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Deliverable. 3.6.2	Guidelines for sustainable capitalization of provisioning services related to non-wood products

BIOPROSPECT: Conservation and sustainable capitalization of biodiversity in forested areas

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Guidelines for sustainable capitalization of provisioning services related to non-wood products

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ABBREVIATIONS

Term	Explanation
CBD	Convention on Biological Diversity
CICES	Common International Classification of Ecosystem Services
CPC	Central Product Classification
ES(s)	Ecosystem Service(s)
EU	European Union
FAO	Food and Agriculture Organization
HS	Harmonized System
HWB	Human Well-Being
ISIC	International Standard Industrial Classification
MA	Millennium Ecosystem Assessment
NWFP(s)	Non-Wood Forest Product(s)
REA	Rapid Ecosystem (Services) Assessment
TEEB	The Economics of Ecosystems and Biodiversity

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FOREWORD

This document provides all related information and description of the methods, means, tools and practical guidelines regarding the sustainable capitalization of provisioning services related to non-wood products.

EXECUTIVE SUMMARY

Deliverable 3.6.2 specifically provides guidelines for sustainable capitalization of provisional services related to non-wood products and, therefore, is a reference material for practitioners in this direction. Through literature review it provides information on the typology and classification of the provisional services related to non-wood products, capitalization mechanisms ensuring sustainability, policies for the selected provisional services, case studies, guidelines and recommendations.

Section 1. Introduction provides information about the framework of the project, the project aims and the objectives of the deliverable 3.6.2.

Section 2. Background and conceptual framework, based on the Ecosystem Approach framework, provides the characterization and categorization of ecosystem services related to non-wood forest products, the importance of ecosystem services to human well-being and highlights the need for sustainable capitalization of provisioning services related to non-wood forest products.

Section 3. Review and Analysis, provides (1) information on natural capital and sustainability, (2) guidelines on the assessment of ecosystem services, focusing on non-wood forest products from ecosystem services quantification to the economic valuation of these services, and (3) the major mechanisms ensuring sustainable capitalization of provisioning services related to non-wood forest products.

Section 4. Case Studies, provides further specific examples of studies focusing on the sustainability and capitalization of provisioning services related to non-wood forest products.

Section 5. Status, Perspectives & Challenges, provides the current status and perspectives of non-wood forest products in Europe, Mediterranean and Balkans and challenges regarding their sustainable development.

1 INTRODUCTION

1.1 Forested Ecosystems: The Problem and the Solution

A forested ecosystem is a dynamic complex of plant, animal and microorganism communities, and their abiotic environment, that interact as a functional unit that reflects the dominance of ecosystem conditions and processes by trees (Fig. 1). Humans, with their cultural, economic and environmental needs, are an integral part of many forest ecosystems [as defined by the Convention on Biological Diversity; CBD; [1]]. Forest area has increased in Europe over the last six decades, covering today nearly 40% of the European surface[2]. In addition to the supply of wood, to which most forested European land is dedicated, forests provide a multitude of benefits in terms of climate regulation, human health, recreation, refuges, fresh water supply and many others[2]. Nowadays, European forest ecosystems face multiple natural and anthropogenic threats[2]. For instance, a changing climate is producing increased droughts in the Mediterranean; forest disturbances are foreseen to increase (forest fires, invasive pests) and competing socio-economic demands for forest goods and services can result in multiple drivers of forest change[2].

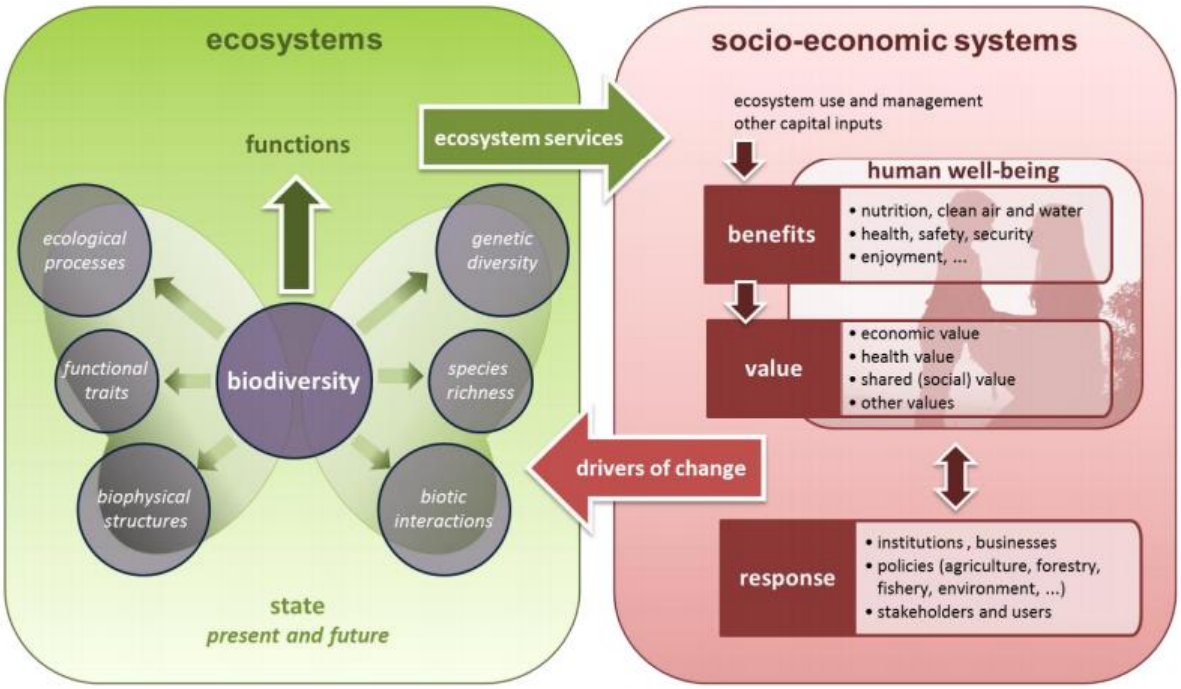

Figure 1 *Conceptual framework for EU wide ecosystem assessments (Adopted from: MAES, 2013[3])*

Forests and biodiversity are strongly interconnected. On the one hand, biodiversity largely depends on the integrity, health and vitality of forested areas[2]. On the other hand, a decrease in forest biodiversity will lead to losses in forest productivity and sustainability. Therefore, sustainable forest management is oriented to support the provision of forest goods and services, and to enhance biodiversity levels[2].

1.2 Objectives of the Project

The main aims of the project are to explore and document the bioprospects of forested protected areas and the ways of sustainable capitalization as a means for their wise management and conservation, to encourage cooperation partnerships and networking among economic development planners and protected area managers, as well as to develop a cross-border bioprospect assessment methodological framework and economic valuation model in order to achieve outcomes which benefit both economic development and conservation. To achieve the above-mentioned goal, the project has specific objectives and outputs (Table 1).

Table 1 Description and expected outputs of the specific objectives (SO) of the project.

SO Description	Outputs
1. Provide operational tools for the conservation of forest biodiversity through economic valuation and sustainable capitalization	• Manuals for: (a) Assessing the status and trends of forest services' availability and distribution, (b) Genetic pool mapping and bioprospect assessment, (c) Stakeholders engagement and public participation in the economic valuation of biodiversity • Operational models for the economic valuation of biodiversity services in forest ecosystems • Guidelines for sustainable capitalization of provisional services in terms of bioprospect for agriculture & industry, water management, tourism & recreation and education & social inclusion
2. Demonstrate the operational application forest economic valuation and capitalization benefits	• Stakeholders mobilization in 5 forested areas (including 3 Protected Areas) • Mapping and valuation of genetic pool and biodiversity services in 5 forested areas • Action plans for improved biodiversity capitalization 4 forested areas • Demonstration interventions in 3 forested areas
3. Integrate economic valuation in operational management of forested areas and policy initiatives of Balkan Mediterranean area	• One-stop-shop for economic valuation of forest Ecosystem Services (e-calculator, e-handbook, e-training) • Networking forested protected areas and training of managers for improved decision making • Roadmaps for promoting biodiversity valuation and bioeconomy in regional and rural development

1.3 Objectives of D3.6.2

BIOPROSPECT Work Package 3 aims to develop a tool box for the economic valuation and sustainable capitalization of biodiversity-ESs. This will be achieved through the specific project objectives; to provide operational tools for the conservation of forest biodiversity through economic valuation and sustainable capitalization.

Deliverable 3.6.2 specifically provides guidelines for sustainable capitalization of provisional services related to non-wood products and, therefore, is a reference material for practitioners in this direction.

Through literature review it provides information on the typology and classification of the provisional services related to non-wood products, capitalization mechanisms ensuring sustainability, policies for the selected provisioning services, case studies, guidelines and recommendations.

2 BACKGROUND AND CONCEPTUAL FRAMEWORK

2.1 The Ecosystem Approach

An ecosystem approach is a framework that involves considering the value of nature and natural resources to society in decision, plan, and policy-making (e.g. assessing the positive and negative impacts of policy options on the services got from nature). It provides a set of principles and guidelines by which the management of ecosystem services (ESs) should be addressed[4]. The ecosystem approach was adopted by the signatories to Convention on Biological Diversity (CBD) in 1995 as the primary framework for action under the Convention.

2.1.1 Description

The Ecosystem Approach as prepared by the CBD is described below:

- The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. Therefore, the application of the ecosystem approach will help to reach a balance of the three objectives of the Convention: (1) conservation, (2) sustainable use and (3) the fair and equitable sharing of the benefits arising out of the utilization of genetic resources.

- An ecosystem approach is based on the application of appropriate scientific methodologies focused on levels of biological organization, which encompass the essential structure, processes, functions and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of many ecosystems.

- This focus on structure, processes, functions and interactions is consistent with the definition of "ecosystem" provided in Article 2 of the Convention on Biological Diversity: "'Ecosystem' means a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit."

- The ecosystem approach requires adaptive management to deal with the complex and dynamic nature of ecosystems and the absence of complete knowledge or understanding of their functioning. Ecosystem processes are often non-linear, and the outcome of such processes often shows time-lags. The result is discontinuities, leading to surprise and uncertainty. Management must be adaptive in order to be able to respond to such uncertainties and contain elements of "learning-by-doing" or research feedback. Measures may need to be taken even when some cause-and-effect relationships are not yet fully established scientifically.

- The ecosystem approach does not preclude other management and conservation approaches, such as biosphere reserves, protected areas, and single-species conservation programs, as well as other approaches carried out under existing national

policy and legislative frameworks, but could, rather, integrate all these approaches and other methodologies to deal with complex situations. There is no single way to implement the ecosystem approach, as it depends on local, provincial, national, regional or global conditions. Indeed, there are many ways in which ecosystem approaches may be used as the framework for delivering the objectives of the Convention in practice.

2.1.2 Principles

The Principles of the Ecosystem Approach by the CBD are described below:

Principle 1: The objectives of management of land, water and living resources are a matter of societal choices. Different sectors of society view ecosystems in terms of their own economic, cultural and society needs. Indigenous peoples and other local communities living on the land are important stakeholders and their rights and interests should be recognized. Both cultural and biological diversity are central components of the ecosystem approach, and management should take this into account. Societal choices should be expressed as clearly as possible. Ecosystems should be managed for their intrinsic values and for the tangible or intangible benefits for humans, in a fair and equitable way.

Principle 2: Management should be decentralized to the lowest appropriate level. Decentralized systems may lead to greater efficiency, effectiveness and equity. Management should involve all stakeholders and balance local interests with the wider public interest. The closer management is to the ecosystem, the greater the responsibility, ownership, accountability, participation, and use of local knowledge.

Principle 3: Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems. Management interventions in ecosystems often have unknown or unpredictable effects on other ecosystems; therefore, possible impacts need careful consideration and analysis. This may require new arrangements or ways of organization for institutions involved in decision-making to make, if necessary, appropriate compromises.

Principle 4: Recognizing potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context. Any such ecosystem-management program should:

- Reduce those market distortions that adversely affect biological diversity
- Align incentives to promote biodiversity conservation and sustainable use
- Internalize costs and benefits in the given ecosystem to the extent feasible

The greatest threat to biological diversity lies in its replacement by alternative systems of land use. This often arises through market distortions, which undervalue natural systems and populations and provide perverse incentives and subsidies to favor the conversion of land to less diverse systems.

Often those who benefit from conservation do not pay the costs associated with conservation and, similarly, those who generate environmental costs (e.g. pollution) escape responsibility. Alignment of incentives allows those who control the resource to benefit and ensures that those who generate environmental costs will pay.

Principle 5: Conservation of ecosystem structure and functioning, in order to maintain ESs, should be a priority target of the ecosystem approach. Ecosystem functioning and resilience depends on a dynamic relationship within species, among species and between species and their abiotic environment, as well as the physical and chemical interactions within the environment. The conservation and, where appropriate, restoration of these interactions and processes is of greater significance for the long-term maintenance of biological diversity than simply protection of species.

Principle 6: Ecosystem must be managed within the limits of their functioning. In considering the likelihood or ease of attaining the management objectives, attention should be given to the environmental conditions that limit natural productivity, ecosystem structure, functioning and diversity. The limits to ecosystem functioning may be affected to different degrees by temporary, unpredictable of artificially maintained conditions and, accordingly, management should be appropriately cautious.

Principle 7: The ecosystem approach should be undertaken at the appropriate spatial and temporal scales. The approach should be bounded by spatial and temporal scales that are appropriate to the objectives. Boundaries for management will be defined operationally by users, managers, scientists and indigenous and local peoples. Connectivity between areas should be promoted where necessary. The ecosystem approach is based upon the hierarchical nature of biological diversity characterized by the interaction and integration of genes, species and ecosystems.

Principle 8: Recognizing the varying temporal scales and lag-effects that characterize ecosystem processes, objectives for ecosystem management should be set for the long term. Ecosystem processes are characterized by varying temporal scales and lag-effects. This inherently conflicts with the tendency of humans to favor short-term gains and immediate benefits over future ones.

Principle 9: Management must recognize the change is inevitable. Ecosystems change, including species composition and population abundance. Hence, management should adapt to the changes. Apart from their inherent dynamics of change, ecosystems are beset by a complex of uncertainties and potential "surprises" in the human, biological and environmental realms. Traditional disturbance regimes may be important for ecosystem structure and functioning, and may need to be maintained or restored. The ecosystem approach must utilize adaptive management in order to anticipate and cater for such changes and events and should be cautious in making any decision that may foreclose options, but, at the same time, consider mitigating actions to cope with long-term changes such as climate change.

Principle 10: The ecosystem approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity. Biological diversity is critical both for its intrinsic value and because of the key role it plays in providing the ecosystem and other services upon which we all ultimately depend. There has been a tendency in the past to manage components of biological diversity either as protected or non-protected. There is a need for a shift to more flexible situations, where conservation and use are seen in context and the full range of measures is applied in a continuum from strictly protected to human-made ecosystems.

Principle 11: The ecosystem approach should consider all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices. Information from all sources is critical to arriving at effective ecosystem management strategies. A much better knowledge of ecosystem functions and the impact of human use is desirable. All relevant information from any concerned area should be shared with all stakeholders and actors, taking into account, inter alia, any decision to be taken under Article 8(j) of the Convention on Biological Diversity. Assumptions behind proposed management decisions should be made explicit and checked against available knowledge and views of stakeholders.

Principle 12: The ecosystem approach should involve all relevant sectors of society and scientific disciplines. Most problems of biological-diversity management are complex, with many interactions, side-effects and implications, and therefore should involve the necessary expertise and stakeholders at the local, national, regional and international level, as appropriate.

Box 1. Further Information:

- For information on the Convention on Biological Diversity
- For information on the Importance and Utility of an Ecosystem Approach: Department for Environment, Food, and Rural Affairs. (2010). What nature can do for you. A practical introduction to making the most of natural services, assets and resources in policy and decision making. London, UK.

2.2 What are Ecosystem Services?

Forest ecosystem functions support the provision of ESs to humans (Fig. 1). ESs are the benefits people derive from an ecosystem[5], in other words are the direct and indirect contributions of ecosystems to human well-being[6]. The publication of the Millennium Ecosystem Assessment (MA)[7] made the concept of ESs popular amongst academics, policy-makers and practitioners[8].

In this context, ecosystem functions are a subset of the interactions between the ecosystem structure and the processes that underpin the capacity of an ecosystem to provide goods and services (Fig. 1)[9]. Therefore, information and assessments of forest functions and services is of paramount importance for the design and implementation of effective sustainable forest management options and forest related policies at the European level [9].

According to MA, the ESs are mainly divided into 3 categories: a) the provisioning, b) the regulating and c) the cultural ESs[3] (Table 2).

According to the definitions used in the Common International Classification of ESs (CICES 4.3):

- **Provisioning services:** include all material and biota-dependent energy outputs from ecosystems; they are tangible things that can be exchanged or traded, as well as consumed or used directly by people in manufacture.

- **Regulating services:** include all the ways in which ecosystems control or modify biotic or abiotic parameters that define the environment of people, i.e. all aspects of the 'ambient' environment. These are ecosystem outputs that are not consumed but affect the performance of individuals, communities and populations and their activities.
- **Cultural services:** includes all non-material ecosystem outputs that have symbolic, cultural or intellectual significance. Within the cultural service section, two major divisions of services are recognized:
    - Physical and intellectual interactions with biota, ecosystems, and land-/seascapes
    - Spiritual, symbolic and other interactions with biota, ecosystems, and land-/seascapes

Table 2 Millennium Ecosystem Assessment ESs classification (Adopted from: MAES, 2013)[3]

Provisioning	Regulating	Cultural
• Food • Fresh water • Fibre, timber • Genetic resources • Biochemicals • Ornamental resources	• Air quality regulation • Water purification and water treatment • Water regulation • Erosion regulation • Climate regulation • Soil formation • Pollination • Pest regulation • Disease regulation • Primary production, Nutrient cycling	• Spiritual and religious values • Aesthetic values • Cultural diversity • Recreation and ecotourism • Knowledge systems and educational values

2.2.1 Provisioning Services

According to the Common International Classification of ESs (CICES v4.3), "provisioning services include all material and biota-dependent energy outputs from ecosystems; they are tangible things that can be exchanged or traded, as well as consumed or used directly by people in manufacture".

Within the provisioning service section, three major divisions of services are recognized:

- **Nutrition** includes all ecosystem outputs that are used directly or indirectly as foodstuffs (including potable water)
- **Materials (biotic)** that are used directly or employed in the manufacture of goods
- **Energy (biomass)** which refers to biotic renewable energy sources and mechanical energy provided by animals.

Provisioning of water is either attributed to nutrition (drinking) or materials (industrial etc.). It is considered as ecosystem service because its amount and quality is at least partly steered by ecosystem functioning. For this reason seawater is not included. The provisioning services groups are further divided in classes and class types [3].

Table 3 Provisioning ESs categories in the three international classification systems, Millennium Ecosystem Assessment [MA], The Economics of Ecosystems and Biodiversity [TEEB] and Common International Classification of ESs [CICES] (Adopted from: MAES, 2013).

MA categories	TEEB categories	CICES v.4.3
Food (fodder)	Food	Biomass (Nutrition)
		Biomass (Materials from plants, algae and animals for agricultural use)
Fresh water	Water	Water (for drinking purposes) [Nutrition]
		Water (for non-drinking purposes) [Materials]
Fiber, timber	Raw materials	Biomass (fibers and other materials from plants, algae and animals for direct use and processing)
Genetic resources	Genetic resources	Biomass (genetic materials from all biota)
Biochemicals	Medicinal resources	Biomass (fibers and other materials from plants, algae and animals for direct use and processing)
Ornamental resources	Ornamental resources	Biomass (fibers and other materials from plants, algae and animals for direct use and processing)
		Biomass based energy sources
		Mechanical energy (animal based)

In terms of forested ecosystems, provisioning services are those related to forest production of biomass, water and energy[10] or otherwise the material benefits obtained from a forested ecosystem (Table 3). In more detail, products derived from ecosystems include[11]:

- **Food and fiber**: This includes the vast range of food products derived from plants, animals, and microbes, as well as materials such as wood, jute, hemp, silk, and many other products derived from ecosystems.
- **Fuel**: Wood, dung, and other biological materials serve as sources of energy.
- **Genetic resources**: This includes the genes and genetic information used for animal and plant breeding and biotechnology.
- **Biochemicals, natural medicines, and pharmaceuticals**: Many medicines, biocides, food additives such as alginates, and biological materials are derived from ecosystems.
- **Ornamental resources**: Animal products, such as skins and shells, and flowers are used as ornaments, although the value of these resources is often culturally determined. This is an example of linkages between the categories of ESs (i.e. between cultural and provisioning services).
- **Fresh water**: Fresh water is another example of linkages between categories— in this case, between provisioning and regulating services.

2.2.2 Non-Wood Forest Products (NWFPs)

Based on the recommendations of an internal interdepartmental FAO meeting on definitions of non-wood forest products (NWFPs) held in June 1999, the following FAO working definition of NWFPs has been adopted:

"Non-wood forest products consist of goods of biological origin other than wood, derived from forests, other wooded land and trees outside forests."

According to this definition, the three components of the term "non-wood forest products" are interpreted as follows[12]:

- **Non-wood**: The term NWFP excludes all woody raw materials. Accordingly, timber, chips, charcoal and fuelwood, as well as small woods such as tools, household equipment and carvings, are excluded[I].
- **Forest**: NWFPs should be derived from forests and similar land uses[II]. FAO has elaborated definitions of "forest" and "other wooded land" in a working paper on terms and definitions for the Forest Resources Assessment 2000. Since plantations are included in the FAO definition of forest, NWFPs that are obtained from plantations, such as gum arabic (*Acacia senegal*) or rubber (*Hevea brasiliensis*), are therefore included in the definition of NWFPs. Many NWFPs are derived from both natural forests and plantations.
- **Products**: In the proposed definition, the term "product" corresponds to goods that are tangible and physical objects of biological origin such as plants, animals and their products. Forest services (e.g. ecotourism, grazing, bioprospecting) and forest benefits (e.g. soil conservation, soil fertility, watershed protection) are excluded. Services and benefits are even more difficult to assess and quantify than NWFPs and have therefore already been excluded from most publications dealing with NWFPs.

Different individuals, institutions and countries choose for different terms depending on their needs and objectives[13]. Within FAO, however, when countries report to the Global Forest Resources Assessment (FRA), a slightly different definition (from the one given above) is used[13]:

"Goods derived from forests that are tangible and physical objects of biological origin other than wood."This working definition is quite different from the above as products collected from trees outside forests; other wooded land and agricultural production systems are excluded, as clarified in the explanatory notes below:

[I] Note: **Non-timber forest products (NTFPs)**, another term that is widely used, generally include fuel wood and small woods; this is the main difference between NWFPs and NTFPs.

[II] Note: The final definition of "trees outside forests" (including trees originating from forests which are located out of the forest and other wooded land) was at that moment still in the process of elaboration.

- Generally includes non-wood plant and animal products collected from areas defined as forest (see above the definition of forest).
- Specifically includes the following regardless of whether from natural forests or plantations:
  - Gum arabic, rubber/latex and resin;
  - Christmas trees, cork, bamboo and rattan.
- Generally excludes products collected in tree stands in agricultural production systems, such as fruit tree plantations, oil palm plantations and agroforestry systems when crops are grown under tree cover.
- Specifically excludes the following:
  - Woody raw materials and products, such as chips, charcoal, fuelwood and wood used for tools, household equipment and carvings
  - Grazing in the forest
  - Fish and shellfish

2.2.3 Classification of NWFPs

Internationally agreed upon product classification codes for major NWFPs and their use by the relevant agencies of countries trading in these products is an essential prerequisite for achieving more accurate international trade statistics on NWFPs and assessing their economic contribution[14]. An initial effort to classify NWFPs has been initiated by Food and Agriculture Organization (FAO) in a recent report by Sorrenti, S. (2017) namely "Non-wood products in international statistical systems". According to the author, data collection on non- wood forest products (NWFPs) has been difficult to become systematic for several reasons[13]:

1. The use of NWFPs is often confined to the informal sector and is thus very difficult to capture through formal statistics.
2. The wide variety of products and species that could potentially fall into this umbrella category is extremely massive.
3. Convergence on a universal definition of NWFPs has not yet materialized.

This report seeks to begin addressing this issue by reviewing international statistics on NWFPs through three main international statistical classifications: the Harmonized System (HS), the Central Product Classification (CPC) and the International Standard Industrial Classification (ISIC)[13]. It discusses specific issues linking major NWFPs across the three reference systems, as well as how countries deal with these issues. It proposes ways for improving the international classification systems and presents some of the main NWFPs. Therefore, it represents an initial guide for NWFPs' classification[13].

Even if there is a need for further breakdown levels to provide classes, Sorrenti (2017) provides a table (Table 4) that classifies the NWFPs into two major categories, the plant-based and the animal-based NWFPs.

According to Sorrenti (2017), there is an urgent necessity for (1) a distinct separation between agriculture-derived products (e.g. mushrooms) and forest-derived products, (2) a

clear classification depending on the processing and preparation method used prior the distribution of NWFPs (e.g. mushrooms kept in vinegar, dried NWFPs, forest berries preserved in sugar) and (3) a further species-based classification (e.g. cranberries, bilberries, strawberries, blueberries, elderberries). Further classification will improve data collection and enable proper statistics gathering for NWFPs' produce.

Table 4 NWFPs basic classification based on ISIC, CPC and HS (Based on Sorrenti, 2017).

Plant-based Products	***Food***	*Mushroom and truffles*
		Forest berries
		Wild edible nuts
		Bamboo shoots
		Wild edible fruits
		Maple syrup/sugar
	Raw materials for medicine, perfumery and aromatic products	*Bark*
		Leaves
		Ginseng roots
		Other roots and parts of plants
	Raw materials for colorants and dyes	*Bark, roots, Stems, stalks, leaves and flowers, gall nuts*
		Other
	Exudates	*Latex*
		Gums and resins
		Lac
	Other plant products	*Bamboo*
		Rattan
		Cork
		Bark
		Christmas trees
		Ornamental plants
Animal-based Products	***Hide skins trophies***	*Hides and skins*
		Fur skins
		Trophies
	Insect products	*Wild honey*
		Beeswax
	Wild meat	*Edible insects*
		Game meat

Box 2. Further Information:

- For information on the NWFPs classification, see: Sorrenti, S. 2017. Non-wood forest products in international statistical systems. Non-wood Forest Products Series no. 22. Rome, FAO.
- For information on ESs classification, see: Common International Classification of ESs (CICES)

2.3 The importance of Ecosystem Services to Human Well-Being

2.3.1 Defining Human Well-Being

Following the suggestion by Kurt and Ulrich (2016), "Human Well-Being" (HWB) can be defined as "a state that is intrinsically and not just instrumentally valuable (or good) for a person or a societal group"[15]. According to Kurt and Ulrich (2016), a rigid specific definition will neither be feasible or useful[16].

HWB has many components (Table 5), including many aspects not based in ESs[17]. In addition, the components of well-being are experienced and perceived differently across cultures and socioeconomic gradients[17].

Table 5 Components of Human Well-being. Well-being depends substantially, but not exclusively, on ESs. The toplevel categories are general, while the sub-elements relate specifically to the contribution by ESs (Adopted from McMichael et al., 2005).

Categories	Sub-elements
Security	• A safe environment • Resilience to ecological shocks or stresses (e.g. droughts, floods, and pests) • Secure rights and access to ESs
Basic material for a good life	• Access to resources for a viable livelihood (including food and building materials) or the income to purchase them
Health	• Adequate food and nutrition • Avoidance of disease • Clean and safe drinking water • Clean air • Energy for comfortable temperature control
Good social relations	• Realization of aesthetic and recreational values • Ability to express cultural and spiritual values • Opportunity to observe and learn from nature • Development of social capital • Avoidance of tension and conflict over a declining resource base
Freedom of choice	• The ability to influence decisions regarding ESs and wellbeing

2.3.2 Linkages between Ecosystem Services and Human Well-Being

Changes in ESs influence all the sub-elements of HWB (Table 5), including security, the basic material needs for a good life, health, good social relations and freedom of choice (Fig. 2). Humans are fully dependent on Earth's ecosystems and the services that they provide, such as food, clean water, disease regulation, climate regulation, spiritual fulfillment, and aesthetic enjoyment[7]. The relationship between ESs and HWB is mediated by access to *manufactured*[III], *human*[IV], and *social*[V] capital[7]. HWB depends on ESs but also on the supply and quality of social capital, technology, and institutions. These factors mediate the relationship between ESs and HWB in ways that remain questioned and incompletely understood[7]. The relationship between HWB and ESs is not linear. When an ES is abundant relative to the demand, a marginal increase in ESs generally contributes only slightly to HWB (or may even diminish it)[7]. But when the ES is relatively scarce, a small decrease can substantially reduce HWB. The degradation of ESs often causes significant harm to HWB[7].

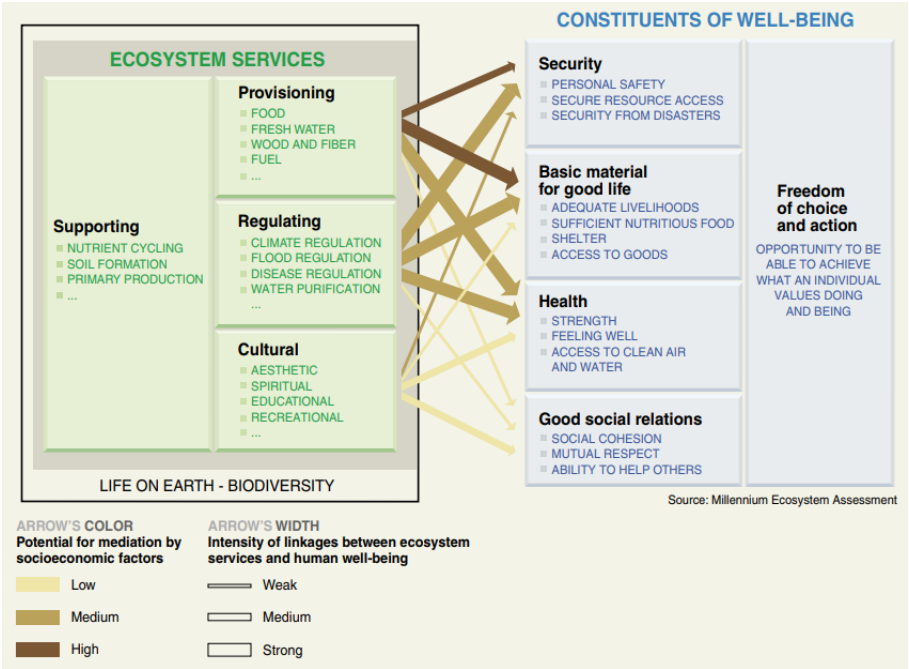

Figure 2 Illustration of the strength of linkages between categories of ESs and components of HWB that are commonly encountered, and the indications of the extent to which it is possible for socioeconomic factors to mediate the linkage. The strength of the linkages and the potential for mediation differ in different ecosystems and regions (Adopted from Millennium Ecosystem Assessment , 2005[7]).

[III] Manufactured capital: the collection of physical, material and technological objects that is available to an organization for use in the provision of services and therefore in fulfilling its purpose.

[IV] Human capital: the stock of habits, knowledge, social and personality attributes (including creativity) embodied in the ability to perform labor so as to produce economic value.

[V] Social capital: social capital basically comprises the value of social relationships and networks that complement the economic capital for economic growth of an organization.

The information available to assess the consequences of changes in ESs for HWB is relatively inadequate[7]. Many ESs have not been monitored and it is also difficult to estimate the relative influence of changes in ESs in relation to other social, cultural, and economic factors that also affect HWB[7]. In addition, many ESs, such as the purification of water, regulation of floods, or provision of aesthetic benefits, do not pass through markets. The benefits they provide to society, therefore, are largely unrecorded: only a portion of the total benefits provided by an ecosystem make their way into statistics, and many of these are misattributed[7]. Even if individuals are aware of the services provided by an ecosystem, they are neither compensated for providing these services nor penalized for reducing them[7]. These non-marketed benefits are often high and sometimes more valuable than the marketed benefits[7].

2.3.3 *The Specific Importance of NWFPs*

According to Millennium Ecosystem Assessment (2005), provisioning services can be: (1) linked to all the sub-elements of HWB, (2) linked strongly with basic material for good life and health and (3) their linkage with basic material and security can be highly mediated with socioeconomic factors (Fig. 2).
In many countries, NWFPs play an important role in the daily life and well-being of their population, particularly in remote areas[18]. In addition to subsistence consumption, NWFPs may also be commodities traded on local, national as well as international markets[19]. Internationally traded NWFPs such as bamboo and rattan products, gum Arabic, aromatic oils and medicinal plants, achieve higher prices as compared to NWFP traded locally and can contribute significantly to poverty alleviation and local economic development[20].

The importance of NWFPs in HWB is briefly given by FAO[21] in the lines below:

- Several million households world-wide depend heavily on NWFP for subsistence and/or income. These products are particularly important in relieving the "hunger periods" in the agricultural cycle, and in smoothing out other seasonal fluctuations[18].
- 80% of the population of the developing world use NWFP for health and nutritional needs.
- Women from poor households are generally those who rely more on NWFP for household use and income.
- At a local level, NWFP also provide raw materials for large scale industrial processing.
- Some NWFP are also important export commodities. At least 150 NWFPs are significant in terms of international trade, including honey, gum arabic, rattan, bamboo, cork, nuts, mushrooms, resins, essential oils, and plant and animal parts for pharmaceutical products.
- NWFP have also attracted considerable global interest in recent years due to the increasing recognition of their contribution to environmental objectives, including the conservation of biological diversity.

NWFPs are, therefore, important to three main groups according to FAO[18] :

- Rural populations, which is actually the largest of the groups, who have traditionally used NWFPs for livelihood and social-cultural purposes
- Urban consumers, a smaller group that is rapidly growing, who purchase NWFPs
- Traders/ Product processors, whose number increase as NWFPs' markets grow.

2.4 The need for Sustainable Capitalization of ESs

Capitalization is the provision of *capital*[VI] for an organization or the conversion of income or *assets*[VII] to capital. Sustainable capitalization is the capitalization able to be maintained at a certain rate or level.

Many indicators suggest that we are using the natural environment in a non-sustainable way[22].Ecosystems can be characterized as environmental resources that, like other capital resources, provide a flow of services over time. If these services are consumed in a sustainable manner, the capital can be kept intact[22]. However, the increasing pressure on ecosystems by human activity was found to cause a decline of nearly the two thirds of the services provided by nature to humankind[23].

People depend on nature for their well-being. However, the benefits of nature are often neglected in policies[24]. In addition, losses in natural capital have direct economic consequences that are often underestimated[24]. The benefits deriving from ESs and the costs of the degradation and loss of ecosystems and biodiversity may be largely ignored[25].

According to MA (2005), it is a major challenge to reverse the degradation of ecosystems while meeting increasing demands for their services. But this challenge can be met. Three of the four MA scenarios show that changes in policies, institutions, and practices can mitigate some of the negative consequences of growing pressures on ecosystems[26].

2.4.1 Specific Reasons for the Sustainable Capitalization of NWFPs

There are two principal reasons for promoting the sustainable capitalization of provisional services related to NFWPs:

(1) The livelihoods perspective: increasing the value of an NWFP in trade (i.e. NWFP commercialization), is expected to increase income and employment opportunities, especially for poor and otherwise disadvantaged people[27]. This expectation is based on the well-documented importance of many NWFPs in rural livelihoods[18,28–30], the emergence of new markets for natural products, the development of new marketing mechanisms (e.g. green marketing, fair trade), and some successful examples[27]. Building on their local

[VI] Capital: wealth in the form of money or other assets owned by an organization or available for a purpose such as investing.

[VII] Asset: an item of property owned by an organization, regarded as having value and available to meet debts, commitments, or legacies.

importance, there is increasing interest in the possibility of NWFPs commercialization acting as an engine for rural growth, and contributing to improved national incomes[27].
(2) The conservation perspective: there has been much speculation that NWFPs commercialization can provide opportunities for (relatively) nonthreatening forest utilization[31] and even create incentives for the conservation of individually valuable species and the environment in which they grow[27]. The idea is that demand for products from a forest environment will translate effectively into demand for forest. This is supported by previous research suggesting that the value of NWFPs that could be sustainably extracted from a hectare of Peruvian Amazon forest far outweighed the value of the timber or alternative land uses[32].

3 REVIEW AND ANALYSIS

3.1 Natural Capital and sustainability

Natural capital can be thought of as producing flows of ESs that ultimately benefit people[4]. Ecosystems can be thought of as consisting of stocks of natural capital assets that provide a range of ESs which, when combined with other capital inputs (e.g. human capital and physical capital), produce goods that are used and valued as a result of the benefits they provide to people[4]. In theory, natural capital assets have the ability to provide a continuous flow of services, provided that these flows are utilized sustainably[4]. For instance, if wild plant species are harvested sustainably (to produce a flow of benefits) the populations (the natural capital stock) can be maintained over time[4]. The point beyond which an asset (and the flow of benefits) is no longer self-sustaining is sometimes referred to as a threshold or tipping point. This may also refer to the point beyond which there will be a sudden or persistent change, such that consequent reversal or recovery is slow, difficult, or impossible[4].

3.1.1 NWFPs: A simple model for a complex issue

According to the outcomes of an international expert workshop on NWFPs in Central Africa (1998), approaches to sustainable NWFPs management are largely influenced by two factors:

- The cultural and economic value of a given NWFP and
- The intensity of exploitation of the NWFP (a function of the productivity of the resource relative to the scale of harvesting)

When the value of an NWFP and the intensity of exploitation are low, human impact on that NWFP are likely to be minimal and little if any formal management of the resource is required[33](Fig. 3). When the value of an NWFP and the intensity of exploitation are extremely high, it is highly likely that the resource is being overexploited and is threatened

with local extinction (in this way substitution or domestication may be the only way to conserve the wild resource without affecting local livelihoods; Fig. 3)[33].

Between these two extremes, human use of wild resources has a measurable impact on NWFP species abundance and productivity but can be sustainable if appropriate management systems are activated[33].

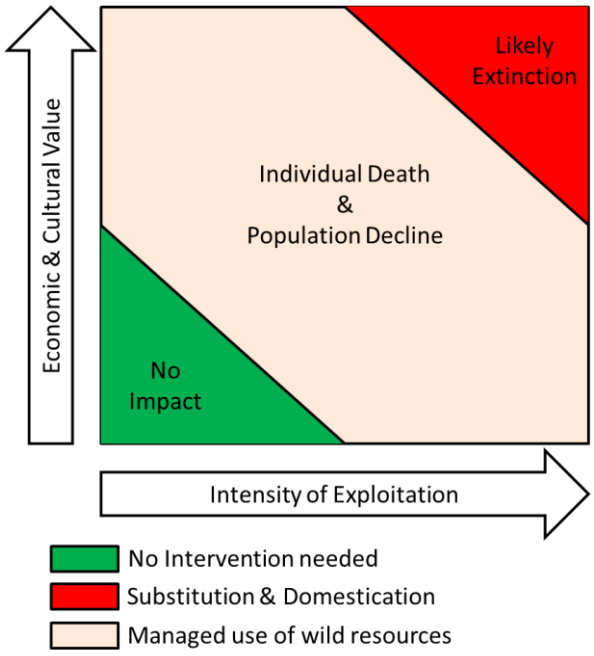

Figure 3 Model of NWFP sustainable use (Adopted from: CARPE, 1998[33]).

3.2 Assessment of Ecosystem Services

ESs may be measured and evaluated in various ways and according to various metrics, which are broadly qualitative, quantitative or monetary[24]:

- Qualitative analysis focuses on non-numerical information[24]. It simply describes the potential scale of decision-making impacts (e.g. increased flood risk)[25]. The decision-maker would have to make a judgment as to their importance relative to any financial costs and benefits[25].
- Quantitative analysis involves numerical data[24]. It would directly measure the change in ESs resulting from the change in land use (e.g. frequency/volume of estimated increase in flood risk/carbon dioxide emissions)[25]. The decision-maker would then have a scientific measure of impacts to weigh up against financial costs and benefits[25].
- Monetary analysis translates quantitative data into currency values[24]. Attaches monetary values to the change in the flow of ESs, to give an impression as to whether a

policy is likely to have a net benefit to society as a whole[25]. It usually builds on quantitative analysis[25].

The type of metric used depends mainly on:

- The benefit being measured
- The time
- The resources available
- The significance of the decisions to be made[24]

Qualitative analyses are usually easier and less expensive to conduct than quantitative analyses. Likewise, quantitative analyses usually require fewer resources than monetary analyses[25]. Figure 4 illustrates the different levels of resources required for each type of analysis[25]. From the bottom towards the top of the pyramid, there are fewer ESs that can be assessed without increasing time and resources[25]. The previously-mentioned is relevant because it may not always be practical to quantify changes in ESs. In many cases, a qualitative assessment may be preferable: more resource-intensive analysis will inevitably be focused on the issues of most concern and potential value[25].

According to "The Economics of Ecosystems and Biodiversity" (TEEB, 2009) a pragmatic approach to valuation can be summed up as follows: "always identify impacts qualitatively, then quantify what you can, then monetize (where possible)". In any type of analysis, it is important to recognize the spatial relationship linking the source supplying the ecosystem service to the various beneficiaries[25]. This aids to detect impacts to be taken into account during the valuation and which stakeholders are likely to be winners or losers from any decision[25].

3.2.1 *Rapid Assessment of ESs (REA)*

An ecosystem can provide several services and most of the times a larger proportion of them is not known or identified yet. One of the first steps in ESs' assessment towards their sustainable capitalization is an overall rapid assessment of the ESs[4]. For the rapid ecosystem assessment (REA) no prior knowledge of ESs is required. The REA is useful as a means of:

- Identifying the important ESs provided by the site (e.g. a forest) and how this range of services might change in the future
- Identifying how these changes might affect key stakeholders[VIII]

[VIII] Stakeholder: An individual or a group of individuals that have an interest in an organization (e.g. a forest ecosystem) and can either affect or be affected by the organization.

REA requires in general:

- Stakeholder engagement and participation in the process (see Box 3)
- Toolkits produced in attempt to explicitly assess the value of ESs (see Box 3).

3.2.1.1 Steps prior the REA

According to McCarthy and Morling, 2014[4] the steps are as below:

(1) Define the site of interest in its current state:

- Define the context and setting for the assessment (e.g. in terms of social, political and economic characteristics.
- Clearly specify the ownership and governance context and the conservation status of the site (e.g. biodiversity importance, key threats etc.)
- Consider the scale of the assessment (e.g. geographic boundaries)

(2) Identify and engage stakeholders:

- Identify key stakeholder group representatives (due to the limited resources and time at this stage it would be rarely feasible to identify and engage all stakeholders).

(3) Specify the objective of the assessment

- Define the objectives and scope of the assessment that should be clear and policy-relevant (e.g. greater public awareness, influence a political process or decision) in consultation with key stakeholders.
- Consider the key problems and/or challenges to be addressed.
- Consider the target audience to ensure that the results of the assessment are relevant- and tailored to their needs.

3.2.1.2 Steps during REA

According to McCarthy and Morling, 2014[4] the steps are as below:

(1) Identify the range of ESs being delivered by the site in its current state

- Describe the main habitats at the site in its current state
  a. Identify the area and current condition of the main habitat/landcover /vegetation types that occur.
  b. Specify the size of the area covered by each of the main habitat types.
  c. Assess their condition.
  d. Identify the ESs at the site in its current state and the people that benefit from those services.
  e. The importance or significance of each service can be scored on a simple scale from 0–5, where 0 = no importance/not relevant; 1 = low importance; and, 5 = high importance (see an example of a template in Annex A).
  f. Stakeholders should be provided with a list of ESs that is basically defining each service type. It might be useful to start by considering and discussing all of the potential services that could be associated with each habitat type and then

narrowing the list down to only those services that are actually delivered at the site.

g. Consider both the number of people benefiting from each service and the size of the benefits provided (e.g. a low score could reflect either that the service is of low value at the site, or is valuable to only a small number of stakeholders).
h. Consider whether current patterns of use are sustainable (In situations where current rates of use or extraction, e.g. harvesting of wild goods, exceed the ability of the system to regenerate, it is clear that there is an issue of long-run sustainability[34]).

(2) Define an alternative state:

- Consider the objective(s) of the assessment i.e. what is the question that you are trying to answer or the policy issue that you are trying to address?
- Involve relevant stakeholders in discussions regarding the definition of the alternative state.
- The alternative state should be defined in such a way that it is possible to describe how the quantity and quality of the different broad habitat types present at the site might change (Fig. 5).
- Requires a suitable matching site which is representative of the alternative state to be identified so that an ecosystem service assessment can be conducted (e.g. field measurements).
- If it is not possible to find a suitable matching site, the alternative state may be assessed by considering how the changes at the study site are most likely to affect the ESs provided by the site.

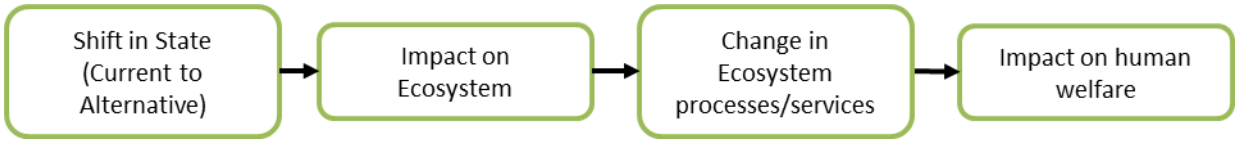

Figure 4 The concept of the potential impact of a shift in state on Ecosystem Processes/Services and human welfare (Adopted from McCarthy and Morling, 2014[4]).

(3) Assess how the ESs delivered by the site might change in the future:

- Repeat step 1 in order to assess how the quantity and quality of habitat types at the site will be affected by a change in state, and how associated ESS might change.
- Assess who is likely to be affected by the change
- Compare directly with the figures already estimated for the current state (see an example of a template in Annex A).

(4) Compare the outcomes and present the results:

- The previous 3 steps provide a very preliminary assessment as to the relative importance of these services and the scale of beneficiaries.

- It may be useful to represent the results of the previous steps visually based on the scores from the REA tables.

Notes:

- **Double-counting**: ESs can be sub-divided into**: (1) Intermediate services** (e.g. pollination) indirectly contributing to the benefits provided by ecosystems by underpinning the (2) **final services** (e.g. fruit production) that directly generate well-being or contribute directly to the production of goods which generate well-being. This distinction between them is important to **avoid double-counting of ecosystem service benefits**, particularly if attempting to aggregate results across a range of different services.
- **Trade-offs**: many inter-linkages that exist within and between ecosystems, and the potential trade-offs that exist between different ESs should be taken into account. Ecosystems provide multiple services that are interdependent and can interact in complex ways; some are positively related, while others are negatively related.

Box 3. Further Information:

- For information on the Stakeholder Engagement and Participation and Toolkits for REA, see: McCarthy and Morling. 2014. A Guidance Manual for Assessing ESs at Natura 2000 Sites. Produced as part of the Natura People project, part-financed by the European Regional Development Fund (ERDF) through the INTERREG IV A 2 Mers Seas Zeeën Crossborder Programme 2007–2013. Pages 40-41.
- For information on how to define an alternative state, see: Peh et al. 2013. TESSA: A toolkit for rapid assessment of ESs at sites of biodiversity conservation importance. ESs.

3.2.2 Selection Criteria and Indicators for NWFPs' further assessment

Chamberlain et al. (2017) have developed a set of criteria and indicators for non-timber forest products (NTFPs; see footnote in page 21 for definition) providing a guidance on deciding which product, or set of products, to prioritize for further assessment in United States[35]:

Criterion 1: Amount of harvest by volume. There is little incentive to devote limited resources for valuation of products that have insignificant demand. There needs to be an indication that large quantities, relative to the product's abundance, are being harvested.

Criterion 2: Availability of data. The basic data requirements to value a non-timber forest product are the harvested or standing stock volumes, measured in an appropriate, the prices paid to a clearly identified market player (e.g., harvester, primary buyer, secondary buyer), and the associated costs (labor, capital, transport, processing).

Criterion 3: Amount of potential product stock in the state. The forest types, and the amount, found in a state are indicators of the resource base and should be a factor in selecting which NTFP to value.

Criterion 4: State's relative standing as producer or potential producer. An important criterion for selecting NTFPs to value is the market share that a site realizes from a particular

product. A state that is the sole producer, or a major producer, should consider directing more resources to estimating the value or provisioning that product.

Criterion 5: **Economic importance to specific communities**. The perceived importance of NTFPs to a State's rural economy should be considered in selecting NTFPs to value.

Criterion 6: Ecological vulnerability to over-harvest. Priority consideration may be given to forest species that are vulnerable or at risk of over-harvesting or some other stressor that can endanger the product.

Table 6 Criteria and Indicators for selection of Non-timber forest products (NTFPs) to estimate value (Modified from Chamberlain et al., 2017)[35].

Criteria	Indicators
Amount of harvest by volume	• Permit volume reported by National Forests • Permit volume reported by State • Harvest volume reported by industry • Harvest volume reported by regulatory agencies
Availability of data	• Harvest volume reported by regulatory agencies • Number of dealers • Permit volumes reported by National Forests
Amount of potential product stock in the state	• Area of potential habitat, as determined by forest type and other parameters
State's relative standing as producer or potential producer	• Area of potential habitat compared to other States • Relative harvest volumes
Economic importance to specific communities	• Expert social knowledge
Ecological vulnerability to over- harvest	• Expert ecological knowledge • State's threatened and endangered listings • State's natural heritage listings • Plant's conservation status

According to Chamberlain et al. (2017), the assessment results depend greatly on quantifying the amounts of NTFPs harvested per area of productive habitat. Quantification can take the form of an estimate of the total physical standing inventory, or "stock," of each NTFP present; or the rate of harvest, or "flow," from those areas. Flow measures are usually preferred [36,37]. The flow approach relies on measuring the amount of NTFPs harvested from a region (e.g. forest, watershed, State) often through reporting of volumes sold to market entities. This provides insight of the volumes of products that enter the market. To estimate values, data are needed on both annual harvest volumes and prices paid to a clearly defined market player (preferably the harvester; see section 3.2.4).

Box 4. Further Information:

- Chamberlain et al. (2017). Forest ESs: Provisioning of Non-Timber Forest Products. The study provides two helpful decision trees for the process of the quantification and the valuation of marginal changes of provisioning services related to NTFPs.

3.2.3 *Ecosystem Services Quantification*

Any assessment of the quantity of ESs provided by a site must consider both (1) the biophysical capacity of the site to provide (potential) ESs and (2) the use made of those services by human beneficiaries. The first step involves assessing the potential or capacity of an ecosystem to output goods and services that people can benefit from. The second stage involves assessing the actual goods and services provided by the site, by considering the extent to which the goods and services provided by the site are actually used by people (either directly or indirectly) or benefit people (e.g. in terms of both use and non-use values; for definition see below in section 3.2.4). Information on the distribution of users, and social economic characteristics, are therefore important[4,38].

Despite a number of challenges involved in terms of directly measuring ESs[4], there are three basic approaches or their combination to use for ESs quantification[39]:

(1) Collection of primary data through direct observations
(2) Proxy methods in which a single or combined indicators are used to define ES
(3) Process models in which indicators are used as variables in the equation.

The method to be used is dependent on:

- Time
- Resources
- Expertise
- Availability of data

Simple proxy methods are the most commonly used method for quantifying ES[39]. This could be partly because primary data are costly, especially at national and continental levels[39]. On the other hand, complex models require sound knowledge, data, and methodological approaches to describe the processes underlying ES supply[39].

3.2.3.1 Collection of primary data through direct observations

Regarding NWFPs, a description of a range of approaches used and methods for selecting appropriate biometric methods resource quantification in different situations and for different products are thoroughly described in literature[40].

3.2.3.2 Proxy Measures or Indicators

Ecosystem service indicators are information that efficiently communicates the characteristics and trends of ESs, making it possible for policymakers to understand the condition, trends and rate of change in ESs[41]. Single indicators are usually insufficient to quantify and map ES; therefore, many different indicators and thus data sources are needed to quantify them[39].

Good ecosystem service indicators are[42]:

- Relevant to the issue, i.e. they capture the changes we are concerned about.

- Transparent and understandable, i.e. their logic and methodology can be properly explained.
- Scientifically robust, i.e. they reflect current scientific understanding about the issue.
- Practically feasible, i.e. they do not imply huge additional efforts if the monitoring budget does not allow for it.

In general, it should be noted that different indicators may differ greatly in the extent to which they represent a reliable measure of the ES in question[4]. When applicable, primary field data should be collected as part of ES assessment. Some indicators are measuring the capacity of a site to provide particular service (potential ESs) and others provide information on the service actually being provided (actual ESs)[4].

Indicators for ESs assessment can be divided into supply indicators (i.e. indicators for stock and flow of ecosystem functions and ESs) and demand indicators (i.e. indicators for the human demand for ESs) according to a conceptual framework linking ecosystem integrity, ecosystem services and human well-being as supply and demand sides in human–environmental systems[43] (Fig. 6).

Figure 5 Conceptual framework linking ecosystem integrity, ecosystem services and human well-being as supply and demand sides in human–environmental systems.(Adopted from Kroll et al., 2012[43]).

The derivation of suitable indicators for the assessment of ecosystem functions and their capacities to supply services is an important step in order to know what will be evaluated[43]. On the other hand, there must be a certain demand by people to use a particular ecosystem service. To assess demands for ESs, data on their actual use are needed[43]. Supply and demands indicators have to be quantified in the same units in order to be comparable[43]. A list of indicators regarding provisioning services is given in Table 7.

Table 7 List of ecological integrity and ecosystem service components with rationales and potential indicators (Modified from Kroll et al., 2012)[43].

Provisioning services	Rationale	Potential Indicators
Crops	Cultivation of edible plants.	Plants/ha; kJ/ha
Livestock	Keeping of edible animals.	Animals/ha; kJ/ha
Fodder	Cultivation and harvest of animal fodder.	Fodder plants/ha; kJ/ha
Capture fisheries	Catch of commercially interesting fish species, which are accessible for fishermen.	Fish available for catch/ha; kJ/ha
Aquaculture	Animals kept in terrestrial or marine aquaculture.	Number of animals/ha; kJ/ha
Wild foods	Harvest of, e.g. berries, mushrooms, wild	Plant biomass/ha; Animals

	animal hunting or fishing.	available/ha; kJ/ha
Timber	Presence of trees or plants with potential use for timber	Wood/ha; kJ/ha
Wood fuel	Presence of trees or plants with potential use as fuel.	Wood or plant biomass/ha; kJ/ha
Energy (biomass)	Presence of trees or plants with potential use as energy source.	Wood or plant biomass/ha; kJ/ha
Biochemicals and medicine	Production of biochemicals, medicines.	Amount or number of products; kg/ha
Freshwater	Presence of freshwater	Liters or m^3/ha

Box 5. Further Information:

- Wong et al. (2001). Resource assessment of non-wood forest products: Experience and biometric principles. In: Non-Wood Forest Products. FAO, Rome. The study supports the development of biometrically sound NWFP assessments.
- Berghöfer and Schneider (2015). Indicators for Managing Ecosystem Services - Options & Examples. ValuES Report. The study supports the development of indicators and indicates examples.
- Seeland and Staniszewski (2007). Indicators for a European Cross-country State-of-the-Art Assessment of Non-timber Forest Products and Services. Small-scale Forestry 6(4) 411-422. The study provides qualitative indicators for NTFPs across Europe.

3.2.3.3 Modeling & mapping techniques

There is a range of existing ES modeling tools. Increasing attention is being paid to modeling and mapping ecosystem services. ESs are naturally spatial, influenced by processes operating across a range of spatial scales[4]. Mapping ecosystems can help to inform land-use and land-management decisions across a broad range of scales of relevance to decision-making. They can also be useful for prioritization and problem identification, especially in relation to synergies and trade-offs, as well as being a powerful communication tool[4]. Currently, most of the mapping approaches available focus on national and regional scale output as a result of the resource-intensive and data-intensive nature of ecosystem service mapping[4]. Nevertheless, there are a growing number of ES mapping initiatives, ranging from local to national scale[44]. The majority are highly resource-intensive and not suitable for widespread application[44]. Most are not applicable at the local scale due to the need for detailed high-resolution data[4]. Some examples related to NWFPs quantification and mapping are given in Table 8.

In addition to the examples of techniques given above, there are some tools that may be useful for the purposes of carrying out a Natura 2000 site assessment[4]. One of the most widely recognized tools with potential for widespread use is InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs), an open-source ES mapping and valuation tool[44]. InVEST uses spatially explicit ecological production functions or "process models" to estimate the influence of land-use/land cover patterns (and other ecosystem characteristics) on ESs provision in biophysical terms and then estimates economic values

for the associated services using value transfer. Other web-based tools that exist for interactive mapping of ecosystem services include WaterWorld and Co$ting Nature.

Table 8 Examples of modeling and mapping studies on NWFPs.

NWFP	Spatiotemporal scale	Scope-Objectives	Literature
Wild Food	Europe	Synthesize the available information on the importance of wild food as an ecosystem service in the European Union. Quantification of the supply, demand and benefits, map the spatial distribution of supply and demand, and evaluate the relations between supply, demand and benefits of the service	Schulp et al., 2014[45]
Wild mushrooms	*Pinus pinaster* forests Central Spain 1997-2013	Estimation of the occurrence and production (i.e., fresh weight) of edible in relation to the provision of fungal-based provisioning ecosystem services, by accounting for the effect of stand, site and meteorological conditions	Taye et al., 2016[46]
NWFPs	2 Forest holdings Finland	Analysis of the synergies and trade-offs between timber production and different NWFPs through correlation matrices and production possibility frontiers in two case study forest holdings	Kurttila et al., 2018[47]
NTFPs	Finland	Study of the climatic and economic factors that affect the annually aggregated supply of non-timber forest products	Tahvanainen et al., 2019[48]

Box 6. Further Information:

- Information on ESs assessment and management tools, see:
  - Ecosystem-Based Management Tools Network
  - Co$ting Nature
- Comparison of descision-support tools, see:
  - Bagstad et al. (2013). A comparative assessment of decision-support tools for ecosystemservices quantification and valuation. Ecosystem Services 5.
  - Martinez-Harms and Balvanera (2012). Methods for mapping ecosystem service supply: a review. International Journal of Biodiversity Science, Ecosystem Services & Management.

3.2.4 Economic Valuation of Ecosystem Services

Valuation is the process of attributing a value to something[24]. It can be either economic or non-economic. Economic valuation of ESs is aiming to measure, in monetary terms, the preferences of the people for the benefits they obtain from ecosystem processes[49]. Non-economic valuation of ESs often studies how the opinions of people are formed or their preferences expressed, beyond monetary terms[24].

Valuing all ESs in monetary terms might be difficult. For example, only a small subset of ecosystem processes and components are priced and incorporated in transactions as commodities or services[49]. Quantifying most ESs in terms that are comparable with the services obtained from human-made assets may be challenging[50]. Economics is about choice, and every decision is preceded by the weighing of values among alternatives[51]. Measurement in monetary terms provides estimates of values in comparable units to enable the assessment of trade-offs and to demonstrate the importance of certain ESs[22]. **The rationale behind ecosystem valuation, therefore, is to unravel the complexities of socio-ecological relationships, make explicit how human decisions would affect ES values, and express such changes in value in units (e.g. monetary) that allow their incorporation in public decision-making processes**[52]. Natural resource management decisions based on comparisons of benefits and costs are likely to be biased, however, when only a few Ess have clearly defined monetary value[53].

3.2.4.1 Total Economic Value Framework (TEV)

Total economic value (TEV; or output value) of ecosystems and biodiversity is defined as the sum of the values of all service flows that natural capital generates both now and in the future[49] (Fig. 7; i.e. output value). These service flows are valued for marginal changes in their provision[49]. TEV contains all components of (dis)utility derived from ESs using a common unit of account: money or any market-based unit of measurement that allows comparisons of the benefits of various goods[49]. Since in many societies people are already familiar with money as a unit of account, expressing relative preferences in terms of money values may give useful information to policy-makers[49].

Economic values can be categorized generally as either use values or non-use values (Fig. 8). The sum of these two values provides the total economic value (TEV). Use values may be either direct, indirect or option values. Direct-use values comprise those benefits derived from the actual, direct use of a forest ecosystem and are normally differentiated as either consumptive (or extractive, implying the consumption/extraction of resources, such as the non-wood products) or non-consumptive (or non-extractive, such as recreation activities, wildlife viewing, and enjoying the beauty of a landscape and scenery in a certain area)[24]. Indirect-use values refer to the benefits derived from an ecosystem's functions without direct interaction with it (such as watershed protection, water quality and purification, carbon sequestration, protection against natural hazards, and pollination)[24]. Option values are those benefits derived from the option of directly or indirectly using forests in the future[49,24]. Some examples are reviewed by Masiero et al. (2019). Option value can be applied when a certain ecosystem is considered as a potential source of future recreation opportunities, environmental study, timber and wood fuel, and biodiversity conservation[24]. For example[24], existing biodiversity might be a source of active agents against future human diseases and agricultural pests. In this case, the quasi-option value of biodiversity

conservation would be a kind of insurance premium paid today to reduce potential losses due to future adverse events[54].

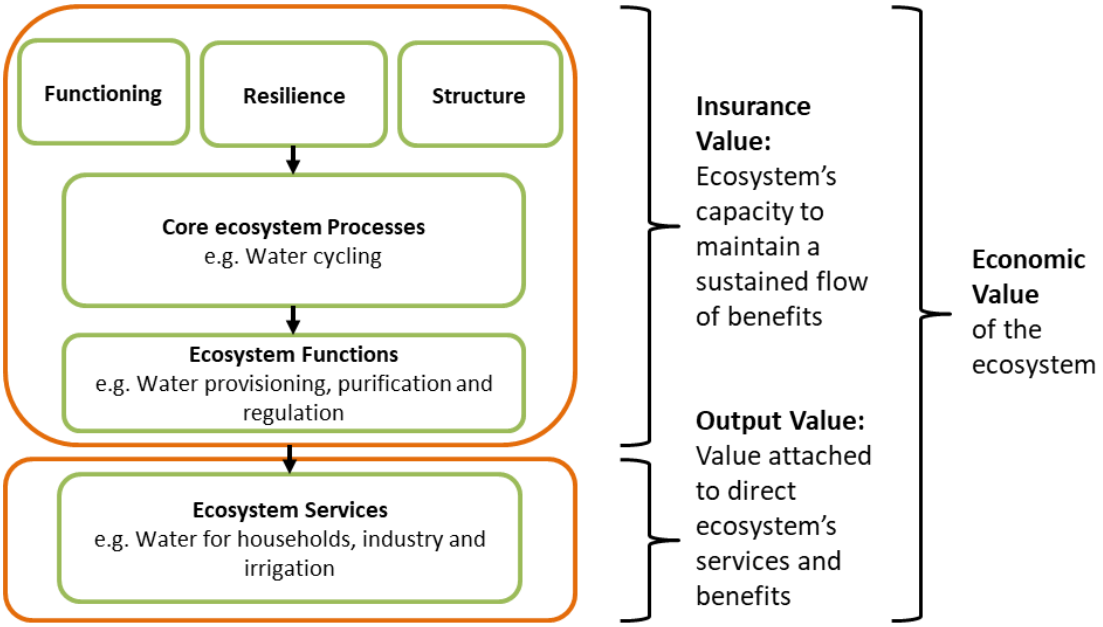

Figure 6 *Insurance*[IX] *and output value as part of the economic value of the ecosystem. The figure poses insurance value (related to the ecosystem's resilience and output value (related to ecosystem service benefits) as the two main components of the economic value of the ecosystem. (Modified from: Pascual et al., 2010*[49]*).*

Non-use values are values unassociated with actual use[24] and are generally categorized as bequest, altruism and existence values[49] (Fig. 8). Existence values comprises the benefits derived from knowledge of the existence of a particular environmental feature or characteristic, such as biodiversity[24]. An example given by Masiero et al. (2019) is the following; some people might value the Royal Bengal tiger or the Amazon forest just because it exists, even though they will never make direct use of such resources. According to Pascual et al. (2010) existence values are related to the satisfaction that individuals derive from the mere knowledge that species and ecosystem continue to exist[49].

[IX] **Insurance value** is associated with ecosystem resilience (i.e. the capacity of an ecosystem to maintain its basic functions and controls under disturbances) There is often a threshold in resilience that can be defined empirically for different natural assets, although this is generally poorly understood for many ecological systems. Evidence suggests that more diverse ecosystems are more resilient as a result of the diversity of responses to disturbance among species contributing to the same ecosystem function[4].

Altruism and Bequest values are the values attached to benefits derived from placing a value on the conservation of a certain environmental feature for other people (altruism) and future generations (bequest)[24,49]. Altruism value is the value assigned to the concern of the people for the welfare of others[24]. Bequest value reflects the satisfaction that people derive from knowing that an environmental feature will be maintained so that future generations will have access to them[24].

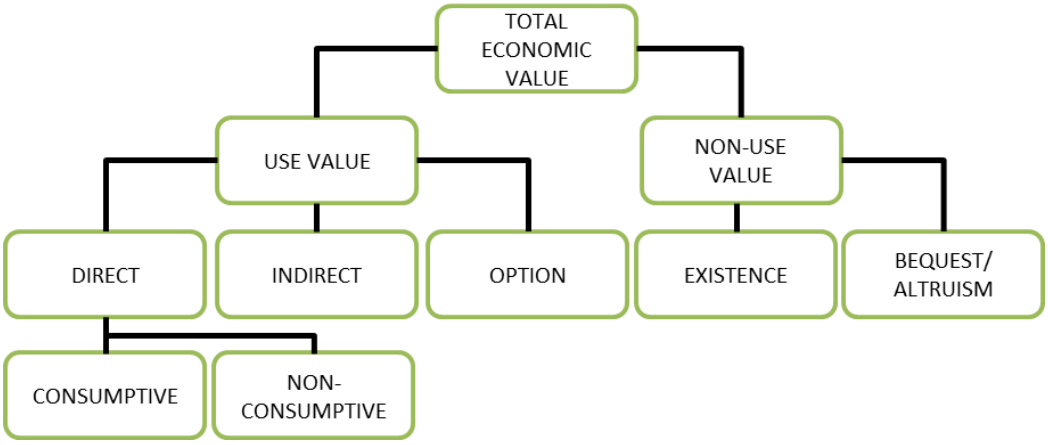

Figure 7 *The Total Economic Value (TEV) framework.*

According to Masiero et al. (2019), measuring indirect-use values poses greater challenges than measuring direct-use values. The assessment of option and non-use values is even more challenging because the values cannot be measured directly and must be inferred from choices, behaviors or surveys[24].

Table 9 ESs and related components of the total economic value (TEV).

ESs	Total Economic Value (TEV)			
	Direct Use Value	Indirect Use Value	Option Value	Non-Use Value
Provisioning	x		x	x
Regulating		x	x	
Cultural	x		x	x

The relationships between the different types of instrumental value under the TEV framework and the main categories of ESs are shown in Table 9. Provisioning ESs may be valued in sets that address more than one TEV component[24]. Although the TEV framework is used, this does not imply that only monetized estimates of value can be used[24].

Due to that the provisioning ESs represent tangible and visible outputs, the identification and quantification of provisioning ESs is generally easier than for other ESs[24]. Tools are available to collect information on the products people collect, the time spent in their collection, and the sources from which they are obtained[24]:

- Guidance and modules for socio-economic surveys in forestry[55]
- Estimated monetary values for provisioning ESs from literature[49]

It should be kept in mind that not all provisioning ESs are traded in the market[24]. When markets exist, they may be informal or not fully transparent (e.g. markets for wild forest products)[24]. The valuation of provisioning ESs mostly takes into consideration use values, particularly direct-use (consumptive) values, but option or non-use values could also be considered[4,24,49].

3.2.4.2 Valuation methodology under the TEV approach

It should be indicated that some valuation methods are more appropriate than others for valuing particular ESs and for the elicitation of specific value components.

Within the TEV framework, values are derived:

- From information of individual behavior provided by market transactions relating directly to the ecosystem service, if available[49].
- In the absence of the above-mentioned information, price information must be derived from parallel market transactions that are associated indirectly with the good to be valued[49].
- If both direct and indirect price information on ESs is absent, hypothetical markets may be created in order to elicit values[49].

These situations correspond to a common categorization of the available techniques used to value ESs (Table 10):

- Direct market valuation approaches,
- Revealed preference approaches
- Stated-preferences approaches[56].

3.2.4.3 Valuation methods usually used for NWFPs

Direct market valuation (pricing approach)[4]: The simplest method that can be used. Basically, for goods and services that are traded in well-functioning (competitive) markets, the market price of the good should reflect its economic value in terms of consumer **"willingness to pay"** for the good in question. Direct market methods can only be used for ecosystem service goods that are traded in markets. They are particularly useful in relation to provisioning services, such as the provision of food and fiber. When using direct market valuation, prices should be adjusted to account for any market distortions (e.g. taxes or subsidies). Calculating net benefits may require adjustments to be made based on production costs.

Indirect market valuation techniques (e.g. cost-based methods such as avoided (damage) cost and replacement cost methods)[4]: The replacement cost approach estimates the value of an ES by considering how much it would cost to replace the service with an alternative or substitute or mitigate the effects caused by its loss. For example, flood protection services provided by wetland ecosystems can be valued by assessing the costs of building alternative man-made flood defenses that would provide an equivalent level of protection.

Table 10 Main valuation methods. (Modified from McCarthy and Morling, 2014[4]).

Method	Description	Value	Example of ESs	Advantages	Disadvantages
Market price (adjusted)	Observed market prices adjusted for distortions (e.g. taxes and subsidies)	Use	**Provisioning** (e.g. crops and livestock, timber) **Regulating** (e.g. carbon storage)	Relatively easy to obtain data. Simple to explain. Accurate providing certain conditions are satisfied.	Accurately controlling for market distortions is challenging. Prices may vary considerably over time. Limited to goods directly traded in markets and can only measure use values.
Production function	Value of ecosystem service as input in production of marketed goods	Use	**Provisioning** (e.g. crops and livestock);	Isolates the contribution of the service	Technically difficult and has high data requirements.
Replacement cost; damage cost	Cost of replacing the service with a man-made alternative/ substitute; Cost of damage avoided as a result of the service.	Use	**Provisioning** (e.g. wild goods); **Regulating** (e.g. flood protection, pollination).	Usually relatively easy to obtain data. Simple to explain. Accurate providing certain conditions are satisfied.	Assumes that cost is a reasonable estimate of value i.e. that the benefits of restoration/ replacement are at least as great as the costs. High potential to over- or under- estimate value. No direct (observable) relationship with benefits.
Revealed preference (e.g. hedonic price, travel cost)	Expenditure on ecosystem-related market goods (e.g. travel, property, expenditure to avoid damage etc.).	Use	**Regulating** (e.g. air and water quality); **Cultural** (e.g. recreation).	Robust value estimates based on actual market transactions (hedonic pricing)/ observed behavior	Data-intensive. Technically difficult with high data requirements. Limited applications.
Stated preference (e.g. contingent valuation)	Surveys to ask individuals to make choices between different levels of environmental goods at different prices to reveal their willingness to pay/willingness to accept	Use and non-use	**Regulating** (e.g. air and water quality); **Cultural** (e.g. recreation, cultural identity).	Ability to estimate non-use values. Applicable to a wide range of services.	Complex. Time- and data-intensive. Results sensitive to numerous sources of bias in survey design and implementation. Expensive and technically difficult to implement.
Value transfer (e.g. unit value and value function transfer	Existing valuation evidence from one context is applied or transferred to a new context for which an estimate of economic value is required	Use and non-use	All	No need to conduct primary valuation study. Widely applicable.	Lacks accuracy. Relies on the quality and applicability of data from existing studies. May require complex adjustments to be made.

Similarly, avoided (damage) cost methods estimate the value of an ecosystem service by considering the costs that would have been incurred in the absence of the service e.g. the cost of damage to property that would have occurred in the absence of the flood protection services provided by a wetland ecosystem. However, such methods should be used with caution due to the suspicion that the estimated costs may bear little resemblance to the values they approximate[57]. These cost-based methods are a proxy for value and only hold true under certain conditions. The replacement cost method requires two assumptions to hold: firstly, that the alternative or substitute is the least-cost way of replacing the service; and, secondly, that society would be willing to pay to replace the service if it were lost[58].

When a (local) market exists such as for certain NWFPs[59,60,61], local prices should be considered, net of production costs such as those associated with harvesting and transportation to the marketplace[24]. Some costs may be informal but should still be taken into account[24]. They may be in-kind payments (e.g. by the provision of labor, or harvest-sharing) and/or they may involve informal fees paid at checkpoints[62] and other informal payments to officials[63]. Informal or even illegal harvesting activities should be taken into account when appraising the value of ESs because they might meaningfully affect the quantity of ESs actually supplied and thus the total value[24]. By influencing supplied quantities and production costs, illegal activities can also affect prices by usually lowering them[24].

If products are aimed at self-consumption rather than commercial sale, market prices can be used for estimating opportunity costs (i.e. the costs of foregone money)[24,60]. There may also be opportunity costs involved in the use of substitute goods and time (e.g. the cost of time foregone in collecting an NWFP rather than spending it on other activities, such as paid work or education)[24].

When the collection or harvesting of NWFPs implies payment of access or collection fees, such payments can be used to generate rough estimates of the value of the ESs themselves[24]; for example, for honey and wax collection in the Sundarbans forests, where access payments are made to the competent authorities[64,65]. This approach is possible to underestimate the value of ESs, however, for several reasons:

- It does not cover informal activities not captured by formal channels (e.g. people may access the resource illegally or harvest more than they are allowed)[24].
- Access fees are set administratively and may not reflect the value of the ESs
- In certain circumstances, the collection of wild products might be associated with recreational experiences that provide benefits to collectors and are valued as such (e.g. mushroom peaking in Mediterranean). In such cases, the payment of fees would include both the value attributed to provisioning ESs (wild products) and cultural ESs (recreation, and leisure from the recreational experience), and it would be difficult to distinguish between them[24].

Table 11 Examples of valuation methods usually used for NWFPs valuation at different geographic scale.

Scale	Description	Methodology	Main sources of data	Literature
Regional	NWFPs as categorized by FAO FRA 2010	Market price	FAO 2010 National Reports and additional literature	Masiero et al., 2016[59]
Regional	Marketed products: Cork, mushrooms, honey, medicinal plants	Market price	Market prices and quantities	Croitoru, 2007[60]
	Non-marketed products: Myrtle, rosemary, carob	Cost-based methods (opportunity costs) (informal markets)	Cost of labor data Market values of equivalent products	
Provincial	Marketed products: Honey & Wax	Economic value estimated using the aggregate of annual revenue earned by Forest Department	Data from the Forest Department	Uddin et al., 2013[64]
Local	Marketed NWFP products	Market price	Market prices and selling costs from the collectors	Vodouhê et al., 2016[61]
	Non-marketed NWFP products	Contingent Valuation	Data from focus group discussion Total cost of the collection	

In principle, provisioning ESs can also be estimated through the cost of substitute goods[24]. For example, the value of potable water provided by a spring can be estimated as the cost of buying bottled water instead[24]. Similarly, the value of fodder provision can be estimated as the cost of alternative animal feedstock, and the value of thatching materials can be estimated as the cost of substitute roofing materials[24]. In most cases, this valuation method is the same as the above-mentioned opportunity-cost approach for substitutes. Examples of studies on NWFPs are given in Table 11.

Box 7. Further Information:

- For ESs valuation methodology, see:
  - TEEB (The Economics of Ecosystems and Biodiversity)
  - DEFRA (Department for Environment, Food & Rural Affairs, UK) – Guidance on ESs
  - McCarthy and Morling. 2014. A Guidance Manual for Assessing ESs at Natura 2000 Sites.
  - Masiero et al.. 2019. Valuing forest ESs A training manual for planners and project developers. FAO, Rome.

3.3 Service Assessment Guide

The basic steps for ES assessment are presented in Figure 9. Consideration should be given to the ways in which services can be assessed in qualitative terms (e.g. descriptive), in quantitative terms (e.g. crop yield; number of visitors per year) and in monetary terms (e.g. € per hectare)[4]. Economic valuation will not always be possible or required. At almost all sites it will be possible to identify and describe more services than can be quantified, and to quantify more services than can be valued[4]. According to McCarthy and Morling (2014)[4], it is, therefore, important to use the results of the rapid assessment to:

- Assess those services that are considered to be particularly significant at the site in terms of the benefits they provide or the distribution of those benefits.
- Assess those services that are likely to be particularly sensitive to the changes that are predicted to occur under the alternative state.
- Consider the extent to which data, expertise, and other resources are available, both in selecting the services to assess in detail, and in choosing the methods to use, as this will affect the feasibility of obtaining useful results.

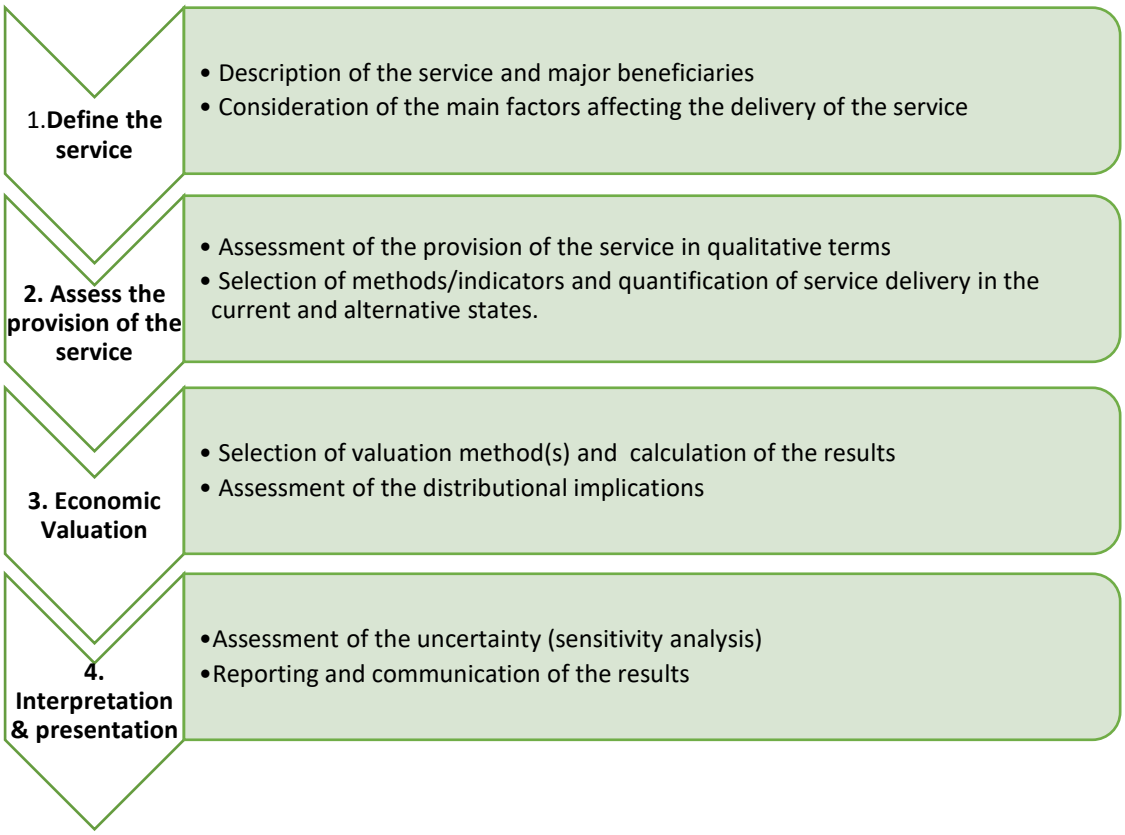

Figure 8 Basic steps for ecosystem service assessment (Modified from: McCarthy and Morling, 2014[4]).

3.4 Assessment of ESs related to NWFPs

A step-by-step approach to assessing the provisioning of wild goods is outlined below (based on TESSA by Peh et al., 2013[66]):

(1) Collection of general information for the main/most important wild goods that are harvested at the site:

- A questionnaire/survey or workshop with informed individuals might need to be conducted (unless other sources of information can be found) in order to:
  - I. Determine the types of wild goods that are collected
  - II. Extract information on the quantities collected (e.g. kg/ha/ year).
- In the case of absence of existing data, it may be necessary to collect new data
  - I. Use of questionnaires or semi-structured interviews to survey individuals or groups that harvest wild goods at the site.
- It should be possible to convert this information into standard units (e.g. tonnes per hectare per year).

Notes:

- The harvest of wild goods can vary considerably by season and appropriate metrics will depend on the type of product. Some will be in small quantities but high value, such as herbs or mushrooms; others will be higher volume but lower value, like animal fodder.
- In assessing the value of this service, it is important to ensure that harvesting is sustainable and is not having a detrimental impact on populations of wild species. In some cases, there may be restrictions on the collection of wild foods for commercial purposes at Natura 2000 sites. It is important to ensure that wild products are being legally and sustainably harvested. Illegally or unsustainably harvested goods should not be included in the analysis. Any declines in availability over time that are noted can be used to indicate that harvest rates are not sustainable.

(2) Consideration of how the types and quantities of wild goods harvested might change under the alternative state.

- If the alternative state is likely to involve a significant change in the condition of the site (and hence the types and quantities of wild goods found at the site), then it may be necessary to look beyond the study site to assess site(s) nearby that are similar to the hypothesized alternative state.

(3) Assessment of the value of the goods collected.

- There are a number of assessment methods that can be used for non-cultivated goods, depending on whether they are collected for commercial or personal use:
  - I. **Marketed goods** (e.g. wild goods that are commercially collected and/or traded in formal markets), can be can be valued using market prices and data

on collection costs (e.g. travel costs, equipment costs, labor costs) in a similar way to agricultural food production.

II. **Wild goods traded in informal markets** for which limited information may be available, can be valued using existing databases held by regional or national authorities that may contain information on average prices and harvest costs. These costs could be considered in terms of labor costs (e.g. hours of work), capital costs (e.g. equipment), and other costs (e.g. license fees). Where no suitable market price data is available, you could use the opportunity cost of labor or the costs of collection as a proxy for the value of the good(s) collected.

III. **Wild goods that are not traded** (e.g. those that are collected recreationally or for personal use) can be valued using the non-market benefits that can be estimated by using the market price of similar goods (or substitute goods) sold in other (commercial) markets (e.g. replacement cost approach). These methods can also be used for other wild goods for which it is not possible to obtain robust market price estimates. It is important to note the potential for non-market benefits associated with the collection of wild foods in terms of leisure/ recreation etc.

(4) Use the information collected to estimate the net value of each of the main harvested wild goods and how this might differ between the current and alternative states.

- This can be summed to produce an estimate of the total value (net of costs).

Notes:

- ***Note:*** *in many cases, the value of non-marketed wild foods is likely to be reflected in recreational values.* ***The travel cost method is one way of evaluating the non-market value of wild food such as edible fungi and berries***[103,104]*.This method works by using the expenses incurred by visitors that travel to a site as an estimate of the value of the services provided by the site. Visitors are surveyed in order to collect data on travel time and travel distance, travel expenses (and other on-site expenses), and a range of other visitor-specific characteristics such as income group. Starbuck et al. (2004) use data on travel costs and harvest costs from a survey of non-commercial forest product harvesters to estimate the recreational value of wild huckleberry and mushroom picking in Washington State, USA. The study estimates that the consumer surplus associated with harvesting these products is approximately $36 per visitor day (2003 US$)*[105].

3.5 Case Study: A Wild Food Supply-Demand-Benefits Framework

Beyond the valuation of NWFPs in terms of benefits for HWB, other significant elements of the chain between the Ecosystem Condition and HWB should be assessed towards the sustainable capitalization of NWFPs. Schulp et al. (2014)[45] aiming at building a conceptual framework for synthesizing the available information on the importance of wild food as an ES in the European Union, they defined the ES wild food as plants, berries, fruit, nuts,

mushrooms and game that are collected in the wild, to be consumed as food or drink[3]. In this framework, ecosystem properties are defined as the ecological conditions that determine whether an ecosystem service can be provided. For wild food, this is the production of wild edible species. Ecosystem functions are the capacity of the ecosystem to provide a service[67,68], which is the availability of specific species that are relevant for food provision. Ecosystem properties and functions are jointly described as the supply of the ES. The ES is defined in the framework as the wild food actually collected. The authors considered both the flow (i.e. the process of collecting) and the demand[69,70]. The collected food provides benefits to the collectors and other consumers, including food, income and cultural services. Collecting wild food can trigger landscape management that influences the ecosystem functions and properties. For example, overexploitation and extermination of species or conservation of ancient woodland forests as hunting grounds for the nobility[71].

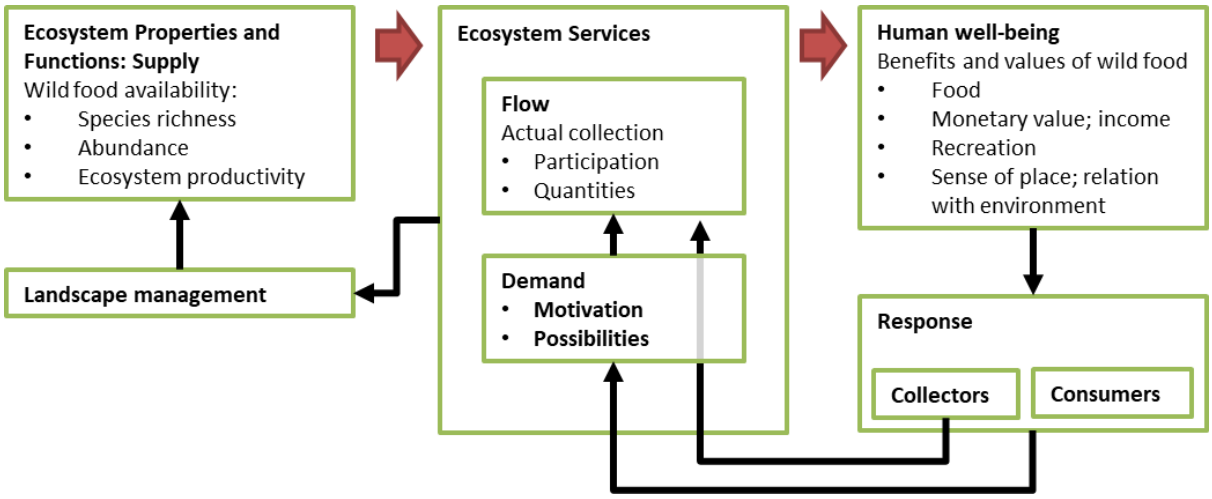

Figure 9 Conceptual framework of the relations between wild food supply, demand and benefits (Modified from: Schulp et al., (2014)[45]**.**

This framework signifies the importance of obtaining knowledge on the different parameters shaping the supply; flow and demand of NWFPs towards the sustainable capitalization of provisioning services related to NWFPs.

3.5.1 *Key drivers for supply: Forest Ecosystem Condition and Pressures*

According to MAES (2018), ecosystem condition is the physical, chemical and biological condition or quality of an ecosystem at a particular point in time. The concept of ecosystem condition is strongly linked to well-being through ESs[2]. Ecosystems need to be in good condition to provide multiple ESs, which, in turn, deliver benefits and increase HWB[2].

Examples of ecosystem condition aspects (or indicators) related to the provision of NWFPs (red lines) are shown in Figure 11. Spatiotemporal data analysis related to species richness (i.e. diversity), occurrence density (i.e. abundance) and biomass volume (i.e. production) per NWFP can give good estimations of NWFPs' supply[45].

Drivers of change can have a positive (e.g. conservation) or negative (pressures; Fig. 11) impact on ecosystem condition[2] and thus on the ESs supply. Towards sustainable capitalization of NWFPs the (potential) pressures threatening the supply (ecosystem condition) of these services should be taken into consideration when designing and implementing research and/or measures.

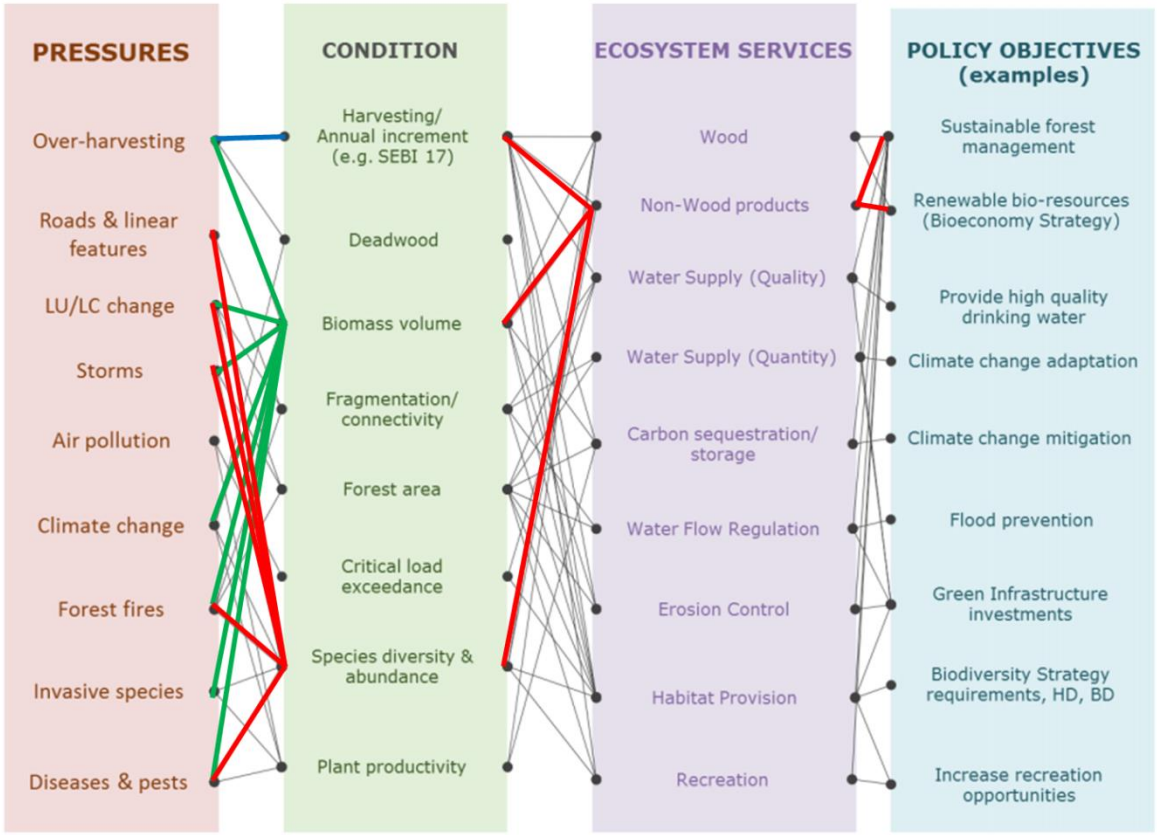

Figure 10 Synthesis of the links between pressures, condition and ecosystems in forest ecosystems. Color lines indicate the relation between NWFPs and pressures, condition and the examples of policy objectives (Modified from: MAES,2018[2]).

3.5.2 Key drivers for flow and demand: socio-economic reasons

In terms of flow, the factors shaping the actual collection (i.e. the participants and the quantities collected) should be taken into consideration[45]. The demand for provisioning services has been quantified in previous studies based on direct use and consumption[72]. Wolff et al. (2015) defined direct use as the possibility to use the service (based on the proximity and accessibility) and consumption as the final consumption of goods in a particular area and time[72] (for examples see Section 4). Schulp et al. (2014) were able to conclude on some of the reasons shaping the demand for wild food in EU based on some indicators developed such as the fraction forest and other woodland, the population density, the gross domestic product per capita, the importance of the wild food in cuisine,

the accessibility regulations for forest and nature, the regulations for NWFP collection and the percent population of hunters[45]. Consequently there is a necessity to understand, evaluate and incorporate the socio-economic factors driving the demand for NWFPs[18] in future studies and measures.

3.6 Mechanisms ensuring Sustainable Capitalization of NWFPs

According to FOREST EUROPE[X], sustainable forest management (SFM) is "the stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfill, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems". Sustainable use, management and governance of NWFPs are an integral part of SFM. Three main criteria should guide forest managers and other stakeholders in setting forest management priorities: economic (e.g. financial viability); social (e.g. demand for forest goods and services, legal access, and traditional rules); and environmental (e.g. resource productivity and ecological suitability)[73].

3.6.1 Inventory of NWFPs species

Inventory and research on key species is considered as probably the most important requirement for stimulating sustainable development initiatives through NWFPs use. According to Shackleton and Pandey (2014), if governments do not know what they have, how can they protect them or promote sustainable use strategies or facilitate markets?[74] According to Guariguata and co-workers (2011), there are certain difficulties in incorporating NWFP inventories into standard forest inventories such as: (a) large diversity of NWFP species, (b) different maturation and thus harvest rotation rates and (c) the variety of products from NWFP species[75]. Despite the large diversity, it might be practical to initially focus such NWFP inventories on those NWFPs with high use or market values because if overharvested it would have significant negative implications for local poverty profiles in the long term[74]. Regional authorities and scientific agencies could begin with the 10–20 most important NTFPs[74]. Research agencies can contribute by developing the most scientifically robust and cost-efficient approaches for different contexts, species and products. Ecologists and ethnobotanists have devised inventory techniques for almost every type of NWFP on a single study site basis, ranging from edible insects, to fern and palm fronds, resins, bulbs and bark[74]. Therefore, there is a library of potential tools available to build further large-scale systematic inventories.

[X] FOREST EUROPE is the pan-European voluntary high-level political process for dialogue and cooperation on forest policies in Europe.

Box 8. Further Information:
For Resource assessment methodology and inventory tools, see:

- Wong et al. (2001). Resource assessment of non-wood forest products: Experience and biometric principles. In: Non-Wood Forest Products. FAO, Rome. The study supports the development of biometrically sound NWFP assessments.
- Lorbach J, Russo L, Vantomme P. Needs and constraints for improved inventory and harvesting techniques for non-wood forest products, FAO, ROME.
- Rural Opportunities Network. (2013). Inventory Toolkit. Centre for Livelihoods and Ecology. Royal Roads University, Victoria BC, Canada. This toolkit is designed to guide readers through the potential methods available for undertaking a non-timber forest resources (NTFR) inventory.
- Liebenberg, L., 2003. A new environmental monitoring methodology. At a basic level CyberTracker is simply a tool to gather data in a very efficient way. It can be used to gather data for scientific research, social surveys, population census, market research, agricultural pest control and environmental monitoring. CyberTracker can be used for any type of data gathering that involves field workers recording information away from the office.

3.6.2 Maintenance/ enhancement of stock and production

To determine what harvest level a resource can sustain without destruction, it is important to know the quantity of non-wood material that the species produces naturally[18]. A major problem among non-wood forest harvesters/enterprises is that most of them do not possess this knowledge[18]. Yield studies, regeneration studies and harvest assessments are important tools for evaluating sustainable harvest levels[18]. When yield, regeneration and harvest studies reveal that actual harvests exceed a species' ability to regenerate, collectors may have to supplement wild sources with domestication[76]. Many forest species depend on the interrelationships of a forest ecosystem to survive, but others may be capable of domestication or cultivation[18].

Domestication offers the possibility of increasing the productivity of certain NWFPs and reducing harvesting pressure on natural forests while increasing and reducing fluctuations in market supply[73]. The domestication of wild forest species, however, usually involves a considerable investment of time and money, which may only be feasible where the product has a very high value and where social and political conditions are such that investors have a reasonable chance of obtaining good returns[73].

According to FAO (2018), key steps that need to be taken to domesticate an NWFP include:

- The identification of key species
- The collection of germplasm
- The development of vegetative multiplication techniques or breeding schemes
- The integration of the NWFP (either vegetative or animal) in agroforestry or agricultural systems.

The sustainable harvesting of NWFPs requires sustainability in overlapping fields, namely the social, economic, political, and ecological[77]. To understand the sustainability of NWFP harvesting from an ecological perspective, we need to know how, where, and when NWFPs are gathered, how this matches current and expected future demands, and what

ecological impacts result from their harvest[77]. The decisions harvesters make on how, where, and when to harvest NTFPs are shaped by cultural, political, and economic factors[77].

The sustainable harvesting limits are known for only few of the NWFPs species internationally[77]. The wide variety of plant and animal types, species and products make it a difficult task[74]. However, tools are widely available for defining sustainable harvesting limits (see Box 9). A flow chart of a basic strategy for establishing sustainable harvest of NWFP plant resources is given in figure 12.

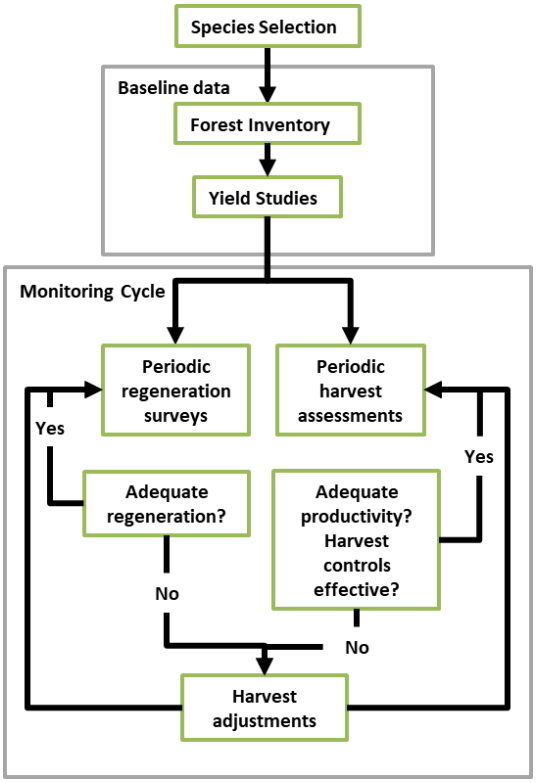

Figure 11 *A flow chart of a basic strategy for establishing sustainable harvest of NWFP plant resources (Modified from: Wong et al.,2001[40]).*

Box 9. Further Information:

For domestication of NWFPs, see:

- FAO (1996). Domestication and commercialization of non-timber forest products in agroforestry, Rome.

For sustainable harvesting, see:

- Lorbach J, Russo L, Vantomme P. Needs and constraints for improved inventory and harvesting techniques for non-wood forest products, FAO, ROME.
- Wong et al. (2001). Resource assessment of non-wood forest products: Experience and biometric principles. In: Non-Wood Forest Products. FAO, Rome.
- Ticktin and Shackleton (2011). Harvesting Non-timber Forest Products Sustainably: Opportunities and Challenges. In: Non-timber Forest Products in the Global Context. Springer, Berlin.
- Peters C.M. (1996). The ecology and management of Non-timber forest resources. World bank technical paper 322.

3.6.3 *Assessment of local use of the resource*

The assessment of the local resource use provides an opportunity to learn how local communities manage key NWFP resources and what practices they employ. Recording and studying this knowledge helps ensure that forest management plans consider all relevant information[18].

3.6.4 *Improved management*

3.6.4.1 Improved harvesting methods

Harvesting - broadly including harvest planning, pre-harvest and post-harvest treatments - is the most important process in managing a resource[18]. It directly affects both the yield and the health of the living resource[18]. Improvements in the harvesting process can make the difference between a healthy forest and degraded land; they can also decide whether an enterprise returns a profit or loss[18].

3.6.4.2 Post-harvest technologies

Post-harvest losses due to spoilage are common and rob producers of potential income[18]. Technologies that reduce these losses are often available and economical, including techniques for depulping fruits and drying plant materials[18]. Optimum post-harvest storage further reduces losses[18]. In many cases, research results describe what type of storage warehouse and conditions (e.g. temperature, airflow, moisture levels, etc.) are best for reducing spoilage[18].

3.6.4.3 Multiple-use management for wood and non-wood products

Combining harvests of a non-wood product with other NWFPs, or with timber harvests, can optimize overall forest management[18]. This type of multiple and diversified uses, traditionally practiced by some forest dwellers, can ease the economic pressures on both wood and non-wood[18]. In planning, resource managers should analyze the inventory information to determine complementary harvest strategies and uncover potential conflicts between wood and non-wood harvests[18]. The local community should participate in prioritizing harvestable products and strategies[18].

Box 10. Further Information:
For NWFPs harvest, see:

- Ticktin T (2015). The ecological sustainability of non-timber product harvest: Principles and methods. In: Ecological sustainability for Non-timber products. Taylor & Francis group.
- Lorbach J, Russo L, Vantomme P. Needs and constraints for improved inventory and harvesting techniques for non-wood forest products, FAO, Rome.
- FAO (1995). Non-wood forest products for rural income and sustainable forestry. Rome.

3.6.5 *NWFPs commercialization: local or beyond the local level?*

The past forty years have witnessed a significant growth in domestic and international trade in practically all the products, including NWFPs[78]. On the one hand, this growth may generate income for the resource harvesters and collectors as well as many other actors in the commodity chain and on the other hand this trade expansion may be detrimental for local markets and forest conservation.

The lack of information on the trade in wild plants and animals makes it difficult to estimate total and relative levels of use for both domestic and commercial purposes, and this is complicated by the difficulty in distinguishing between subsistence use and trade for commercial purposes[78].

Effective NWFP trade faces practical challenges as NWFPs are often small in size, come from many different sites and a far bigger range of species and products exists than for the two key-traded resources, timber and fisheries[78]. NWFP trade is, accordingly, far more complex and difficult to understand and regulate, as NWFP cannot be successfully regulated as a uniform commodity[78]. There is an urgent necessity for the adoption of trade-related measures that are supportive for conservation and sustainable use[78].

Unlike at the local level, where a family may gather fruit and sell it direct to local consumers, for nationally or internationally traded products the whole production-to-consumption system involves a chain or network of different types of organizations. Some types of organization may be more appropriate for performing different functions along the value chain[27]. Intermediaries often play a critical role in communicating information from consumers to producers (e.g. providing market expertise, organizing transport and quality control, advancing credit, consolidating volumes for export or national processing and shouldering risk).

As trade develops beyond local and regional markets it becomes ever more sophisticated and relationships between actors are likely to shift from informal to formal agreements bounded by contracts and memoranda of understanding[27]. Access to such markets can be unapproachable or impossible for poor rural people. Nevertheless, there is increasing global interest in ensuring fair trade. This usually means introducing conditions or practices to safeguard the interests of the less powerful partners in any relationship, typically the producers, or increasing their ability to exert their power by promoting producer associations and networks[27].

Box 11. Further Information:

- For information on the Commercialization of NWFPs see:
  - Neumann and Hirsch (2000). Commercialisation of Non-Timber Forest Products: Review and Analysis of Research. CIFOR, Bogor, Indonesia.
  - Marshall et al., (2006). Commercialization of non-timber forest products: Factors influencing success. Lessons Learned from Mexico and Bolivia and Policy Implications for Decision-makers. UNEP World Conservation Monitoring Centre, Cambridge, UK.
  - Belcher and Schreckenberg (2007). Commercialisation of Non-Timber Forest Products: A Reality Check. Development Policy Review.

3.6.5.1 NWFPs' value chain analysis

According to Marshall and Chandrasekharan (2009), as NWFPs are sourced, derived and extracted from different parts and types of plants and animals, they have varying and complex requirements for their resource management, harvesting, post-harvest treatments, processing and marketing. All NWFP activities take place within a production-to-consumption system, which is sometimes referred to as a market, supply, or value chain. Value chain resembles a network in which many of the activities, such as storage and transport, are repeated several times by different people and at different locations before the final product reaches the end consumer[79].

NWFP value chains comprise a number of different activities:

- **Collection** of the wild resource,
- **Management** of the wild resource,
- Cultivation or domestication of the resource,
- **Processing**, ranging from cleaning or air-drying to more complex processing requiring specialist skills (e.g. drying, weaving, distilling), purchased inputs (e.g. ammonia to make rubber goods) or technologies (e.g. fermentation, solvent extraction)
- **Storage**, including accumulating the raw product and/or the processed product at different points in the chain,
- **Transport**, from the harvesting site to the home and along the value chain
- **Marketing**, identifying and developing good market niches
- **Sale**, often between several sets of people, or actors, working in the value chain[79].

NWFP value chains may involve different actors:

- **Private or community owners** of the resource.
- **Individual collectors** of the product.
- **Individual cultivators** of the plant from which the product is derived.
- **Individual processors**.
- **Informal groups of producers**.
- **Community-based traders**, who transport NWFPs from source to market, often accompanied by accumulation of the product and a degree of quality control.

- **Traders and companies** situated outside the community, who may be responsible for starting up new value chains.
- **Community-owned enterprises**.
- **Cooperatives**, which may act to negotiate quantities, qualities and prices of product sold onto end consumers, or wholesalers, or more specialist processors, etc.
- **Associations**, which may have many of the benefits of a cooperative, but possibly without any decision-making capacity.
- **Government departments**, which may have a regulatory role in issuing and monitoring permits, providing grants, and promoting NWFPs.
- **Non-governmental organizations** (NGOs), which may play a role in information provision and technical and business support[79].

Various people and processes are involved in moving the NWFP along the value chain, from collection to the final use or consumption[79]. These actors fulfill the different functions of processing, storage, packaging, marketing and selling of the product, and at each stage they add value to the product. Each actor plays a role in successful trade, and has different incentives and abilities to influence the value chain[79].

Value chain analysis is important to assess how well the value chain is working and specifically in:

- Identifying these main actors or organizations and their specific activities,
- The different routes for trading the NWFP (which currently exists and what potentially is available or could be developed)
- The skills, capacity and experience available for successfully engaging in trade[79]

Value chain analysis enables the assessment of constraints and opportunities for successful NWFP trade helps in decision-making:

- The advantages and disadvantages of local value addition through processing.
- How organizing into community, producer or processor groups can help market access, improve the quality and quantity of supply and strengthen negotiating power with traders.
- Opportunities for product innovation at production-, processing- or trading level to meet changing consumer demand.
- Options for closer relationships with key traders to reduce vulnerability to sudden changes in the market.
- How to obtain more detailed information on the price, quality and quantity requirements of different markets[79].

Box 12. Further Information:

- For information on the Value Chain Analysis, case studies and examples of NWFP value chains see:
  - Marshall and Chandrasekharan (2009). Non-farm income from non-wood forest products. FAO, Rome.
  - Lockman (2016). Value chain development, value addition and development of NWFP-based rural microenterprises: Tynisia. FAO, Rome.
  - Elsheikh Mahmoud (2016). Value chain development, value addition and development of NWFP-based rural microenterprises in Sudan. Consultancy Report, FAO, Rome.
  - Value Chain Analysis. Non-Wood Forest Products. Mitrovicë/a Region (2015). Ministry for foreign affairs of Finland, UNDP.

3.6.6 Product certification[XI]

NWFP management, trade and use can be promoted through certification[78,80–82]. Certification may provide social benefits, strengthening harvesting rights and empowering local actors; economic benefits, by creating additional value, improving market access and increasing transparency; environmental benefits, since it may control harvesting rate and methods, therefore helping in not depleting species[83]. Certification may create virtuous effects among value chain actors and policy makers by laying the foundations of a sustainable management of NWFP[80]. However, NWFP certification presents some barriers. NWFPs are more difficult to certify than timber, because they comprise a group of very diverse products, also with wide end uses (e.g. food, cosmetics, pharmaceuticals components, handcrafts). Factors such as insecure harvesting rights can limit from the beginning the applicability of certification[84]. Economic barriers can hinder the process as well: harvesting in the wild often requires high labor inputs for low values and for this reason NWFPs suffer from diseconomies of scales[85]. In addition, many NWFPs are affected by seasonality and this creates discontinuity in production[83]. Often they are traded on small local scales, without efficiently structured trade systems[83]. Ecological and technical assessments such as the definition of the sustainable harvesting rates for some species may also be difficult[83]. Despite these barriers, several successful examples of standards and certification schemes that can be applied to NWFPs exist in the market.

Box 13. Further Information:

- For information on the Product Certification Schemes, see:
  - Certification schemes and standards for NWFPs (FAO)
  - NWFP branding and certification. StarTree
  - European Commission > EIP-AGRI > Certification opportunities to make wild forest products more marketable
- For information on examples of certification and labeling, see:
  - FairWild Standard

[XI] Certification is the provision by an independent body of written assurance that the product , service or system in question meets specific requirements

3.6.7 Institutions and NWFP Sustainable Capitalization

Institutions (e.g. policies, legislation, property rights and policy instruments) are essential for NWFPs' sector development. The EU role resides in formulating general rules, which each member state can freely assume and adapt to its own national legislation, according to the principle of subsidiarity[86].

According to Prokofieva et al. (2014), at EU level, there are neither policies nor legislation specifically and exclusively targeting NWFPs. However, the recognition of the ecologic, economic and social role of NWFP and the willingness to promote them is highlighted in different European and International policies and agreements concerning forests (Table 12).

Table 12 European Actions Related to Forests and NWFPs.

Environment Action Programme to 2020 **Over the past decades the European Union has put in place a broad range of environmental legislation. The 7th Environment Action Programme (EAP) will be guiding European environment policy until 2020. In order to give more long-term direction it sets out a vision beyond that, of where it wants the Union to be by 2050: "In 2050, we live well, within the planet's ecological limits. Our prosperity and healthy environment stem from an innovative, circular economy where nothing is wasted and where natural resources are managed sustainably, and biodiversity is protected, valued and restored in ways that enhance our society's resilience. Our low-carbon growth has long been decoupled from resource use, setting the pace for a safe and sustainable global society."** **It identifies three key objectives:** • **to protect, conserve and enhance the Union's natural capital** • **to turn the Union into a resource-efficient, green, and competitive low-carbon economy** • **to safeguard the Union's citizens from environment-related pressures and risks to health and wellbeing**
The Environmental Implementation Review **The Environmental Implementation Review (EIR) is a tool to improve implementation of EU environmental law and policy. It aims to address the causes of implementation gaps and try to find solutions before problems become urgent.**
Green growth and circular economy **Managing the life cycle of natural resources, from extraction through the design and manufacture of products, to what is considered as waste is essential to green growth and part of developing a resource-efficient, circular economy where nothing is wasted. Smarter design allowing products to be repaired, re-used, remanufactured and then recycled again should become the norm.**

Nature and biodiversity

Policy aiming to terminate biodiversity loss in the EU and help stop global biodiversity loss by 2020.

- ***The Nature and biodiversity law***
  - **The Birds Directive: The Birds Directive aims to protect all of the 500 wild bird species naturally occurring in the European Union.**
  - **The habitats directive: The Habitats Directive ensures the conservation of a wide range of rare, threatened or endemic animal and plant species. Some 200 rare and characteristic habitat types are also targeted for conservation in their own right.**
  - **Legislation on Wildlife Trade: Most of the EU action on wildlife trade derives from the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).**
- ***Natura 2000:* Natura 2000 is a network of core breeding and resting sites for rare and threatened species, and some rare natural habitat types which are protected in their own right. It stretches across all 28 EU countries, both on land and at sea. The aim of the network is to ensure the long-term survival of Europe's most valuable and threatened species and habitats, listed under both the Birds Directive and the Habitats Directive.**
- ***EU Pollinators Initiative :*The Initiative which sets strategic objectives and a set of actions to be taken by the EU and its Member States to address the decline of pollinators in the EU and contribute to global conservation efforts. It sets the framework for an integrated approach to the problem and a more effective use of existing tools and policies. The initiative sets actions under three priorities:**
  - **Improving knowledge of pollinator decline, its causes and consequences**
  - **Tackling the causes of pollinator decline**
  - **Raising awareness, engaging society-at-large and promoting collaboration**

- *Green Infrastructure:* **Green infrastructure is a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services such as water purification, air quality, space for recreation and climate mitigation and adaptation. This network of green (land) and blue (water) spaces can improve environmental conditions and therefore citizens' health and quality of life. It also supports a green economy, creates job opportunities and enhances biodiversity. The Natura 2000 network constitutes the backbone of the EU green infrastructure.**

- *Knowledge and data:* **The Biodiversity Strategy includes specific actions to improve monitoring and reporting, to build on the biodiversity knowledge base and to continue to fill research gaps, including on the mapping and assessment of ecosystem services in Europe. Amongst other things, it will improve our understanding of the links between biodiversity and climate change, and of the role of soil in delivering key ecosystem services, such as carbon sequestration and food supply.**

  The EU 2010 biodiversity baseline and the updated EU biodiversity indicators will be key components of this work, which will also draw on other data and information, such as that produced by the Shared Environmental Information System and Global Monitoring for Environment and Security, the European Forest Data Centre and the LUCAS Land Use Cover Area Frame Survey.

Forest policies, access rights and non-wood forest products in northern Europe (FAO)

This article discusses policies concerning NWFPs. Their role in forestry is greatly influenced by the general status assigned by legislation to the multiple uses of forests. Free access rights to multiple products and services of forests are characteristic of many northern European countries and are examined country by country. Finally, a general framework for the development of NWFP policies is outlined.

Forestry legislation in Europe: Geneva Timber and forest discussion paper 37 (2004)

It is a study providing a synopsis of forestry legislation until 2004. On this basis similarities and common

approaches in European national forest legislation were analyzed. Three essential rules were explored: (1) obligation to reforest, (2) public access to forests and (3) public use of NWFPs. The study shows that all three issues are addressed by most of the analyzed national legislation, while the specific implementation and execution of these legislative rules differs to some extent from country to country. The conclusion drawn is that common rules already exist in national forest related legislation in many European countries. The outcome of the study can be used as a basis for further comparison of national forest policies and legislation in practice, and their common features, demonstrating their contribution to the sustainable development of the region.

3.6.7.1 Case study: The role of institutions in NWFP development: current state and historical changes (Prokofieva et al., 2014)

An analysis of institutions related to NWFPs in EU member countries has been conducted by the StarTree project in 2014. The study defined "instruments" as those initiatives that attempt to make a change in forest management or the use of NWFPs and classified them firstly into:

(1) **Informational instruments**: aiming at changing forest owner or picker behavior by providing them certain knowledge;

(2) **Regulations**: establish rights and duties aiming at changing behavior in order not to be punished;

(3) **Economic instruments**: provide positive or negative incentives by modulating the financial restrictions and monetary expectations of relevant actors[86].

The identified instruments were classified then based on different NWFPs aspects as below:

(1) **Instruments for NWFP production**: those affecting forest owner or manager to orientate the forest interventions towards NWFPs production, such as subsidies that are focused for the production of certain NWFPs;

(2) **Instruments for NWFP collection, harvesting or extraction**: those affecting NWFP pickers, harvesters or hunters, such as establishment of quotas, access fees or access permits, harvesting licenses, picking fees, mandatory training on harvesting methods, aids for fencing, allowed harvesting period, etc.

(3) **Instruments for NWFP trading**: those affecting intermediaries, wholesalers and retailers, such as taxes or subsidies on sales, norms restricting sales (place, market days, market permits), health requirements, quality standards, etc.

(4) **Instruments for NWFP consumption**: those that affect final consumers' decision to purchase or not a certain product, such as certification of sustainable forest management sources, label of origin denomination, etc[86].

This analysis revealed over 160 instruments addressing NWFPs[86]. The NWFP category for which the highest number of instruments has been identified is that of mushrooms, truffles and other fungi, followed by instruments addressing game and hunting, fruits and nuts, berries and other NWFPs.

The majority of the identified instruments addresses in one way or another collection or harvesting of NWFPs; less instruments related to consumption and trade, while the least number of instruments has been identified on the side of production, that is, those instruments addressing primarily forest owners or forest managers[86].

Among the instruments addressing primarily forest owners or forest managers, economic instruments (i.e. subsidies or tax exemptions) dominate. Regulatory instruments on the production side are mainly related to game management regulations and permits for the installation of bee hives. Harvesting instruments, on the contrary, tend to be mainly of regulatory nature, among them the authors found legislation concerning harvesting rights, permits and quotas, as well as the limitation of areas where harvesting can take place[86].

Among consumption instruments the majority are informational instruments, predominantly certification and label of origin schemes. They are complemented by regulatory instruments, such as sanitary requirements, mandatory quality controls and species lists. Trade instruments are also dominated by regulatory instruments – typically different types of sales permits or trade bans. Economic instruments also have their fair share, including mainly direct financial support to businesses or different tax exemptions[86].

Prokofieva et al. (2014) mainly concluded that:

- The relevant legislation comes mainly from the national level acts; however there are differences between the legal frames at national, regional or local level. There are many and various differences between the legal frame and the actual practices on the ground, requesting therefore a careful approach of informal rules and institutions governing the use of NWFPs.
- The changes occurred in the last decade in the studied regions (Austria, Finland, Germany, Italy, Latvia, Portugal, Romania, Serbia, Slovenia, Spain, Turkey, United Kingdom) were triggered by the need to address various societal challenges such as nature protection, food safety, conflict in resource utilization, but in general had minor impact on property rights arrangements.
- The analysis of the pre-conditions for commercial use of NWFPs showed that the distinction between the commercial and personal use of NWFPs does not always operates in practice, and that the selling of the right to collect and the leasing are generally known, but practiced in few cases.
- The ability of the owner or right holder (e.g. authorized collector) to exclude the others from the commercial use varies from a region to other, and besides the law, customs and local practices regulate the public access
- The owner or the right holder are subject to different administrative procedures (e.g. quota, harvesting plans) for being allowed to the commercial use of NWFPs, however in practice they might be never implemented or enforced.
- The management of the resource for enhanced NWFPs production is possible in most of the regions, with prior approval from the authorities or based on traditional forest management planning procedures.
- Instruments addressed at production side are not very common. The ones that can be found are related to the clearly commercial products, such as chestnuts and pine kernels (Turkey, Trentino- Alto Adige, Catalonia), and also mushrooms (Castilla and Leon).
- Harvesting instruments are the dominant instruments, especially those of regulatory character.
- In many cases, there are many instruments which do not specifically address NWFPs, but rather affect them indirectly (e.g. grants for establishing and managing hedges in

Scotland), or different labels of origin that are applicable to products from a certain region, including but not exclusively NWFP.

Box 10. Further Information:

- For information on the Policies related to NWFPs, see:
  - FAOLEX database: comprehensive and up-to-date legislative and policy database, one of the world's largest electronic collection of national laws, regulations and policies on food, agriculture and natural resources management. FAO, Rome.

4 CASE STUDIES

Except from the case studies mentioned in the sections above within this report, other aspects related to the sustainable capitalization of provisioning services are described briefly below.

4.1 NWFPs: Forest condition - management scenarios and NWFPs productivity

- **Impact of forest management intensity on landscape-level mushroom productivity: A regional model-based scenario analysis (De-Miguel et al., 2014)**
  The aim of this study was to predict the effect of forest management intensity on mushroom productivity at the landscape level by means of a model-based scenario analysis. The study area was Catalonia region, north-eastern Iberian Peninsula. Mushroom yield models were developed for the most common pine- dominated forest ecosystems. The models accounted for the effect of site and stand structure on mushroom occurrence and yield. The mushroom yield models and individual-tree growth models were used in continuous cover forestry simulation and optimization to assess the impact of alternative regional forest management intensity scenarios on landscape-level mushroom productivity[87].

- **Synergies and Trade-Offs in the Production of NWFPs Predicted in Boreal Forests (Kurttila et al., 2018)**
  The objective of this study was to examine the relationships among various NWFPs and timber production at the forest holding scale. The relationships were studied with correlation analyses that were based on a large number of efficient forest plans created for two forest holdings. In addition, the relationships were studied with production possibility frontiers. The positive or negative correlations between different products reveal, respectively, the synergistic or competitive relation between NWFPs and timber, whereas the production possibility frontiers give information on how the relationship develops when the production of a given NWFP is increased within the planning area studied. In this study, empirical yield models were used to predict the production of the selected NWFPs and timber within two forest holdings having different growing stocks and growing site conditions, but typical to Finnish forests[47].

- **Meteorological conditions and site characteristics driving edible mushroom production in *Pinus pinaster* forests of Central Spain (Taye et al., 2016)**
  The aim of this study was to predict edible mushroom yield in *Pinus pinaster* forests of Central Spain, based on a 17-year data series. Two-stage mixed-effects models were used to examine the effect of predictors on mushroom occurrence and yield separately with the aim of providing further insight into the ecological system. The authors identified diverse predictors. The diversity of drivers became more apparent at the fungal species level. The models can be used for predicting the production of edible fungi under different meteorological and site conditions[46].

4.2 NWFPs: Mapping the Supply and Demand of NWFPs

- **Wild food in Europe: A synthesis of knowledge and data of terrestrial wild food as an ecosystem service (Schulp et al., 2014)**
  The authors quantified the supply, demand and benefits, mapped the spatial distribution of supply and demand, and evaluate the relations between sup- ply, demand and benefits of wild food. They present (1) an overview of the conceptual framework used to structure of their synthesis, (2) a description of the methods and data used and (4) present both descriptive results as well as an overview of the quantitative data. All available information is brought together in maps to illustrate the spatial variability of availability and demand for terrestrial wild food. This study concludes on the importance of this service in the European context and possible ways forward to further include these surveys in ecosystem service mapping[45].

4.3 NWFPs: The use of NWFPs

- **From economic survival to recreation: contemporary uses of wild food and medicine in rural Sweden, Ukraine and NW Russia (Stryamets et al., 2015)**
  The aim of this study was to compare the present use of wild food and medicine in three places representing different stages of socio-economic development in Europe. Specifically the authors explored which plant and fungi species people use for food and medicine in three selected rural regions of Sweden, Ukraine and the Russian Federation. They studied the current use of NWFPs for food and medicine in three rural areas that represent a gradient in economic development. All areas were characterized by (a) predominating rural residency, (b) high forest coverage, and (c) free access to NWFPs. A total of 205 in-depth semi-structured interviews were conducted with local residents in the three study areas. The collected NWFPs data included (1) the species that are used; (2) the amount harvested, (3) uses and practices (4) changes over time, (5) sources of knowledge regarding the use of NWFPs as wild food and medicine and (6) traditional recipes. They concluded that in the economically less developed rural areas the use of NWFPs continues to be an important part of livelihoods, both as a source of income and for domestic use as food and medicine. In economically developed areas the collection

of wild food has become mainly a recreational activity and the use of medicinal plants is no longer prevalent. This study suggests that the consumption of wild food and medicine is influenced by the socio-economic situation in a country[88].

- **From famine foods to delicatessen: Interpreting trends in the use of wild edible plants through cultural ecosystem services (Reyes-García et al., 2015)**
  The argumentative line of this study is that cultural ecosystem services and values associated to the consumption and gathering of wild edible plants might help interpreting divergent trends in the use of these plants. Using information from seven sites in the Iberian Peninsula and one in the Balearic Islands, the authors first identified current trends in the consumption and gathering of wild edible plants and then analyzed how different cultural ecosystem services relate to such trends. They concluded that cultural services and values associated to the gathering and consumption of some wild edible plants are important factors explaining divergent trends across plant species[89].

- **A Matter of Taste: Local Explanations for the Consumption of Wild Food Plants in the Catalan Pyrenees and the Balearic Islands (Serrasolses et al., 2016)**
  In this study, the authors used empirical data to explore the factors driving the consumption of a selected set of wild food plants. The study was initiated by analyzing the different trends (i.e., abandonment, maintenance, and valorization) across 21 selected species with different food uses. The authors then explored the reported motivations that drive such trends using data collected among 354 respondents in three Catalan-speaking rural areas. The consumption of wild food plants was found to be decreasing in the three study areas and across the categories of food use analyzed. Respondents listed sociocultural factors, rather than environmental or economic factors, as more prominent determinants of consumption trends; taste preferences seemed to be the most relevant motivation for those who continue to consume wild food plants, whereas a myriad of motivations related to changes in lifestyle were provided by those who explain the abandonment of their consumption[90].

- **A manifesto for the valorization of wild edible plants (Bacchetta et al., 2016)**
  This study aims to stimulate national and international bodies dealing with food and agriculture, to increase their attention and investments on wild edible plants, leveraging the results of scientific investigation, enhancing the link between in situ conservation strategies and sustainable use of plant genetic diversity. According to the authors, wild edible plants should be reconsidered throughout their value chain, capturing their important socio-cultural, health, and economic benefits to indigenous and local communities and family farmers who are engaged in their production and wild-harvesting[91].

- **Prediction of the conditions for the consumption of game by Polish consumers (Kwiecińska et al., 2017)**

Based on quantitative data from 1000 respondents a model predicting the consumption of wild game based on logistic regression has been prepared in this study. T demonstrated that consumers are likely to increase their consumption of game, provided that it will have a higher quality and greater commercial availability. A higher propensity to change eating habits in respect of game was displayed mainly by men, city dwellers and those who evaluated their own knowledge on nutritional and diet higher than others[92].

4.4 NWFPs: Supply Chain

- **Natural biotic resources in Life Cycle Assessment (LCA): Towards an impact assessment model for sustainable supply chain management (Crenna et al., 2018)**
  The aim of this study was to enable the inclusion of biotic resources in the assessment of products and supply chains. This paper puts forward a framework for biotic resources assessment, including: (1) the definition of system boundaries between ecosphere and technosphere, namely between naturally occurring and man-made biotic resources; (2) a list of naturally occurring biotic resources which have a commercial value, as basis for building life cycle inventories (NOBR, e.g. wild animals, plants etc); (3) an impact pathway to identify potential impacts on both resource provision and ecosystem quality; (4) a renewability-based indicator (NOBRri) for the impact assessment of naturally occurring biotic resources, including a list of associated characterization factors. The study highlights and discusses the critical aspects and paradoxes related to biotic resource inclusion in LCA: from the system boundaries definition up to the resource characterization.

- **A comparative study of the legal and grey wild product supply chains (Grivins, 2016)**
  The study analyses two types of supply chains that have emerged due to lack of government presence and illustrates possibilities for community both supply chain types offer[93].

4.5 NWFPs: Authentication and Certification

- **Game meat authentication through rare earth elements fingerprinting (Danezis et al., 2017)**
  The authors of this study developed and validated a new method for authentication of wild rabbit meat using elemental metabolomics approach. Elemental analysis was performed using rapid ultra-trace multi-element measurement by inductively coupled plasma mass spectrometry (ICP-MS). Elemental signatures showed excellent ability to discriminate the wild rabbit from non-wild rabbit meat. The authors concluded that their results demonstrate the usefulness of metabolic markers -rare earth signatures, as well as other trace element signatures for game meat authentication[94].

4.6 NWFPs: Policy tools

- **What to do with mushroom pickers in my forest? Policy tools from the landowners' perspective (Górriz-Mifsud et al., 2017)**
  Through a survey of private forest owners in Catalonia (north-eastern Spain), this study examines their experiences with mushroom pickers, the factors shaping their related policy preferences and their willingness to engage in mushroom reserves. The results show broad support for introducing mushroom picking norms. A regulation would allow outsider pickers to enter private land, but only under certain conditions, i.e. to comply with socio- ecological rules of the area. Among respondents who support the regulation, active land owners who report instances of picker-related harm (both tangible and intangible) tend to support the establishment of a fee system which could be reinvested into forest management. That was also the position of the respondents who perceive mushrooms as a private right, i.e. they believe to have a legitimate right to exclude outsider pickers and, eventually, to raise revenues from that asset. On the contrary, forest owners who conceive mushroom picking as a free-access activity prefer neither to regulate it nor to charge fees. The option to establish a mushroom picking reserve depends on the landholder being a fee-supporter and perceiving instances of harm. Harm, instead, is mainly determined by the perception of congestion of pickers, which in turn is determined by the mushroom productivity of their forest, their level of privacy protection and their involvement to the primary sector. The authors suggest, that these findings help policymakers to better understand the logic and sensitivities of forest owners in view of designing mushroom picking policies that can effectively solve picker-landowner conflicts[95].

- **Viability of Introducing Payments for the Collection of Wild Forest Mushrooms in Catalonia (North-East Spain; Prokofieva et al., 2017)**
  According to the authors, wild mushrooms are among the most valuable non-wood forest products in the world, and mushroom picking activities are well developed in many countries. Recent studies have demonstrated important links between forest management options and the productivity of mushrooms. Furthermore, there is evidence that the optimal forest management oriented at maximizing joint revenues from timber and mushrooms can lead to higher profits than the traditional timber-oriented management. The precondition for such management, however, is that forest owners derive benefits from mushrooms produced in their forests. In this study, we discuss the feasibility of implementing payments for mushroom harvesting in Catalonia, North East Spain. As in many other European regions, mushroom picking in Catalonia is a long-standing tradition, which has been practiced with negligible limitations for centuries. The rising popularity of this activity in the last decades, however, has caused forest owners to voice concerns about the sustainability of this activity and about the impact it has on the private forest property. The authors documented the results of a public opinion survey and contrast them with the issues emergent from forest owners' interviews about the regulation of mushroom picking activities. Their results showed

that mushroom pickers support the idea of introducing payments for mushroom harvesting. Based on the survey and interview results, the authors also discuss the design aspects of payments for mushroom picking and articulate the key issues in their implementation[96].

5 STATUS, PERSPECTIVES & CHALLENGES

As mentioned above, capitalization is the provision of capital for an organization or the conversion of income or assets to capital. Sustainable capitalization is the capitalization able to be maintained at a certain rate or level.

Sustainable capitalization of provisioning services related to NWFPs as a definition resembles the need for recognizing the status, perspectives, challenges and actions to be taken to address these challenges in order to better safeguard the local livelihoods and sustain forest ecosystems to continue supplying NWFPs in the long-term.

5.1 Status and Perspectives for Europe, Mediterranean and Balkans

According to Wiersum et al. (2018), the importance of NWFPs as commercial resources is illustrated by the formal country data on NWFP production as published in the State of European Forests 2010[97]. The overall value of NWFPs is 2,763 million Euro[97] of which 83% is generated by plant products[98]. This value represents around 10% of the value of roundwood, which is quite important especially when considering that the overall NWFP value is an indicative of a minimum value as it only includes formally enumerated NWFPs and do not include self-collected and informal use of NWFPs[98]. Particularly in the Mediterranean region, where an immense diversity of NWFP exists, and the profitability of wood is lower, the value of NWFP is representing a considerable part of the total forest production[98]. The estimated total value for NWFP production by Mediterranean forests is 822.4 million Euro and product types are differently distributed in sub-regions[59].

Europe is characterized by diversity in NWFP production and use[97]. Due to the prevailing socio-economic conditions relatively few people depend on these products for their basic livelihood needs or for gaining an income[97]. However, household surveys in 29 European countries indicate that almost 90% of European households consume NWFPs in one form or another and that around 25% of households collect NWFPs for personal use[98]. Another survey in 13 European regions indicates that around 75% of all NWFPs were opportunistically harvested without any specific management of their production[98]. According to Wiersum et al. (2018), the previously-mentioned surveys reflect that the personal use of NWFPs in Europe dwarfs their contribution as an industrial resource[97].

The trends in NWFP production and use in Europe show that many products are progressively evolving from a basic rural livelihood and industrial product to an intrinsic component of nature-based experiential products for modern society[97]. This change is related to the ongoing process of rural transformation together with the rise of well-being as a personal and societal goal[97]. However, the social, economic and cultural differences observed between different European countries/regions result in a variety of perspectives

on the development potential of NWFPs[97]. Focusing only in the South-eastern European countries, for example, the perspectives resemble more of a livelihood focus[97].

A survey amongst country representatives of the COST Action FP1203 on European non-wood forest products identified five main orientations on the perceived development potential of NWFPs:

- NWFPs serving as cultural resources representing cultural landscape heritage values that contribute to the conservation of traditional forested landscapes and serve to enhance recreational activities of urban people.
- NWFPs serving as resources for forest enterprise development enabling diversification and optimization of forest income through multi-purpose management and/or co-production.
- NWFPs contributing to regional development by providing niche products for regional markets often mediated by cooperative producer or marketing net-works; such products may be stimulated by subsidies and incentives for rural development.
- NWFPs serving as common pool resources that provide 'wild foods' serving as assets for education and health improvement and which require public aware-ness on rights for personal collection and a careful regulation of commercial production.
- NWFPs serving as a bio-economic resource that has potential for greening of agriculture and the development of forest-analogue production systems.

The different orientations were ranked differently depending on the country/region and stakeholder type. Mediterranean and South-Eastern countries, for example, perceived the overall scope of NWFP development higher than the rest European regions[97]. In the Mediterranean region the potential for production of NWFPs as both cultural and common resources was rated highest. In contrast, in the South-eastern European countries the potential for regional development and related forest enterprises is considered most important[97].

Wiersum et al. (2018), in an extensive review, concluded that when considering the development potential of NWFPs in Europe, not only the optimization of the production and marketing systems need attention, but also the newly emerging forms of NWFP use that result from socio-cultural dynamics and processes of rural transformation[97].

5.2 Identification and classification of NWFPs

There is a major data gap in current global NWFP statistics. Even when information is available, it is often partial or fragmented and lacks comparability across countries and over time. This imbalance has led to an underestimation of existing and potential socioeconomic benefits, and, furthermore, of the full economic contribution of forests. NWFPs are recognizable under a wide range of categories in the three international schemes HS, CPC and ISIC, although with varying levels of detail. Furthermore, NWFPs are often classified under agricultural categories without any distinction between wild and farmed produce. A

clear boundary between agriculture and forest products is needed for the purposes of collecting statistics, especially for the identification of food items. Some NWFPs are classified in broad categories which cover a wide variety of products. It is essential to understand the importance of forest items included in these categories and eventually to categorize them under a separate code. Statistics practitioners are recommended to adopt the internationally agreed framework of statistical standards. Details on products and suggested improvements allow users to collect and compile internationally comparable data according to their needs. National statistics on NWFP production often refer to the marketed production and do not include the quantity used for self-consumption or sold/exchanged through informal sector transactions. Consequently, the amount of wild harvested production will be much higher than the existing data sources show. This magnitude can be captured through targeted household surveys.

The above-mentioned derived from Sorrenti (2017) concluding that further actions should be taken to improve NWFPs statistics:

(1) Further clarify definition and classification issues
(2) Improve awareness of and collaboration with national statistical agencies, trade associations, CITES national management authorities and related entities regarding data collection on NWFPs and associated terminology challenges.
(3) Strengthen collaboration between FAO and the international agencies responsible for the maintenance, updating and revision of reference classification of products, UNSD and WCO, in order to harmonize NWFP data.

5.3 Inadequate information for the assessment of Ecosystem Services related to NWFPs

The information available to assess the consequences of changes in ESs for HWB is relatively inadequate[7]. Many ESs have not been monitored and it is also difficult to estimate the relative influence of changes in ESs in relation to other social, cultural, and economic factors that also affect HWB[7]. In addition, many ESs, such as the non-marketed NWFPs do not pass through markets. The benefits they provide to society, therefore, are largely unrecorded: only a portion of the total benefits provided by an ecosystem make their way into statistics, and many of these are misattributed[7]. Even if individuals are aware of the services provided by an ecosystem, they are neither compensated for providing these services nor penalized for reducing them[7]. These non-marketed benefits are often high and sometimes more valuable than the marketed benefits[7]. This report and incorporated literature provide tools to further and proper assess NWFPs-related ESs. There is an urgent necessity for a general widely-accepted assessment methodology dedicated to NWFPs.

5.4 The Way through Proper Ecosystem Services Assessment

ESs may be measured and evaluated in various ways and according to various metrics, which are broadly qualitative, quantitative or monetary[24]. Qualitative analyses are usually easier and less expensive to conduct than quantitative analyses. Likewise, quantitative analyses

usually require fewer resources than monetary analyses[25]. According to TEEB (2009) a pragmatic approach to valuation can be summed up as follows: "always identify impacts qualitatively, then quantify what you can, then monetize (where possible)".

One of the first steps in ESs' assessment towards their sustainable capitalization is an overall rapid assessment of the ESs[4]. For the rapid ecosystem assessment (REA) no prior knowledge of ESs is required. Steps towards REA: (1) Define the site of interest in its current state, (2) Identify and engage stakeholders, (3) Specify the objective of the assessment. Steps during REA: Identify the range of ESs being delivered by the site in its current state, (2) define an alternative state, (3) assess how the ESs delivered by the site might change in the future, (4) compare the outcomes and present the results. Notion should be taken to avoid double-counting and potential trade-offs between different ecosystem services.

Any assessment of the quantity of ESs provided by a site must consider both (1) the biophysical capacity of the site to provide (potential) ESs and (2) the use made of those services by human beneficiaries. The first step involves assessing the potential or capacity of an ecosystem to output goods and services that people can benefit from. The second stage involves assessing the actual goods and services provided by the site, by considering the extent to which the goods and services provided by the site are actually used by people (either directly or indirectly) or benefit people (e.g. in terms of both use and non-use values).

There are three basic approaches or their combination to use for ESs quantification: (1) Collection of primary data through direct observations, (2) Proxy methods in which single or combined indicators are used to define ES, (3) Process models in which indicators are used as variables in the equation. Examples for NWFPs are provided in this report.

Measurement in monetary terms provides estimates of values in comparable units to enable the assessment of trade-offs and to demonstrate the importance of certain ESs[22]. The rationale behind ecosystem valuation, therefore, is to unravel the complexities of socio-ecological relationships, make explicit how human decisions would affect ES values, and express such changes in value in units (e.g. monetary) that allow their incorporation in public decision-making processes[52]. Total economic value (TEV; or output value) of ecosystems and biodiversity is defined as the sum of the values of all service flows that natural capital generates both now and in the future[49]. The elements of TEV are described in this report.

Direct- and indirect market valuation techniques can be used for the valuation of the provisioning services related to NWFPs however some precautions should be considered (mentioned in this report). For example, NWFPs can be marketed or non-marketed. In many cases, the value of non-marketed wild foods is likely to be reflected in recreational values. The method to be used is dependent on (1) time, (2) resources, (3) expertise and (4) the availability of data.

5.5 Sustainable harvesting of NWFPs and Forest Management

The sustainable harvesting limits are known for a small number of NWFPs species internationally[77]. The aggregate value of the top NWFP species is annually worth billions of euro to local people and economies. According to Shackleton and Pandey (2014) a research budget of only a small fraction (<0.25%) of this aggregate value of NWFPs could be wisely invested in securing the long term access and yields from these species by investigating their autecology, sustainable yield and best management options[74].

5.6 Challenges for NWFPs production and marketing

According to Wolfslehner et al. (2013), the environment for NWFP suffers from traceability and transparency of the real dimension of marketing and trade. The market structure has been deeply explored in the forestry sector with regard to wood-based material, but only few large-scale studies have been carried out related to NWFPs[98]. Additionally, there are a few studies exploring the actors (stakeholders) relation in the regional market, only few works have explore the role of territorial marketing in NWFP promotion, and means used to increase the stakeholder awareness to enhance the use of NWFP at local or regional level[98].

5.7 The need for successful NWFPs international trade

NWFP trade is, relative to that of other commodities such as timber, far more complex and difficult to understand and regulate, as NWFP cannot be successfully regulated as a uniform commodity[78]. Bechler and Schreckenberg (2007) indicate some of the challenges of commercializing NTFPs beyond the local level such as the markets are poorly developed and the production is often dispersed, markets are diverse and faddish but product development is long, volumes of NTFPs are typically small[27].

The international trade in NWFP is regulated through a broad range of trade-related instruments:

- The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and certain national species conservation measures have their basis in the conservation of biodiversity
- Import tariffs or phytosanitary certificates are used for capturing revenue, or for food health and quality control.
- There are also many trade-related instruments such as trade rules within the World Trade Organisation (WTO) that are based on enhancing trade liberalization, covering a broad range of products in international trade. For these instruments NWFP are not the key commodities being targeted and the impacts are not always supportive of sustainable use and trade.

NWFP trade is also affected by voluntary trade measures developed by the private sector, such as certification and eco-labeling schemes, that generally aim to achieve the dual aim of biodiversity conservation and the equitable distribution of benefits to the communities for whom such trade plays a key livelihood role.

5.8 Challenges for governance

According to Wolfslehner and co-workers (2013), the lack of institutional capacity has been recognized as a major constraint in NWFPs market development[99,100]. Institutional capacity, according to the authors, is the capacity of policies, regulations, policy instruments and informal norms to address relevant NWFP issues[98].

In parallel there is evidence for several major trends in NWFP governance such as (a) increasing formalization of informal norms and practices; (b) the emergence of new formal standards for NWFP production, harvesting, consumption and trade, and (3) the increasing hybridization of governance forms[101,102]. Summing up, Wolfslehner and co-workers (2013), indicate that scientific research aiming to identify the barriers and opportunities for NWFP sector needs to be advanced in several ways:

- There is a need to explore the influence of policies (national, international, sectorial and cross-sectorial) on different stages of NWFP value chain, and critically assess their capacity for advancing the potential of NWFP sector.
- A systematic assessment of the implementation measures of policies and regulations addressed at promoting the development of NWFP sector need to be performed in order to identify the gaps in their performance and establish the successful patterns with the potential to be replicated in other similar contexts (both across geographical areas and across different NWFPs).
- The role of different actors in the promotion of NWFP sector needs to be identified and their role as drivers of institutional change needs to be explored.

5.9 Innovation and NWFPs

Provision of information on market potential and strategies, intersectional integration and financial assets for investments into real innovation in forest goods and service are crucial for a further development of NWFP[98]. According to Wolfslehner and co-workers (2013), the following points require specific attention:

- Innovation potentials and trends in new non-wood products.
- Understanding of the formulation and implementation of policies aiming at the support of innovations and start-ups in the non-wood sector, including the effect of innovation support instruments.
- Understanding of the role of different public and private actors, including the land-owners, rural companies, service providers, interest groups, policy makers, research, training and education organizations, etc.
- Understanding the role of the institutional frameworks for the development and implementation of innovations.
- Understanding the role of innovation system functions such as information provision, coordination of actors as well as financing and other incentives.
- Practical recommendations, guidelines and tools for innovation support, for companies and institutional actors.

6 CONCLUSIONS

There are two principal reasons for promoting the sustainable capitalization of provisional services related to NFWPs: (a) The livelihoods perspective: increasing the value of an NWFP in trade (i.e. NWFP commercialization), is expected to increase income and employment opportunities, especially for poor and otherwise disadvantaged people[27], (b) The conservation perspective: NWFPs commercialization can provide opportunities for (relatively) nonthreatening forest utilization[31] and even create incentives for the conservation of individually valuable species and the environment in which they grow[27]. The idea is that demand for products from a forest environment will translate effectively into demand for forest.

When the value of an NWFP and the intensity of exploitation are low, human impact on that NWFP are likely to be minimal and little if any formal management of the resource is required[33]. When the value of an NWFP and the intensity of exploitation are extremely high, it is highly likely that the resource is being overexploited and is threatened with local extinction (in this way substitution or domestication may be the only way to conserve the wild resource without affecting local livelihoods; Fig. 3)[33]. Between these two extremes, human use of wild resources has a measurable impact on NWFP species abundance and productivity but can be sustainable if appropriate management systems are activated[33](Fig.13).

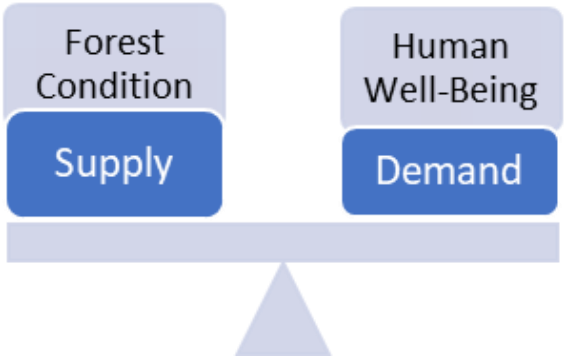

Figure 12. *Towards balancing supply and demand*

In this report, setting the Ecosystem Approach as the guiding principle, knowledge derived from previous studies has been gathered, structured and presented regarding the sustainable capitalization of provisioning services related to NWFPs. Following the importance of the sustainable capitalization of these ecosystem services we (1) review and analyze the steps for a proper assessment of NWFPs-related provisioning services from the rapid assessment to the economic valuation, (2) indicate the mechanisms ensuring the

sustainable capitalization of NWFPs, (3) provide case studies and (4) present the status, perspectives and challenges for the NWFP sector.

Based on the guidelines given in this report on different aspects of NWFPs sustainable capitalization, some important statements derived from the present process are summed up below:

- There is a need for proper classification of NWFPs that will improve data collection and statistics
- There is a need for the use of proper supply and demand indicators towards NWFPs assessment.
- There is a need to take into account non-market activities when appraising provisioning services related to NWFPs.
- There is a need to consider pressures threatening the supply and demand for these services when designing and implementing research and/or measures.
- Inventory and research on key species are considered as probably the most important requirement for stimulating sustainable development initiatives through NWFPs use.
- Yield studies, regeneration studies and harvest assessments are important tools for evaluating sustainable harvest levels.
- The sustainable harvesting of NWFPs requires sustainability in overlapping fields, namely the social, economic, political, and ecological.
- The assessment of the local resource use provides an opportunity to learn how local communities manage key NWFP resources and what practices they employ.
- Improved harvesting methods, post-harvest technologies and measures for multiple co--management of wood and non-wood products are essential tools for enhancing the sustainability of NWFPs.
- Value chain analysis is crucial for identifying the main actors or organizations and their specific activities, the different routes for trading the NWFP (which currently exists and what potentially is available or could be developed), the skills, capacity and experience available for successfully engaging in trade.
- NWFPs' certification may provide social benefits, strengthening harvesting rights and empowering local actors; economic benefits, by creating additional value, improving market access and increasing transparency; environmental benefits, since it may control harvesting rate and methods, therefore helping in not depleting species.
- When considering the development potential of NWFPs in Europe, not only the optimization of the production and marketing systems need attention, but also the newly emerging forms of NWFP use that result from socio-cultural dynamics and processes of rural transformation.

- There is a lack of institutional capacity and as such, scientific research aiming to identify the barriers and opportunities for NWFP sector needs to be advanced in several ways.

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ANNEX A TEMPLATES EXAMPLE FOR REA

A1. Template for the identification of the ESs at the site in its current state and the people that benefit from those services.

Service	Associate habitat Type(s)	Relative importance Score (0-5)	Key-beneficiaries (local-global)

Adopted from McCarthy and Morling (2014)

A1. Templates for the comparisons between the current and alternative states concerning habitat type and services.

Hapitat type	State	Percentage coverage (%)	Change in percentage (%) cover	Description of change
Woodland	Current	90	-10%	Conversion of Woodland to Agriculture
	Alternative	80		

Service	Associated habitat type(s)	State	Relative importance score (0-5)	Key-beneficiaries (local-global)
		Current		
		Alternative		

Adopted from McCarthy and Morling (2014)

ANNEX B TEMPLATES TABLE FOR NWFPS ASSESSMENT

ANNEX C USEFULL LINKS

Link	Description – Notes
NTFP-EP (Non-Timber Forest Products Exchange Program)	A collaborative network of over 60 non-governmental organizations (NGOs) and community-based organizations (CBOs) working with forest-based communities to strengthen their capacity in the sustainable management of natural resources in the Philippines, India, Indonesia, Malaysia, Vietnam, and Cambodia.
SFM (Sustainable Forest Management Toolbox-FAO)	The SFM Toolbox collates a large number of tools, case studies and other resources, 84rganized in modules. It has been created to provide forest owners, managers and other stakeholders with easy access to those resources for the implementation of SFM.
SFM – Management of Non-Wood Forest Products	The Management of Non-Wood Forest Products (NWFP) Module is aimed at all actors – such as local communities, the private sector, governments, traders and consumers – involved in the management, use and marketing of NWFPs. The module provides basic and more detailed information on the process of NWFP management, including planning, harvesting, marketing and trade. The module also provides links to tools for NWFP management and case studies of effective management.
MA (Millennium Ecosystem Assessment)	The objective of the MA was to assess the consequences of ecosystem change for human well-being and the scientific basis for action needed to enhance the conservation and sustainable use of those systems and their contribution to human well-being. The MA has involved the work of more than 1,360 experts worldwide. Their findings, contained in five technical volumes and six synthesis reports, provide a state-of-the-art scientific appraisal of the condition and trends in the world's ecosystems and the services they provide (such as clean water, food, forest products, flood control, and natural resources) and the options to restore, conserve or enhance the sustainable use of ecosystems.
MAES (Mapping and Assessment of Ecosystems and their	Aims to provide a knowledge base on ecosystems and their services in Europe. It underpins the achievement of all 6 targets of the strategy and is also relevant to a number of other EU sectoral policies such as

Services)	agriculture, maritime affairs and fisheries, and cohesion.
StarTree	StarTree is a pan-European project to support the sustainable exploitation of forest resources for rural development. The project ran from November 2012 – October 2016 and is now completed.
TEEB (The Economics of Ecosystems and Biodiversity)	The TEEB study is underpinned by an assessment of state-of-the-art science and economics. The goal of TEEB Ecological and Economic Foundations is to provide the conceptual foundation to link economics and ecology, to highlight the relationship between biodiversity and ESs and to show their importance for human well-being.
DEFRA (Department for Environment, Food & Rural Affairs, UK) – Guidance on ESs	Guidance for policy and decision makers on using an ecosystems approach and valuing ESs.
BISE (Biodiversity Information System for Europe) – ESs	BISE is a single entry point for data and information on biodiversity supporting the implementation of the EU strategy and the Aichi targets in Europe.
biodivcanada (Canada's national biodiversity clearing-house) – ESs Toolkit	The ESs Toolkit is a technical guide to ESs assessment and analysis that offers practical, step-by-step guidance for governments at all levels, as well as for consultants and researchers.
SINCERE PROJECT (Spurring Innovations for forest ESs in Europe)	SINCERE will develop novel policies and new business models by connecting knowledge and expertise from practice, science and policy, across Europe and beyond
ESP (ESs Partnership) – Ecosystem Service Valuation Database	Worldwide network to enhance the science, policy and practice of ESs for conservation and sustainable development
CICES (Common International Classification of ESs)	The Common International Classification of ESs (CICES) developed from the work on environmental accounting undertaken by the European Environment Agency (EEA). It supports their contribution to the revision of the System of Environmental-Economic Accounting (SEEA) which is currently being led by the United Nations Statistical Division (UNSD).
EVRI (Environmental Valuation Reference Inventory)	
Valuing Nature	The Valuing Nature Program aims to better understand and represent the complexities of the natural environment in valuation analyses and

	decision making. It will consider the economic, societal and cultural value of ESs.
OpenNess (OPERATIONALISATION OF NATURAL CAPITAL AND ESS)	OpenNESS aims to translate the concepts of Natural Capital (NC) and ESs (ES) into operational frameworks that provide tested, practical and tailored solutions for integrating ES into land, water and urban management and decision-making. It examines how the concepts link to, and support, wider EU economic, social and environmental policy initiatives and scrutinizes the potential and limitations of the concepts of ES and NC.