5	−2.1	−139.6		41.3	41.3	125.1	26.8
Cork	0.0		0.0		1.6	1.6	0.1	1.7
Firewood	0.0	0.0	0.0		0.5	0.5	0.0	0.5
Pine cones	−50.9	−0.5	−51.4		2.6	2.6	48.0	−0.8
Grazing	0.9	−0.3	0.6	18.1	0.3	18.4	2.4	21.5
Conservation forestry	1.1	−0.5	0.6				31.6	32.2
Residential	3.6	−0.9	2.7				1.0	3.7
Amenity				78.7		78.7		78.7
Ecosystem trustee	10.7	−10.4	0.3	264.6	17.3	281.9	51.6	333.8
Fire fighting	2.9	−4.1	−1.1				26.1	24.9
Recreation	4.7	−3.6	1.0	17.4		17.4	12.0	30.4
Mushrooms	0.1	0.0	0.0	11.2		11.2	0.1	11.3
Carbon				74.1	17.3	91.4		91.4
Landscape	1.5	−1.2	0.3	112.1		112.1	7.7	120.2
Biodiversity	1.6	−1.6	0.0	8.0		8.0	5.7	13.8
Water				41.8		41.8		41.8
Stone pine forest	−172.0	−14.8	−186.8	361.4	63.6	425.1	259.8	498.1

Note: As ecosystem disservice is not present in Stone pine forests, net return on environmental asset and environmental net operating income coincide.

Table 7. SNA gross value added integrated into the sustainable incomes under the rSEEA for the Stone pine forest of Andalusia (2010: €÷ha).

Class	SNA Gross Values Added	Non-SNA Ecosystem Services	Gross Values Added of rSEEA	Change in Capitals	Autonomous Revaluation of Environmental Assets	Ordinary Change in Capitals	Ordinary Entries of Fixed manufactured Capitals	Sustainable Incomes
	GVA_{SNA} 1	$ES_{NON-SNA}$ 2	GVA_{rSEEA} 3 = 1 + 2	CC 4	EAra 5	CCo 6 = 4 − 5	FCmeo 7	SI 8 = 3 + 6 − 7
Landowner	57.3	78.7	136.0	2.2	−42.7	44.9	16.5	164.4
Timber	1.1		1.1	25.7		25.7		26.8
Cork	0.3		0.3	1.4		1.4		1.7
Firewood	*		*	0.5		0.5		0.5
Pine cones	−2.9		−2.9	2.1		2.1		−0.8
Grazing	21.5		21.5	*		*		21.5
Conservation forestry	32.8		32.8	16.0		16.0	16.5	32.2
tResidential	4.6		4.6	−0.9		−0.9		3.7
Amenity		78.7	78.7	−42.7	−42.7			78.7

Table 7. *Cont.*

Class	SNA Gross Values Added	Non-SNA Ecosystem Services	Gross Values Added of rSEEA	Change in Capitals	Autonomous Revaluation of Environmental Assets	Ordinary Change in Capitals	Ordinary Entries of Fixed manufactured Capitals	Sustainable Incomes
	GVA_{SNA} 1	$ES_{NON-SNA}$ 2	GVA_{rSEEA} 3 = 1 + 2	CC 4	EAra 5	CCo 6 = 4 − 5	FCmeo 7	SI 8 = 3 + 6 − 7
Ecosystem trustee	62.2	264.6	326.8	15.6		15.6	8.8	333.7
Firefighting	28.9		29.0	−0.8		−0.8	3.3	25.0
Recreation	16.7	17.4	34.0	−1.2		−1.2	2.5	30.4
Mushrooms	0.1	11.2	11.3	*		*	*	11.2
Carbon		74.1	74.1	17.3		17.3		91.4
Landscape	9.2	112.1	121.3	0.3		0.3	1.5	120.2
Biodiversity	7.3	8.0	15.3	*		*	1.5	13.8
Water		41.8	41.8					41.8
Stone pine forest	119.6	343.3	462.9	17.8	−42.7	60.5	25.3	498.1

Note: As ecosystem disservice is not present in Stone pine forests, environmental net operating surplus NON-SNA ($NOSe_{NON_SNA}$) and ecosystem service coincide ($ES_{NON-SNA}$). * value less than EUR 0.05÷ha.

Table 8. SNA net values added integrated into the sustainable incomes under the rSEEA for the Stone pine forest of Andalusia (2010: €÷ha).

Class	SNA Net Value Added	NON-SNA Ecosystem Service	NON-SNA Ordinary Change in Environmental Asset Condition	Ordinary Change In manufactured Fixed Capital	Ordinary Entries of Fixed Manufactured Capital	Manufactured Consumption of Fixed Capital	Sustainable Incomes
	NVA_{SNA} 1	$ES_{NON-SNA}$ 2	$CEAco_{NON-SNA}$ 3	CMFCo 4	FCmeo 5	CFC 6	SI 7= 1 + 2 + 3 + 4 − 5 + 6
Landowner	81.4	78.7		12.2	16.5	8.6	164.4
Timber	24.7			−2.1		4.2	26.8
Cork	1.7						1.7
Firewood	0.5			*		*	0.5
Pine cone	−1.3			−0.5		1.1	−0.8
Grazing	21.2			−0.3		0.5	21.5
Conservation forestry	31.7			16.0	16.5	1.0	32.2
Residential	2.8			−0.9		1.8	3.7
Amenity		78.7					78.7
Ecosystem trustee	54.9	264.6	17.3	−1.6	8.8	7.4	333.9
Firefighting	26.2			−0.7	3.3	2.9	24.9
Recreation	14.1	17.4		−1.2	2.5	2.6	30.4
Mushrooms	0.1	11.2		*	*	*	11.3
Carbon		74.1	17.3				91.4
Landscape	8.4	112.1		0.3	1.5	0.8	120.2
Biodiversity	6.2	8.0		*	1.5	1.1	13.8
Water		41.8					41.8
Stone pine forest	136.3	343.3	17.3	10.6	25.3	16.0	498.1

Note: As ecosystem disservice is not present in Stone pine forest environmental net operating surplus NON-SNA ($NOSe_{NON_SNA}$) and ecosystem service coincide ($ES_{NON-SNA}$). * value less than EUR 0.05÷ha.

Table 9. Comparison of economic result indicators under the System of National Accounts (SNA) and the refined System of Environmental-Economic Accounting (rSEEA) for the Stone pine forest of Andalusia (2010: €÷ha).

Class	SNA	rSEEA	Index (rSEEA ÷ SNA)
1. Total product (TP)	255.5	603.8	2.4
1.1 Intermediate product (IP)	91.7	96.6	1.1
1.2 Final product (FP)	163.8	507.2	3.1
1.2.1 Final product consumption (FPc)	138.6	481.9	3.5
1.2.2 Manufactured gross fixed capital formation (GFCF)	25.3	25.3	1.0
2. Intermediate consumption (IC)	135.9	140.9	1.0
2.1 Purchase of intermediate consumption (ICp)	66.2	66.2	1.0
2.2 Own intermediate consumption (ICo)	69.7	74.6	1.1
3. Gross value added (GVA)	119.6	462.9	3.9
3.1 Labor cost (LC)	259.8	259.8	1.0
3.2 Gross operating surplus (GOS)	−140.2	203.1	−1.4
3.2.1 Manufactured gross operating surplus (GOSm)	[−172.0]	−172.0	1.0
3.2.2 Ecosystem service (ES)	[31.8]	375.1	11.8
4. Manufactured consumption of fixed capital (CFC)	16.0	16.0	1.0
5. Depletion (D)	−32.7	na	
6. Net value added (NVA)	136.3	446.9	3.3
7. Net operating surplus (NOS)	−123.6	187.0	
7.1. Manufactured net operating surplus (NOSm)	[−188.0]	−188.0	1.0
7.2 Environmental net operating surplus (NOSe) (7 − 7.1)	[64.5]	375.1	5,8
7.2.1 Ecosystem services (ES)	[31.8]	375.1	11.8
7.2.2 Depletion (D) (7.2 − 7.2.1)	−32.7	na	-
8. Gross operating income (GOI)	na	449.2	
9. Ordinary revaluation of capital (Cro)	na	48.9	
9.1 Ordinary revaluation of manufactured fixed capital (FCmrpo)	[−14.8]	−14.8	1.0
9.2 Ordinary revaluation of environmental asset condition (EArco)	na	63.6	
10. Ordinary change in environmental asset condition (CEAco)	na	−50.0	
11. Manufactured capital income (CIm)	na	−186.8	1.0
12. Environmental income (EI)	na	425.1	
13. Sustainable income (SI)	na	498.1	
14. Ordinary cash flow (CFo)	[−271.0]	−271.0	1.0

Note: The numbers in brackets are not shown explicitly by the SNA.

4.7. Ordinary Cash Flow

The result for the Stone pine forest ordinary cash flow (CFo) reveals a negative value of EUR −271÷ha (Tables 5–8). The ordinary cash flows of the landowner and the government ecosystem trustee are EUR −218÷ha and EUR −53÷ha, respectively (Tables 5 and S3). Negative CFo results are expected when Stone pine forest (SPF) management implies direct manufactured total cost for generating additional consumed final goods and services without market prices. However, the SPF results for the gross values added and environmental incomes reveal that both landowner and ecosystem trustee management regimes generate positive environmental incomes, which are notably greater than the negative landowner and ecosystem trustee ordinary cash flows.

5. Discussion

5.1. New Advancements in Forest Ecosystem Sustainable Income

The idealized conditions under which the rSEEA is applied to the Stone pine forest have allowed progress to be made in terms of our understanding of the contribution of environmental income to the sustainable income enjoyed by people from a forest ecosystem. A clear advantage of sustainable income estimation is that by integrating and expanding

the SNA values added measurements, new information is gained on the transaction price values of the environmental net operating surplus, the ecosystem service, ordinary change in the environmental asset, and the ordinary revaluation of manufactured fixed capital, all of which are omitted by the SNA.

The measurement of the sustainable income of the SPF has evidenced the importance of improved information in comparison to the SNA values added. However, the concept and measurement of sustainable income developed and applied in this research amount to an experimental exercise which has revealed the need for consistence in the implementation of environmental–economic accounting as a standard seen as an ongoing process in permanent review.

The measurement of sustainable income under the refined System of Environmental-Economic Accounting (rSEEA) consists of two linked variables. The first of these variables is embedded in the product, measured ex post according to its production (gross operating income), and the second variable which is the measurement of part of the components ex ante according to the future production (ordinary revaluation of total capital). Gross operating income presents the actual results corresponding to the accounting period at current (or nominal) transaction prices. These prices may be observed in formal, imputed, or simulated markets. It can be stated that the gross operating income is a variable that reflects the true social valuation of consumed products and accumulated manufactured products from a natural area. The measurement of gross operating income is conditioned by the uncertainties inherent in measuring simulated prices based on stated or revealed marginal willingness to pay by consumers for the products consumed without observed or imputed market prices. Ordinary capital revaluation excludes autonomous (or extraordinary) capital revaluations from the accounting period. A condition of the measurement of this variable is that the steady state of the current period is maintained in the future. This approach is adopted by the system of national accounts for estimating net value added (or net domestic product). Thus, sustainable income explains the income from valued products in the current period under the idealized conditions of no future changes in institutional dynamics and other autonomous processes. In this regard, it would endanger the meaning of sustainable income to incorporate expectations of medium- and long-term future changes in institutions and other autonomous processes [8] (pp. 190–193), [9] (p. 177). The dynamics of future institutional changes and other autonomous processes lead to effects on environmental assets and manufactured capital in the future. These effects necessitate to extended cost–benefit analysis, which falls beyond the analysis of sustainable income for the current period, which is the main objective of this research.

Our primary objective in this research is to measure the sustainable income from 15 individual products and their factorial allocations. Non-market product valuation methods have previously been published in scientific journals and are briefly described in Supplementary Text S2. The sensitivity analysis of the discount rate affecting ordinary revaluations of the condition of environmental assets has only a limited effect on sustainable income in our case study. This small effect is due to the fact that the biophysical indicators of flows and stocks present an almost steady-state situation, with low economic values for ordinary revaluations of the condition of environmental assets as a whole. At a 3% discount rate, ordinary revaluations of the condition of environmental assets only account for 13% of sustainable income.

5.2. The Economic Rationale of the Negative Ordinary Cash Flow of the Stone Pine Forest

The market price valuation criterion applied to the extracted timber and pine cone products gives to negative results for their manufactured gross operating surpluses (Tables S2 and S3). Both products are valued equally in the SNA and the rSEEA. However, the

Andalusian Regional Government's criteria is to finance the negative cash flows generated by public forests from harvested timber and pine cones. These public forests make up 70% of Andalusia's Stone pine forests [19] (Table 3). The hypothesis (not incorporated in this study) of assuming an intermediate product of non-market services measured by the competitive non-market gross operating surplus of manufactured capital immobilized in harvested timber and pine cones appears to be the most plausible valuation logic. The intermediate product of services would be incorporated as own intermediate consumption of non-market services in the landscape conservation final product consumed. Therefore, the gross operating surplus of the landscape conservation final product consumed would decrease by the same value as the increase in the intermediate service products of harvested timber and pine cones. In conclusion, the sustainable income from Andalusia's Stone pine forests is not affected by the omission of intermediate products from timber and pine cones. However, it would be affected if these intermediate products had been imputed, reducing the ecosystem service of the landscape conservation final product consumed, with the counterpart being the positive value revealed by the manufactured gross operating surplus from harvested wood and pine cones.

Citizens as a whole finance through taxes the negative ordinary cash flow of the products of the public landowner and ecosystem trustee of the SPF. Conservation forestry seeks to promote the persistence of the economic productivity of natural environment products used by humans in the management of forests as a cultural landscape [29]. However, this objective of cultural (or working) landscape persistence is conditioned by the limitation of the maximum tolerable cost to the non-industrial landowners and society as a whole through the government and other non-profit organizations. The private non-industrial landowner can also contribute to the provision of the intermediate public service product consisting of maintaining the economic products of cultural landscape conservation.

The products of public and private owners generate negative ordinary cash flows that are "offset" by the hidden commercial intermediate products of services generated by non-profitable economic products at market prices. These hidden intermediate products are used as own intermediate consumptions of the final products consumed from private amenity services of the landowner and the public services (recreational, landscape, and biodiversity) of the ecosystem trustee. Therefore, if the consumed total product is recorded in the production account as imputed sale, then the economic products of the SPF would show a positive cash flow at the closing of the current period. The rationale for manufactured investment in products with negative results for manufactured net operating surpluses as business as usual at observed market price is that there are hidden intermediate products which have the effect of increasing the amenity and landscape services, in particular, among other consumed final products. Thus, this is the landowner and government ecosystem trustee non-business as usual rationale in their respective Andalusian SPF management regimes.

5.3. Challenge of Economic Meaning of Carbon Net Sequestration Environmental Asset

The controversial economic accounting record of the net result for forestry carbon sequestered less carbon emission is what characterizes it as a candidate for consideration as an environmental asset or as a liability component of the forest ecosystem net worth. In the SPF, the simulated virtual exchange values for net carbon sequestration and the ordinary revaluation of the carbon environmental asset in 2010 is estimated to be positive, hence facilitating the consistent consideration of carbon as a consumed final product and an environmental asset.

The resource price estimation of the carbon net sequestration ecosystem service is independent of the government ecosystem trustees of the SPF and atmospheric ecosystems

as the imputed market price is that of the European market for industrial transactions of carbon [26].

The estimate of the consumed final carbon product from woody products excludes other carbon emissions from forest ecosystem products not valued in this research as well as other carbon sequestration and emission effects. The net sequestration of carbon by forests is dependent on the fertilization effect of the emission, which could lead to an improvement in the biological productivity of woody products. This possible improvement involves increased evapotranspiration, leading to a decrease in the ecosystem service of water runoff and deep aquifer recharge. Extensive livestock rearing may have the effect of substituting cultivated foodstuff, which reduces the emission of carbon dioxide and, opposite to the SPF, the livestock emit greenhouse-effect carbon dioxide equivalent (methane). These three factors of unknown net sequestrations of carbon limit the significance of the forest carbon ecosystem service effect estimated in the SPF of Andalusia.

5.4. The Omissions of Consumed Product Valuations in the Stone Pine Forest Case Study

Determining the sustainable incomes from multiple uses of a natural area may be an impossible task to complete in practice. The uncertainty associated with measuring the sustainable income from a forest ecosystem is due to the many data sources underlying the management of economic products and capital at the closing of the current period. The usual absence of robust standardized data on the physical quantities of products consumed without market prices is a major obstacle to the measurement of sustainable income.

In this research, the measurement of several consumed final products on-site and off-site from the SPF are omitted [17]. The products omitted, among others, include (1) the amount of precipitated water which, due to deep filtration, refills the aquifers from which water is pumped for use on irrigated crop lands as well as other economic uses downstream, the market value of which has not been estimated in the SPF; (2) the ecosystem services for free-access recreational visitors within the surrounding area of the SPF and captured by the inland tourism industry are not valued in this research, while in the case of the SPF on the Atlantic coast, this could be of notable importance; and (3) the tourism industry commonly takes advantage of the environmental provisioning resources and cultural services of the SPF as if they were provided for free by nature or assumes the absence of individual or collective appropriation.

5.5. Environmental Assets Dependent on a Subjective Rate of Discounting

The *Plan Estratégico del Sector de la Piña en Andalucía* sustained that "Stone pine forest is an ecosystem which is widespread in Andalusia and *highly profitable* given its capacity to provide services" [30] (p. 16). This notion with regard to SPF profitability in the Strategic Plan is accurate according to the results for sustainable income and capital in this research. The profitability of the Stone pine forest measured by the capital income over the total opening capital is 2.6%, increasing to 5.4% if it is measured according to sustainable income. However, due to the high weight of ecosystem services with simulated market prices, the environmental assets are to a large extent dependent on the subjective real discounting rate of 3% chosen by the authors, and therefore the estimated rates of profitability over the total capital are not independent of the discount rate chosen to estimate the environmental assets valued at simulated market prices. In other words, the profitability rate results for consumed products without market prices are considered not to have an economic meaning independent of the subjective discount rate chosen.

5.6. Threatened Wild Biodiversity Preservation Existence Value Service

The technical reports on the economic products in natural areas do not usually address the contribution of the threatened wild biodiversity preservation existence value service of

a natural ecosystem, but rather, they present the economic effects of the spending by visitors on other economic products included in the standard System of National Accounts. Nevertheless, this business as usual criterion applied to the threatened wild species biodiversity existence option value may not be the criterion which governs biodiversity management by the ecosystem trustee in SPF. As regards the threatened biodiversity product of existence option value, government investment can be dictated by the maximum tolerable cost to society in order to avoid the permanent loss of a unique wild biological variety. The threatened wild biodiversity is managed such that the possibility of a loss in sustainable income is accepted in order to achieve the objective of bequeathing the greatest possible endowment of assets of unique threatened genetic varieties to future generations, which avoids or mitigates the risk of extinction.

5.7. Policy Implications

The absence of georeferenced and standardized environmental–economic- statistics for sustainable income from natural areas is an important limitation when assessing the efficiency, equity, and contribution of economic policies in the natural environment to the lasting economic well-being of people [1]. The limitations of the SNA gross value added highlighted by academic experts and national accountants, along with the lack of consistent and more complete measurements of the concept of sustainable income, have not led to the SNA framework being reformed in order to integrate it into a standardized total social sustainable income system of accounts.

Governments have not provided new public expenditure figures to national statistics offices for the generation of physical and environmental–economic statistics required to estimate the sustainable income for the current period, nor updated the closing environmental assets affected by the dynamics of changes in institutional and other autonomous factors.

The dominant opinion among experts and governments is that the standardization by national statistics office of a satellite SEEA EA should be delayed [11,31]. They argue that there must be improvements in the scientific methods used for valuing ecosystem services based on revealed and stated consumer preferences before standardization can be contemplated. In this research, it is argued that, rather than delaying the implementation of standard ecosystem accounts, it would be better to learn from the experiences gained from the applications of a kind of rSEEA methodology, the main purpose of which is to measure georeferenced sustainable income and its factorial appropriation of a natural area. This purpose inevitably requires that idealized conditions of the dynamics of future prices and institutional and other autonomous factors that affect the capital of the economic products of national/subnational forest ecosystems are assumed at the closing of the current period.

6. Conclusions

This research has shown that under idealized conditions, it was possible to develop the concepts and measurements of the components of sustainable income at transaction prices omitted by the gross and net values added under the standard System of National Accounts (SNA).

One of the findings of this research is that of having demonstrated that the SNA gross and net values added under the SNA hide a substantial part of the sustainable income from the Stone pine forest. However, the measurement of the sustainable income by the rSEEA also presents notable uncertainty in the results due to the lack of standardized data for environmental–economic accounts and the idealized conditions assumed in its application.

The main policy challenge faced by the government is to extend the central framework of the System of National Accounts to move towards the objective of consistent measure-

ment of sustainable income based on the best available scientific knowledge regarding economic ecosystem services and ordinary revaluation of environmental assets.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/f16091370/s1. Supplementary Text S1: Stone pine forest of Andalusia; Supplementary Text S1.1 [19]: Stone pine forest extent and institutional settings; Supplementary Text S1.2: Physical yields and stocks measured in the stone pine forest [17,32,33]; Supplementary Text S2: Consumed products from the stone pine forest under the refined System of Environmental-Economic Accounting; Supplementary Text S2.1 [21,32]: Timber, cork, and firewood natural growths and extractions; Supplementary Text S2.2 [30,32]: Pine cones; Supplementary Text S2.3: Grazing [34–36]; Supplementary Text S2.4: Residential; Supplementary Text S2.5: Amenity [36]; Supplementary Text S2.6: Conservation forestry; Supplementary Text S2.7: Firefighting [29]; Supplementary Text S2.8 [24,37]: Mushrooms; Supplementary Text S2.9: Water [26,38]; Supplementary Text S2.10: Carbon; Supplementary Text S2.11 [39]: Recreation; Supplementary Text S2.12: Landscape conservation [40]; Supplementary Text S2.13: Biodiversity preservation [19,41]; Supplementary Text S3: Measuring the sustainable income and capital of the forest ecosystem under the refined System of Environmental-Economic Accounting; Supplementary Text S3.1: From the Agroforestry Accounting System to the refined System of Environmental-Economic Accounting; Supplementary Text S3.2. Product valuation; Supplementary Text S3.3: The refined System of Environmental-Economic Accounting for sustainable income applied to the stone pine forest of Andalusia; Supplementary Text S3.3.1: Capital balance account under the rSEEA; Supplementary Text S3.3.2: Sustainable income under rSEEA; Supplementary Text S3.3.2.1: Values added; Supplementary Text S3.3.2.2: Gross operating income; Supplementary Text S3.3.2.3: Ordinary revaluation of capital; Supplementary Text S3.3.2.4: Environmental income; Supplementary Text S3.3.2.5: Sustainable income; Table S1. Prices of consumed products under the refined System of Environmental-Economic Accounting for the Stone pine forest of Andalusia (2010); Table S2: Gross and net values added measured at market prices under the System of National Accounts for the stone pine forest of Andalusia (2010: €÷ha); Table S3: Stylized sequence of single products' sustainable incomes under the refined System of Environmental-Economic Accounting for the Stone pine forest of Andalusia (2010: €÷ha); Table S4: Ecosystem services measured under the refined System of Environmental-Economic Accounting for the stone pine forest of Andalusia (2010: €÷ha); Table S5: Environmental incomes measured under the refined System of Environmental-Economic Accounting for the stone pine forest of Andalusia (2010: €÷ha); Figure S1: Environmental incomes of the single products under the refined System of Environmental-Economic Accounting for the Stone pine forest of Andalusia.

Author Contributions: Conceptualization, P.C.; methodology, P.C. and J.L.O.; formal analysis, P.C., J.L.O., A.Á. and B.M.; data curation, P.C., J.L.O., A.Á. and B.M.; writing—original draft preparation, P.C.; writing—review and editing, P.C., J.L.O., A.Á. and B.M.; visualization, P.C., J.L.O., A.Á. and B.M.; supervision, P.C. and J.L.O.; project administration, P.C. and J.L.O.; funding acquisition, P.C. and J.L.O. All authors have read and agreed to the published version of the manuscript.

Funding: This study was funded by the Agency for Water and Environment of the Regional Government of Andalusia, Contract NET 165602, and the Spanish National Research Council (CSIC), grant number ref. 201810E036, ref.: 202010E141 and ref.: 202410E111.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to ownership rights.

Acknowledgments: The authors thank the Agency for Water and Environment of the Regional Government of Andalusia for the financial and field work support for the REnta y CApital de los Montes de ANdalucía (RECAMAN) project (Contract NET 165602), the Valoraciones de servicios y activos de AMenidades privadas de fincas SILvopastorales (VAMSIL) project of CSIC (ref.: 201810E036), the Modelización de cuentas bio-físicas y Económicas de hábitats Costeros: estudios de casos de empresas Agrarias y Pesqueras en el suroeste de la península Ibérica (MECAPI) project of CSIC (ref.: 202010E141) and the Cuentas Económico-Ambientales Experimentales de Ecosistemas Marinos

(CEAM) project of CSIC (ref.: 202410E111). We also thank Isabel Martin and Luis Guzman at the Andalusian Environment and Water Agency (AMAYA) for their important contribution to the field work of the RECAMAN project. We acknowledge the contributions of Alejandro Caparrós, Paola Ovando, Eloy Almazán, Begoña Álvarez-Farizo, Luis Díaz-Balteiro, Gregorio Montero, Mario Díaz, and other colleagues in the framework of the RECAMAN project for the methods and results presented in this paper. We thank Adam B. Collins for reviewing the final English version of this paper.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Brundtland, G.H. Editorial: The Scientific Underpinning of Policy. *Science* **1997**, *277*, 457. [CrossRef]
2. Stone, R. The Accounts of Society. 1984. Available online: https://www.nobelprize.org/uploads/2018/06/stone-lecture.pdf (accessed on 19 November 2024).
3. Eurostat; International Monetary Fund; Organization for Economic Co-operation and Development; United Nations Statistics Division-United Nations Secretariat; World Bank. *System of National Accounts 2025*; United Nations: New York, NY, USA, 2025; p. 1227. Available online: https://unstats.un.org/unsd/nationalaccount/snaupdate/2025/2025_SNA_Combined.pdf (accessed on 26 June 2024).
4. Cavendish, W. Quantitative methods for estimating the economic value of resource use to rural households. In *Uncovering the Hidden Harvest-Valuation Methods for Woodland & Forest Resources*; Cambell, B.M., Luckert, M.K., Eds.; Earthscan: London, UK, 2002; pp. 17–65.
5. Krutilla, J.V. Conservation reconsidered. *Am. Econ. Rev.* **1967**, *57*, 777–786.
6. Eisner, R. *The Total Incomes System of Accounts*; The University of Chicago Press: Chicago, IL, USA, 1989; p. 336, ISBN 9780226196381.
7. European Communities. *Manual on the Economic Accounts for Agriculture and Forestry EAA/EAF 97 (Rev. 1.1)*; EUROSTAT: Luxembourg, 2000; p. 172. Available online: http://ec.europa.eu/eurostat/documents/3859598/5854389/KS-27-00-782-EN.PDF/e79eb663-b744-46c1-b41e-0902be421beb (accessed on 19 November 2024).
8. Nordhaus, W.D.; Kokkelenberg, E.C. *Nature's Numbers: Expanding the National Economic Accounts to Include the Environment*; National Research Council (NRC), The National Academies Press: Washington, DC, USA, 1999; p. 262. [CrossRef]
9. Hicks, J. *Value and Capital*; Oxford University Press: Oxford, UK, 1946; p. 340.
10. United Nations Statistical Commission. *Supplement to the Report of the Intersecretariat Working Group on National Accounts Prepared by the Intersecretariat Working Group on National Accounts*; Fifty-First Session 3–6 March 2020 Item 3 (d) of the Provisional Agenda Items for Discussion and Decision: National Accounts; United Nations Statistical Commission: New York, NY, USA, 2020. Available online: https://unstats.un.org/unsd/statcom/51st-session/documents/BG-Item3d-NationalAccounts-E.pdf (accessed on 19 November 2024).
11. United Nations; European Union; Food and Agriculture Organization of the United Nations; International Monetary Fund; Organization for Economic Co-operation and Development; United Nations Environment Program; World Bank. *System of Environmental-Economic Accounting—Ecosystem Accounting (SEEA EA)*; United Nations: New York, NY, USA, 2024; p. 409. Available online: https://seea.un.org/sites/seea.un.org/files/documents/EA/seea_ea_f124_web_12dec24.pdf (accessed on 21 December 2024).
12. King, S.; Juhn, D.; Vardon, M.; Larsen, T.; Grantham, H.S.; Brown, C.; Mark Eigenraam, M.; Turner, K. Linking biodiversity into national economic accounting. *Environ. Sci. Policy* **2021**, *116*, 20–29. [CrossRef]
13. Droste, N.; Bartkowski, B. Ecosystem Service Valuation for National Accounting: A Reply to Obst, Hein and Edens (2016). *Environ. Resour. Econ.* **2018**, *71*, 205–215. [CrossRef]
14. Narita, D.; Lemenihb, M.; Shimodac, Y.; Ayana, A.M. Economic accounting of Ethiopian forests: A natural capital approach. *For. Pol. Econ.* **2018**, *97*, 189–200. [CrossRef]
15. Siikamäki, J.; Piaggio, M.; Da Silva, N.; Álvarez, I.; Chu, Z. *The Changing Wealth of Nations: Global Assessment of the Economic Value of Non-Wood Forest Ecosystem Services*; World Bank: Washington, DC, USA, 2024; p. 211. Available online: https://documents1.worldbank.org/curated/en/099101124145545368/pdf/P17844610f0e240911a4ad138b4c4c8780f.pdf (accessed on 18 December 2024).
16. World Bank. *The Changing Wealth of Nations. Revisiting the Measurement of Comprehensive Wealth*; World Bank: Washington, DC, USA, 2024; p. 31. Available online: https://documents1.worldbank.org/curated/en/099101024111541936/pdf/P1784461801839 0a41b7e61b28be7f722d1.pdf (accessed on 18 December 2024).
17. Campos, P.; Caparrós, A.; Oviedo, J.L.; Ovando, P.; Álvarez-Farizo, B.; Díaz-Balteiro, L.; Carranza, J.; Beguería, S.; Díaz, M.; Herruzo, A.C.; et al. Bridging the gap between national and ecosystem accounting application in Andalusian forests, Spain. *Ecol. Econ.* **2019**, *157*, 218–236. [CrossRef]

18. Campos, P.; Alvarez, A.; Mesa, B.; Oviedo, J.L.; Caparrós, A. Linking standard economic account for forestry and ecosystem accounting: Total forest incomes and environmental assets in publicly-owned conifer farms in Andalusia-Spain. *For. Pol. Econ.* **2021**, *128*, 102482. [CrossRef]
19. Campos, P.; Oviedo, J.L.; Álvarez, A.; Mesa, B. Measurement of the Threatened Biodiversity Existence Value Output: Application of the Refined System of Environmental-Economic Accounting in the *Pinus pinea* Forests of Andalusia, Spain. *Land* **2022**, *11*, 1119. [CrossRef]
20. MMA. *Mapa Forestal de España 1:50.000*; Dirección General de Conservación de la Naturaleza, Ministerio de Medio Ambiente: Madrid, Spain, 2008. Available online: https://www.miteco.gob.es/es/biodiversidad/temas/inventarios-nacionales/mapa-forestal-espana/mfe_50.html (accessed on 19 November 2024).
21. MMA. *Tercer Inventario Forestal Nacional (IFN3)*; Ministerio de Medio Ambiente: Madrid, Spain, 2007. Available online: https://www.miteco.gob.es/es/biodiversidad/servicios/banco-datos-naturaleza/informacion-disponible/ifn3.aspx (accessed on 19 November 2024).
22. Berrens, R. The safe minimum standard of conservation and endangered species: A review. *Environ. Conserv.* **2001**, *28*, 104–116. [CrossRef]
23. Anderson, T.L.; McCheney, F.S. *Property Rights: Cooperation, Conflict and Law*; Princeton University Press: Princeton, NJ, USA, 2003; p. 408, ISBN 0-691-09997-9.
24. Oviedo, J.L.; Campos, P.; Caparrós, A. Contingent valuation of landowner demand for forest amenities: Application in Andalusia, Spain. *Eur. Rev. Agric. Econ.* **2021**, *49*, 615–643. [CrossRef]
25. Berbel, J.; Mesa, P. Valoración del agua de riego por el método de precios quasihedónicos: Aplicación al Guadalquivir. *Econ. Agric. Resourc. Nat.* **2007**, *7*, 127–144. [CrossRef]
26. SENDECO2. *Historical CO_2 Prices for EUAs*; Carbon Dioxide Emission Allowances Electronic Trading System; SENDECO2: Barcelona, Spain, 2011. Available online: http://www.sendeco2.com (accessed on 19 November 2024).
27. Edens, B.; Hein, L. Towards a consistent approach for ecosystem accounting. *Ecol. Econ.* **2013**, *90*, 41–52. [CrossRef]
28. IECA. *Contabilidad Regional Anual de Andalucía. Revisión Estadística 2019*; Consejería de Economía, Conocimiento, Empresas y Universidad, Instituto de Estadística y Cartografía de Andalucía: Seville, Spain, 2020. Available online: https://www.juntadeandalucia.es/institutodeestadisticaycartografia/craa/index.htm (accessed on 19 November 2024).
29. Council of Europe. *European Landscape Convention*; European Treaty Series—No. 176; Council of Europe: Florence, Italy, 2000. Available online: https://www.citego.org/bdf_fiche-document-2630_en.html (accessed on 18 August 2025).
30. Junta de Andalucía. *Plan Estratégico del Sector de la Piña en Andalucía*; Junta de Andalucía: Seville, Spain, 2013; p. 116.
31. Buckley, R.; Chauvenet, A. Six caveats to valuing ecosystem services. *Nature* **2021**, *592*, 188. [CrossRef] [PubMed]
32. Díaz-Balteiro, L.; Caparrós, A.; Campos, P.; Almazán, E.; Ovando, P.; Álvarez, A.; Voces, R.; Romero, C. Economía privada de productos leñosos, frutos industriales, bellota, pastos y el servicio del carbono en los sistemas forestales de Andalucía. In *Economía y Selviculturas de los Montes de Andalucía*; Campos, P., Díaz-Balteiro, L., Eds.; Memorias Científicas de RECAMAN, Memoria 1.3; Editorial CSIC: Madrid, Spain, 2015; Volume 1, pp. 397–722. Available online: http://libros.csic.es/product_info.php?products_id=987 (accessed on 19 November 2024).
33. Campos, P.; Caparrós, A.; Oviedo, J.L.; Almazán, E.; Ovando, P.; Álvarez, A.; Mesa, B. *RECAMAN Project Georeferenced Economic Accounts for Andalusian Forest Systems*; Consejería de Agricultura, Pesca y Desarrollo Sostenible de la Junta de Andalucía and CSIC: Sevilla, Spain, 2015. Available online: https://recaman.agenciamedioambienteyagua.es/VICAF/visor.html (accessed on 19 November 2024).
34. Campos, P.; Ovando, P.; Mesa, B.; Oviedo, J.L. Environmental income of livestock grazing on privately owned silvopastoral farms in Andalusia, Spain. *Land Degrad. Dev.* **2018**, *29*, 250–261. [CrossRef]
35. Carranza, J.; Torres-Porras, J.; Seoane, J.M.; Fernández-Llario, P. Gestión de las poblaciones cinegéticas de los sistemas forestales de Andalucía. In *Poblaciones, Demanda y Economía de las Especies Cinegéticas en los Montes de Andalucía*; Campos, P., Martínez-Jauregui, M., Eds.; Memorias Científicas de RECAMAN, Memoria 3.1; Editorial CSIC: Madrid, Spain, 2015; Volume 3, pp. 7–185.
36. Oviedo, J.L.; Campos, P.; Caparrós, A. Valoración de servicios ambientales privados de propietarios de fincas agroforestales de Andalucía. In *Renta Total y Capital de las Fincas Agroforestales de Andalucía*; Campos, P., Ovando, P., Eds.; Memorias Científicas de RECAMAN, Memoria 4.1; Editorial CSIC: Madrid, Spain, 2015; Volume 4, pp. 8–155. Available online: http://libros.csic.es/product_info.php?products_id=990 (accessed on 19 November 2024).
37. Martínez-Peña, F.; Aldea, J.; de Frutos, P.; Campos, P. Renta ambiental de la recolección pública de setas silvestres en los ecosistemas forestales de Andalucía. In *Biodiversidad, Usos del Agua Forestal y Recolección de Setas Silvestres en los Ecosistemas Forestales de Andalucía*; Campos, P., Díaz, M., Eds.; Memorias Científicas de RECAMAN, Memoria 2.3; Editorial CSIC: Madrid, Spain, 2015; Volume 2, pp. 274–388. Available online: http://libros.csic.es/product_info.php?products_id=988 (accessed on 19 November 2024).

38. Beguería, S.; Campos, P.; Serrano, R.; Álvarez, A. Producción, usos, renta y capital ambientales del agua en los ecosistemas forestales de Andalucía. In *Biodiversidad, Usos del Agua Forestal y Recolección de Setas Silvestres en los Ecosistemas Forestales de Andalucía*; Campos, P., Díaz, M., Eds.; Memorias Científicas de RECAMAN, Memoria 2.2; Editorial CSIC: Madrid, Spain, 2015; Volume 2, pp. 102–273. Available online: https://libros.csic.es/product_info.php?products_id=988 (accessed on 19 November 2024).
39. Oviedo, J.L.; Álvarez-Farizo, B.; Caparrós, A.; Campos, P. Valoración ambiental de servicios recreativos públicos de los sistemas forestales de Andalucía. In *Valoración de los Servicios Públicos y la Renta Total Social de los Sistemas Forestales de Andalucía*; Campos, P., Caparrós, A., Eds.; Memorias Científicas de RECAMAN, Memoria 5.1; Editorial CSIC: Madrid, Spain, 2016; Volume 5, pp. 7–111. Available online: http://libros.csic.es/product_info.php?products_id=1013 (accessed on 19 November 2024).
40. Campos, P.; Oviedo, J.L.; Álvarez, A.; Ovando, P.; Mesa, B.; Caparrós, A. Measuring environmental incomes beyond standard national and ecosystem accounting frameworks: Testing and comparing the agroforestry Accounting System in a holm oak dehesa case study in Andalusia-Spain. *Land Use Policy* **2020**, *99*, 104984. [CrossRef]
41. Díaz, M.; Concepción, E.D.; Oviedo, J.L.; Caparrós, A.; Álvarez-Farizo, B.; Campos, P. A comprehensive index for threatened biodiversity valuation. *Ecol. Indic.* **2020**, *108*, 105696. [CrossRef]

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.