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Assessment of Ecosystems and Ecosystem Services in Romania

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Only by integrating nature into public decisions at all levels can be ensured the upholding of biodiversity and, along with it, the long-term human well-being.

For more information project-related, please visit the N4D project website: maesromania.anpm.ro and for more information about EEA grants visit www.eeagrants.org, www.eeagrants.ro and www.eeagrantsmediu.ro.

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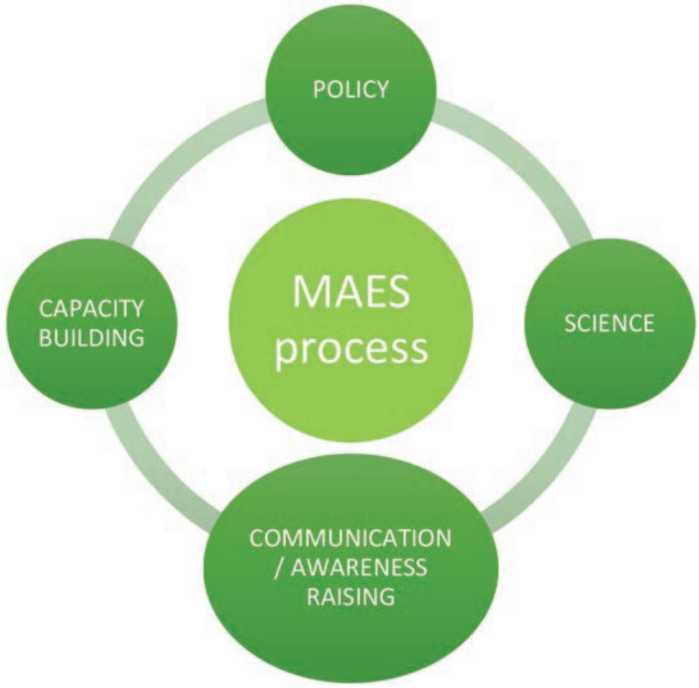
Chapter 1
Introduction

The complexity of today's environmental problems has amplified to the point where we have finally admitted that we have been ignoring sustainability in human action with great impact on the functioning of natural systems.

The process of Mapping and Assessing Ecosystems and their Services (MAES) promoted by the European Commission **is considered a first step** to achieve good state of ecosystems and their services. Romania has launched the MAES process in March 2015 with the implementation of the project "Demonstrating and promoting natural values to support decision-making in Romania" (shortly N4D – Nature for decision-making).

MAES is a complex process that goes beyond its title of Mapping and Assessing Ecosystems and their Services. In fact, MAES is about science, policy, capacity building and communication/ awareness raising, which altogether constitute the conceptual framework[1] used for the implementation of the N4D project (Figure no.1).

Figure 1. MAES conceptual framework underpinning the implementation of the N4D project.



Action 5 of the Biodiversity Strategy requires Member States, with the assistance of the Commission, to map and assess the state of ecosystems and their services in their national territory by 2014. Given the later start of the process in Romania, the opportunity to adopt, since the beginning, an **integrated approach** between the four MAES pillars was taken based on the following considerations: a policy analysis is a

1 The conceptual framework used for the MAES process in Romania is based on the fact that to achieve Good Ecosystems Governance, scientific information on ecosystems and their services need to be integrated into public policies dealing with natural resources and environmental management. Once ecosystems and their services are mapped and assessed, scientific information needs to be communicated to relevant stakeholders. Awareness must be raised on the importance to improve public policies in order to avoid biodiversity loss and achieve a Sustainable Green Economy in the context of sustainable development. If necessary, stakeholders' capacity to use MAES knowledge needs to be built.

necessary complement to the scientific assessment of ecosystems and their services to be able to improve decision and policy making, using MAES process results in order to achieve Good Ecosystems Governance and sustainable development; also, awareness raising and capacity building of relevant institutions take time and are fundamental for the successful uptake of scientific information into decision and policy making since it is not possible to manage what it is not known.

Assessing the economic value of all ecosystems services, and promote the integration of these values into accounting and reporting systems at EU and national level is to be done by 2020, so a **follow up** of the N4D project is also a necessity and a logical step towards achieving good state of ecosystems and their services and consequently **human well-being**.

1.1. Objectives of the Report

The purpose of this report is to inform EU and Romanian Government and other stakeholders (scientific institutions, civil society) about the implementation of the MAES process in Romania, the results of the implementation and recommendations.

This report is mainly addressed to **national policy and decision makers** as well as **government administrations and institutions** responsible for implementing national policies. It is primarily intended for the **Ministry of Environment** (MoE), responsible for the MAES process, and the **National Environmental Protection Agency** (NEPA), with delegated responsibilities for implementing the MAES process at national level. **Scientific circles** including national research institutes, universities as well as independent experts also constitute a primary audience due to the strong link between scientific research and policy elaboration. This report is also relevant for **civil society organizations** active in the environmental and development fields on issues such as improvement of public policies, protected area management, natural resources management, sustainable production and consumption, etc. Finally, the **European Commission** is interested in Member State's experience and progress towards implementation of the MAES process and thus, the report will be shared with their representatives.

1.2. Background

The problem of **biodiversity loss** has been recognized globally along with the fact **that adequate indicators are needed to address the global challenges of the 21st century** such as climate change, poverty, resource depletion, health and quality of life, and last but not least, the consequent mounting migration phenomena of "political-environmentally (resource) displaced people".

Economic indicators such as GDP were never designed to be comprehensive measures of prosperity and well-being. In 2007, the European Commission (EC), European Parliament, Club of Rome, OECD and WWF hosted the high-level conference "Beyond GDP" with the objectives to clarify which indices are most appropriate to measure progress, and how these can best be integrated into the decision-making process and taken up by public debate. In August 2009, **the EC released the Communication "GDP and beyond: Measuring progress in a changing world"** providing a roadmap made of five key actions to be undertaken in the near term:

- Complementing GDP with highly aggregated environmental and social indicators
- Near real-time information for decision-making
- More accurate reporting on distribution and inequalities
- Developing a European Sustainable Development Scoreboard
- Extending National Accounts to environmental and social issues.[2]

2 http://ec.europa.eu/environment/beyond_gdp/background_en.html

The 2013 EC report on "GDP and beyond" actions shows that progress has been made over the last 3-5 years in the development of **environmental indicators**: two summary indices on environmental pressures at EU level and on the global environmental impacts of EU consumption are being developed and tested. Progress has also been made by Eurostat and the European Environmental Agency on the issue of **"early estimates"** of key environmental indicators sufficiently accurate to inform policy decisions. On the **quality of life** and social side, indicators and indices as well as a solid basis to provide objective information on quality of life and well-being are now available. In particular, progress towards poverty eradication is now followed using an aggregate indicator measuring "people at risk of poverty or social exclusion" while the European statistical system has developed its wide-ranging EU statistics on income and living conditions. The **system of national accounts** is being extended to environmental and social issues to provide a sound basis for indicator production. A first regulation, adopted in 2011, contains three modules: air emissions, environmentally related taxes and material flow account, while a second regulation, adopted at the end of 2013, included physical energy flow, environmental goods and services and environmental protection expenditures.[3]

Indeed, science-based benchmarks and quantitative tracking contribute to focus the debate on sustainable economics and well-being rather than on merely growth, which does not necessarily mean well-being. Sustainability policies that apply Ecological Footprint-HDI findings **can help achieve Sustainable Development Goals**, including:

- Engaging public actors in transforming Ecological Footprint diagnoses into sector-specific policy prescriptions;
- Promoting the incorporation of the risk of global ecological overshoot into economic decision-making;
- Developing sector-level Ecological Footprint assessments to reduce the gap between awareness and implementation of solutions designed to align the human economy with planetary boundaries.

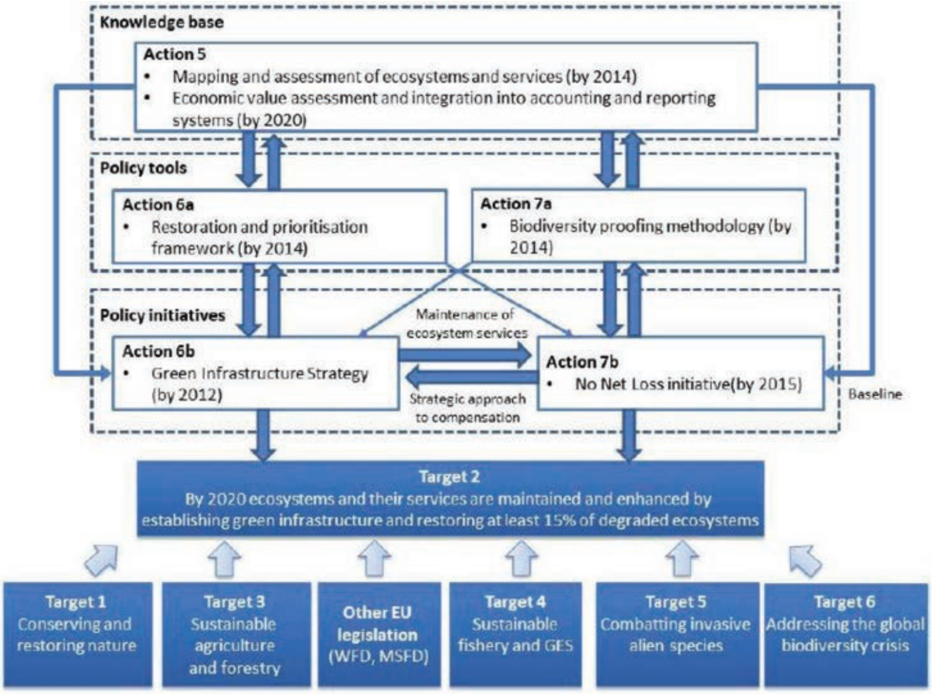
The role of measures that go beyond GDP in policy-making is at least twofold. On the one hand, they can be used by politicians to **better monitor and evaluate progress** at society level, taking into account environmental sustainability and social inclusion, which are not covered by GDP. On the other hand, such measures can be used to **better communicate in a clear way** that a given policy may affect many other elements of the society and not only the thought-to-be targeted economic activity.[4]

On March 2010 the EC adopted its **Europe 2020 strategy** and engaged to monitor annually the situation on the basis of a set of indicators showing overall progress towards the objective of smart, green and inclusive economy delivering high levels of employment, productivity and social cohesion.[5]

Last but not least, the **EU biodiversity strategy to 2020** was adopted on May 2011 with the aim to halt the loss of biodiversity and ecosystem services in the EU by 2020. Resulting from two commitments made by European leaders in 2010 (the Environmental Council conclusions of 15 and 26 March) and also in line with the commitments taken by the EU at the international Convention on Biological Diversity, it includes a **2020 Target** - *To halt the loss of biodiversity and the degradation of ecosystem services in the EU by 2020, restore them in so far as feasible, while stepping up the EU contribution to averting global biodiversity loss*, and a **2050 Vision** - *Our biodiversity and the ecosystem services it provides – its natural capital – are protected, valued and appropriately restored for their intrinsic value and essential contribution to human well-being and economic prosperity, and so that catastrophic changes caused by the loss of biodiversity are avoided*.[6] The **MAES (Mapping and Assessment of Ecosystems and their Services) process** coordinated by the EC falls under Target no.2 – Action no.5 of the EU biodiversity strategy to 2020 as explained in Figure no.2 below.

3 Idem
4 Idem
5 http://ec.europa.eu/europe2020/europe-2020-in-a-nutshell/index_en.htm
6 http://ec.europa.eu/environment/nature/biodiversity/policy/index_en.htm

Figure 2. Importance of Action 5 in relation to other supporting Actions under Target 2 and to other Targets of the EU Biodiversity Strategy (European Commision, 2013)



The scientific work under the MAES process focuses on assessing ecosystems capacity to provide ecosystems services that benefits individuals and the society in general. The European and national assessments are based on the definition and quantification of indicators representative of ecosystems functions responsible for the provision of ecosystems services. A further step in the MAES process is ecosystems valuation and the establishment of National Accounts for Ecosystems Services.

Chapter 2
Selection of ecosystems and ecosystem services

2.1. Policy analysis methodology

A **policy analysis** has been carried out under the N4D project with the purpose **to assess whether current public policies stimulate the transition towards a Sustainable Green Economy, and suggest recommendations** to improve current policies in the direction of achieving a Sustainable Green Economy.

The policy assessment has been carried out against **3 general criteria and 4 specific criteria** explained in Table no. 1 below.

Table 1. Criteria used to assess the contribution of Romanian policies to the transition towards Sustainable Green Economy

No.	Criteria	Description
General criteria – Are used to determine the economic paradigm underpinning development in Romania		
1	Existence of a Sustainable Green Economy Strategy	Besides the adoption of a National Sustainable Development Strategy[7], a green economy strategy based on the principles of a green, fair and inclusive economy (Sustainable Green Economy Strategy) exists to support the achievement of the Sustainable Development Goals and demonstrating a paradigm shifting approach.
2	Existence of National Ecosystems Assessment (NEA) as a result of the MAES process	The MAES process has been finalized so that a full NEA is available for decision and policy making and it is actually used in the policy cycle.
3	Institutional integration and coordination aimed at Sustainable Green Economy implementation	There is coordination and integrated action among the different ministries and public institutions to implement the SDGs as well as a Sustainable Green Economy Strategy. Specific procedures and institutional structures exist in this sense. In particular, a governance system for the MAES process and for the implementation of a Sustainable Green Economy is in place and includes relevant stakeholders from public authorities, scientific circles and civil society linked through a Policy - Science Interface.
Specific criteria – Are applied to each policy sector dealing with natural resources management		
1	Level of integration of the Ecosystem Approach	Ideally, funds are spent to implement measures design to maintain ecosystems and their services beyond conceptual and operational integration of the Ecosystem Approach.
2	Integration of the Ecosystem Approach according to the Convention on Biological Diversity	Man is recognized as part of the ecosystem. The 12 principles reflecting Good Ecosystem Governance that is sustainable management of ecosystems and human activities, are respected: Equity of benefits and needs; Subsidiarity, decentralized management; Consideration of adjacent impact on other ecosystems; Economic sensitivity to market distortions through adverse subsidies and incentives, etc.; Resilience, conservation of ecosystem structure and functioning; Management within the limits of ecosystem's functions and capacity; Local to global harmonization; Respect of timescales; Adaptive management; Balance between conservation and use; Knowledge based management; Stakeholders participation.
3	Use of policy instruments beyond greening	Resources efficiency and technological innovation are decoupled from the stimulation of growth. Instead are inspired by the principles to avoid environmental risks and to respect planetary boundaries.

No.	Criteria	Description
Specific criteria – Are applied to each policy sector dealing with natural resources management		
4	Use of MAES indicators for EU reporting and decision-making as well as Beyond GDP indicators	MAES knowledge is used to improve EU reporting obligations as well as to inform decision and policy making along with indicators beyond GDP such as Ecological Footprint, Biocapacity, Global Green Economy Index[8].

Of all the relevant policies identified for the MAES process in Romania, **the policy assessment has covered** the following sectors: **Water, Marine, Forestry, Biodiversity, Climate Change – Mitigation, Energy, Fisheries and aquaculture, Agriculture and Rural Development, Transport, Regional Development, Territorial Planning**. In the next stage of MAES process implementation and follow-up to the N4D project, policies related to Air, Soil, Climate Change – Adaptation, Sustainable Development, and Tourism should also be assessed.

Due to time and capacity constraints sectoral policies have been assessed at strategic level including national strategies and programs, action plans, environmental reports. Nevertheless, framework ordonnances have been analyzed for the agriculture sector, and the main law is analyzed for the forest sector since Romania does not have a forest strategy. The **policy documents analyzed** for each sector are listed in Table no.2 below.

Table 2. Policy documents analyzed for MAES relevant sectors (WWF-Romania, 2015)

Policy sector	Analyzed policy document
Water	National River Basin Management Plan 2015-2021
Marine	National Strategy Monitoring Program for the marine environment 2014-2020 Article 12 - Technical Assessment of the MSFD 2012 obligations: reports for the Regional Seas - Black Sea
Forestry	European Strategy for the forest sector Forest Code National Rural Development Program 2014-2020 (forest related objectives and measures)
Biodiversity	National Strategy Action Plan for biodiversity conservation 2014-2020 (11.12.2013)
Climate Change – Mitigation and Adaptation	National Strategy for Romania on Climate Change 2013-2020 (Part I – Reduction of GHG emissions and growth of the natural capacity of absorption of CO2 from the atmoshpere) National Action Plan 2016-2020 on Climate Change (Chp. 1-3) (12.2015)
Fisheries and aquaculture	National Strategy for the fishery sector 2014-2020 National Multi-Annual Strategic Plan for aquaculture 2014-2020 Operational Program for Fisheries and Maritime Affairs 2014-2020

7 Chapter 8 of Agenda 21 *(The 2030 Agenda for Sustainable Development)* calls on countries to adopt national strategies for sustainable development (NSDS) that should build upon and harmonize the various sectoral economic, social and environmental policies and plans that are operating in the country. This Agenda is a plan of action for people, planet and prosperity. The 17 Sustainable Development Goals (SDGs) and 169 targets have been agreed upon in 2015 by Member States signing the Declaration (adopted with resolution *A/RES/70/1 - Transforming our world: the 2030 Agenda for Sustainable Development)*, and demonstrate the scale and ambition of this new universal Agenda, which builds on the Millennium Development Goals and complete what these did not achieve. https://sustainabledevelopment.un.org/post2015/transformingourworld

8 The Global Green Economy Index (GGEI) is published by consultancy Dual Citizen LLC since 2010 and is now at its 5th edition (2016). It measures the green economic performance and perceptions of it in 80 countries and 50 cities along four main dimensions of leadership & climate change, efficiency sectors, markets & investment and the environment. http://dualcitizeninc.com/global-green-economy-index/

Policy sector	Analyzed policy document
Agriculture and Rural Development	Agriculture Policy Perspectives Brief no.5, December 2013, EC - Overview of the CAP reform 2014-2020
	Urgency Ordinance no. 3/18.03.2015 on the approval of payment schemes in agriculture during 2015-2020, and modifying Art. 2 of Law no. 36/1991 on agriculture firms and other forms of association in agriculture (published in the Official Monitoring no. 191/23.03.2015)
	Joint Order MARD/MMAP/ANSVSA no. 352/2015 on the approval of eco-conditionality norms within support schemes and measures for farms in Romania (MONITORUL OFICIAL NO.363 din 26 mai 2015)
	The CMEF of the CAP 2014-2020, Publications Office of the EU, 2015
	Partnership Agreement 2014-2020
	National Rural Development Program 2014 - 2020 (Measure 10 - Agro-environment and climate, Measure 11 – Organic Agriculture)
Transport	Report on the General Master Plan for Transport of Romania in the short, mid and long term (revised final version)
	Environmental Report for the General Master Plan for Transport of Romania
Energy	Energy Strategy of Romania 2007-2020, updated 2011-2020
	Environmental Report for the Energy Strategy of Romania 2007-2020, updated 2011-2020
	Environmental Permit (Aviz) no. 10938/Dec.2012
Regional Development	Regional Operational Program 2014-2020
	Environmental Report for the Regional Operational Program 2014-2020
Territorial Planning	Territorial Development Strategy of Romania "Policentric Romania 2035: Coheision and territorial competitiveness, development and equal opportunities for people"
	Environmental Report for the Territorial Development Strategy of Romania

Consequently, **overall conclusions** have been drawn **concerning the policy relevance**, that is whether sectoral policies cover the issue of Sustainable Green Economy or instead sustain a grey economy referred to as Business As Usual, **and scope of sectoral policies**, that is whether sectoral policies cover all criteria underpinning a Sustainable Green Economy, but not their enforcement (that is whether regulations are in place and proper budget is allocated to ensure sectoral policy implementation) and compliance (that is whether sectoral policies are actually implemented). Table no. 3 below summarizes the so-called overall assessment matrix of public policies regarding the transition to a Sustainable Green Economy.

Table 3. Overall assessment matrix of Romanian public polices regarding the transition to Sustainable Green Economy

POLICY RELEVANCE *Do sectoral policies cover the issue of Sustainable Green Economy or grey economy that is Business As Usual?*	**POLICY SCOPE** *Do sectoral policies cover all criteria underpinning a Sustainable Green Economy?*
POLICY ENFORCEMENT *What regulations are in place to ensure implementation of sectoral policies aimed at Sustainable Green Economy? Is budget allocated to implement the regulations?*	**POLICY COMPLIANCE** *Are sectoral policies aimed at Sustainable Green Economy actually implemented? Yes/No and reason(s) why e.g. lack of awareness*

During the assessment of sectoral policies **special attention has been given to the implementation of *Good Ecosystems Governance* together with the associated MAES process with** the following **specific objectives**:

1. To assess the level of integration of the Ecosystem Approach into public policies for the period 2014-2020 and provide recommendations for the next programming period;
2. To prioritize ecosystems and propose[9] those to be assessed quantitatively[10] by April 2017, end of the N4D project, leaving to project follow-up the completion of a full National Ecosystems Assessment;
3. To identify the type of knowledge that MAES can provide, including to improve national reporting obligations towards the EU;
4. To identify relevant actors for establishing a Policy-Science Interface, and consequently to promote a governance system for the MAES process able to support the transition to a Sustainable Green Economy.

Comparing the level of integration of the Ecosystem Approach into public policies with the list of selected ecosystems for the MAES process by April 2017 before the end of the N4D project, **it is possible to identify the existing gap between policy design and policy implementation**. The opportunity lies in the possibility to improve policy design at the next evaluation phase of the respective policy cycle in order to achieve Good Ecosystem Governance and thus good ecosystem status at implementation level. Table no. 4 below summarizes the **next evaluation cycle of the analyzed policies**, which generally coincides with the programming period of EU funding (currently 2014-2020):

9 Under the policy pillar of the MAES process, ecosystems prioritization is based on information currently reported by Romania under the Habitats Directive and the State Of the Environment Report as well as on the level of integration of the Ecosystem Approach into public policies. Policy-oriented ecosystems prioritization is meant to identify policy domains that urgently need improvement in decision and policy making if Sustainable Development and a Sustainable Green Economy are to be achieved based on Good Ecosystems Governance. Results and actions will have to be further calibrated following the biophysical assessment of ecosystems, which will provide a prioritization of ecosystems based on a reality check of their status and their capacity to deliver ecosystems services. Also, the quantitative assessment of ecosystems and their functions is done under the scientific pillar of the MAES process based on data availability.

10 In scientific research, accounting for both the social sciences and the natural sciences, there are two main types of research analysis: qualitative and quantitative. Qualitative research is used in social science to help draw conclusions about a topic and relies heavily on observation and inferences, rather than attempting to directly quantify data. Quantitative research, on the other hand, is usually relied upon in the natural sciences — and at times in the social sciences — to directly measure research results, often assigning exacts measurements. Between these two extremes is semi-quantitative analysis, which assigns approximate measurements to data, rather than an exact measurement. Often used in cases where a direct measurement is not possible, but inference is unacceptable, semi-quantitative analysis has many applications in both the natural and social sciences. http://www.wisegeek.com

Table 4. Evaluation cycle of MAES relevant policies

Policy sector	Evaluation cycle of MAES relevant policies (only for the analyzed policies)
Water	2015: Mid-term deadline to meet environmental objectives, First management cycle ends 2021: Second management cycle ends 2027: Third management cycle ends, final deadline for meeting objectives
Marine	The baseline status of marine ecosystems was assessed in 2012. The Monitoring Program for the ongoing assessment and periodic update of strategic objectives was elaborated in July 2014. The Program of Measures was supposed to be elaborated until 2015 and its implementation to start in 2016. According to Art. 15 (2) of the Marine Strategy, the baseline status of ecosystems, objectives, Monitoring Program and measures must be updated every 6 years, the next cycle starting in 2018.
Forestry	Without a national forest strategy there are no established deadlines for achieving objectives
Biodiversity	2020
Climate Change – Mitigation and Adaptation	2020 – Strategy revision and updated of strategic objectives is recommended in the first half of 2015 and during 2020
Fisheries and aquaculture	2020
Agriculture and Rural Development	In 2018 the first report to the European Parliament and to the Council on monitoring and evaluation of the CAP 2014-2020 will focus on policy implementation and first results. A more complete assessment of the impact of the CAP is expected by 2021. Throughout the programming period Member States send notifications to the Commission on the implementation of direct payments and market measures. Concerning the NRDP, each Member State is obliged to implement the CMEF, based on which the Monitoring Authority presents the EC with relevant data about indicators of measures selected for funding and finalized, and prepares the Annual Implementation Report; the consolidated version is due 2017, 2019 and the ex-post evaluation in 2024. The elaboration of the NRDP has included ex-ante evaluation, indicators and evaluation plans.
Transport	2030 is the horizon for the implementation of the General Master Plan for Transport. Taking into consideration the level of uncertainty of long-term forecasts, recommendations beyond this horizon will have to be confirmed by updating the Plan for example in 2025 or earlier. For sectors with high volatility such as the air transport sector, recommendations concerning planning and investments are limited to 2020, and recommendations beyond this date will have to be confirmed based on further analysis, market researches, etc.
Energy	2020 or maybe later since a new Energy Strategy has been elaborated at the end of 2016 and in 2017 will go through a Strategic Environmental Assessment.
Regional Development	2020
Territorial Planning	Within 6 months from the publication of the legislation approving the National Territorial Development Strategy, the Implementation Plan should be elaborated and approved; it will be updated every 3 years based on the conclusions of the periodic report on the implementation of the Strategy. Results of monitoring and assessment of the National Territorial Development Strategy will be included in the periodic report on the implementation of the Stratey, the final report on the National Territorial Development Strategy implementation due 2035 including the ex-post assessment, and the procedure assessing the territorial impact of strategies, programs and policies with a territorial profile elaborated by central authorities.

2.2. Assessment of Romanian sectoral policies

Romanian ecosystems and human pressures

In terms of **ecosystems classification**, the Romanian MAES process uses the **methodology agreed at European level** and reproduced in Table no. 5.

Table 5. MAES typologies of ecosystems (European Commision, 2013)

ECOSYSTEM TIPOLOGY		Representation of habitats (functional dimension by EUNIS[11] / MSFD for marine ecosystems)	Representation of land cover (spatial dimension)
LEVEL 1 (MAES)	**LEVEL 2 (MAES)**		
TERRES-TRIAL	URBAN	Constructed, industrial and other artificial habitats	Urban, industrial, commercial and transport areas, urban green areas, mines, dump and construction sites
	WOODLAND AND FOREST	Woodland, forest and other wooded land	Forests.
	CROPLAND	Regularly or recently cultivated agricultural, horticultural and domestic habitats	Annual and permanent crops
	GRASSLAND	Grasslands and land dominated by forbs, mosses or lichens	Pastures and (semi-) natural grasslands
	SAND DUNES AND SHRUB	Sand dunes , scrub and tundra (vegetation dominated by shrubs or dwarf shrubs)	Moors, sand dunes and sclerophyllous vegetation
	SPARSELY OR UNVEGETATED LAND	Unvegetated or sparsely vegetated habitats (naturally unvegetated areas included)	Open spaces with little or no vegetation (bare rocks, glaciers and beaches, dunes and sand plains
	WETLANDS	Mires, bogs and fens	Inland wetlands (marshes and peatbogs)
FRESH-WATER	RIVERS AND LAKES	Inland surface waters (freshwater ecosystems)	Water courses and bodies incl. coastal lakes (without permanent connection to the sea)
MARINE	MARINE INLETS AND TRANSITIONAL WATERS	Pelagic habitats: Low/reduced salinity water (of lagoons); Variable salinity water (of coastal wetlands, estuaries and other transitional waters); Marine salinity water (of other inlets). Benthic habitats: Littoral rock and biogenic reef; Littoral sediment; Shallow sublittoral rock and biogenic reef; Shallow sublittoral sediment	Coastal wetlands: Saltmarshes, salines and intertidal flats Lagoons: Highly restricted connection to open sea, reduced, often relatively stable, salinity regime Estuaries and other transitional waters: Link rivers to open sea, variable, highly dynamic salinity regime. All WFD transitional waters included sea lochs, marine salinity regime Embayments: Non-glacial origin, typically shallow, marine salinity system. Pelagic habitats in this type include the photic zone, benthic habitats can include it or not
	COASTAL	Pelagic habitats: Coastal waters. Benthic habitats: Littoral rock and biogenic reef Littoral sediment; Shallow sublittoral rock and biogenic reef; Shallow sublittoral sediment	Coastal, shallow-depth marine systems that experience significant land-based influences. These systems undergo diurnal fluctuations in temperature, salinity and turbidity, and are subject to wave disturbance. Depth is up to 50-70 meters. Pelagic habitats in this type include the photic zone, benthic habitats can include it or not

For analytical purposes, it is important to say that **the concept of "natural habitat" as defined in the Habitats Directive is largely similar to the ecosystem concept** and refers to "terrestrial or aquatic areas distinguished by fully natural or semi-natural

11 http://eunis.eea.europa.eu/habitats-code-browser.jsp?expand=#level_A

geographical, abiotic and biotic features. Natural and semi-natural habitats encountered at the national level are characteristic of the aquatic, terrestrial and subterranean environment. These are aquatic – marine, coastal and fresh water habitats, terrestrial – forest, meadow and brush, peat bog and wetland habitats, steppe and forest steppe habitats, underground – cave habitats."[12] Several systems of habitat type classification have been accepted in Romania. In 2005-2006, in their paper on "Romanian Habitats", Doniţă et al. have tried to establish the similarities between these different classification systems, many of which have equivalents in the main classification systems used at the European level (Natura 2000, Emerald habitat, CORINE habitat, Palearctic habitat, and EUNIS habitat classification system).[13] **The fact that the scientific work carried out under the N4D project has made a correlation between the different classification systems of Romanian habitats in order to have an ecosystems matrix that suits the MAES purpose, allows for use of policy analysis results into the scientific work.**

For **ecosystem services classification**, the **methodology agreed at European level** for the MAES process is the Common International Classification of Ecosystem Services – **CICES version 4.3**.

The MAES process has identified 9 types of ecosystems in Romania with agricultural ecosystems occupying most of the surface (35.12%) followed by forest ecosystems (28.28%), grasslands (12.97%), marine and coastal ecosystems (11.09%), urban ecosystems (5.09%), rivers and lakes (2.95%), wetlands (0.16%), shrubs (0.12%), sparsely or unvegetated land (0.01%).

The **main pressures caused by human activities upon Romanian ecosystems** are building of grey infrastructure, urban development, intensive agriculture and forest activities, intensive fisheries and aquaculture, mine extractions, land use changes, introduction of invasive species, and improper waste management, which result in the following types of **impact on the environment and ecosystems**: pollution, habitat degradation and fragmentation, depletion of natural resources, Green House Gas (GHG) emissions growth, and climate changes. Details for each policy sector are provided in Table no.6 below.

Table 6. Overview of human pressures and impacts on Romanian ecosystems

Policy sector	**Natural Re-source**	**Ecosystem Typology (MAES Level 2)**	**Pressures from human activities (Sectoral policy analy-sis & State of the Environment National Report 2013/2014)**	**Type of impact resulting from pressures (Sectoral policy analysis & State of the Environment National Report 2013/2014)**
Soil	Soil	ALL	Agriculture and forest waste *Although this policy sector is not assessed in the policy analysis, info from the report is included given the link with agriculture and forestry*	Soil pollution

12 CBD Fifth National Report - Romania (English version), 2014
13 Idem

Policy sector	Natural Re-source	Ecosystem Typology (MAES Level 2)	Pressures from human activities (Sectoral policy analysis & State of the Environment National Report 2013/2014)	Type of impact resulting from pressures (Sectoral policy analysis & State of the Environment National Report 2013/2014)
Water	Water	Rivers and lakes Wetlands	Human settlements; industry (industrial and urban water treatment stations; facilities for iron and steel production as well as production of ferrous and nonferrous metals; production of organic/inorganic chemical substances; oil and gas refineries; opencast mining and quarrying - ballast and sand extraction; production of cellulose from timber, paper and cardboard); agriculture; fisheries and aquaculture; forest exploitations; accidental pollution sources; hydromorphological pressures (dams, derivations, regularizations, damming, shore defenses) due to hydropower, navigation or structural measures for flood protection	Diffuse and point-source pollution; hydromorphological changes of the water body
Marine		Marine inlets and transitional waters Coastal	Commercial and leisure fishing; aquaculture; agriculture; nautical activities; extraction; deposits of substances from the atmosphere; thermal stations; marine traffic; urban expansion	Physical damage and loss – habitats destruction, coastal erosion; changes in thermal regime; water pollution from contamination with dangerous substances; depletion of natural resources – biological disturbances caused by the introduction of nutrients and organic matter
Forestry		Woodland and forest	Uncontrolled exploitation of woodmass and illegal logging, especially in forests recentrly returned to original owners and not currently managed; wood industry; land use change	Habitats fragmentation; soil erosion or landslides; flooding; micro-climate modifications
Biodiversity		ALL	Land conversion aimed at development of urban, industrial, agriculture, touristic or Transport and energy infrastructure; development and expansion of human settlements; hydraulic works; over-exploitation of natural resources (forest management, grazing, illegal hunting, exploitation of non-renewable resources); introduction of invasive species	Degradation, destruction and fragmentation of habitats and implicitely decline in natural populations; the extensive modification, sometimes above the critical threshold, of the structural configuration of watersheds and water courses, associated with significant reductions in the resilience of aquatic ecosystems versus pressures from human activities; the excessive simplification of the structure and multifunctional capacity of ecosystems; destructuration and reduced productivity of biodiversity components in agriculture (increased vulnerability of the Romanian territory in front of geomorphological, hydrological and climate hazards as a result); pollution and nutrient loading

Policy sector	Natural Re-source	Ecosystem Typology (MAES Level 2)	Pressures from human activities (Sectoral policy analysis & State of the Environment National Report 2013/2014)	Type of impact resulting from pressures (Sectoral policy analysis & State of the Environment National Report 2013/2014)
Climate Change – Mitigation and Adaptation		ALL	Agriculture (land use change, illegal logging, mechanization, chemical inputs, intensive animal breeding), transport (urban expansion, use of roads as main way of transport, intensification of airplane traffic), energy (production from fossil sources - fossil fuels and their use in other industrial processes), waste management (increasing consumption, improper deposit)	cresterea GES ca o consecinta a intensificari activitatilor umane/antropice (sectorul energie (69,23%) - industria energetica 39.4%, industria prelucratoare si de constructii 18.7%, transporturi 18.3%, emisii fugitive 9.6; sectorul agricultura (15.3%) - soluri agricole 45,38%, fermentația enterică 44,04%, managementul gunoiului de grajd 9,89%, arderea în câmp a reziduurilor agricole 0,60%, cultivarea orezului 0,09%; sectorul deseuri (4.93%)) increase in GHG because of intensified human activities (energy sector (69,23%) – energy industry 39.4% manufacturing and construction industry 18.7%, transport 18.3%, fugitive emissions 9.6; agriculture sector (15.3%) - soils 45,38%, enteric fermentation 44,04%, manure management 9,89%, burning of agricultural residues in the field 0,60%, rice cultivation 0,09%; waste sector (4.93%))
Fisheries and aquaculture	Fish	Rivers and lakes Coastal		Biological, ecological, and physical disturbances
Agriculture and Rural Development		Cropland Grassland	Intensification of agriculture (mechanization, chemical inputs), land use change (grasslands into arable land or grasslands intensely used), abandonment of agricultural activities, lack of expansion of afforested areas and of development of forest windbreaks	Changing climatic conditions can lead to increasing attacks from pests and diseases as well as to lower natural productivity of agricultural and forest land; land abandonment has negative effects on biodiversity conservation, soil quality, and landscapes status, especially in areas affected by natural constraints; risk of point source pollution of water, eutrophication of wetlands, and increasing GHG emissions due to inadequate management of the number of animals and manure; soil degradation in the absence of the afforestation; pronounced manifestation of climate change phenomena due to a lack of forest windbreaks
Transport		ALL	Land use change aimed at building new transport corridors or extending existing ones	Loss or fragmentation of habitats; changes in the population density of certain species of flora or fauna; fauna mortality due to accidents; impact on the conservation status of habitats and species of flora and fauna

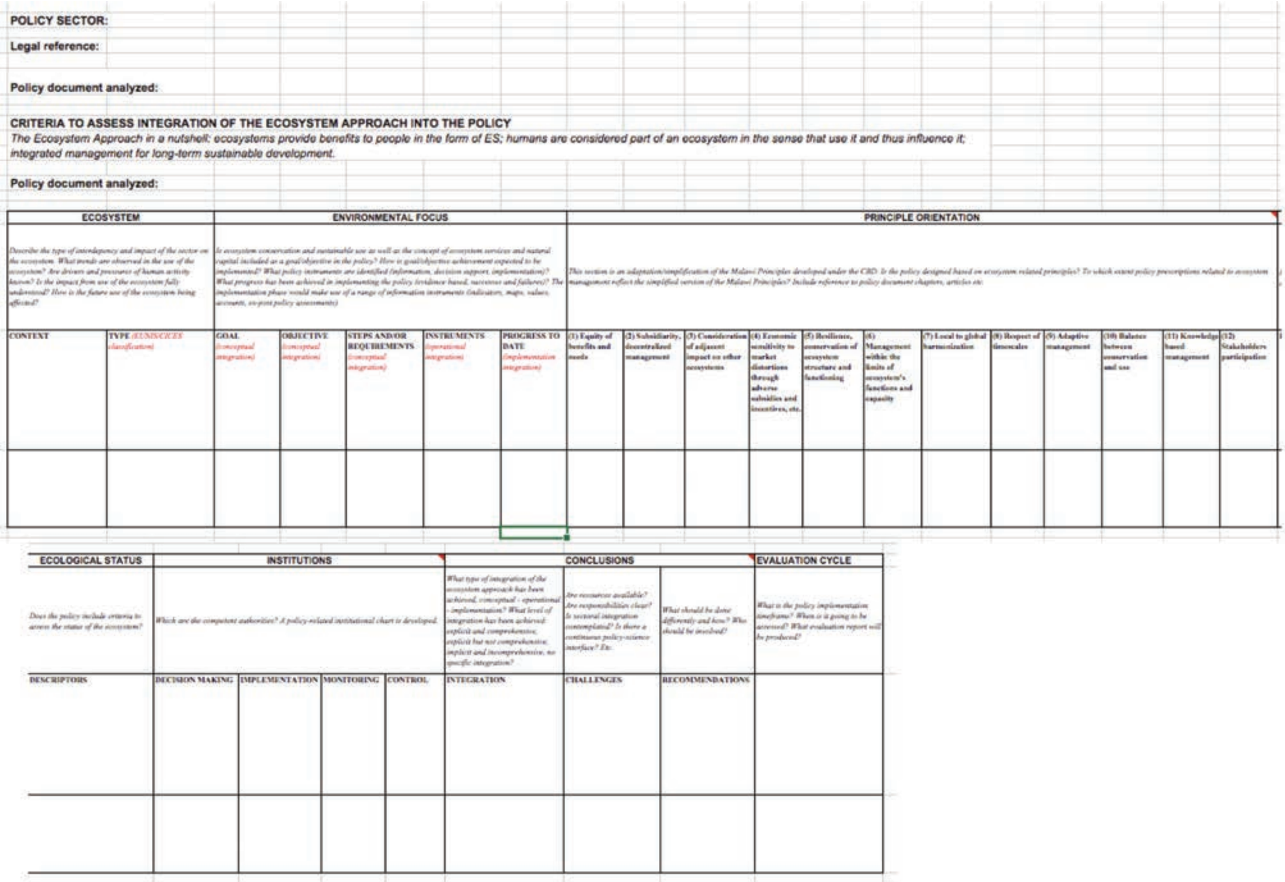
Policy sector	Natural Re-source	Ecosystem Typology (MAES Level 2)	Pressures from human activities (Sectoral policy analy-sis & State of the Environment National Report 2013/2014)	Type of impact resulting from pressures (Sectoral policy analysis & State of the Environment National Report 2013/2014)
Energy		ALL	GHG emissions from energy ba-sed on fossil fuels; construction of hydropower facilities; construction of wind power facilities interfering with birds' migration routes; bio-mass energy from plantations; con-struction of photovoltaic facilities	Soil and air pollution from GHG emissions with impact on human health and biodiversity; hydromorphological changes of river ecosystems and reduced water debit for local communities resulting from hydropower; birds' mortality due to wind power; invasive species resulting from energy plantations affecting biodiversity; land use competition between biomass energy, agriculture and forests; land use competition between photovoltaic energy and agriculture
Regional De-velopment		ALL	Industrial activities, transport, agriculture, tourism, constructions, infrastructure for heating as well as water and waste management	Inadequate air quality and climate change; inadequate quantity and quality of water resources; pollution of soil and the environment in general; deterioration of the natural and built capital - loss and fragmentation of habitats and over-exploitation of resources; damage of human health

The level of integration of the Ecosystem Approach into Romanian policies

In order to assess the level of integration of the Ecosystem Approach into Romanian policies designed for the period 2014-2020 and identified for the MAES process in Romania, an analytical framework has been developed and used under the N4D project; it combines the **approach developed under the OPERAs project**[14] with the so-called **Malawi Principles promoted by the Convention on Biological Diversity**[15] (Figure no. 3).

14 http://www.operas-project.eu
15 https://www.cbd.int/ecosystem/principles.shtml

Figure 3. Template to assess the integration of the Ecosystem Approach into Romanian policies



POLICY SECTOR:

Legal reference:

Policy document analyzed:

CRITERIA TO ASSESS INTEGRATION OF THE ECOSYSTEM APPROACH INTO THE POLICY

The Ecosystem Approach in a nutshell: ecosystems provide benefits to people in the form of ES; humans are considered part of an ecosystem in the sense that use it and thus influence it; integrated management for long-term sustainable development.

Policy document analyzed:

ECOSYSTEM		ENVIRONMENTAL FOCUS					PRINCIPLE ORIENTATION											
Describe the type of interdependency and impact of the sector on the ecosystem. What trends are observed in the use of the ecosystem? Are drivers and pressures of human activity known? Is the impact from use of the ecosystem fully understood? How is the future use of the ecosystem being affected?		*Is ecosystem conservation and sustainable use as well as the concept of ecosystem services and natural capital included as a goal/objective in the policy? How is goal/objective achievement expected to be implemented? What policy instruments are identified (information, decision support, implementation)? What progress has been achieved in implementing the policy (evidence based, successes and failures)? The implementation phase would make use of a range of information instruments (indicators, maps, values, accounts, ex-post policy assessments)*					*This section is an adaptation/simplification of the Malawi Principles developed under the CBD. Is the policy designed based on ecosystem related principles? To which extent policy prescriptions related to ecosystem management reflect the simplified version of the Malawi Principles? Include reference to policy document chapters, articles etc.*											
CONTEXT	TYPE (EUNIS/CICES classification)	GOAL (conceptual integration)	OBJECTIVE (conceptual integration)	STEPS AND/OR REQUIREMENTS (conceptual integration)	INSTRUMENTS (operational integration)	PROGRESS TO DATE (implementation integration)	(1) Equity of benefits and needs	(2) Subsidiarity, decentralized management	(3) Consideration of adjacent impact on other ecosystems	(4) Economic sensitivity to market distortions through adverse subsidies and incentives, etc.	(5) Resilience, conservation of ecosystem structure and functioning	(6) Management within the limits of ecosystem's functions and capacity	(7) Local to global harmonization	(8) Respect of timescales	(9) Adaptive management	(10) Balance between conservation and use	(11) Knowledge based management	(12) Stakeholders participation

ECOLOGICAL STATUS	INSTITUTIONS				CONCLUSIONS			EVALUATION CYCLE
Does the policy include criteria to assess the status of the ecosystem?	*Which are the competent authorities? A policy-related institutional chart is developed.*				*What type of integration of the ecosystem approach has been achieved, conceptual - operational - implementation? What level of integration has been achieved: explicit and comprehensive, explicit but not comprehensive, implicit and incomprehensive, no specific integration?*	*Are resources available? Are responsibilities clear? Is sectoral integration contemplated? Is there a continuous policy-science interface? Etc.*	*What should be done differently and how? Who should be involved?*	*What is the policy implementation timeframe? When is it going to be assessed? What evaluation report will be produced?*
DESCRIPTORS	DECISION MAKING	IMPLEMENTATION	MONITORING	CONTROL	INTEGRATION	CHALLENGES	RECOMMENDATIONS	

Briefly, the OPERAs project identifies three different levels of integration of ecosystem services and natural capital into different policy areas:

- **Conceptual integration** - refers to the integration of ecosystem services and natural capital into the overall premises and objectives of different policy areas; it is assessed based on the key strategic policy documents setting out the scope and objectives for sectoral policies
- **Operational integration** - refers to the uptake of ecosystem services and natural capital in practical policy implementation; it is assessed based on the availability of concrete policy tools and instruments that take up and implement the concepts
- **Implementation integration** - refers to the final stage of the integration process, i.e. where concrete m easures achieve integration on the ground in actual policy and decision making situations (e.g. using a range of instruments and measures to protect or invest in ecosystems services).

The policy analysis focuses on assessing conceptual and operational integration (Table no. 7).

Table 7. OPERAs report, Deliverable D 3.3, 2015

LEVEL OF INTEGRATION	CONCEPTUAL	OPERATIONAL
Explicit and comprehensive	Explicit recognition of all ecosystem services, including the recognition of ecosystem services and natural capital as underpinning elements of human wellbeing.	Dedicated instruments exist for addressing ecosystem services and natural capital in a comprehensive manner within a policy area.
Explicit but not comprehensive	Some explicit integration (e.g. some specific ecosystem services), including some recognition of ecosystem services and natural capital as underpinning elements of human wellbeing.	Some instruments exist that proactively address / build on the understanding of ecosystem services and natural capital within the policy area.
Implicit and comprehensive	Implicit and indirect integration, generally focus on preventing negative impacts of a policy sector on ecosystem services and natural capital.	No dedicated instruments exist for directly addressing ecosystem services and natural capital. Some aspects – mainly focusing on avoiding negative impacts on (some) ecosystem services - integrated into sectoral instruments.
Without specific integration	No recognition (direct / indirect) of ecosystem services and natural capital.	No instruments exist that would in any way address ecosystem services and natural capital.

Table no. 8 below shows the level of integration of the Ecosystem Approach according to the OPERAs project classification:

Table 8. Level of integration of the Ecosystem Approach into Romanian sectoral policies according to OPERAs project classification

Policy sector	Na-tural Reso-urce	Ecosys-tem Ty-pology (MAES Level 2)	Conceptual Integration	Operational Integration
Water	Water	Rivers and lakes Wetlands	The Water Framework Directive (WFD) does not explicitely mention the word "ecosystem services". However, the main objective of the WFD is to secure good water quality and quantity, which are important ecosystem services provided by freshwater ecosystems. At national level, neither the National River Basins Management Plan (NRBMP) explicitely mention the word "ecosystem services". The water resource is managed based on standards including chemical, physical-chemical and biological parameters that partly cover structural aspects of aquatic ecosystems but the functioning of the latter from which depends the provision of ecosystem services, is not explicitely analized. The maintenance of ecosystem services is only indirectly supported by aiming to secure good water quality and quantity, and not directly by implementing good ecosystem management. Likewise, aiming to prevent negative impacts on water ecosystems by water users helps to protect water related ecosystem services but a sustainable management of human activities is not directly foreseen. As a matter of fact, the environmental cost included in the cost of water services (administrative and infrastructure services for the water sewage system and the supply of water to users) is defined as the cost of pollution (the cost of the environmental damage produced as a result of loss or degradation of water ecosystems due to pressures produced by a water user) as well as the cost of preventing environmental quality degradation. No beneficiary pays principle is applied.	The financial instruments in place to cover the needs of the NRBMP and its Program of Measures are linked to the use of financial allocations under the Operational Program for large infrastructure (Programul Operational Infrastructura Mare) as well s to the application of the contributions system for the use of water as a resource from a quantitative and qualitative point of view. The contributions system includes payments, bonifications ("bonificații") and penalties, and is part of the business model of the National Administration Romanian Waters (Administrația Națională Apele Române) having the objective to secure the provision of the water resource both quantitatively and qualitatively (Art.9 of the Water Directive). On one end, the underlining principles for the quantitative management are: cost recovery, polluter pays, equal access to water resources, rational use of water resources. On the other end, the underlining principles for the qualitative management are: cautiousness and prevention, cost recovery, polluter pays. The system of contributions is about water administrative and infrastructure services; consequently, only indirectly it recognizes the ecosystem service of water provision. Methods for the definition and assessment of water ecosystem services are lacking as well as the legal framework for their applicability. The intervention logic of the WFD is not properly transposed into Romanian water policy and there are serious doubts on the method used for assessing the ecological status of rivers: in the First NRBMP almost 3% of national rivers were assessed as having "high ecological status" (139 water bodies) while the Second NRBMP proposes their downgrading to "good ecological status" with only 1 water body being proposed with "very good ecological status".

Policy sector	Natural Resource	Ecosystem Typology (MAES Level 2)	Conceptual Integration	Operational Integration
Marine		Marine inlets and transitional waters Coastal	The goal of the National Marine Strategy is to achieve the Good Ecological State of the marine environment by 2020, defined by 11 descriptors including on the integrity of the habitat and its functions. The Action Plan includes the following objectives: (i) By 15 July 2012, baseline assessment of ecological status of marine waters and of the environmental impact of human activities on such waters; (ii) By 15 July 2012, assessment of Good Ecological Status of marine waters; (iii) By 15 July 2012, establishment of environmental objectives and indicators; (iv) By 15 July 2014, elaboration and implementation of a monitoring program for the continuous assessment and periodical update of objectives in accordance with the legislation in place. The Monitoring Program includes: (i) The elaboration of an Action Plan meant to ensure the achievement or maintenance of Good Ecological Status by 2015 at the latest; (ii) The implementation of the Action Plan defined under (i) by 2016 at the latest. Given that the focus of the National Marine Strategy is not on preventing negative impacts, integration of the Ecosystem Approach is considered explicit but not comprehensive even though there is no reference to human well-being.	For the moment there is no specific integration of the Ecosystem Approach due to the fact that the Action Plan to ensure that Good Ecological Status of the marine environment is achieved or maintained was supposed to be elaborated until 2015 but no official information has been found so far. The Operational Program for Fisheries and Maritime Affairs (POPAM) does not include specific measure for the protection of the marine environment end ecosystems.
Forestry		Woodland and forest	Romania does not have a national strategy for the forestry sector with objectives, measures and deadlines. The existing draft with horizon 2013-2022 is not officially adopeted and it looks rather like a wish list. Instead, there is a Forestry Code that mentions the implementation of a certified forest management as well as the identification, mapping and securing of forest biodiversity hot spots. Although the focus is on preventing negative impacts of the forestry sector and to achieving economic benefits from the processing of forest resources, the contribution of forests to human well-being is somehow mentioned: Art. 60 Par. 5 (d) speaks about securing fire wood availability for the population; Art. 60 Par. 5 (a) (b) speaks about superior valorification of wood and community development based on local processing of wood. Furthermore, forest ecosystem services are mentioned in Art. 6 Par. 4, Art. 11 Par. 7 (e), Art. 15 Par. 5 (c).	Art. 11 and Art. 15 foresee compensatory payments and payments for ecosystem services (e.g. PES) although a methodology for their implementation is not officially adopted. Furthermore, the National Rural Development Program 2014-2020 provides funding for an environmental-forestry measure ("masura de silvo-mediu") as well as for a first afforestation measure ("masura pentru prima impadurire"), both intended to have a positive impact on the maintenance of forest ecosystems.
Biodiversity		ALL	The National Strategy and Action Plan for biodiversity conservation aim at: halting biodiversity loss and restoring degraded ecosystems; integrating biodiversity conservation into sectoral policies; promoting innovatory methods and practices as well as green technology for biodiversity conservation to support sustainable development. Sustainable use of biodiversity components and equitable access to benefits resulting from use of genetic resources are included among the strategic objectives. The latter include also: securing the efficient management of the national protected areas network as well as the favourable conservation status of protected wild species; controlling invasive species. In order to ensure the integrated management of the transport, energy and and exploitation of non-renewable natural resources sectors, operational objectives include: integrating biodiversity conservation into these policy sectors; reducing the impact of the road transport on the natural environment; applying environmental impact assessment procedures to these sectors. The fact that biodiversity is fundamental for the delivery of ecosystem services to individuals and society is directly mentioned among the actions: assessment and economic valuation of biodiversity components and of ecosystem services; elaboration and implementation of methodologies that consider biodiversity values in cost-benefit analysis for feasibility studies and business plans; integration of the Ecosystems Approach in the National Strategy for Research, Development and Innovation.	The biodiversity Action Plan foresee that funding from the State budget and the European Fund for Agriculture and Rural Development (FEADR) should be used for: protected areas management; compensations for forest and land users that respect management restriction for Natura 2000 sites; and compensations for forest users that respect restrictions on the exploitation of forests with protection functions of national interest (forest cathegories T1 and T2). However, a functional compensation system in not yet in place.

Policy sector	Natural Resource	Ecosystem Typology (MAES Level 2)	Conceptual Integration	Operational Integration
Climate Change – Mitigation (and Adaptation)		ALL	The National Strategy for Climate Change (Part I on Mitigation) mentions the capacity of Romanian forests to sequester carbon as well as the fact that water ecosystems from forest habitats (e.g. floodplains along river sectors, lakes, swamps, peat bogs, marshes) deliver ecosystems goods and services that are important in forest ecology. However, no explicit reference to human well-being is made. Furthermore, Objective no. 4 under the Biodiversity Chapter no. 4.9 of the biodiversity Action Plan mentions the "assessment of ecosystem services and the implementation of the Ecosystem Approach in decision-making".	Green Certificates are foreseen in national legislation to encourage energy production from renewable sources (sun, wind, hydro, geothermal); however, conditions for biodiversity conservation are not included with the risk of negative impact on the adaptation potential of ecosystems to climate change. Besides, the biodiversity Action Plan foresees instruments to be developed such as: payments for ecosystem services in the context of climate change to support adaptation; national bonifications scheme for afforestation, reafforestatin and conservation of virgin forests (a need foreseen in the National Biodiversity Strategy). Furthermore, related to Objective no. 4 under the Biodiversity Chapter no. 4.9 are foreseen actions such as: taking into consideration the phenomenon of climate change in establishing payments for ecosystems services; and taking into consideration economic arguments in favor of investments in natural solutions to address climate change. Also, the Transport Chapter, Objective no. 1 mentions the introduction of economic incentives (e.g. price instruments) for a system of ecological transport and includes a measure to raise taxes on carbon price, car registration, parking, etc. during 2016-2022. However, the approach is not efficient nor socially fair (e.g. higher costs for using private transport) if measures to improve public transport are not implemented first (Objective no. 2 and no. 3). With respect to ES, the Strategy recognizes the benefits from forest and aquatic ecosystems in reducing GHG emissions. Objective no. 4 of the Action Plan - Biodiversity Chapter no. 4.9 foresees the „Assessment of ES and the implementation of the Ecosystem Approach into decision-making", with actions like: inclusion of ES assessment and Ecosystem Approach into management of natural resources; inclusion of Ecosystem Approach within the context of climate change into university programs; inclusion of climate change consideration in the development of PES and of economic arguments for investments in nature based solutions; improving the capacity of public authorities to understand ES values and the Ecosystem Approach in the context of climate change; establishment of an inter-governmental platform on biodiversity and ES to provide decision makers with the necessary knowledge to elaborate biodiversity policies in the context of climate change; training of natural resources managers and natural protected areas administrators on the Ecosystem Approach in order to adapt to climate change; assessment of ES delivered by natural protected areas or of the protected areas network contribution to climate change control.
Fisheries and aquaculture	Fish	Rivers and lakes Coastal	The concept of aquatic ecosystem is better integrated in the case of aquaculture given its clearer geographical delimitations. Less considerations and consequently less measures are provided for the fishery sector. Natural ecosystems are recognized as well as the necessity to maintain biodiversity. The concept of ecosystem and in particular of marine ecosystems, are taken from UE legislation terminology. Ecosystem services are mentioned only in the case of aquaculture; however, they are not completely listed. The improvement of production capacity is especially mentioned. The economic importance of aquaculture as well as of activity diversitification (in particular at local community level) is recognized. Thus, ecosystem services are indirectly recognized as underpinning well-being.	The Operational Program for Fisheries and Maritime Affairs (POPAM - Programul Operational pentru Pescuit si Afaceri Maritime), includes a measure for the improvement of the aquatic environmentl, which gives the opportunity to integrate the delivery of ecosystem services e.g. water quality and quantity; however, a clear and approved methodology for the identification, maintenance and management of ecosystem services does not exist.

Policy sector	Natural Resource	Ecosystem Typology (MAES Level 2)	Conceptual Integration	Operational Integration
Agriculture and Rural Development		Cropland Grassland	As a result of the 2013 reform, there has been a greening of the Common Agriculture Policy (CAP) as well as improved equitability, eventhough civil society in particular had called for a more ambitious reform from the environmental point of view (in particular, the CAP needs to move from non-targeted decoupled payments to incentives aimed at delivering benefits for society, which would reward farmers for the public goods they can deliver such as conservation of biodiversity on their farmland). With regards to rural development, the National Rural Development Program (NRDP) recognizes that High Nature Value Farmlands deliver ecosystem services to society and thus conserving such ecosystems provides environmental and socio-economic benefits. Furthermore, by encouraging organic agriculture objectives related to the environment such as biodiversity and ecosystems maintenance as well as protecton of soil and water resources, are pursued. However, the contribution of the NRDP upon nature conservation and the environment has not been assessed yet using existing indicators. Besides, organic agriculture is not treated differently based on small versus large scale farming, which clearly have different impacts on the ecosystem.	So far, the CAP has not delivered for biodiversity nor for the environment. Improved sustainability (the so-called greening) of the CAP is expected to be achieved by the combined and complementary effects of various instruments: cross-compliance; green direct payment; rural development measures. The following direct payment schemes are applied in Romania during programming period 2014-2020: a) Single Area Payment Scheme (SAPS); b) Redistributive payment; c) Payment for agriculture practices that are good for the climate and the environment; d) Payment for young farmers; e) Coupled support scheme; f) Simplified scheme for small farmers; g) Transitional national aid. With regards to rural development, under the NRDP compensations are given to conserve species and habitats typical of High Nature Value Farmlands (Measure no. 10), to stimulate organic agriculture (Measure no. 11), and for areas facing natural or other specific constraints (Measure no.13). So far, the NRDP has not delivered with respect to environmental objectives. However, the Natura 2000 concept is not integrated. Besides, although the Rural Development Regulation foresees articles for achieving objectives related to Natura 2000 (habitats and species conservation) and the WFD (ecological reconstruction of wetlands), the NRDP has not included any of these opportunities.
Transport		ALL – including urban and except ocean	According to the report on the General Master Plan for Transport (GMPT) in the short, medium and long term, the main purpose of the GMPT is to ensure the conditions for the development of a transport system that is efficient, sustainable, flexible and secure, which is fundamental for the economic development of Romania. On the achievement of this objective is based the elaboration of the 2014-2020 Large Infrastructure Operational Program (POIM – Programul Operational Infrastructura Mare) as well as other decisions linked to the optimum planning of investments in transport infrastructure. The Environmental Report resulting from the SEA of the GMPT takes into consideration the impact of the transport sector on ecosystems and recommends measures to avoid or, if this is not possible, to mitigate and compensate for biodiversity loss: Avoid, mitigate, compensate sensible areas (natural protected areas, heavily populate areas, natural barriers such as water courses, mountain areas, etc.) alreay from the stage of feasibility study and project design; Reconsider routes in case of Natura 2000 sites, (outside the site in case of small surfaces or outside areas occupied by habitat ans species of community interest in case of large surfaces or considerable antropization), mitigate or compensate; Apply the Environmental Impact Assessment and the Impact Assessment procedures already during the planning stage; Correlate GMPT measures with those related to the transport sector and included in other national or European programs, strategies or plans; Prevent and reduce direct and indirect effects on the environment by selecting the best methods for project design and construction; Correctly assess the efficiency of the implemented environmental protection measures; Limit land surfaces permanently or temporarily occupied by projects included in the GMPT; Prevent and control pollution in the construction and operating stages; Adapt new investments in the transport sector to climate change; Reduce environmental costs associated with the implementation of projects included in the GMPT. However, management tools/mechanisms are not developed and feasibility studies do not consider the option not to invest. Furthermore, the Environmental Report foresees that the calendar for the implementation of transport projects takes into account both the amount of time and the budget necessary to collect scientific data on biodiversity. Information on ecosystems capacity to deliver goods and services (ecosystems limits) is insufficient.	The Environmental Monitoring Program on the effect of the implementation of the General Master Plan for Transport identifies and tries to prevent negative effects upon the environment by proposing supplementary protective measures that reduce the impact or for remediation of affected areas. The Monitoring Program defines the following: what to monitor based on the environmental objectives of the General Master Plan for Transport; which indicators to measure and monitor; the duration and frequency of monitoring activities; who is responsible for organizing and coordinating the monitoring system. Monitoring measures are defined for the four stages of planning, project design, construction and exploitation/operation.

Policy sector	Natural Resource	Ecosystem Typology (MAES Level 2)	Conceptual Integration	Operational Integration
Energy		ALL – including urban and except ocean	The main purpose of the 2011-2020 Energy Strategy for Romania is to produce energy based on the need to ensure security of energy provision, sustainable development and competitiveness by focusing on improving energy efficiency and promoting renewable energy sources. Also, one of the fourteen strategic objectives is to reduce the negative impact of the energy sector on the environment; however, the Strategy does not foresee measures to prevent, reduce, compensate for such effects. Furthermore, the Strategy does not foresee a developmet plan for the different types of infrastructure necessary for the different types of renewable energy (e.g. small hydropower, wind, etc.) but only some general guidelines, which limits the possibility to correctly assess the environmental impact on ecosystems. Measures to reduce negative impact or conservation measures associated with infrastructure development, including indicators, are described in the Environmental Report resulting from the SEA of the Strategy and have been included in the Environmental Notification. It has been noted that indicators for conservation measures are not correctly associated. In the Strategy there is no reference to ecosystem services potentially affected by the development of the energy sector. Also, the Strategy does not integrate other national strategies and plans such as the biodiverstiy conservation strategy. Reference is made to European objectives on the reduction of Green House Gases (GHG) under the Climate Change Strategy but without a development plan for the energy sector it is not possible to quantify the contribution of the Strategy at European or global levels. Information on ecosystems capacity to deliver goods and services (ecosystems limits) that are relevant for the energy sector is not enough. Regarding the impact on the ecological status of rivers, the Environmental Report confirms certain analytical mistakes in the Strategy: related to environmental objectives OR no. 3 (water funtions) and no. 8 (maintenance and development of national protected area network), only potential negative effects of included measures have been identified; measure no. C.1.7.9 („Valorificarea eficienta a potentialului hidroenergetic, prin realizarea de noi capacitati de productie, inclusiv prin atragerea de capital privat) is among those scoring the highest values of potential negative effects on the environment (-6 points). Other problems include: the lack of an Action Plan for investments in the energy sector; lack of protected area management plans approved at the time when the Strategy was elaborate; lack of scientific data on biodiversity; non recognition and thus non implementation of the Environmental Notification by the authorities subordinated to the issuing authority that is the Ministry of Environment (because of procedural matters); the monitoring methodology for conservation measures has been proved to be deficitary (e.g. improper correlation of indicators – for river conservation measures the performance indicator is the ecological status of reservoirs).	The 2011-2020 Energy Strategy for Romania included the following instruments: Green Certificates (Law no. 220/2008 for establishing the system to promote energy production from renewable sources); Certificates for the emissions of GHG; The Romanian market and related platform for the transaction of Green Certificates and Certificates for GHG emissions (OPCOM - Operatorul Pietei de Energia Electrica si Gaze Naturale din Romania). Green Certificates focus on reducing pollution but do not foresee biodiversity proofing on the exploitation of renewable energy sources. The validity of the Environmental Notification is not accepted by all relevant institutions and thus mitigation and conservation measures are not implemented.

Policy sector	Natural Resource	Ecosystem Typology (MAES Level 2)	Conceptual Integration	Operational Integration
Regional Development		ALL – including urban and except ocean	The 2014-2020 Regional Operational Program (POR - Programul Operational Regional) aims at improving economic competitiveness as well as life conditions of regional and local communities by supporting the development of business (in particular small and medium enterprises from the agriculture, fishery and aquaculture sectors), infrastructure and services in order to ensure the sustainable development of regions; the latter must be able to manager resources efficiently and to protect the environment, to use their innovation potential, and to integrate technological progress. Innovation and technology are meant to support the transition towards a low carbon economy in all sectors, to promote sustainable transport systems and viable infrastructure for major transport networks. On the social side, POR promotes social inclusion and poverty eradication, investment in long life education and learning, mobility and sustainable occupation of qualified workforce. An important objective is also the strengthening of institutional capacity and improving the efficiency of the public administration. Although sustainable development is mentioned, no reference is made to resources limits. Also, the concept of good ecosystems management as fundamental condition for socio-economic development is not comprehensively integrated; instead, attention is given to resources protection and environmental impact/pollution prevention. The actions foreseen to conserve, protect, promote and develop the cultural and natural heritage will focus on: the protection of habitats important for bird species, especially when a transport network crosses or is nearby a natural protected area; the conservation of national tourist resources and a clean environment (sustainable tourism development should be correlated with territorial management plans where protection levels are specified for each tourist objective). Furthermore, measures will be taken to reduce the impact upon the environment of investments funded by POR as recommended by the SEA – Environmental Report undertaken during ex-ante evaluation of the POR: application of EIA and SEA procedures to projects; maintenance and conservation of natural diversity, of fauna, flora and habitats in natural protected areas and Natura 2000 sites in particular; prevention of point and diffuse pollution of water bodies and maintenance of surface water quality and state; conservation and valorization of leisure areas; harmonization between the natural and built environments, etc. Finally, ecosystem services are not explicitly mentioned, only indirectly it is mentioned the maintenance of surface water quality and state and the reduction of carbon emissions.	Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA) procedures are applied to projects based on the environmental legislation and on recommendations of the SEA undertaken during ex-ante evaluaton of the POR. Ecosystem services are not yet integrated into EIA ans SEA procedures. Based on ex-ante evaluation of the POR, financial instruments for investments through the 2014-2020 Regional Operational Program (POR - Programul Operational Regional) are identified, especially for supporting SMEs and to invest in energy efficiency.

Policy sector	Natural Resource	Ecosystem Typology (MAES Level 2)	Conceptual Integration	Operational Integration
Territorial Planning		ALL	The National Strategy for Territorial Development horizon 2035, briefly lists Romanian ecosystems as follows: natural and semi-natural ecosystems represents 47% of the national surface (forests, pastures, freshwater and salty ecosystems, marine and coastal ecosystems, underground ecosystems). Protected areas recognized in Romania are also listed. The following five general objectives are pursued: - ensuring the functional integration of the national territory in Europe by supporting the efficient interconnection of energy, transport and broadband networks; - improving quality of life by developing infrastructure and public services that ensure urban and rural areas of quality, attractive and inclusive; - developing a network of competitive and cohesive local areas by supporting territorial specialization and the development of functional urban areas; - protection of the natural and built environment and valorization of territorial identity elements; - improving institutional capacity to manage territorial development processes. The National Strategy recognizes that the inadequate exploitation of natural resources can have a negative impact on the latter. Furthermore, it mentions the possibility that ecosystem services are affected because of climate change. Finally, the need to improve the management of natural potential is mentioned with the purpose to practice/develop tourism. In conclusion, there is recognition of the country’s natural capital (listed ecosystems and protected areas), the importance of territorial cohesion and functionality, the need to protect and avoid negative impacts on natural resources, and the link between quality of life and quality/attractiveness/inclusiveness of urban and rural areas. Ecosystem services are generally mentioned in relation to climate change pressures. However, ecosystem services and natural capital are not explicitly integrated as underpinning well-being as well as the quality/attractiveness/inclusiveness of urban and rural areas.	The Environmental Report resulting from the SEA of the National Strategy includes an impact matrix that assesses potential negative effects upon the environment including interconnections between them. Chapter IX proposes measures to prevent, reduce and compensate the identified adverse effects upon the environment. The National Strategy includes: Measure no. 4.2.3.7 for the protection of natural habitats against climate change; and, Measure no. 4.3.3.9 on the conservation of natural protected areas as well as the biodiversity of mountain areas. Some Specific Objectives address the problem of balancing conservation and use and include measures with reduced impact on ecosystems (SO 4.1 – Heritage protection and promotion of measures for natural capital restoration; SO 4.4 – To ensure the balanced development of urban and rural areas by protecting resources associated with agriculture and forest land and by limiting the extension of urban areas; SO 2.3 – To improve the attractiveness of urban and rural areas by improving their residential functions, developing public spaces of quality as well as transport services adapted to local needs and characteristics). However, the principle of management within ecosystem capacity and limits is not mentioned. In conclusion, the focus is mainly on avoiding negative impacts on the environment, ecosystems and biodiversity.

Table no. 9 (a) below shows the level of integration of the Ecosystem Approach according to the CBD principles 1-6:

Table 9 (a). Level of integration of the Ecosystem Approach into Romanian sectoral policies according to CBD principles 1-6

Policy sector	Natural Resource	Ecosystem Typology (MAES Level 2)	(1) Equity of benefits and needs from natural resources management	(2) Subsidiarity, decentralized management of ecosystems	(3) Consideration of ecosystem management impact on adjacent ecosystems	(4) Management of market distortions affecting ecosystems and integration of costs and benefits	(5) Resilience, conservation of ecosystem structure and functioning	(6) Management within the limits of ecosystem's functions and capacity
Water	Water	Rivers and lakes Wetlands	X – Not treated	✓ – The National Administration Romanian Waters (ANAR) supervises 11 sub-river basin administrations (ABA - Administratie Bazinala de Apa), one for each important river basin. In addition, a water administration exists for each county (SGA - Serviciul de Gospodarire al Apei). Also, some water management responsibilities or measures are transferred to water users (municipalities, natural protected areas as administrators / custodians, etc). However, proper implementation of the WFD, monitoring and control, all remain under ANAR's responsibility along with the commercial activity of renting water usage[16], thus indicating a potential conflict of interest; instead, monitoring and control should be separated from water related management and profit generation.	X – Not treated	X = The cost paid by users for the water infrastructure varies between the two institutions owning it.	! – Basic Measures and some Supplementary Measures designed to achieve Good Ecological Status of water bodies. However, the parameters analyzed for monitoring water quality and quantity include some biological components of ecosystems but do not take into account the structure and especially the functions of ecosystems.	X – Not treated
Marine		Marine inlets and transitional waters Coastal	X – Not treated	X = Centralized decision-making; decentralized monitoring and control.	! – According to the Strategy (Art. 12.2), Romania elaborates the monitoring program with other Member States in the same marine region to ensure that relevant impact and transboundary characteristics are taken into account.	X – Not treated	✓ – To achieve Good Ecological Status 11 qualitative descriptors are included in the Strategy; Descriptor no. 6 monitors if the entire aspect of the seabed ensures that ecosystem structure and functions are conserved, and benthic ecosystem in particular are not affected.	X – Not treated. Information on the ecosystems capacity to deliver goods and services is insufficient.

Policy sector	Natural Resource	Ecosystem Typology (MAES Level 2)	(1) Equity of benefits and needs from natural resources management	(2) Subsidiarity, decentralized management of ecosystems	(3) Consideration of ecosystem management impact on adjacent ecosystems	(4) Management of market distortions affecting ecosystems and integration of costs and benefits	(5) Resilience, conservation of ecosystem structure and functioning	(6) Management within the limits of ecosystem's functions and capacity
Forestry		Woodland and forest	X – Generally treated in the National Law (Codul Silvic) but not in the subsequent law.	✓ – Although State forests are centrally administered, management is decentralized for both State and private forests.	✓ – Only certified forests have a plan to assess certain social and environmental (implicitly about ecosystems) impact indicators. Above 40% of Romanian forests are certified.	X – Not treated	✓ – Forest management plans take conservation of forest ecosystems and functions into account.	✓ – Forest Management plans allow the use of resources within the limits while the law addresses overuse. However, lack of forest roads can lead to localized pressures.
Biodiversity		ALL	X – Not treated	✓– The Action Plan is implemented by the Ministry of Environment and its subordinated institutions including local agencies (e.g. NEPA/EPAs) as well as by natural protected areas administrators, etc.	! – The Actin Plan foresees the harmonization of management measures between transboundary natural protected areas (Measure B.23). Furthermore, the law on natural protected areas foresees zoning as a management tool, however it is not sure how the Strategy uses the information.	✓ – The Action Plan puts high priority on action D.3.3 to assess the impact of current incentives, subsidies and State Aid on biodiversity conservation in order to eliminate those with perverse effect	✓ – SEA/EIA/EA procedures applied to projects for the development of transport and energy infrastructure and for the exploitation of nonrenewable resources. Conservation ex-situ. Control of invasive species. Furthermore, the Strategy considers fundamental to value natural resources and ES delivered by well-functioning ecosystems, and to integrate costs of conservation and restoration the costs assessment of sectoral policies.	! – The Strategy mentions biocapacity versus ecological footprint of Romania, however data used are from 2006 while more recent data exist from 2012. This information is not necessarily used for integrated strategy elaboration across policy sectors.

Policy sector	Natural Resource	Ecosystem Typology (MAES Level 2)	(1) Equity of benefits and needs from natural resources management	(2) Subsidiarity, decentralized management of ecosystems	(3) Consideration of ecosystem management impact on adjacent ecosystems	(4) Management of market distortions affecting ecosystems and integration of costs and benefits	(5) Resilience, conservation of ecosystem structure and functioning	(6) Management within the limits of ecosystem's functions and capacity
Climate Change – Mitigation (and Adaptation)		ALL	✓ – Both the Strategy and the Action Plan recognize that ecosystems deliver benefits to all. The Chapter "Social risks" of the Action Plan implies to assess the social acceptance of the actions in case poor and vulnerable groups are disproportionally affected. Further measures are needed to address isssues of accessibility and equity.	✓ – Reorganization of the National Commission on Climate Change (CNSC) with technical working groups involving relevant institutions and authorities. Establishment of a network of climate partners (RPC - Rețele a Partenerilor Climatici) including the private sector and thus improving implementation capacity.	✓ – In the Action Plan the promotion of renewable energy sources foresees the assessment of environmental impact with respect to the impact on ecosystems (e.g. hydro-energy infrastructure)	X – The Transport Chapter, Objective no. 1 mentions the introduction of economic incentives (e.g. price instruments) for a system of ecological transport and includes a measure to raise taxes on carbon price, car registration, parking, etc. during 2016-2022. However, the approach is not efficient nor socially fair (e.g. higher costs for using private transport) if measures to improve public transport are not implemented first (Objective no. 2 and no. 3).	X – Under Action 4.2 – Drinking water and water resources, objectives and measures for ecological reconstruction are lacking while are mentioned investments in classical structural measures such as dams and dykes.	X – Not treated
Sustainable Development		ALL	-	-	-	-	-	-
Fisheries and aquaculture	Fish	Rivers and lakes Coastal	X – Not treated	✓ – ANPA implements the strategy with its local branches, supported by other authorities in control matters; ARBDD is responsible for implementation in the Danube Delta. Furthermore, FLAGs implement territorial strategies.	X – Not treated	X – Not treated	X – Not treated	! – Treated under Sustainable Development however the focus is on human needs rather then on ecosystems or the need to maintain an equilibrium between fishing capacity and available resources.

Policy sector	Natural Resource	Ecosystem Typology (MAES Level 2)	(1) Equity of benefits and needs from natural resources management	(2) Subsidiarity, decentralized management of ecosystems	(3) Consideration of ecosystem management impact on adjacent ecosystems	(4) Management of market distortions affecting ecosystems and integration of costs and benefits	(5) Resilience, conservation of ecosystem structure and functioning	(6) Management within the limits of ecosystem's functions and capacity
Agriculture and Rural Development		Cropland Grassland	✓ - Achieved through 2014-2020 payment schemes such as the redistributive payment on SAPS, which can lead to a significant increase in payments for small and medium sized family farms, the payment for good environmental and climate practices, the payment for young farmers, and the simplified small farmers scheme	✓ - APIA and AFIR implement eco-conditionality norms; APIA, which has local structures, also implements direct payments; control is also delegated	✓ - Eco-conditionality measures are referred to water, soil, biodiversity, landscape, and animal welfare	✓ - Direct payments decoupled from production since 2003. In 2014-2020 coupled support only for sectors mentioned in art. 52 alin. (2) of Reg. (UE) no. 1.307/2013, undergoing difficulties and important from an environmental and socio-economic point of view. Besides, direct payments are an income support for farmers independent from market dynamics	✓ - Eco-conditionality measures are referred to water, soil, biodiversity, landscape, and animal welfare; greening measures	X – Promotion of organic agriculture, however intensive agriculture continues to be business as usual and the impact of greening measures designed by the last CAP reform is not significant
Transport		ALL –	X – Not treated	X = Not applied	X – Not treated	X – Not treated	✓ – The Environmental Report considers the impact of the transport sector on ecosystems and recommends first of all to avoid areas with high biodiversity (e.g. natural protected areas)	X – Not treated. Information on the ecosystems capacity to deliver goods and services for the transport sector are insufficient.
Energy		ALL	X – Not treated	X – The National Authority for the regulation of the energy domain (ANRE - Autoritatea Națională de Reglementare în domeniul Energiei), which is controlled by the Parliament, oversees and coordinates the national electricity market and issues regulatory acts. Transelectrica manages the national electricity network (it operates the transport and energy systems).	X – Not treated	X – Not treated	X – Conservation measures for the development of the energy sector are included in the Environmental Notification to the Strategy, however indicators are not well correlated and the Notification is not recognized nor implemented by subordinated institutions (due to procedural matters)	X – Not treated. Information on the ecosystems capacity to deliver goods and services for the energy sector are insufficient.

Policy sector	Natural Resource	Ecosystem Typology (MAES Level 2)	(1) Equity of benefits and needs from natural resources management	(2) Subsidiarity, decentralized management of ecosystems	(3) Consideration of ecosystem management impact on adjacent ecosystems	(4) Management of market distortions affecting ecosystems and integration of costs and benefits	(5) Resilience, conservation of ecosystem structure and functioning	(6) Management within the limits of ecosystem's functions and capacity
Regional Development		ALL	X – Not treated	✓ – POR Managing Authority within the Ministry of Regional Development and Public Administration (MDRAP); Regional Development Agencies, which elaborate Regional Development Plans synthetized in the National Strategy.	✓ – EIA/AA Procedures	X – Not treated	✓ – Environmental objectives: biodiversity conservation within protected areas; harmonization of natural and built environments; etc.	X – Not treated
Territorial Planning		ALL	✓ – General objective on improving the quality of life in urban and rural areas in correlation with their quality, attractiveness, and inclusiveness	X – Decentralized decision making is recognized but not explicitly mentioned. Decision-making and monitoring are at the level of MDRAP except for programs implemented by the local administration, implementation is done at local levels, control is done by the Ministry of Finance.	✓ – The Environmental Report considers environmental characteristics of the area that could possibly be affected with respect to air, surface and underground water, soil, biodiversity, natural protected areas, natural and cultural heritage, landscape, population, waste, climate change, socio-economic environment (Cap. 4)	X – Not treated	✓ – Recognition that inadequate use can have negative impact on natural resources. Measure 4.2.3.7 for the protection of natural habitats against climate change, because ES could be affected. Measure 4.3.3.9 on the conservation of natural protected areas and biodiversity in mountain areas.	X – Not treated

Legend:
X = the criteria is not met
! = the criteria is partially or not clearly met
✓ = the criteria is met

16 According to current legislation, ANAR receives revenues from water management activities (hydropower plants, gravel extractions, etc.) based on concessions, rentals and permits to potential investors. Thus, ANAR is both involved in the exploitation of water resources in the pursuit of profit and in the control and prevention of negative impacts over such resources. Evidently, these two functions are in conflict and should be separated in order to avoid negative consequences upon river ecosystems.

Table no. 9 (b) below shows the level of integration of the Ecosystem Approach according to the CBD principles 7-12:

Table 9 (b). Level of integration of the Ecosystem Approach into Romanian sectoral policies according to CBD principles 7-12

Policy sector	Natural Resource	Ecosystem Typology (MAES Level 2)	(7) Management based on appropriate spatial and temporal scales including connectivity	(8) Set-up of long term objectives that respect timescales of ecosystem processes including lag effect	(9) Recognition of ecosystem changes through adaptive management	(10) Balance between conservation and use of biodiversity	(11) Knowledge based management of ecosystems	(12) Stakeholders participation in ecosystems management
Water	Water	Rivers and lakes Wetlands	✓ – There is a National River Basin Management Plan as well as Sub-river basins management plans.	X – The objectives of river management plans are set in the long-term, until 2027, based on 3 management cycles. The timescales of the ecosystem are not specifically taken into account.	X – Not treated. Possible perturbations in the ecosystems (e.g. due to climate change) are not analyzed.	✓ – Comparing with the previous cycle of river basin management plan, the tendency to balance conservation and water use exists by including conservation measures in sub-basins management plans (e.g. wetland restoration for habitats protection).	✓ – River basins management plans are based on scientific studies and experts judgement but do not consider local knowledge.	✓ – The elaboration of river basin management plans includes a multi-stakeholders public consultation process where measures are presented but not thoroughly discussed. Also, there is insufficient transparency with regards to water data. Similarly, river basin management is based on a public instrument e.g. the river basin management plan, and a non-public instrument e.g. the river basin development plan.
Marine		Marine inlets and transitional waters Coastal	✓ – Cooperation protocols exist between Romania and Bulgaria at the level of the Black Sea basin (e.g. Black Sea Commission). However, based on the EC report on Art. 12 it is not known whether cooperation has actually taken place.	! – Not sure	X – Not treated	X – Not treated	✓ – INSPIRE Directive; Global Monitoring for Environment and Security Program (GMES); Framework for collecting data from the fishery sector; Shared Environmental Information System (SEIS); Water Information System for Europe (WISE) extended to the marine water; European observation and data collection network for the marine environment (ur-EMODnet)	! – Not sure

Policy sector	Natural Resource	Ecosystem Typology (MAES Level 2)	(7) Management based on appropriate spatial and temporal scales including connectivity	(8) Set-up of long term objectives that respect timescales of ecosystem processes including lag effect	(9) Recognition of ecosystem changes through adaptive management	(10) Balance between conservation and use of biodiversity	(11) Knowledge based management of ecosystems	(12) Stakeholders participation in ecosystems management
Forestry		Woodland and forest	X – Not treated	✓ – Forest management plans cover 10 years	! – Forest management plans are renewed and adapted every 10 years, however lacking flexibility if change is needed before	! – Well ruled, however economic pressure on forest ecosystem poses practical problems	✓ – Field data are used to elaborate forest management plans; a national system is in place for annual reporting (SILV); the national forest inventory (IFN) is updated every 5 years	! – New concept usually applied to certified forests (above 40%); due to a lack of "stakeholder culture" stakeholders are not interested in nor prepared for public consultations
Biodiversity		ALL	✓ – The Strategy mentions the need to ensure the ecological coherence of the network of natural protected areas of national and community interest	X – Not treated	X – Not treated	✓ – Priority to biodiversity conservation is given the elaboration of policies for transport, energy and exploitation of non renewable resources policies, identified as impact sectors. Measures to reduce impact of road transport are identified at national, county and local level. SEA/EIA/EA procedures are applied to projects for the development of transport and energy infrastructure and for the exploitation of non-renewable resources.	✓ – ES valuation is mentioned as very important in order to take decisions that affect biodiversity	✓ – The Action Plan foresees to assess the implication of local communities in decision making for natural protected areas management

Policy sector	Natural Re-source	Ecosys-tem Ty-pology (MAES Level 2)	(7) Mana-gement based on appropri-ate spa-tial and temporal scales including connecti-vity	(8) Set-up of long term objectives that respect timescales of ecosystem processes including lag effect	(9) Recognition of ecosys-tem changes through adap-tive manage-ment	(10) Balance be-tween conser-vation and use of biodiversity	(11) Knowledge based ma-nagement of ecosystems	(12) Stakeholders participation in ecosystems management
Climate Change – Mitigati-on (and Adaptati-on)		ALL	✓ – The contri-bution of the Action Plan to interna-tional targets is assessed according to the Chapter on "Res-ponsibi-lities and interna-tional targets". One of the actions includes "Research on the use of global climate models to make pro-jections at regional and local scales in order to obtain local as-sessments of climate change effects in different regions".	! – The Action Plan includes the assessment of ES and it can be assumed that this infor-mation will be used to correla-te climate chan-ge management measures with the functioning of ecosystems.	✓ – The Action Plan considers the preventive principle but also the flexi-bility to adapt policy measures based on future knowledge on climate chan-ge. Actions monitoring and assessment is thus conside-red important. Furthermore, biodiversity ac-tions include the "Establishment of management plans for natural protected areas taking into ac-count the prin-ciple of adaptive management.	✓ – One action under Objective no. 4 is about including ES assessment and the Ecosystems Approach into natural reso-urces manage-ment	✓ – The Action Plan menti-ons the need to assess ES and to adapt the measures accordingly. Furthermore, it says that deci-sions must be based on proofs and knowled-ge and should be pragmatic; also, the newest researches and experiences should be used in defining the actions.	✓ – Stakehol-ders have been consulted for the Strategy elaboration. The principle is also included in the Action Plan.
Fisheries and aqu-aculture	Fish	Rivers and lakes Coastal	✓ – Ma-nagement promoted at farm level; also, measures stimula-ting the impro-vement of the aquatic environ-ment	✓ – Payments for organic aquaculture and for the improvement of the aquatic environment are given based on this principle. Also an Order that prohibits fishing is issued annually based on reproduction periods.	✓ – The Nati-onal Strategy and the Opera-tional Program for Fisheries are revised every 7 years.	! – Reflected in the National Strategy chap-ter on Problem and Solutions. Also the Opera-tional Program for Fisheries - Sustainable Development chapter, men-tions its desi-rability under the Common Fishery Policy.	✓ – Stated in both the Nati-onal Strategy (vision) and the Operational Program for Fisheries (PU1, PU2) although certain data necessary for implementation are lacking.	✓ – Existence of a working group also mentioned in the National Strategy pre-amble, including national public administration, associations of fishermen and processors, research institu-tes, academics and NGOs.
Agricul-ture and Rural Develop-ment		Cropland Grass-land	✓ - Ma-nagement promoted at farm level aims at achieving simulta-neously water, cli-mate and biodiver-sity ob-jectives, including Natura 2000	✓ - Conver-sion period of 5 years considered by measures for the transition towards orga-nic agriculture; conservation of HNVF is a long-term objective	✓ - Measu-res promoting adaptation to climate change	✓ - respect of eco-conditiona-lity measures as well as of conservation requirements foreseen in the measures e.g. amounts of in-puts, harvesting periods asso-ciated with re-production and feeding needs of species, etc.	! – Stakehol-ders' expertise is used for the elaboration of measures, however sho-uld be more involved in de-cision-making; also, the effecti-veness of mea-sures should be monitored on the ground	! – Good use of working groups in the elabora-tion of 2014-2020 strategy and program but little trans-parency in de-cision-making e.g. selection of NRDP Monito-ring Committee members

Policy sector	Natural Re-source	Ecosys-tem Ty-pology (MAES Level 2)	(7) Mana-gement based on appropri-ate spa-tial and temporal scales including connecti-vity	(8) Set-up of long term objectives that respect timescales of ecosystem processes including lag effect	(9) Recognition of ecosys-tem changes through adap-tive manage-ment	(10) Balance be-tween conser-vation and use of biodiversity	(11) Knowledge based ma-nagement of ecosystems	(12) Stakeholders participation in ecosystems management
Transport		ALL	X – Not treated	X – Not treated. It could be be-cause the GMPT is a general document.	✓ – Routes fo-reseen in future transport pro-jects are suppo-sed to be esta-blished based on the impact of the different alternatives on natural protec-ted areas, etc.	✓ – The En-vironmental Report takes into considera-tion the impact of the trans-port sector on ecosystems and recommends measures to avoid or, if this is not possible, to mitigate and compensate for biodiversity loss	✓ – The En-vironmental Report foresees that the calen-dar for the im-plementation of transport pro-jects takes into account both the amount of time and the budget neces-sary to collect scientific data on biodiversity.	! – Stakehol-ders have been consulted for the Strategy elaboration but the principle is not applied during imple-mentation of investments projects. The legal procedu-re for public participation is applied but not sufficiently.
Energy		ALL	! - Refe-rence is made to EU Clima-te Change Strategy objectives on GHG reduction, however the lack of a develop-ment plan precludes an assess-ment of national Strategy contribu-tions. No correlati-on exists with the Biodiver-sity Stra-tegy	X – Not treated	X – Not applied since detailed planning is not integrated in the Strategy (e.g. what to produce, how much, where, etc.)	X – Not treated	X – Not treated	! – Stakehol-ders have been consulted for the Strategy elaboration but the principle is not applied during imple-mentation
Regional Develop-ment		ALL	✓ – Con-sideration of protec-ted areas needs.	! – Biological processes could be taken into consideration in EIA/AA proce-dures for pro-jects appraisal	! – Not explici-tly covered. The Environmental Report men-tions SEA/EIA procedures and that monitoring frequency of POR objectives varies	✓ – Conservati-on and preven-tion of negative effects	X – Not trea-ted. The need to obtain more data on bio-diversity and ecosystems processes is not mentioned	! – The legal procedure for public partici-pation has been used in the Strategy elabo-ration. SEA/EIA procedures

Policy sector	Natural Re-source	Ecosys-tem Ty-pology (MAES Level 2)	(7) Mana-gement based on appropri-ate spa-tial and temporal scales including connecti-vity	(8) Set-up of long term objectives that respect timescales of ecosystem processes including lag effect	(9) Recognition of ecosys-tem changes through adap-tive manage-ment	(10) Balance be-tween conser-vation and use of biodiversity	(11) Knowledge based ma-nagement of ecosystems	(12) Stakeholders participation in ecosystems management
Territorial Planning		ALL	✓ – Mea-sures for trans-boundary areas aimed at mana-gement capacity and coo-peration.	X – Not treated	✓ – Yearly update of mo-nitoring system with results feeding into Strategy revi-sion. Update of the Strategy implementation plan every 3 years.	✓ – Specific Objectives including mea-sures with redu-ced impact on ecosystems: SO 4.1 on heritage protection and promotion of measures for natural capital restoration; SO 4.4 on ensuring a balanced development between urban and rural areas by protecting agriculture and forest land resources and limiting the expansion of urban areas; SO 2.3 on im-proving the attractiveness of urban and rural areas by improving resi-dential functi-ons, developing quality public spaces and transport servi-ces adapted to local needs and characteristics	✓ – Monitoring of Strategy implementation: annual report on the state of the Romanian territory (dy-namics of terri-torial develop-ment, economic growth, mode and extent of resources use, results of mea-sures against poverty and disparities be-tween people and territories)	! – Legal proce-dure for public participation in the Strategy elaboration. No imposition of stronger consul-tation of local actors (NGOs, business, etc.)

Legend:
X = the criteria is not met
! = the criteria is partially or not clearly met
✓ = the criteria is met

Status of Romanian ecosystems currently known and reported

The MAES process is meant to provide an in-depth evaluation of ecosystems status. So far, the **2007-2012 reporting on Article 17 of the Habitats Directive (National summary)** and the **State of the Environment National Report of 2013 and/or 2014** are the two official tools monitoring and reporting to the EU directly on the status of ecosystems and the environment and including information on land management, ecosystem characteristics and sources of pressure.[17] Both documents have been examined **to prioritize ecosystems and ecosystem services in order of urgency of needed intervention, and select those to be assessed by the end of the N4D project in April 2017.** The prioritization is necessary **due to time constraints given by project duration** and the completion of NEA is still highly recommended to achieve Good Ecosystems Governance through improved decision and policy making. Also, the status of Romanian ecosystems currently known and highlighted in this policy analysis is meant **to provide a baseline necessary for the further improvement of sectoral policies since it is not possible to change what we do not know**. The

17 Both reports fall under the responsibility of the National Environmental Protection Agency that centralizes data received by other institutions for their respective field of competence.

MAES process is going to confirm or provide more accurate information on Romanian ecosystems status.

Other environment related reporting obligations that Romania fulfils towards the EU have not been considered in assessing the baseline status of Romanian ecosystems because the information provided is already used in the State of the Environment National Report.

Using the color-coding shown in Table no. 10 below (adjusted from the Habitats Directive) **to interpret information from Article 17 and the national state of the environment reporting**, **it is possible to see which ecosystems** have a bad and almost bad status, meaning that they **need serious management interventions and thus an improvement of the related policy objectives and measures.** Some policies clearly state that there is a need for more accurate information about ecosystem functions and values; this is the case for biodiversity and energy.

Table 10. Code of colors for interpreting ecosystem status based on information officially reported on biodiversity and the environment

Conservation status[18]	Conservation trends	Code of colors for interpreting ecosystem status based on information officially reported on biodiversity and the environment	
FV = Favorable	Us = Unfavourable Stable		Favorable status
U1 = Unfavorable Inadequate	Ud = Unfavourable Declining	Almost Favorable status	Inadequate status
U2 = Unfavorable Bad	Uu = Unfavorable Unknown	Almost Bad status	Bad status

18 **Favorable Conservation Status (FCS)** is the overall objective to be reached for all habitat types and species of community interest and it is defined in Art. 1 of the Habitats Directive. It can be described as a situation where a habitat type or species is prospering (in both quality and extent/population) and with good prospects to do so in future as well. The fact that a habitat or species is not threatened (e.g. not faced by any direct extinction risk) does not mean that it is in FCS. According to the Habitats Directive, FCS needs to be defined, reached and maintained; it is therefore more than avoiding extinctions. FCS is assessed across all national territory (or by biogeographical or marine region within a country where 2 or more regions are present) and should consider the habitat or species both within the Natura 2000 network and in the wider countryside or sea. **For habitats, FCS is defined as follows (Article 1e):** its natural range and areas it covers within that range are stable or increasing; the specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future; the conservation status of its typical species is favorable. **For species, FCS is defined as follows (Article 1i):** population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats; the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future; there is and will probably continue to be a sufficiently large habitat to maintain its populations on a long-term basis. **For reporting under Art.17 a format with three classes of Conservation Status has been adopted: Favorable (FV), Unfavorable Inadequate (U1), and Unfavorable Bad (U2):** FV describes the situation where the habitat or species can be expected to prosper without any change to existing management or policies; U1 describes situations where a change in management or policy is required to return the habitat type or species to FV but there is no danger of extinction in the foreseeable future; U2 is for habitats or species in serious danger of becoming extinct (at least regionally). The "Unknown" class can be used where there is insufficient information available to allow an assessment. Overall assessments of Conservation Status that are unfavorable should be qualified to indicate if the status is improving, stable, declining or unknown by adding a plus, equal, minus sign or an 'x'. **For graphical representation, each class is color coded:** green for FV, amber for U1, red for U2, and grey for Unknown. *Assessment and reporting under Article 17 of the Habitats Directive. Explanatory Notes and Guidelines for the period 2007-2012*, Final version, July 2011.

Table no.11 below provides an overview of the baseline status of Romania's ecosystems evaluated within this analysis.

Table 11. Status of Romanian ecosystems derived and interpreted from official reportings

Policy sector	Natural Re-source	Ecosys-tem Ty-pology (MAES Level 2)	2007-2012 reporting on Art. 17 of the Habi-tats Directive (National summary)	State of the Environment National Report of 2013 and/or 2014
Water	Water	Rivers and la-kes	Freshwater habitats: 90% FV, 10% U1	SOER2013: Total hydrographic basins: 59% good ecolo-gical status, 40.5% moderate ecological status; Heavily modified water bodies: 50% good ecological potential, 50% moderate ecological potential; Natural lakes: 8% good ecological status, 88% moderate ecological status, 4% poor ecological status.
		Wetlands	Bogs, mires and fens habitats: 37% U2, 44% U1	
Marine		Marine inlets and transi-tional waters		
		Coastal		SOER2013: The quality of bathing waters along the coast-line has been according to legal provisions in force and the compulsory value has been 100% met. Surfaces un-dergoing erosion processes: ~ 153 ha. The advancement of the shoreline for more than 10 m distance has been registered on ~ 12% of the total length while the retreat of the shoreline with more than 10 m has been registe-red on 52% of the total length, the remaining part of the shore being in dynamic equilibrium - the shoreline has withdrawn or advanced with +/- 10 m. Sea level: the annual average (2012) was with 3,3 cm above the multi-annual average from 1933-2011. Phyto-plankton: the amplitude of phytoplankton development was much lower in coastal waters comparing to transiti-onal and marine waters, with 2012 being characterized by the low development of phytoplankton communities. Zooplankton: 30 taxons were identified in the qualitative structure of zooplankton, which belong to 12 taxonomic groups, the highest value registered since 2004. Phyto-benthos: the opportunistic green alga has been predo-minantly observed in the Northern part of the Romanian seaside while the brown alga *Cystoseira barbata* has been observed in Mangalia, 2 Mai and Vama Veche where mari-ne waters are known for their superior quality, which has allowed for the restoration and existence of this key spe-cies for the marine ecosystem. Zoobenthos, an indicator for eutrophication status, continues to show a constant evolution of species diversity. The qualitative assessment of all the investigated water bodies (Sulina - Vama Veche) has led to the identification of 52 macrozoobenthos spe-cies, with the faunistic landscape maintaining its charac-teristics over the past years.

Policy sector	Natural Re-source	Ecosys-tem Ty-pology (MAES Level 2)	2007-2012 reporting on Art. 17 of the Habi-tats Directive (National summary)	State of the Environment National Report of 2013 and/or 2014
Forestry		Woo-dland and forest	Forest habitats: 14% U2, 41% U1.	SOER2013: Out of the total surface under the State forest fund that has undergone the regeneration process, 57,1% (14701 ha) has been natural regeneration, which means 8,8% more than in 2011[19], while 42,9% (11.026 ha) has been afforestation (artificial regeneration), with 4,1% less than the year before. Surfaces that have been subjected to cuttings (about 9026 ha) have exceeded regenerated and reforested surfaces[20]. The volume of harvested tim-ber is increasing compared to 2006. The surface of rege-nerated forests is decreasing compared to 2006. SOER2014: The afforested area is slightly growing (0.1%) compared to 2013. Forest area per inhabitant has incre-ased from 0, 30 ha/inhabitant in 2010 to 0,32 ha/inhabi-tant in 2014. [21]
Biodiver-sity		ALL	Habitats - conservation status: 4% U2, 23% U1; trends: 64% Us, 23% Ud, 11% Uu; Species: 38% Us, 41% Ud, 20% Uu. Species - conservation status: 3% U2, 68% U1; trends: 38% Us, 41% Ud, 20% Uu. Species - Vascu-lar plants: 9% U2, 43% U1; Reptiles: 5% U2, 80% U1; Anthropods: 3% U2, 81% U1. Main pressures and threats with higher frequency - habitats: agri-culture, natural systems modifications, natural biotic and abiotic proces-ses (without catastro-phies), mining extraction of materials and energy production; species: natu-ral systems modifications, agriculture, forestry, urba-nisation. Dunes habitats: 20% U2, 40% U1	More than 60% of Romanian habitats assessed and reported have a favorable conservation status while approximately 7% of them had been assessed with a totally unfavorable status. Most habitats with favorable conservation status are in the alpine region. A very high percentage of marshes and peat bogs habitat category is assessed with unfavorable conservation status (more than 80%). A high percentage (67%) of all assessed spe-cies has an unfavourable inadecuate conservation status while 5% has a totally ufavourable status. Thus, with an average value of 72% of unfavourable conservation status for species of community interest, Romania far outstrips the European average (54% in UE-25 - SOER 2010). 18% of assessed species has a favourable conservation status (with respect to the EU average of 17%) and the percent of unassessed species in Romania is smaller comparing with the European average. Among assessed species, fishes have the lowest favourable conservation status, followed by amphibians, arthropods, reptils, molluscs, mammals and plants. The country surface covered by Natura 2000 sites has increased with the designation of new sites: from 12,5% of country surface covered by SPA in 2007 to 15,5% in 2012; from 13,8% of country surface covered by SCI in 2007 to 17,4% in 2012. Overall, the to-tal percentage of country surface covered by Natura 2000 sites has increased from 17,84% to 23,38%.
Climate Change – Mitiga-tion and Adapta-tion		ALL		SOER2014: In 2013, the level of total GHG emissions (excluding the contribution of LULUCF) has increased with approximately 8,57% compared with the level of emissi-ons registered in 2012. The level of GHG emissions from sectors like "Industrial processes", "Use of solvents and other products", and "Agriculture" has decreased signifi-cantly compared with the level of emissions registered in 1989. Average annual temperatures forecasts register in-creases over the whole Romanian territory, in all scenari-os, more significant in those with higher concentrations of GHG both globally and regionally.
Fisheries and aqu-aculture	Fish	Rivers and la-kes Coastal	Fish: 18% U2, 79% U1	SOER2014: Among the species assessed, fishes have registered the lowest favourable conservation status

Policy sector	Natural Re-source	Ecosys-tem Ty-pology (MAES Level 2)	2007-2012 reporting on Art. 17 of the Habi-tats Directive (National summary)	State of the Environment National Report of 2013 and/or 2014
Agricul-ture and Rural Develop-ment		Cropland		SOER2014: Soil pollution from agriculture and forest waste as well as residues is reported for 1140 ha of which 948 ha are very aggressively and excessively polluted with animal dejections. The latter type of pollution alters the chemical composition of soil due to nitrates augmentation, which can have toxic effects also upon the underground water. Are affected in varying degrees 4.937 ha of which 1.097 ha are moderately strong/excessively affected. Pesticides soil pollution is reported only in some counties for a total of 2.076 ha of which 1.986 ha are in Bacau county in the surroundings of the industrial compound Chimcomplex; in general, pollution is low and moderate. Increase of fertilized area (from 3.640.900 ha to 6.676.089 ha) and of the amount of fertilizers per ha (from 35,4 kg to 48,2 kg); decreased use of phytosanitary products (from 1,18 kg s.a./ha in 1999 to 0,72 kg s.a./ha in 2014). The surface arranged for irrigation represents, theoretically, 36,77% of total works, 115413 ha less compared to 1999; the surface arranged for draining/drainage represents 36,71% of total works with a decrease of 115.413 ha in 2014 compared to 1999; the surface arranged with anti-erosion works represents 26,52% of total works with a decrease of 47891 ha in 2014 compared to 1999. Increase of organic agriculture surfaces; in 2014, only 6,5% of cultivated land is fertilized with organic fertilizers.
		Grass-land	Grasslands habitats: 3% U2, 12% U1	

2.3. Results of the policy assessment: analysis and conclusions

Growth is the economic paradigm underpinning Romania's development path. In 2008 Romania has adopted a National Sustainable Development Strategy (NSDS) to 2013-2020-2030 where reference is made to all forms of capital, natural, physical, human and social, but also to sustainable growth. The concept of Green Economy is mentioned in the strategy of the Ministry of Economy called "Competitive Romania", however natural capital is considered as a driver for development and economic growth. No reference is made to planetary boundaries and measures mentioned to avoid environmental degradation in favor of production fall in the category of *greening*. Without a **Sustainable Green Economy Strategy** (general criteria no.1 in the policy assessment), chances to ensure human well-being across the entire population of the country are little.

The Romanian MAES process has begun in March 2015 with the implementation of the N4D project, due to time constraints only selected ecosystems (forests, agricultural, urban and freshwater) had been assessed quantitatively and semi-quantitatively. In any case, the methodologies developed for the MAES process are applicable to perform a **NEA**, which should be pursued as a priority as soon as possible (general criteria no. 2 in the policy assessment).

Institutional integration and coordination is crucial to implement a Sustainable Green Economy (general criteria no. 3 in the policy assessment). An Inter-ministerial Committee (ImC) for coordinating the integration of the environmental protection domain in sectoral policies and strategies at national level has been established with

19 Natural regeneration happens in forest where cuttings have taken place, so not in stable forests. Natural regeneration of forest is directly proportional to cuttings. The more is cut the more is regenerated. Thus, information about natural regeneration should not be considered independently.

20 Cuttings do not mean that forest vegetation has totally been cut, which should be the case for natural regeneration to happen.

21 For clarity reasons, reporting about forest habitats needs a better correlation and explaination of data.

Government Decision no. 1097/2001 and reorganized with Decision no. 741/2011. It is a consultative body but not a juridical entity, working closely with the Ministry of Environment according to Government Decision no. 38/2015 (Art. 12.1a). Its composition and rules of engagement have been updated with Ministerial Order no. 649/2016 and no. 15/2015 respectively. The current focus of the ImC is on implementing and monitoring the Sustainable Development Goals without reference to Sustainable Green Economy and the role that governmental institutions should play altogether to ensure the transition. Under the N4D project the premises for a national Policy – Science Interface have been set-up: a governance system for the MAES process has been developed including a MAES Steering Group made of ministerial technical representatives, and a Scientific Group made of publicly selected experts. However, the link between the MAES governance system and the ImC has not been made yet.

Looking further at the 11 sectoral policies assessed, only biodiversity explicitly and comprehensively integrate the **Ecosystem Approach** at conceptual level; 4 explicitly but not comprehensively integrate the Ecosystem Approach at conceptual and operational level, that is forestry, agriculture and rural development, fisheries and aquaculture, climate change mitigation, while marine does it at conceptual level; 4 implicitly and comprehensively integrate the Ecosystem Approach at conceptual and operational level, that is water, regional development, transport and territorial planning, while biodiversity does it at operational level; finally, there is no specific integration for energy at both conceptual and operational level, and for marine at operational level (see table 12).

Tabel 12. Level of integration of ecosystem approach in sectorial policies

POLICY	CONCEPTUAL	OPERATIONAL
National River Basin Management Plan 2015-2021, Water Law		
Marine Strategy Art.11 Monitoring Program		
Forest Code		
National Strategy and Action Plan for Biodiversity Conservation		
Romanian National Strategy on Climate Change 2013-2020		
Operational Program for Fisheries and Maritime Affairs		
National Program for Rural Development		
General Master Plan for Transport 2014-2020		
Energy Strategy for Romania 2007-2020 updated for 2011-2020		
Regional Operational Program 2014-2020		
Romanian Territorial Planning Strategy		

Besides, none of the policy sectors integrate all the CBD principles of Good Ecosystem Governance. Use of the 12 **CBD principles** to assess the integration of the Ecosystem Approach into public policies shows for example, that **management within the limits of ecosystem's functions and capacity** is usually not treated, only forestry does it while biodiversity as well as fisheries and aquaculture do it partially. Similarly, **equity of benefits and needs from natural resources management** is usually not treated except for agriculture and rural development, climate change mitigation and territorial planning. Except for regional development, all policy sectors address the issue of **knowledge-based management of ecosystems** with biodiversity clearly mentioning ecosystem services valuation as very important in order to take decisions that affect biodiversity, and energy mentioning the need to assess ecosystem services and to adapt policy measures accordingly. Furthermore, **balance between conservation and use** is not treated by marine and energy policy sectors, while it is not clearly treated in forestry as well as fisheries and aquaculture policy sectors. **The policy sector meeting most of CBD principles on the Ecosystem Approach is climate change mitigation followed by biodiversity and territorial planning; on the contrary, the energy sector is not meeting any principle followed by the transport policy sector.**

The design of **policy instruments beyond greening** is practiced by some policy sectors such as transport, biodiversity, climate change mitigation and territorial planning but there is definitely space for more creativity.

Table no.13 below provides an overview of assessment results against specific criteria.

Table 13. Assessment of Romanian public polices vis-à-vis specific criteria reflecting the transition to Sustainable Green Economy

Policy relevance	Policy sector	SPECIFIC CRITERIA		
		Level of integration of the Ecosystem Approach	Integration of the Ecosystem Approach according to the Convention on Biological Diversity (12 principles)	Design of policy instruments beyond greening
Environmental factors	Water	Conceptual and Operational: Implicit and incomprehensive	✓ = 5 X = 6 ! = 1	X = Financial allocations under the Operational Program for large infrastructure. Also, contributions system for the use of water (payments, bonifications and penalties) based on cost recovery, polluter pays, equal access to water resources, rational use of water resources (for the quantitative management) and cautiousness and prevention, cost recovery, polluter pays (for the qualitative management). Consequently, only indirectly it recognizes the ES of water provision.
Natural resources management	Agriculture and Rural Development	Conceptual and Operational: Explicit but not comprehensive	✓ = 9 X = 1 ! = 2	✓ = agro-environmental payments contributing to ES delivery
	Forestry	Conceptual: Implicit and incomprehensive. Operational: Explicit but not comprehensive.	✓ = 6 X = 3 ! = 3	✓ = Elimination of taxes for FSC certified surfaces; compensatory payments; PES under art.11 and 15 of the Forest Code; due diligence; NRDP measures for agro-forestry, and first afforestation. All contributing to ES delivery
	Fisheries and aquaculture	Conceptual and Operational: Explicit but not comprehensive	✓ = 6 X = 4 ! = 2	✓ = compensatory payments; payments for the improvement of the aquatic environment. All contributing to ES delivery
	Marine	Conceptual: Explicit but not comprehensive. Operational: No specific integration.	✓ = 3 X = 6 ! = 3	X = The Monitoring Program to ensure that Good Ecological Status of the marine environment is achieved or maintained was supposed to be elaborated until 2015 but no official information has been found so far.
Use of / impact upon natural resources	Regional development	Conceptual and Operational: Implicit and incomprehensive	✓ = 5 X = 4 ! = 3	X = Ecosystem services are not yet integrated into EIA ans SEA procedures (valid for project assessment across policy sectors). Investments focused on energy efficiency and to support SMEs
	Transport	Conceptual and Operational: Implicit and incomprehensive	✓ = 4 X = 7 ! = 1	✓ = Monitoring Program to prevent negative effects upon the environment by proposing supplementary protective measures that reduce the impact or for remediation of affected areas.
	Energy	Conceptual and Operational: No specific integration	✓ = 0 X = 10 ! = 2	X = Green Certificates focused on reducing pollution but without biodiversity proofing. Certificates for the emissions of GHG. Environmental Notification including conservation measrues not recognized nor implemented.

Policy relevance	Policy sector	SPECIFIC CRITERIA		
		Level of integration of the Ecosystem Approach	**Integration of the Ecosystem Approach according to the Convention on Biological Diversity (12 principles)**	**Design of policy instruments beyond greening**
Cross-cutting issues	Biodiversity	Conceptual: Comprehensive and explicit. Operational: Implicit and incomprehensive.	✓ = 7 X = 3 ! = 2	✓ = Protected areas management using State and FEADR budget; compensations for forest and land users that respect management restriction for Natura 2000 sites; and compensations for forest users that respect restrictions on the exploitation of forests with protection functions of national interest (forest cathegories T1 and T2).
	Climate Change – Mitigation (and Adaptation)	Conceptual and Operational: Explicit but not comprehensive	✓ = 8 X = 3 ! = 1	✓ = Green Certificates to produce energy from renewable sources but without biodiversity proofing. PES for adaptation to climate change. National bonifications scheme for afforestation, reafforestation and conservation of virgin forests. Nature based solutions to climate change. Economic incentives for ecological transport.
	Territorial Planning	Conceptual and Operational: Implicit and incomprehensive	✓ = 7 X = 4 ! = 1	✓ = Support aimed at improving territorial competitiveness and cohesion as well as quality of life based on quality, attractiveness and inclusiveness of urban and rural areas. Protection of the natural and built environment and valorization of territorial identity elements.

Legend:
X = the criteria is not met
! = the criteria is partially or not clearly met
✓ = the criteria is met

Numbers reflect the total of CBD principles that meet, do not meet or partially meet the criteria of Ecosystem Approach integration

The use of MAES indicators as well as Beyond GDP indicators for EU reporting and decision-making is an ongoing activity at the moment and aims to facilitate the way different ministries, mainly from the MAES Steering Group, reports to EU.

In conclusion, **none of the three general criteria used to assess whether Romanian public policies stimulate the transition towards Sustainable Green Economy is met**. Also, **any of the policy sectors is meeting all the four specific criteria used in the policy assessment.** Overall, **sectoral policies continue to support the Business as Usual scenario** and do not even mention "green economy".

Human pressures on the environment and ecosystems are the result of a developing, upper-middle income market economy, the 17th largest in the EU by total nominal GDP[22] and the 13th largest based on Purchasing Power Parity[23]. The collapse of the Communist regime in 1989, reforms in the late 1990s and early 2000s and Romania accession to the EU in 2007 have led to an improved economic outlook. As a matter of fact, in the Romanian press the economy has been referred to as the "Tiger of the East" during the 2000s. **The country continues to have a considerable economic potential** based on over 10 million hectares of agricultural land, diverse

22 **Nominal GDP –** Nominal GDP is gross domestic product (GDP) evaluated at current market prices, GDP being the monetary value of all the finished goods and services produced within a country's borders in a specific time period. Nominal differs from real GDP in that it includes changes in prices due to inflation or a rise in the overall price level. http://www.investopedia.com/terms/n/nominalgdp.asp

23 **Purchasing Power Parity –** It is a theory in economics that approximates the total adjustment that must be made on the currency exchange rate between countries that allows the exchange to be equal to the purchasing power of each country's currency. The relative version of PPP is calculated as: S = P1/P2 where "S" represents exchange rate of currency 1 to currency 2, "P1" represents the cost of good "x" in currency 1, "P2" represents the cost of good "x" in currency 2. http://www.investopedia.com/terms/p/ppp.asp

energy sources (coal, oil, natural gas, hydro, nuclear and wind), a substantial, although aging, manufacturing base and opportunities for expanded development in tourism in the Black Sea coast and in the mountains. (Economy of Romania, 2017)

The main sectors of the economy are agriculture, forestry, fishing, industry and services (auto industry and IT & C). The volume of **traffic** in Romania, especially goods transportation, has increased in recent years due to its strategic location in South-East Europe. In the past few decades, much of the freight traffic shifted from rail to road. A further strong increase of traffic is expected in the future. The **energy sector** is dominated by state-owned companies. Fossil fuels are the country's primary source of energy, followed by hydroelectric power. Due to dependency on oil and gas imports from Russia, the country has placed an increasingly heavy emphasis on nuclear energy since the 1980s. For domestic heating/cooking rural and small-town households use almost exclusively domestically produced wood as the main energy source. Romania has the largest wind power potential in Southeast Europe (in 2015 installed wind power was representing 11% of national energy grid). (Ministery of Energy, 2016)

Under the N4D project, **9 types of ecosystems have been identified in Romania during the scientific assessment of the MAES process**, with croplands occupying most of the surface (34.96%) followed by forest ecosystewith agricultural ecosystems occupying most of the surface (35.12%) followed by forest ecosystems (28.28%), grasslands (12.97%), marine and coastal ecosystems (11.09%), urban ecosystems (5.09%), rivers and lakes (2.95%), wetlands (0.16%), shrubs (0.12%), sparsely or unvegetated land (0.01%).

The **main pressures caused by human activities upon Romanian ecosystems** are building of grey infrastructure, urban development, intensive agriculture and forest activities, intensive fisheries and aquaculture, mine extractions, land use changes, introduction of invasive species, and improper waste management, which result in the following types of **impact on the environment and ecosystems**: pollution, habitat degradation and fragmentation, depletion of natural resources, Green House Gases (GHG) growth, and climate changes.

Given current knowledge on **Romanian ecosystems** status available from the 2007-2012 National summary report under Art. 17 of the Habitats Directive and from the State of the Environment National Report (SOER) of 2013 and/or 2014, the following **prioritization** has been made: wetlands, croplands, forests, marine and coastal, freshwaters and grasslands. Wetlands deserve significant attention since bogs, mires and fens habitats have a bad conservation status. With regards to croplands, it is particularly important to gain further knowledge about soil, which is the basis for most ecosystem services, and are a priority ecosystem given intensification of agriculture, land conversion and abandonment. Freshwater ecosystems deserve consideration since rivers are reported to have a good and moderate ecological status, 92% of natural lakes still have a moderate ecological status, but fish species have the worse conservation status. Forests also deserve attention since on one hand, under Art.17 of the Habitats Directive 14% of forests are reported to have an unfavorable bad conservation status and 41% are reported to have an unfavorable inadequate conservation status; on the other hand, SOER2014 presents a positive image of forests with the afforested area slightly growing (0.1%) compared to 2013 and the forest area per inhabitant having increased from 0, 30 ha/inhabitant in 2010 to 0,32 ha/inhabitant in 2014. No information is specifically available regarding urban ecosystems, shrubs and rocks.

When discussed with the Scientific Group **under the N4D project**, the status and prioritization of ecosystems for the Romanian MAES process has been agreed as follows: grasslands, facing a declining status with a reduction in surfaces, production, fodder quality and biodiversity; forests followed by wetlands, both facing a declining status and with the need to better manage the supply of floods control and drainage regulation functions respectively; marine and coastal ecosystems with a stationary status; urban ecosystems, croplands, freshwaters, shrubs and rocks with an improving status. Considering data availability, the ecosystems selected for an in-depth assessment (quantitative) by the end of the N4D project in April 2017 are forests, freshwaters, croplands and urban ecosystems.

With respect to policy making, given that the main pressures and threats with higher frequency on habitats are agriculture, natural systems modifications, natural biotic and abiotic processes (without catastrophes), mining extraction of materials and energy production, while on species are natural systems modifications, agriculture, forestry, and urbanization, the **priority public policy sectors to be monitored** are agriculture, energy, forestry, mining exploitation, transport, and urban development. Furthermore, a comparison between the level of integration of the Ecosystem Approach into Romanian sectoral policies and the status of Romanian ecosystems shows that **sectoral policies** such as biodiversity, water, fisheries and aquaculture, agriculture and rural development, and forestry are **not fully effective in protecting natural capital through sustainable integrated management that is Good Ecosystem Governance**. The implicit and comprehensive integration of the Ecosystem Approach at conceptual and operational level of the water policy explains the contradiction between the good status of rivers and lakes and the bad status of fish species, with little consideration being given to the functional characteristics of water bodies. Also, it explains the bad conservation status of wetlands. The explicit and comprehensive integration of the Ecosystem Approach at conceptual level and the implicit and comprehensive integration at operational level explain why 67% of species have an unfavorable inadequate conservation status while the trend in habitats status is unfavorable stable for 64%, unfavorable declining, for 23%, unfavorable unknown for 11%. The explicit but not comprehensive integration of the Ecosystem Approach at conceptual and operational level further explains the bad status of fish species. Similarly, it explains the average status of croplands and the declining status of grasslands as reported by the Scientific Group under the N4D project. Also, it explains the differences in reportings about forest ecosystems. Surprising, marine ecosystems have on average a good status although there is explicit but not comprehensive integration of the Ecosystem Approach at conceptual level, and no specific integration at operational level.

Considering that sectoral policies have been assessed at strategic level due to time and capacity constraints, as mentioned in the premises for the policy assessment, it follows that a further operational assessment of public policies including regulations and norms, can provide a comprehensive picture on the effectiveness of public policies in protecting natural capital through sustainable integrated management, that is Good Ecosystem Governance, and is recommended in the follow-up phase of the N4D project.

Finally, the policy questionnaire distributed to members of the MAES Steering Group **to assess the system currently in place for the elaboration of public policies in Romania** and **promote an institutional environment able to use MAES knowledge** for the improvement of policy and decision making as well as biodiversity and environmental reporting towards the EU, has provided the following institutional picture:

- a clear definition of the notion of *ecosystem services* is needed especially for ministries not directly managing natural resources such as the Ministry of Transport; it fallouts the issue of a usable definition, one formally endorsed by the governmental system. Contrariwise, when asked whether the ecosystem service concept is found in rules and laws concerning their policy sector, representatives from the Ministry of Environment Waters and Forests, NEPA, the National Forest Administration, and the Ministry of Agriculture and Rural Development have replied affirmatively;
- 4 institutional representatives said to have ecosystem services related knowledge about mapping and assessment, 2 about economic valuation, 5 about monitoring indicators, and 2 about economic instruments. Also at institutional level, ecosystem services related knowledge is mainly at conceptual level;
- representatives from Ministry of Transport, Ministry of Agriculture and Rural Development and Ministry of Regional Development could not identify departments with specific attributes for dealing with ecosystem services;

- the majority of institutions are satisfied with the information instruments currently available for reporting and decision-making while few are only partially satisfied;
- the majority of institutions said that rules and laws on land and natural resources management do not cover all the activities under their policy sector;
- on the question about the efficient integration of the ecosystem services concept within their policy sector, the National Forest Administration representative considers it to be inefficient, a representative from NEPA and the Ministry of Environment Forests and Water representative consider it to be insufficiently efficient, and the Authority for Payments and Interventions in Agriculture does not know;
- all institutional representatives have agreed that major problems in the integration and implementation of the ecosystem services concept within public policies are: the fact that the concept is not understood, lack of information about ecosystem services, lack of implementation instruments, an ambiguous legislative framework, and unclear institutional responsibilities. Similarly, when asked what could be improved the majority said about raising stakeholders' awareness, improving clarity of the legislative framework, and clearly defining responsibilities;
- the type of information system used by each institution is not clearly defined, whether it is specific for activities managed by the institution and/or for ecosystems supporting activities managed by the institution and/or geographic/geospatial;
- the need for an integrated information system with on-time information has been raised. Still, information from different information sources seems to be integrated and used in decision-making. However, a more comprehensive image about ecosystem services is necessary for decision-making.

Overall, the following challenges have been encountered in the process of engaging institutional stakeholders:

- understanding the relevance concerning the involvement within the MAES process of the Ministry of Transport and the Ministry of Economy;
- keeping continuity in institutional representation in the MAES process as well as ensuring communication between decision makers and technical personnel;
- understanding the link between a sectoral policy and the environment. For example, Ministry of Transport and Ministry of Economy consider that the Ministry of Environment is overall responsible for environmental objectives;
- lack of intra-institutional communication and coordination about reporting obligations, which makes finding the information a lengthy and beaurocratic process;
- short-term involvement in project activities like the N4D project rather then engagement in a long-term process such as MAES, and lack of official intra-institutional communication about the personnel designated and the process itself.

2.4. Recommendations for policy and decision making towards a Sustainable Green Economy

This report concludes with the following recommendations to policy and decision makers that are willing to implement a Sustainable Green Economy in the context of sustainable development:

1. To develop and implement a **Sustainable Green Economy strategy** correlated with the National Sustainable Development strategy. Strategy development should be based on **business sector analysis** about use of and dependence upon ecosystem services necessary to plan the transition to a Sustainable Green Economy. Furthermore, **beyond GDP indicators** should be used in decision and policy making such as Ecological Footprint and Biocapacity indicators as well as other green economy indicators. Also, the concept of **Sustainable Green Economy** defined for Romania should be **integrated into sectoral public policies** dealing with ecosystems and natural resources management and implemented accordingly.

2. **Inter-institutional integration and coordination** should be actively pursued to achieve **Good Ecosystems Governance**. Also, to ensure understanding and use of scientific knowledge on ecosystems and their services it is fundamental to establish a functional **Policy-Science Interface**. In this context, the **MAES governance system** developed and implemented under the N4D project should be formalized and continued, for example through the Inter-ministerial Committee for coordinating the integration of the environmental protection domain in sectoral policies and strategies at national level. It is recommended **to keep the same institutional representatives throughout the process** as well as **to ensure communication between decision makers and technical personnel**.
3. **All four pillars under the conceptual framework for the MAES process in Romania should be continued** as follow-up to the N4D project and appropriate funding and coordination should be allocated to finalize the MAES process. Under the scientific pillar, **the National Ecosystems Assessment should be completed including integration of ecosystem services values into national accounts**. Under the policy pillar, the **full policy assessment** should be performed at least for the policy sectors associated with selected ecosystems (forests, freshwaters, croplands, and urban ecosystems), that is forestry, agriculture and rural development, and water; it means that norms and regulations should be analyzed in addition to the strategic assessment in order to find entry points for the integration of the Ecosystem Approach and the achievement of Good Ecosystems Governance. Under the communication pillar, scientific information should continue to be translated into non-technical language and key messages should be further elaborated for all stakeholders (government representatives, civil society, media, and the general public). **The N4D project communication strategy should be reviewed** to also include actions for the further outreach and awareness raising of all stakeholders. Finally, under the capacity building pillar, a **training needs assessment** should be performed and implemented accordingly.
4. The assessment on the level of **integration of the Ecosystem Approach into public policies** and on its integration according to CBD principles should be used to **improve policy elaboration in the next policy cycles**. Also, the **assessment of public policies** should be continued **to cover the issues of enforcement and relevance** vis-à-vis the implementation of a Sustainable Green Economy. This could be also part of a follow-up to the N4D project. Particular attention should be given to assessing the **efficacy of current policy instruments** (for example the Environmental Impact Assessment procedure, the appraisal procedure of large infrastructure projects, the Prioritized Action Framework for Natura 2000, protected areas management plans, etc.) towards Good Ecosystems Governance and to integrate ecosystems assessment into such instruments. In case an assessment already exists, then resulting recommendations should be implemented. Besides, **innovative policy instruments** such as Payments for Ecosystem Services should be explored, understood and implemented correctly.
5. **Data on biodiversity, ecosystems** status and functions and **natural resources** should be **periodically updated** based on research protocols defined under the N4D project; also, to ensure more informed and timely decision-making geospatial data should be granted **public access and transparency** according to the INSPIRE Directive. Furthermore, it is desirable that a **database of knowledge** produced and **network of expertise** involved in research projects including topics such as MAES, Payments for Ecosystem Services, etc. is managed by the Ministry of Environment and granted public access.
6. Last but not least, **biodiversity conservation** should be seen as **complementary to development** rather than opposed to it. Being aware of and respecting **ecological limits** as well as preserving **ecosystems resilience** is fundamental to secure citizens' **well-being** in the long-term.

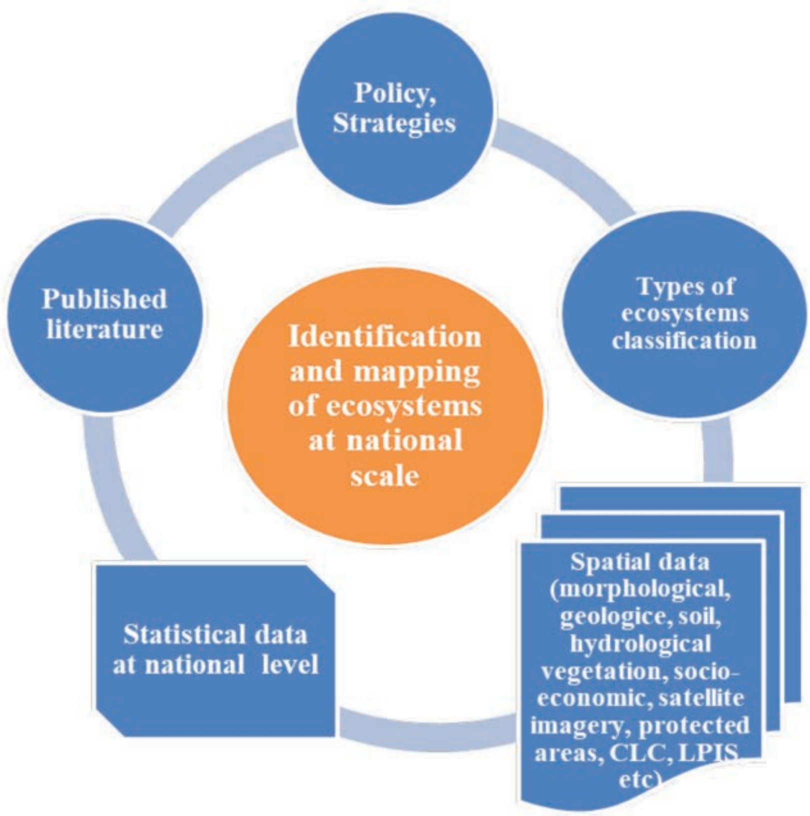
Chapter 3
Methodologies underpinning scientific work

3.1. Mapping of ecosystems

In this context, starting with the requirements of biodiversity policies and according to the objectives proposed by the project, the first step towards identifying ecosystems and mapping the ecosystems at national level was the evaluation of the most important ecosystem classification typologies developed especially at international level, but applicable at local, regional and national scale.

After selecting the typology for identifying and classifying ecosystems on a national scale, validating it by establishing relationships with the most important classification systems recognized and used especially at European level, a national cartographic representation of different types of ecosystems identified has been achieved. For this stage the available data and information have been used both at national level and those made available by different European institutions. The whole process of ecosystem identification and mapping at national scale is schematically represented in Figure 4.

Figure 4. The process of identifying and mapping ecosystems at national level



Typologies for identifying and classifying ecosystems

The evaluation stage of the ecosystems classification typology sought to identify a unitary typology, recognized at European level, which can be applied to the national biogeographical specificity.

In the last decades, a number of classifications have been developed, especially for habitats, both at pan-European and national levels, currently there are several classification systems accepted and used both locally and regionally, nationally and internationally.

Some of this classification systems are more detailed, for example the CORINE typology (1991), the PALEARCTIC classification (1996,1999) and the EUNIS classification (1997,2005), and others are briefer, including those types of habitats whose conservation requires adopting specific measures, like EMERALD (2000), The Habitats Directive (1992, adopted in 1999 and 2002) (Doniță et al, 2005). Besides the existing habitat classification systems for Europe, in most countries have been developed national systems for habitat or ecosystem classification. To meet the need of developing an uniform pan-European habitats/ecosystems classification, the first initiatives begun since the 1980s. The first harmonized classification system at European level based on land cover was developed through CORINE (European Environmental Agency (EEA) 1999 project, Heymann et al. 1993), and complementary to the CORINE Biotope classification, the purpose of this system its o track changes that occur in the land use at European level, analysed at timescales in order to capture evolution trends, highlighting degradation and/or anthropogenic pressures, identifying 43 classes of anthropic and natural elements.

Both classification systems used Earth Observation techniques but did not reach a level of coverage across Europe. The CORINE Biotope classification, published in 1991, aimed to identify and describe habitats of major importance for conservation within the European Community. It is a hierarchical classification system, designed to cover all types of habitats but with an emphasis on natural and semi-natural habitats, a limited coverage of marine habitat types. Although it is based on the phytosociological approach, it also includes other factors, such as geography, climate, soil, and captures several types of habitats without vegetal cover.

Another objective of the CORINE program is to bring together all the attempts that have been made over the years at different levels (international, community, regional and national) to get as much information as possible about the environment and how it changes. Starting with the CORINE program, the term habitat has been developed in Europe, which, *stricto senso*, means a place to live, that is to say, the abiotic environment in which a distinct body or biocenosis lives. But in the sense that it was given in the CORINE program and then in other classification systems that followed, the term habitat it was actually understood as an ecosystem, like a "habitat" *stricto senso* and the corresponding biocenosis that occupies it (Doniţa et al , 2005).

The CORINE Biotope classification has been expanded to cover the whole of Europe by developing the PALEARCTIC classification system (Devillers Devillers-Terschuren 1996). Although the PALEARCTIC classification has extended geographical coverage, the classification of marine habitats has still remained deficient, and clear criteria for discretization of different types of habitats have not been developed. Several more recent classification systems have evolved in standards for habitat conservation at European level (e.g. EUNIS developed for AEM (Davies & Moss, 2002, European Environment Agency (EEA), 2003 and classification from Annex 1 Habitats Directive).

The first version of the classification developed in Annex I of the Habitats Directive published in 1992 is a selection from CORINE Biotope classification (Evans, 2010), identifying 233 types of habitats of conservative interest, the European Environment Agency establishing a correspondence between habitats codes from Annex I and the CORINE classification. Habitats are listed in Annex I of the Habitats Directive and described in the Interpretation Handbook (European Commission 2007). Although the Interpretation Handbook provides more details than the list of habitats in Annex 1, there are still many problems when trying to identify the types of habitats on site, selecting sites, evaluating national lists for the proposed sites and monitoring them. Some of these problems arise from the flawed, sometimes overlapping, and definition of habitat types. This has led to differences in interpretation between different countries and regions.

The classification in Annex 1 of the Habitats Directive does not define ecosystems, this typology is still working with the term habitat, addressing in particular to natural and semi-natural habitats which requires the identification of a protection and conservation regime.

In 1995, the European Environment Agency began drafting the EUNIS classification, the objective being the development of a ranked classification of land, freshwater and marine habitats for the whole Europe and its islands and seas. The EUNIS (European

Nature Information System) classification was developed by the European Topic Centre for Nature Protection and Biodiversity (ETC / NPB) for the European Environment Agency and EIONET (European Environmental Information Observation Network), which is currently considered a common classification scheme strengthened at European level.

In the sense and according to the purpose of the EUNIS classification, the term "habitat" is defined as "the space in which species of plants and animals cohabit, characterized primarily by abiotic conditions - topography, soil, climate, hydrography, etc. - and by species of plants and animals living in that area "(EUNIS Habitat Classification Revised 2004). An important aspect of this typology is the developing the criteria in the form of identification keys for the first three classification levels (four for marine habitats), while the first relationships with the other existing classifications, including the national and regional classifications, are also achieved.

The EUNIS classification is a pan-European system developed to facilitate harmonized habitat description and data collection across Europe by using habitat identification criteria. The strength of this classification is represented by the fact that it covers all habitat types from natural to artificial, from land to freshwater and marine, identifying 5282 types of ranked habitats. The EUNIS classification system is also developed in correspondence with the CORINE classification system and the Natura 2000 classification system (Annex I Habitats Directive). The development of correspondence between different existing classifications allowed users to link national systems with those used internationally, in particular with Annex I of the EU Habitats Directive. The EUNIS classification redefined the PALEARCTIC classification, which extended the geographical coverage of the CORINE program, which also underpin the development of the classification system defined in Annex I of the Habitats Directive.

While phytosociological classifications (based on the identification of plant associations) are relatively well understood by some ecologists in many parts of Europe, they are still hardly accessible to most biologists and conservationists. However, many habitats are not covered by vegetation, especially in the marine environment, so that a full enumeration of habitats cannot be based solely on the vegetation criterion. With the help of the EUNIS system, habitat types are characterized using different specific biotic and abiotic parameters, very useful in identifying discontinuities at different landscape levels (e.g. substrate type, dominant life form, humidity, depth, human use and impact, biogeographical areas etc.). The EUNIS classification, which is strictly hierarchical, is based on efficient criteria developed using these specific parameters, forming habitats identification keys, compared with the species identification keys.

Also in Romania, the problem of identifying habitats has been established since 1991, when the collaboration for the CORINE International Program began, occasion in which over 240 habitats types were presented. Over the years, the number of identified and briefly described habitats has increased, reaching in 1995 a number of 986 entries belonging to 7 ranked classification levels. Recently, 57 categories of habitats have been outlined and their correspondence with habitat categories of the Habitats Directive, EMERALD and EUNIS (Sarbu et al., 2003) has been outlined.

The scientific work Habitats from Romania (Doniță et al., 2005) is a first attempt to consistently describe the main types of habitats found on the national territory, most of them with summed names and characterizations in the CORINE (1991) and PALAEARCTIC (1996, 1999) habitats classification systems, as well as correspondence with the classification systems used at European level, especially the one used for NATURA 2000. There were described 357 types of habitats that fall into 7 classes and 24 subclasses of the PALAEARCTIC classification system.

Reference works such as The Habitats of Romania (Doniță et al 2005) and European classification systems such as EUNIS, PALEARCTIC, CORINE Biotope / CLC, Natura 2000, etc., can be used in a complementary manner by a specific approach to a relational model of existing classifications. These classification systems have been developed with different degrees of complexity specific to the purpose and information used for identification.

The MAES approach plans to develop a system of ecosystem classification, in the sense that the ecosystem is defined as a complex of flora and fauna in relationship with the abiotic environment. This typology separates at level 1 three major categories of ecosystems: terrestrial, freshwater and marine (see Figure 5).

Figure 5. MAES Typology for ecosystem classification (European ecosystem assessment-concept, data and implementation, EEA Technical Report, no 6/2015)

Box 2.1 Typology of ecosystems

Member States, together with DG-ENV, the JRC and the EEA, agreed on a list of Europe-wide ecosystem types feasible for the aggregation of national and local data and the dis-aggregation of European data — also reflecting main policy areas and environmental reporting. A detailed description is available in Maes et al., 2013.

Major eco-system category (level 1)	Ecosystem type for mapping and assessment (level 2)	Description
Terrestrial	Urban	Urban ecosystems are areas where most of the human population lives. This class includes urban, industrial, commercial, and transport areas, urban green areas, mines, dumping and construction sites.
	Cropland*	Croplands are the main food production areas including both intensively-managed ecosystems and multifunctional areas supporting many semi-natural and natural species along with food production (lower intensity management). It includes regularly or recently cultivated agricultural, horticultural and domestic habitats and agro-ecosystems with significant coverage of natural vegetation (agricultural mosaics).
	Grassland*	Grasslands are areas covered by a mix of annual and perennial grass and herbaceous non-woody species — including tall forbs, mosses and lichens, with little or no tree cover. The two main types are managed pastures, semi-natural and natural (extensively managed) grasslands.
	Forest and woodlands	Woodlands and forests are areas dominated by woody vegetation of various age, or they have succession-climax-vegetation types on most of the area, supporting many ecosystem services. Information on ecosystem structure, e.g. age group, species and diversity, is especially important for this ecosystem type.
	Heathland and shrub	Heathlands and shrubs are areas with vegetation dominated by shrubs or dwarf shrubs. They are mostly secondary ecosystems with unfavourable natural conditions. They include moors, heathland and sclerophyllous vegetation.
	Sparsely vegetated land	Sparsely vegetated lands often have extreme natural conditions that might support particular species. They include bare rocks, glaciers and dunes, beaches and sand plains.
	Wetlands	Inland wetlands are predominantly water-logged, specific plant and animal communities that support water regulation and peat-related processes. This class includes natural or modified mires, bogs and fens, as well as peat extraction sites.
Freshwater	Rivers and lakes	Rivers and lakes are the permanent freshwater inland surface waters. This class includes water courses and waterbodies.
Marine**	Marine inlets and transitional waters	Marine inlets and transitional waters are ecosystems on the land-water interface under the influence of tides and with salinity regimes higher than 0.5 ‰. They include coastal wetlands, lagoons, estuaries and other transitional waters, fjords and sea lochs as well as embayments.
	Coastal	The coastal ecosystems include coastal, shallow, and marine systems that experience significant land-based influences. These systems undergo diurnal fluctuations in temperature, salinity and turbidity, and are subject to wave disturbance. Depth is between 50m and 70m.
	Shelf	The shelf refers to marine systems away from coastal influence and down to the shelf break. They experience more stable temperature and salinity regimes than coastal systems, and their seabed is below wave disturbance. They are usually about 200m deep.
	Open ocean	The open ocean refers to marine systems beyond the shelf break with very stable temperature and salinity regimes particularly at the deep seabed. Depth is beyond 200m.

Note: * Croplands including permanent crops and actively managed grasslands are often summarised and reported under the term agro-ecosystems.

** The current zonal classification refers to the reporting units of the Marine Strategy Framework Directive (MSFD) and might be replaced by a more ecosystem-based approach in the future.

The EU member states, together with DG-ENV, JRC and EEA, have agreed on this type of ecosystem classification at European level, thus the data at local and national level could be aggregated in an integrating manner, this unitary typology also reflecting the needs of the most important reporting policies at European level.

According to the MAES approach, spatial delimitation of ecosystems is based on the identification of discontinuities, such as the area of a species, hydro-geomorphological delimitations (soil types, hydrographic basins, water depths, etc.), spatial relationships (home range of a species, migration corridors, material flows). Ecosystems in the same category are characterized by similar biological, climatic and social factors. Concretely, similarities between the ecosystem categories can be grouped into: climatic conditions, hydro-geomorphological conditions, type of use, land cover (type of vegetation etc.), specific composition, resource management.

Mapping ecosystems is the spatial delimitation of ecosystems as a result of an internationally agreed typology that is highly dependent on the purpose of mapping and the scale chosen. In the MAES approach, this was done by aggregating the CORINE Land Cover (CLC) classes with the types of ecosystems identified in Romania to achieve the goal proposed by MAES. This aggregation is based on a detailed analysis of the relationship between land cover classes and habitat classification systems and ensuring consistency between these approaches. The selection of habitat types or ecosystems that can be assessed for their status and contribution to the provision of ecosystem services should be carefully undertaken to ensure both a balanced representation of important European ecosystems and habitats listed in Annex I of the Habitats Directive.

Following the directions established by the EU 2020 Biodiversity Strategy, the MAES proposal for ecosystems classification is based on a combination of CLC classes for explicit mapping of space related to EUNIS habitat types.

The proposal for MAES classification level 2 corresponds to EUNIS level 1 classification. This approach is considered relevant to EU policies and is compatible with global ecosystem classification. It is typological (allows comparison between different areas of Europe), maintains a pan-European scale and takes into account current mapping issues (application of CLC data for spatial delimitation).

These key classes established for ecosystem types should allow for consistent assessments of ecosystem status and services at local, national and European level. Information from a more detailed local classification with higher spatial resolution must be compatible with this classification developed at European level and aggregated in a coherent, unitary manner.

The MAES specific methodology has been successfully applied in various member states of the European Union (Austria, Spain, the Netherlands, Switzerland etc.) thus demonstrating its effectiveness and the advantage of achieving unitary results at European level.

The MAES methodology presents the benefit of its application across all EU member states and is based on the EU 2010 Biodiversity Baseline approach (European Environment Agency, 2010) which mentions the use of the CORINE Land Cover classes monitored in the Copernicus program (European Environment Agency, 2013).

At present there are several thousand types of potential habitats at European level. Most classification systems are purely theoretical, based on evaluations of different experts but not fully validated by field mapping. The detailed level of habitats used is very different from one classification system to another. For example, the type of habitat "9110 *Luzulo-Fagetum* beech forests" of the Habitats Directive includes both pure beech woods as well as fir beech, beech and spruce fir beams of the same type herbaceous acidophilic flora (*Luzula luzuloides, Deschampsia flexuosa, Calamagrostis villosa*, *Vaccinium myrtillus*, etc.). For example, in the PALAEARCTIC classification, the type of habitat mentioned above, corresponds to 18 habitat types.

These classification systems (Table 14) show a number of similarities, but they are not identical and reporting at European level is therefore difficult. Moreover, international directives and conventions use different types of classifications, complicating the connections between them.

Thus, the need for unitary characterization of the current distribution of ecosystems, structural and functional units generating goods and services emerges through a methodological approach of existing, unitary classification systems using the current relational database facilities for gaining relevance in the conceptual approach of the mapping methods for ecosystems.

Table 14. Comparative assessment of the most important habitats / ecosystems classification systems, useful information in selecting a unitary and usable classification system according to European requirements

Classification system / Characteristics	Corine Land Cover (CLC)	Natura 2000	EUNIS	Mapping and Assessment of Ecosystems Services	Habitatele din România (Doniță et al. 2009)
Types of habitats / ecosystems	Natural, semi-natural and anthropic	Natural, present in natural protected areas	Natural, semi-natural and anthropic habitats	Natural, semi-natural and anthropic ecosystems	Natural and semi- natural habitats
Level	Pan-European	Pan-European	Pan-European	Pan-European	National
Space representation	Continue	Discontinue (space fragmentation by addressing only protected habitats)	Continue	Continue	Discontinue (only the classification of natural and semi-natural habitats)
Spatial data availability	Yes	Yes (few data only within the protected areas)	Yes (CLC and data from some of the national territories)	Yes/CLC	Yes (few data of the natural and semi-natural national habitats)
Resolution	1:100000 (25 ha MMU)	1:10000	Different resolutions depending of the evaluated territory	1:100000	-
Spatial data accessibility	Accessible and usable data, but on a regional scale	High data accessibility for the protected areas, limited data accessibility for the mapped habitats within protected areas	Data available at regional scale, but relatively reduced at local and national scale	Data available at regional scale, but relatively reduced at local and national scale	Reduced
Relevance	Captures structural heterogeneity at regional level	Captures structural heterogeneity at protected habitats level	Captures structural heterogeneity for habitats at local level	It captures both structural and functional heterogeneity (ecosystem services) both locally and regionally (based on a combination of the main spatial and non-spatial CLC-EUNIS classifications);	It captures the structural heterogeneity of natural and semi-natural habitats at national level
Constraints / Limitation on Ecosystem mapping at national level	Minimum mapping unit is 25ha (500x500m); CLC Geometry does not capture structural heterogeneity at the local level	It only addresses Natura 2000 sites. Limited data on habitat distribution within protected areas;	Non-spatial, detailed typology based on identification keys for habitat types; difficult to map without a spatial representation of the ecological systems.	Using only the CLC geometry and the current MAES classification does not capture the structural and functional heterogeneity of ecosystems for an optimal assessment of the services they offer	It can only be applied to natural and semi-natural habitats

Correspondence between habitats/ecosystems classification systems

Because the most important habitats classification systems are often based on different working methods, matching them is a complex operation that requires a coherent system of equivalence and interpretation. Such handbooks of equivalence of the European habitat classification systems, especially those used in the implementation of the NATURA 2000 network, with the national ones, have been carried out in most of the member states of the European Union (Doniță et al., 2005).

Although there are several habitats classification systems, most of them have the potential to develop relationships, usually represented as correspondence tables. Current experience shows that there are major differences in how habitats are interpreted at different scales. Such differences occur in case of field assessments, the experts allocating different types of habitats to the mapped polygons, also delimiting the identified habitats. Differences also arise due to local interpretations of the various documents used at national or European level. This problem was identified when interpreting the description of habitats in Annex I of the Habitats Directive, the differences occurring between different countries or even between different regions at national level.

At European level, a major importance is attributed to Annex 1 of the Habitats Directive, thus the correspondence between all the habitat types listed in Annex 1 and the EUNIS typology is made.

The development of the EUNIS classification system has allowed science-based correspondence between the different classifications accepted at European level. The relation between EUNIS classification and other types of habitat classification helps users to make the correspondence between national and international data in the unitary approach of habitats classification systems used by different national and European legislation.

Understanding these correspondences between different habitat classification systems is a complex task, it is essential for users to understand and use the same interpretation. Interpretation problems arise in particular from the fact that these correspondents are often of the type m: m (one class in a classification corresponds to more than one class in another classification). However, matching between the different classifications systems is extremely useful for the unitary approach of classification methodologies.

The development of a relational database can link the different classifications, indicating only the existence of a relationship between them, but cannot provide quantitative information on the degree of correspondence. This database can also be used for a practical comparison of all Pan-European classifications and those developed for different countries.

The type of relationships "many to many" identified in the correspondence between the EUNIS and CLC classes can be further refined using auxiliary spatial data. This can be done by identifying available spatial data sets, data with a high degree of accuracy at European level, and further developing a set of rules applicable to each habitat type. This set of rules can be developed as a support expert system for defining differences in the relationships type m: m between the different classifications. Overlaps can be solved using identification based on geographic criteria (e.g. presence of certain EUNIS classes only in certain geographical areas) or using certain environmental conditions (presence of certain EUNIS classes only under certain environmental conditions).

In this context, taking into account the heterogeneity of the natural and anthropogenic ecosystems existing in Romania and the limitations of the existing approaches regarding the identification, classification and mapping of ecosystems, and relying only on the 44 CORINE Land Cover classes related to level 2 of MAES typology and level 1 From the EUNIS classification (approach proposed by MAES), the consortium made up of National Environmental Protection Agency, Romanian Space Agency and WWF - Romania proposes for the identification and classification of ecosystems on a national scale an integrated methodology that preserves the principles of the MAES approach regarding the major categories of ecosystems and the services provided by them, but which aims to obtain the mapping of national ecosystems at a higher level of detail, using for this purpose the **level 3 of the EUNIS typology**.

The justification for the use of Level 3 of the EUNIS classification comes from the need to optimally identify the heterogeneity of ecosystems at national level in terms of both the requirements regarding the assessment of ecosystem services as well as the available and, above all, usable data and information at national level. The identification and mapping of national ecosystems at EUNIS 3 level is supported by the fact that we now have selection criteria for habitat types elaborated within the EUNIS habitat classification methodology and identification keys for differentiating habitats up to EUNIS level 3 based on different parameters.

This approach is based on the scientific foundation of the fact that ecosystems that have different specific compositions, defined by different abiotic factors and having different material, energy and information flows, also generate different ecosystem services (e.g. an ecosystem of riparian forests and galleries (EUNIS level 3 G1.1) provides different ecosystem services than a non-acidic peat forest ecosystem (EUNIS level 3 G1.4)).

In order to identify as accurately as possible all types of EUNIS level 3 ecosystems at national level, it was necessary in the first stage **to establish correspondences between the different typologies of habitat / ecosystem classification**.

Taking into account the important classification systems and the correspondence between these systems, the team of experts involved in the project has made the selection of the ecosystem types at national level, starting mainly from **the habitat types identified in The Habitats of Romania (Doniță et al., 2005)**.

In order to identify the national ecosystems according to the EUNIS typology, the table of correspondence of the national habitats classes with the main EUNIS, PALEARCTIC and Habitats Directives was analysed, a table already developed by Doniță et al in 2005 (Figure 6). For the types of national habitats for which Doniță et al (2005) did not identify correspondence with the EUNIS typology, the links with this classification system were made through thorough checks by the experts involved in the project of the correspondences between the national habitats and the PALEARCTIC classification systems, and The Habitats Directive, and afterwards **the PALEARCTIC-Habitats Directive-EUNIS correspondence has been verified**, and all existent national EUNIS 3 level habitats have been identified by cross-checks.

In order to optimize the decision support expert systems, a MS Access databases have been developed in order to achieve all correspondences between the main EUNIS classification systems, the Habitats Directive, CORINE Land Cover, PALEARCTIC and MAES, the relationships between them being modelled as many to many (m:m) relationships (e.g. a CLC class may contain multiple EUNIS or MAES classes and vice versa) (Figures 6, 7, 8).

Figure 6. Extract from databases on the correspondence between different types of habitat classification systems (Doniță et al)

ID	PALEARCTIC_COD	PALEARCTIC_Name	EUNIS_COD	EUNIS_Name
13	11.28	Pebbly shore littoral communities	A2	Littoral sediment
14	11.28	Pebbly shore littoral communities	A2.1	Littoral coarse sediment
15	17.1	Unvegetated shingle beaches	A2.1	Littoral coarse sediment
16	11.27	Soft sediment littoral communities	A2.2	Littoral sand and muddy sand
17	14.1	Mud flats and sand flats	A2.2	Littoral sand and muddy sand
18	16.1	Sand beaches	A2.2	Littoral sand and muddy sand
19	16.11	Unvegetated sand beaches	A2.21	Strandline
20	16.11	Unvegetated sand beaches	A2.22	Barren or amphipod-dominated mobile sand shores
21	16.11	Unvegetated sand beaches	A2.23	Polychaete/amphipod-dominated fine sand shores
22	11.27	Soft sediment littoral communities	A2.3	Littoral mud
23	14.1	Mud flats and sand flats	A2.3	Littoral mud
24	11.27	Soft sediment littoral communities	A2.4	Littoral mixed sediments
25	14.1	Mud flats and sand flats	A2.4	Littoral mixed sediments
26	15	Saltmarshes, salt steppes, salt scrubs	A2.5	Coastal saltmarshes and saline reedbeds
27	15.35	Atlantic saltmarsh and drift rough grass communities	A2.511	Atlantic saltmarsh and drift rough grass communities
28	15.36	Atlantic saltmarsh driftline annual communities	A2.512	Atlantic saltmarsh driftline annual communities
29	15.56	Mediterranean saltmarsh driftlines	A2.513	Mediterranean saltmarsh driftlines
30	15.34	Atlantic brackish saltmarsh communities	A2.521	Atlantic and Baltic brackish saltmarsh communities
31	15.341	Pearlwort-saltmarsh grass swards	A2.5211	Pearlwort-saltmarsh grass swards
32	15.342	Baltic [Carex paleacea] swards	A2.5212	Baltic [Carex paleacea] swards
33	15.343	Baltic [Carex mackenziei] swards	A2.5213	Baltic [Carex mackenziei] swards
34	15.344	Baltic salt basin [Agrostis]-[Triglochin] swards	A2.5214	Baltic salt basin [Agrostis]-[Triglochin] swards
35	15.345	Baltic [Deschampsia bottnica] swards	A2.5215	Baltic [Deschampsia bottnica] swards
36	15.51	Mediterranean tall rush saltmarshes	A2.522	Mediterranean [Juncus maritimus] and [Juncus acutus] saltmarshes
37	15.52	Mediterranean short rush-sedge-barley-clover coast:	A2.523	Mediterranean short [Juncus], [Carex], [Hordeum] and [Trifolium] saltme
38	15.57	Mediterranean saltmarsh couch-wormwood stands	A2.524	Mediterranean [Elymus] or [Artemisia] stands
39	15.58	Mediterranean fine-leaved rush beds	A2.525	Mediterranean [Juncus subulatus] beds
40	15.61	Mediterranean saltmarsh scrubs	A2.526	Mediterranean saltmarsh scrubs
41	15.611	Creeping glasswort mats	A2.5261	Creeping glasswort mats
42	15.612	Shrubby glasswort thickets	A2.5262	Shrubby glasswort thickets
43	15.613	Glaucous glasswort thickets	A2.5263	Glaucous glasswort thickets

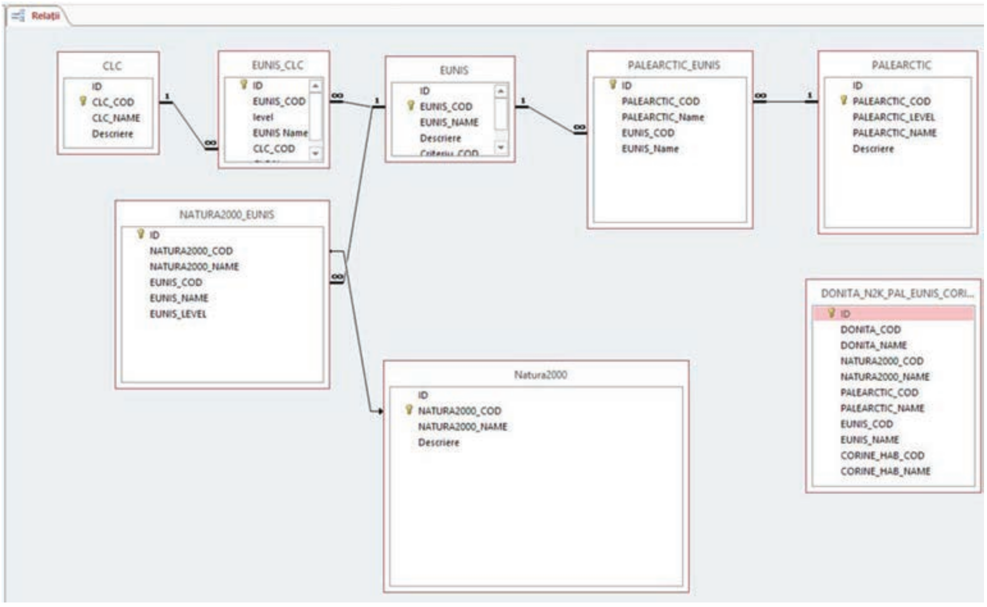
Figure 7. Table of relationship between habitats classification systens, Habitat Directive and EUNIS (Doniță et al)

ID	NATURA2000_COD	NATURA2000_NAME	EUNIS_COD	EUNIS_NAME	EUNIS_LEVEI	F
130	1110	Sandbanks which are sl	A5.1	Sublittoral coarse sediment	3	
134	1110	Sandbanks which are sl	A5.2	Sublittoral sand	3	
146	1110	Sandbanks which are sl	A5.4	Sublittoral mixed sediments	3	
152	1110	Sandbanks which are sl	A5.5	Sublittoral macrophyte-dominated sediment	3	
157	1110	Sandbanks which are sl	A5.53	Sublittoral seagrass beds	4	
159	1110	Sandbanks which are sl	A5.531	[Cymodocea] beds	5	
160	1110	Sandbanks which are sl	A5.533	[Zostera] beds in full salinity infralittoral sediments	5	
162	1110	Sandbanks which are sl	A5.54	Angiosperm communities in reduced salinity	4	
153	1120	Posidonia beds (Posidc	A5.5	Sublittoral macrophyte-dominated sediment	3	
158	1120	Posidonia beds (Posidc	A5.53	Sublittoral seagrass beds	4	
161	1120	Posidonia beds (Posidc	A5.535	[Posidonia] beds	5	
3	1130	Estuaries	A1.2	Moderate energy littoral rock	3	
7	1130	Estuaries	A1.3	Low energy littoral rock	3	
11	1130	Estuaries	A1.4	Features of littoral rock	3	
16	1130	Estuaries	A2.1	Littoral coarse sediment	3	
19	1130	Estuaries	A2.12	Estuarine coarse sediment shores	4	
20	1130	Estuaries	A2.2	Littoral sand and muddy sand	3	
25	1130	Estuaries	A2.3	Littoral mud	3	
31	1130	Estuaries	A2.4	Littoral mixed sediments	3	
35	1130	Estuaries	A2.5	Coastal saltmarshes and saline reedbeds	3	
81	1130	Estuaries	A2.6	Littoral sediments dominated by aquatic angiosperms	3	
85	1130	Estuaries	A2.7	Littoral biogenic reefs	3	
90	1130	Estuaries	A3.2	Atlantic and Mediterranean moderate energy infralittoral rock	3	
94	1130	Estuaries	A3.3	Atlantic and Mediterranean low energy infralittoral rock	3	
99	1130	Estuaries	A3.36	Faunal communities on variable or reduced salinity infralittoral rock	4	
103	1130	Estuaries	A3.7	Features of infralittoral rock	3	
112	1130	Estuaries	A4.2	Atlantic and Mediterranean moderate energy circalittoral rock	3	
116	1130	Estuaries	A4.3	Atlantic and Mediterranean low energy circalittoral rock	3	
131	1130	Estuaries	A5.1	Sublittoral coarse sediment	3	
135	1130	Estuaries	A5.2	Sublittoral sand	3	
138	1130	Estuaries	A5.22	Sublittoral sand in variable salinity (estuaries)	4	

Figure 8. Table of relationship between habitats classification systems, PALEARCTIC and EUNIS

ID	PALEARCTIC_COD	PALEARCTIC_Name	EUNIS_COD	EUNIS_Name
13	11.28	Pebbly shore littoral communities	A2	Littoral sediment
14	11.28	Pebbly shore littoral communities	A2.1	Littoral coarse sediment
15	17.1	Unvegetated shingle beaches	A2.1	Littoral coarse sediment
16	11.27	Soft sediment littoral communities	A2.2	Littoral sand and muddy sand
17	14.1	Mud flats and sand flats	A2.2	Littoral sand and muddy sand
18	16.1	Sand beaches	A2.2	Littoral sand and muddy sand
19	16.11	Unvegetated sand beaches	A2.21	Strandline
20	16.11	Unvegetated sand beaches	A2.22	Barren or amphipod-dominated mobile sand shores
21	16.11	Unvegetated sand beaches	A2.23	Polychaete/amphipod-dominated fine sand shores
22	11.27	Soft sediment littoral communities	A2.3	Littoral mud
23	14.1	Mud flats and sand flats	A2.3	Littoral mud
24	11.27	Soft sediment littoral communities	A2.4	Littoral mixed sediments
25	14.1	Mud flats and sand flats	A2.4	Littoral mixed sediments
26	15	Saltmarshes, salt steppes, salt scrubs	A2.5	Coastal saltmarshes and saline reedbeds
27	15.35	Atlantic saltmarsh and drift rough grass communities	A2.511	Atlantic saltmarsh and drift rough grass communities
28	15.36	Atlantic saltmarsh driftline annual communities	A2.512	Atlantic saltmarsh driftline annual communities
29	15.56	Mediterranean saltmarsh driftlines	A2.513	Mediterranean saltmarsh driftlines
30	15.34	Atlantic brackish saltmarsh communities	A2.521	Atlantic and Baltic brackish saltmarsh communities
31	15.341	Pearlwort-saltmarsh grass swards	A2.5211	Pearlwort-saltmarsh grass swards
32	15.342	Baltic [Carex paleacea] swards	A2.5212	Baltic [Carex paleacea] swards
33	15.343	Baltic [Carex mackenziei] swards	A2.5213	Baltic [Carex mackenziei] swards
34	15.344	Baltic salt basin [Agrostis]-[Triglochin] swards	A2.5214	Baltic salt basin [Agrostis]-[Triglochin] swards
35	15.345	Baltic [Deschampsia bottnica] swards	A2.5215	Baltic [Deschampsia bottnica] swards
36	15.51	Mediterranean tall rush saltmarshes	A2.522	Mediterranean [Juncus maritimus] and [Juncus acutus] saltmarshes
37	15.52	Mediterranean short rush-sedge-barley-clover coast	A2.523	Mediterranean short [Juncus], [Carex], [Hordeum] and [Trifolium] saltme
38	15.57	Mediterranean saltmarsh couch-wormwood stands	A2.524	Mediterranean [Elymus] or [Artemisia] stands
39	15.58	Mediterranean fine-leaved rush beds	A2.525	Mediterranean [Juncus subulatus] beds
40	15.61	Mediterranean saltmarsh scrubs	A2.526	Mediterranean saltmarsh scrubs
41	15.611	Creeping glasswort mats	A2.5261	Creeping glasswort mats
42	15.612	Shrubby glasswort thickets	A2.5262	Shrubby glasswort thickets
43	15.613	Glaucous glasswort thickets	A2.5263	Glaucous glasswort thickets

Figure 9. Schematic representation of relationships between different classification systems



Following verification of all correspondence between the EUNIS habitat types and the most commonly used classification systems, 110 types of EUNIS level 3 ecosystems have been identified at national level.

Mapping national level ecosystems

The MAES National Working Group proposes for the mapping of ecosystem types a typology that combines the Corine Land Cover (CLC) classes for a spatially explicit mapping with a non-spatial classification of habitats system (EUNIS).

The practical approach proposed by MAES for the spatial delimitation of ecosystems is the use of parameters which define certain biotic and abiotic conditions specific to different types of ecosystems (ex. distribution of populations, soil types, river basins, feeding areas, vegetation types, climatic and geological characteristics, etc.) in order to identify the border areas and the discontinuities between different types of ecosystems.

In this context, the mapping of the EUNIS ecosystem types identified at national level was achieved firstly by linking them to the CLC classes (2006), the correspondence between the EUNIS-CLC classification systems being already developed by the ETC-BD (European Topic Centre for Nature Protection and Biodiversity).

The process of mapping ecosystems in Romania started from the **level 3 Corine Land Cover classes** and the initial association with the **high resolution spatial themes** elaborated by the National Plots Identification System (LPIS), identification and classification system developed mainly for agricultural and pastoral land, other types of land use being also differentiated.

The spatial association of the CORINE Land Cover at **1: 100000 scale** with the spatial theme represented by the LPIS plots (**scale 1: 5000**) provides a local gain of spatial distribution of natural and anthropic ecosystems and allows them to be classified at a greater detailed level than CLC class 3.

Geometry elements and associated attributes are analyzed through specific spatial analysis techniques using available maps and data (Table 15), materials that provide a high degree of detail on heterogeneity within high ecosystem complexes with high similarity.

Table 15. Input data used for mapping of ecosystems

Space theme	Source	Description	Scale / resolution
CORINE Land Cover	European Environment Agency (EEA)	The spatial distribution of 44 land use classes, valid over time series (1990, 2000, 2006 and 2012).	1:100000
LPIS (Agricultural plot identification system)	National Agency of Cadastre and Land Registration	The delimitation of land plots used for agricultural purposes with stable natural or artificial linear limits and which may include one or more agricultural plots. The physical block is uniquely identified in the geographical information system and represents the reference parcel adopted within the LPIS system in Romania.	1:5000
Orthophoto map	National Agency of Cadastre and Land Registration	Aerial images taken over by digital airborne photogrammetric cameras that are rectified and georeferenced; Orthophoto maps are obtained by orthophotographs processing. Orthophoto maps with national coverage, used for the discretization of natural ecosystems. The need for discretization at this level of detail comes from the differences in the functionality of each ecosystem and thus in the services provided (Becker et al., 2007, Sæbø et al., 2012), distinct in intensity or area.	1:5000
DTM LIDAR	Ministry of Environment	LIDAR data is a remote sensing technology for providing altitude data with a very good prediction. LIDAR scanning uses the laser technique to measure the distance between the aircraft and the ground, taking into account buildings, communication routes and vegetation distribution. LIDAR / FLI-MAP digital terrain models used in hydrological modelling processes, both in the ecosystem mapping stage and in the assessment of ecosystem services (Quinn et al., 1991). Also, topographical features of the land have a major influence on hydrological, biological and geomorphological processes at its surface, resulting in a large heterogeneity in a reduced space of associated ecosystems and ecosystem services (Moore et al., 1991).	Resolution 5 m
Satellite imagery SPOT	CNES (Centre national d'études spatiales)	SPOT satellite images are high-resolution Earth observation commercial imagery designed to broaden knowledge of natural resources by detecting and forecasting events related to oceanography, climatology or anthropogenic activities. SPOT satellite imagery used to distinguish very similar classes in forest ecosystems, for example, where forest-based ecosystems or coniferous forest ecosystems can be extracted by supervised classification (Salajanu et al., 2001; Xiao et al. 2002).	Resolution MS: 5 m – 6 m

Space theme	Source	Description	Scale / resolution
Geological map	Geological Institute of Romania	The geological map of Romania, disposed in 50 individual sheets (the layout and nomenclature respects the Gauss-Kruger projection), presents the geological sections (the main features of the depth structure of the territory of each map sheet) and the stratigraphic columns (the ensemble of the existing formations, and formation which do not appear up to date). The material presents a written part on the lithological and paleontological contents of the formations, their distribution and considerations regarding the geological evolution of the territory.	1:200000
Soil map	National Research and Development Institute for Pedology, Agrochemistry and Environmental Protection	The geological map of Romania, disposed in 50 individual sheets, describes the pedological characteristics of Romania's territory to subtype level.	1:200000
DEM **-altitude** **-slope** **-exposition** **-landforms, etc.**	European Environment Agency (EEA)	EU-DEM: The Digital Terrain Model used is a combination of SRTM 90 and DTED data. SRTM (The Shuttle Radar Topography Mission) obtains large-scale elevation data to generate high-resolution digital models globally.	100*100m
Climatic data	WorldClim – Global Climate Data	Data generated by interpolation of climatic data with a monthly average frequency. The variables included are annual precipitation, monthly average, minimum and maximum temperatures, and 19 derivatives bioclimatic variables.	Resolution 1 km^2
Map of the potential natural vegetation of Europe	BfN, BOHN &NEUHAUSL 200/2003	EuroVegMap 2.0.6 Representing on a Europe-wide scale areas of potential natural vegetation, which correspond to certain climatic conditions, soil properties, flora specific to various parts of Europe.	1:2,5 mil
Forest type map	Joint Research Centre, EC	Forest Type Map 2006 Map of forest types, especially for coniferous, hardwoods and water bodies.	25*25m
Natura 2000 network map	Ministry of Environment	The map of protected areas at community level and especially the map of SCIs at national level. Within these areas, the habitat types in Annex I of the Habitats Directive are delimited at national level.	1:5000

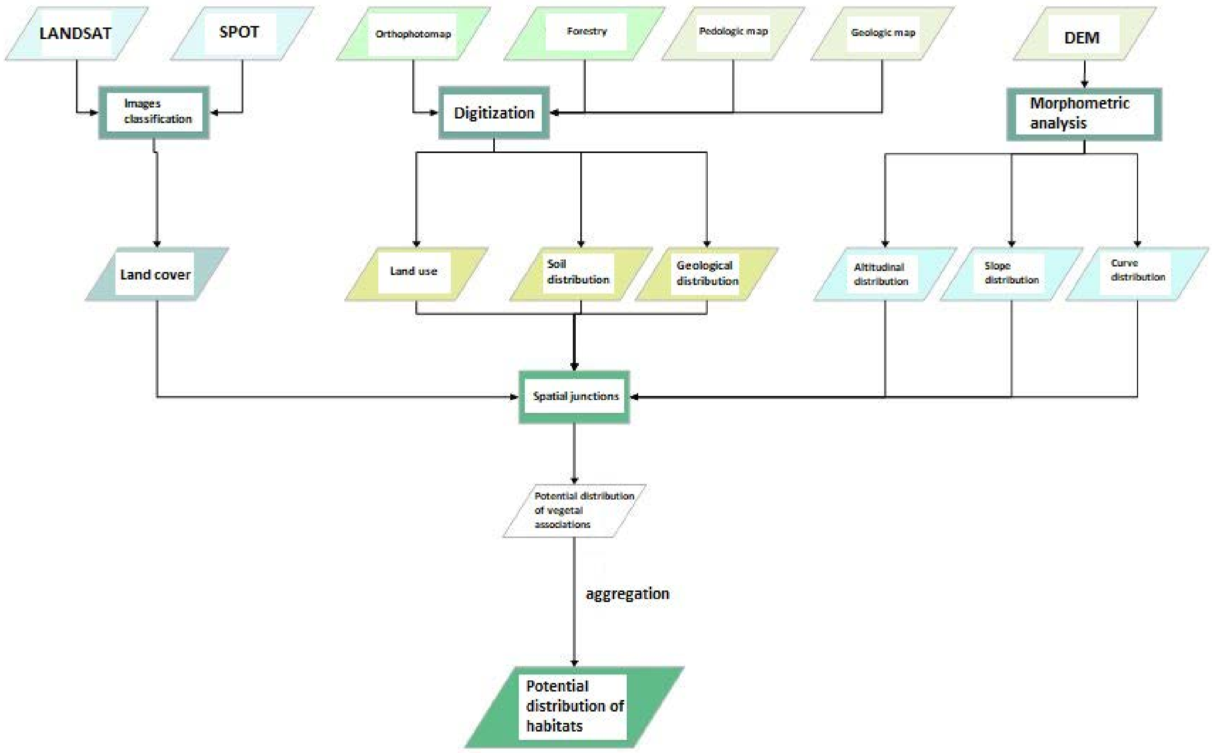
The first step in the creation of the **geospatial database** is to obtain a discretization of ecosystems at national level by using resources such as maps, plans, orthophoto maps, satellite images, different vector space themes and applying specific methods of interpretation / assisted / unassisted classification in order to obtain a more accurate classification of land use classes and potential habitats / ecosystems at national level. These combined with the morphometric analysis of the terrain by the 1st order (slope, mountainsides exposure) and 2nd order (plane curvature, profile curvature, total curvature) morphometric indicators lead to the unitary identification of the whole area investigated in subunits, respectively ecosystems of interest which will then be subsequently validated by field observations.

Based on the geodatabase scheme, this approach involves the following main activities (Figure 10):

- Use of existing information (ex. plans, maps, CLC, LPIS, geology, pedology, hydrology, vegetation etc.) that will underpin the realization of digital models that will contribute to the differentiation of ecosystem types;
- The morphometric analysis of the land will allow the differentiation of parameters of first order (slope, slope exposure, flow direction) and second order derivations (plane curvature, curvature in profile, total curvature) allowing functional identification (identification of water drainage, saturated ones, areas prone to erosion, floods etc.), in particular using digital terrain models.

- Analysis of SPOT multispectral satellite imagery will allow testing and parameterization of classification models based on different indices (e.g. vegetation indices etc.). The analysis was initially done on SPOT 5 images and final results are to be checked on SPOT 6 images.
- Validation and completing the information on vegetal associations and other biotic and abiotic factors that allow for clear differentiation of ecosystem types - this stage will require the subsequent combination of field and office information on ecosystem types.

Figure 10. Graphic representation of an expert system developed for mapping the potential distribution of habitats / ecosystems at national level



After the verification and validation of the new spatial themes resulted from CLC-LPIS overlaps, the spatial themes have been correlated with the non-spatial classification of EUNIS habitats, an association designed to achieve a higher characterization of ecosystems.

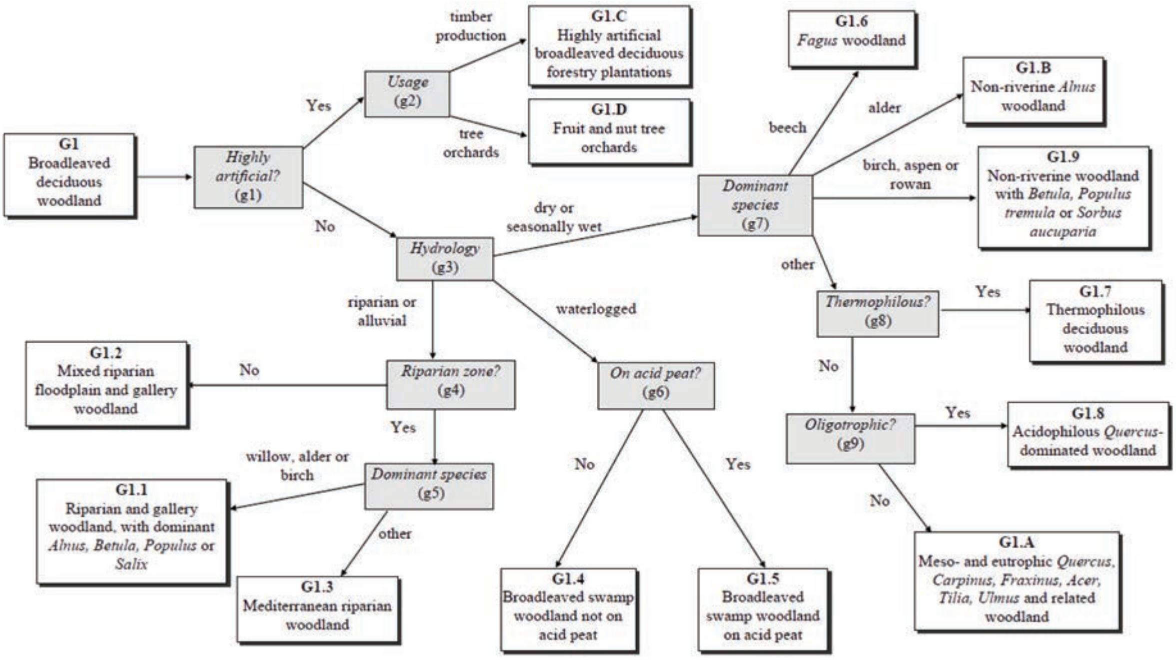
Figure 11. Overlaps of EUNIS Level 3 Classes with CLC Level 3 Classes and MAES Types for National Ecosystem Identification

EUNIS_COD	CLC_COD	ECOSISTEM_MAES
F9.3	322	TERENURI ARIDE SI ARBUSTI
G1.1	311	Paduri
G1.2	311	Paduri
G1.3	311	Paduri
G1.4	311	Paduri
G1.6	311	Paduri
G1.7	311	Paduri
G1.8	311	Paduri
G1.9	311	Paduri
G1.A	311	Paduri
G3.1	312	Paduri
G3.2	312	Paduri
G3.4	312	Paduri
G3.5	312	Paduri
G3.E	312	Paduri
G4.6	313	Paduri
G5.8	324	Paduri
H2.3	332	TERENURI CU VEGETATIE RARA
H2.4	332	TERENURI CU VEGETATIE RARA
H2.6	332	TERENURI CU VEGETATIE RARA
H3.1	332	TERENURI CU VEGETATIE RARA
H3.2	332	TERENURI CU VEGETATIE RARA
I1.1	211	TERENURI ARABILE
I1.1	212	TERENURI ARABILE
I1.2	211	TERENURI ARABILE
I1.3	243	TERENURI ARABILE
I1.4	213	TERENURI ARABILE
I1.5	211	TERENURI ARABILE

The correlation of the two (spatial and non-spatial) themes was done using a number of criteria, among which we can mention the type of soils, elevation, slope, geology, biogeographic regions, humidity level, temperature, rainfall, altitude classes, vegetation type, the intensity of human activities, in this way issues related to the existence of several types of EUNIS ecosystems overlapped on a single CLC class and vice versa (Figure 11) can be solved using identification based on, for e.g. on geographic criteria (e.g. the presence of certain EUNIS classes only in certain geographical areas) or using certain environmental conditions (the presence of certain EUNIS classes only under certain environmental conditions), the presence of plant associations only in certain areas etc.

In order to increase the level of detail, to identify the discontinuities and to observe the structural and functional heterogeneity at the level of different types of national ecosystems, in this activity a **correspondence has been made between the types of national ecosystems classified EUNIS level 3, CLC level classes 3 and the MAES typology Classification of ecosystems.** Having the national ecosystems identified and mapped at EUNIS level 3 is also supported by the habitat identification criteria from the EUNIS habitat classification methodology, identification keys that differentiate between level 3 habitats based of different parameters (Figure 12).

Figure 12. The parameters used to differentiate the different deciduous forests habitats EUNIS Level 3 (Revised EUNIS Habitat Classification, Davies 2004)



A number of **182 criteria**, identified according to the EUNIS methodology, were used for the discretization of ecosystems at national level. (figure 13).

Figure 13. Databases designed to identify the criteria used for ecosystems identification at national level

CRITERIU	VALOARE_TXT	DESCRIERE	EUNIS_COD_SURSA	EUNIS_COD_TINTA	CRITERIU_SUP	VALOARE_BOL
INTENSITATEA ANTROPIZARII	MARE	Hedgerows mainly of native species mar	FA	FA.2	401	☐
NUMAR DE SPECII	RIDICAT	Hedges which are rich in shrub species ar	FA	FA.3	403	☐
NUMAR DE SPECII	REDUS	Hedges which are rich in shrub species ar	FA	FA.4	403	☐
PLANTARI REGULATE		Shrub plantations which are cultivated re	F	FB	349	☑
UTILIZARE	IN INTREGIME	Shrub plantations are separated on the b	FB	FB.1	350	☐
UTILIZARE	FRUNZE SI RAMURI	Shrub plantations are separated on the b	FB	FB.2	350	☐
UTILIZARE	FRUCTE	Shrub plantations are separated on the b	FB	FB.3	350	☐
UTILIZARE	VITICULTURA	Shrub plantations are separated on the b	FB	FB.4	350	☐
DOMINA ARBORII >10%		Habitats where the dominant vegetation		G	235	☑
TIPUL DE VEGETATIE	ARBORI	Regularly tilled habitats are separated ac		G	523	☐
TIP DOMINANT DE PADURE	BROADLEAVED DECIDUO	Forest is characterised by the dominant t	G	G1	35	☐
SPECII DOMINANTE	SALCIE, ARIN, MESTEACA	Riparian woodlands dominated by willov	G1	G1.1	56	☐
ZONE RIPARIENE		Riparian woods with one or few dominar	G1	G1.2	46	☐
SPECII DOMINANTE	OTHER	Riparian woodlands dominated by willov	G1	G1.3	56	☐
TURBARIE ACIDA		Broadleaved swamp woodlands are disti	G1	G1.4	45	☐
TURBARIE ACIDA		Broadleaved swamp woodlands are disti	G1	G1.5	45	☑
SPECII DOMINANTE	FAG	Dry and seasonally wet woodland habita	G1	G1.6	44	☐
TERMOFILE		Woodlands characterised by thermophil	G1	G1.7	50	☑
OLIGOTROFE		Woodlands characteristic of oligotrophic	G1	G1.8	51	☑
SPECII DOMINANTE	MESTEACAN, PLOP, ROW	Dry and seasonally wet woodland habita	G1	G1.9	44	☐
OLIGOTROFE		Woodlands characteristic of oligotrophic	G1	G1.A	51	☐
SPECII DOMINANTE	ARIN	Dry and seasonally wet woodland habita	G1	G1.B	44	☐
UTILIZARE	PRODUCTIE DE LEMN	Highly artificial forestry plantations norr	G1	G1.C	40	☐
UTILIZARE	LIVEZI	Highly artificial forestry plantations norr	G1	G1.D	40	☐
TIP DOMINANT DE PADURE	BROADLEAVED EVERGRE	Forest is characterised by the dominant t	G	G2	35	☐
SPECII DOMINANTE	STEJAR	Habitats are separated according to their	G2	G2.1	63	☐

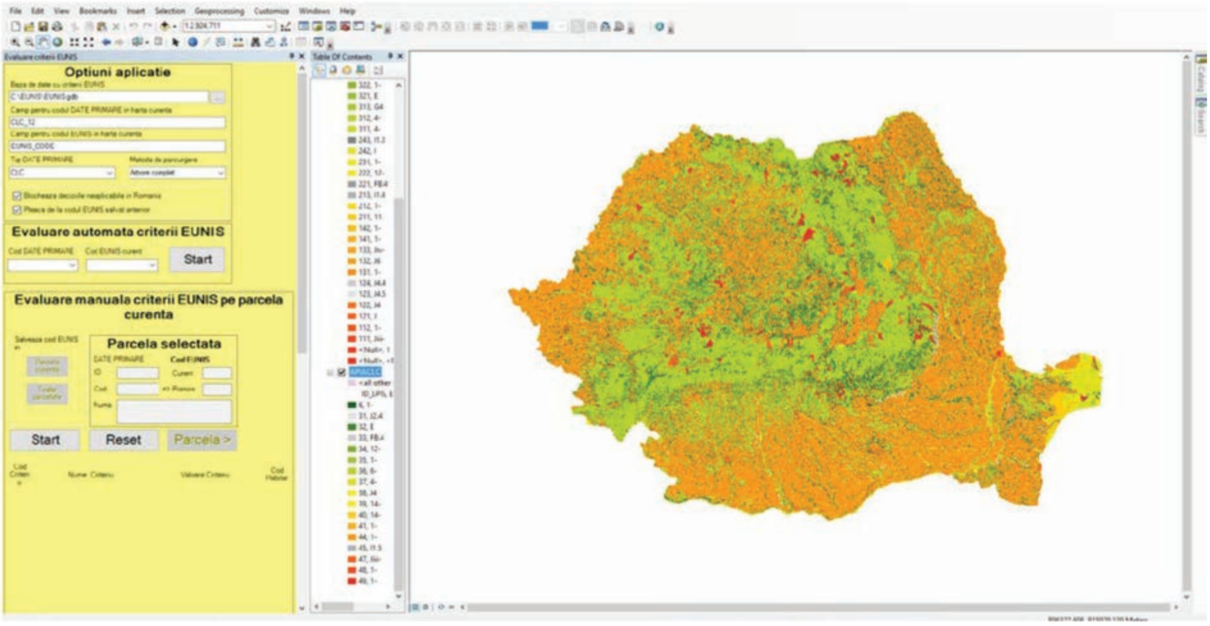
These parameters (identification keys) were used to develop an IT application that automated the process of identification of EUNIS 3 level ecosystems and mapping of ecosystems at national level (figure 13).

The main steps taken in the process of **automatic identification and mapping of ecosystems** at national level:

- Plotting automation of EUNIS habitats, starting from CLC plotting by developing the EUNIS Tree browsing program in Access VBA with algorithm setting (logic scheme).
- Primary evaluation of EUNIS criteria by estimating how criteria are assessed.
- Identify the EUNIS departure criteria for each CLC code and identify on the CLC 2006/2012 map the parcels corresponding directly to a EUNIS level 3 habitats and the area occupied by each habitat obtained.
- Adjusting the database defining the EUNIS Manual as a structure (design tables, queries, reports, relationships establishment) and data (completion and redistribution).
- Creating custom applications (embedded / independent, ArcPython / Visual Basic, Visual C language), incorporate applications (ADD-IN) ARCGIS MAP, used programs ArcObjects 10.3 SDK for .NET + Visual Studio 2013 Express, ARCGIS Map integration – VS.
- Generation of maps for EUNIS criteria related to different abiotic parameters (eg pedology, hydrology) that reflect the distribution of the values of each criterion at national level.
- Developing the EUNIS habitats application, starting with primary data, adapting the existing application (with primary CLC data) to LPIS primary data (APIA).
- Make spatial associations at national level from LPIS to CLC.
- Elaborate the map at national level with the EUNIS habitats in the variants:
- LPIS-CLC + spatial association CLC-EUNIS start-up association;
- Table start association LPIS-EUNIS.
- Reporting of the surfaces of the two map variants at national level with EUNIS starting levels (0, 1, 2, 3) and classes (A, B, C, ... J).
- Application development for EUNIS habitats: creation of interface for automatic application of a criterion (criterion for which spatial information that exists).
- Elaboration of the code for the automatic application of a criterion. Applying the principle of preserving the initial geometry and the principle of adopting the value of the criterion (decision) that occupies the maximum area on a given plot.
- Identification of parcels with a certain combination (start CLC + EUNIS current) and determination of the value of the applied criterion on each plot and of the new current EUNIS code (by the direct individual search method in the tables and by the combination of the tables).
- Application development for EUNIS habitats: Generalization for the application of all criteria for all plots associated with a specific CLC code.
- Optimization by setting the EUNIS start code and a minimum Tree of Criteria according to the LPIS code combination | CLC code - identifying possible combinations and associated EUNIS (creation of LPIS | CLC tables).
- For automatic evaluation, generalization by choosing the primary data type (CLC, CLC | LPIS, LPIS, ...) from a list and changing the data sources of the controls according to this choice.

For situations where identification could not be done automatically, it was developed the possibility to **manually classify each plot** and fit it into the EUNIS 3 level ecosystem type, which is extremely useful for further enhancing the classification process at the local level.

Figure 14. Ecosystems national level mapping application



In order to exemplify the process and rules used in national ecosystem mapping, we can analyse the discretization of a level 3 EUNIS habitat using, for example, the correspondence with Natura 2000 habitats, this typology having developed the spatial component.

Description of EUNIS E1.1 habitat type and upper classes

EUNIS level 1, category E - Meadows and land dominated by herbaceous vegetation, moss or lichens

Non-coastal, dry or wet seasonal land (with water at or above ground level for less than half a year) with more than 30% vegetation coverage. The vegetation is dominated by grasses and other non-woody plants, including mosses, macrolichens, ferns, grasses, sedges and herbs. Includes the semi-arid steppe with *Artemisia* isolated forbes. Includes semiarid steppes with weed vegetation of *Artemisia*. Includes successive weed vegetation and managed pastures, such as recreational fields and lawns. Exclude regularly grown habitats (I1), dominated by cultivated herbaceous vegetation, such as arable land.

Descriptive parameters:

- Dominant species: herbaceous vegetation, weeds, bryophytes, lichens
- Coverage characteristics: vegetation> 30%

EUNIS level 2, category E1 – Dry grasslands

Well-drained or dry lands dominated by grass or grasses, often unfertilized and low productivity. Included are the steppes with Artemisia. Dry Mediterranean land with other types of shrubs, where shrubs layer exceeds 10% is excluded;

Descriptive parameters:

- Dominant species: herbaceous vegetation, weeds, bryophytes, lichens, dwarf plants
- Coverage characteristics: vegetation> 30%
- Humidity characteristics: dry, arid.

EUNIS level 3, category E1.1 Inland sand and rock with open vegetation

Open vegetation, thermophilic sands or rock debris in the non-moral and local area, in the Mediterranean or boreal plain to Europe's mountainous areas. Including open lawns from strong sands to limestone, and the vegetation formed mostly of annual and succulent or semi-succulent plants on decomposed rocks of edges, edges or mounds, limestone or siliceous soils.

Descriptive parameters:

- Dominant species: herbaceous vegetation, weeds, dwarf plants;
- Coverage characteristics: vegetation> 30%, uncovered field> 30%;
- Humidity characteristics: dry, unproductive;
- Soil chemical parameters: preponderant alkaline/ basic;
- Substrate types: sandy, detritus soils;
- Phytosociological associations: *Alysso alyssoidis-Sedion albi; Bromo pannonici-Festucion pallentis; Diantho lumnitzeri-Seslerion albicantis; Helianthemo-Globularion;Hyperico perforati-Scleranthion perennis; Koelerion aranariae; Koelerion glaucae; Sedion Anglici; Sedo albi-Veronicion dillenii; Sedo-Cerastion; Sedo-Scleranthion biennis*.

The identification process of E1.1 habitats used the criteria gradient (gray cells) defined within the tree developed by the EUNIS typology (Figure 15).

Figure 15. The EUNIS tree used for identification the E1.1 habitat

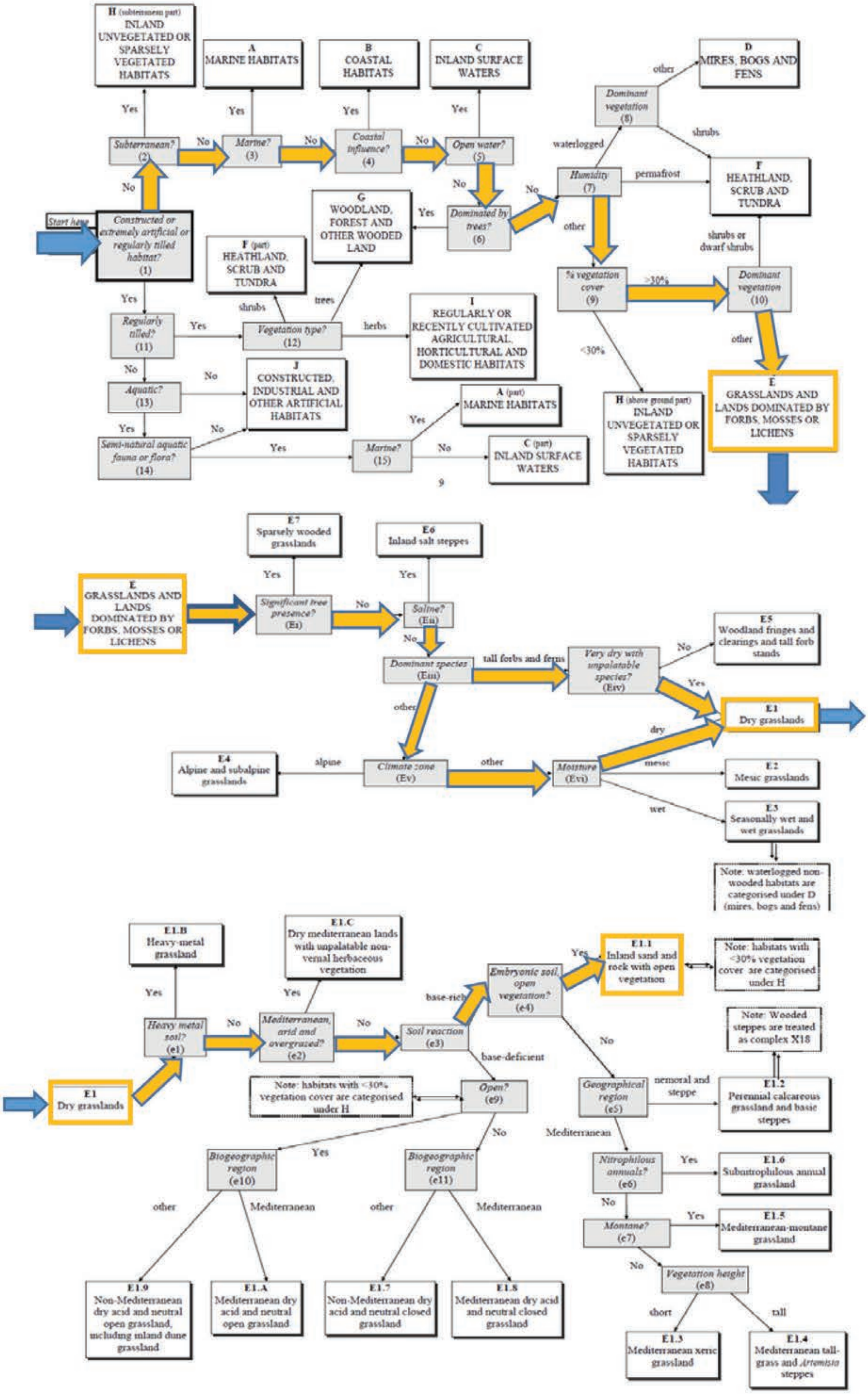


Table 16. Parameters used for E1.1 habitat identification

Parameter	Value
EUNIS level 1, category E	
Build habitats or highly anthropic	NO
Underground habitats	NO
Marin habitats	NO
Coastal influence	NO
Surface water	NO
Dominated by trees	NO
Humidity	OTHER (NO wetlands, NO permafrost)
% of vegetation coverage	>30%
The dominant vegetation	OTHER (NO scrubs)
EUNIS level 2, category E1	
The smouldering presence of the trees	NO
Saline areas	NO
Dominant species	OTHER
Climatic zone	OTHER (NO alpine)
Humidity	ARID
EUNIS level 3, category E1.1	
Soils rich in heavy metals	NO
Mediterranean, arid and overgrazing	NO
Soil chemistry	Basic
Primary soils, open vegetation	YES

To facilitate the identification and mapping of different types of EUNIS level 3 habitats existing within a CLC class, have been used both the correspondence with the most important classification systems (e.g. the Habitats Directive classification that also has a spatial representation of protected habitats -Table 17) but also the identification criteria developed by the EUNIS typology and discussed previously.

Table 17. The correspondence between EUNIS level 3 and the most important habitat classification typologies for the E1.1 habitat

EUNIS 3	CLC 3	Habitats Directive	PALEARCTIC	Doniţă et al
E1.1	321	6110, 6120	34.11, 34.12	R3403

For habitat mapping E1.1 we have identified the correspondences with the CLC spatial classes. As can be seen from Table 18, the relationship between the two classification types is not 1: 1, the space class CLC 321 corresponds to 16 EUNIS level 3 categories identified at national level.

Table 18. Correspondence between CLC class 321 and EUNIS level 3 habitat types

CLC level 3	EUNIS level 3
321	E1.1
	E1.2
	E1.5
	E1.7
	E1.9
	E1.D
	E2.2
	E3.4
	E3.5
	E4.1
	E4.3
	E4.4
	E5.1
	E5.4
	E5.5
	E6.2

The solution to the identification problems of EUNIS habitat types that typologically overlap with the same CLC classes was achieved through the automation developed for this process and explained earlier.

Below are some maps, examples of the EUNIS E1.1 habitat identification and mapping process by overlapping available spatial information layers (CLC, LPIS, Natura 2000 habitats, soil types etc.) and the use of defined identification parameters EUNIS (Figures 16 to 19).

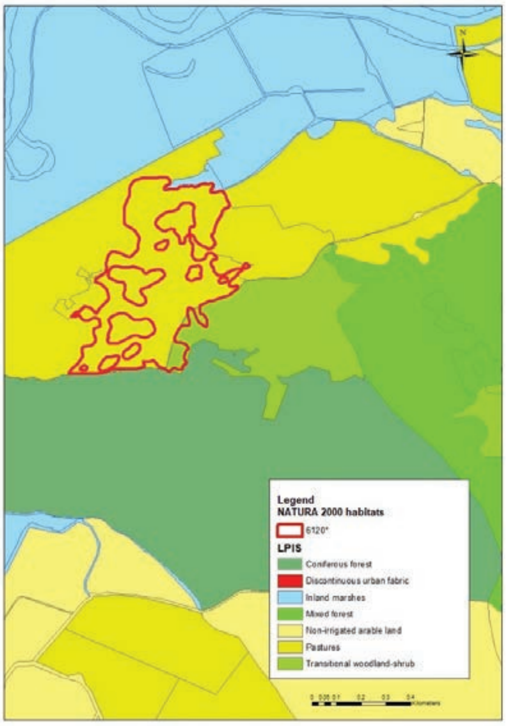


Figure 16. LPIS classes increase the degree of local detail (one can see how the LPIS-pasture class corresponds to the parameters defining habitat 6120 (EUNIS E1.1)

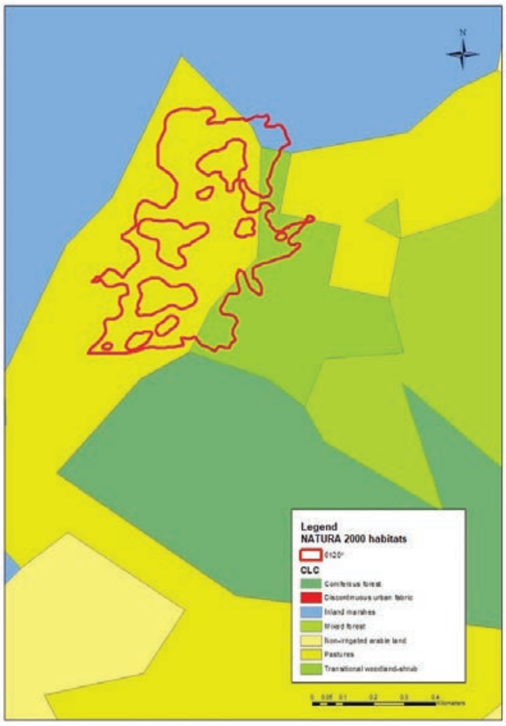


Figure 17. CLC Level 3 classes define on a regional scale the type of land cover (it can be noticed that potential habitat 6120 (EUNIS E1.1) overlaps CLC class 321-pastures)

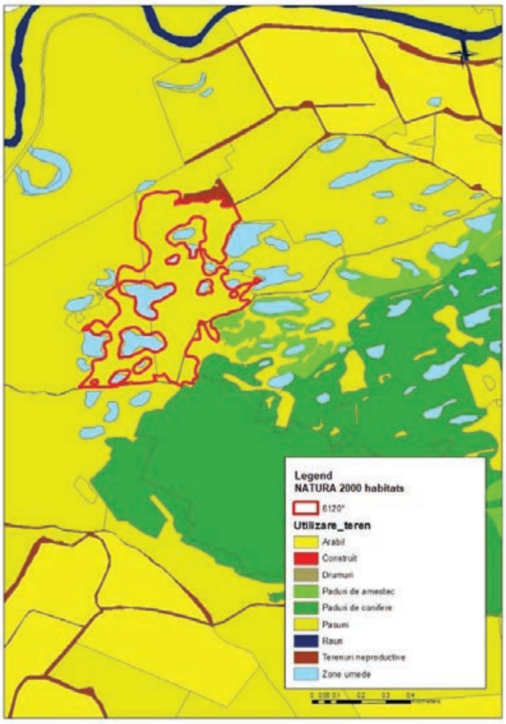


Figure 18. Increasing the degree of detail and improving the accuracy of identification of different types of ecosystems using spatial themes such as hydrography or wetlands.

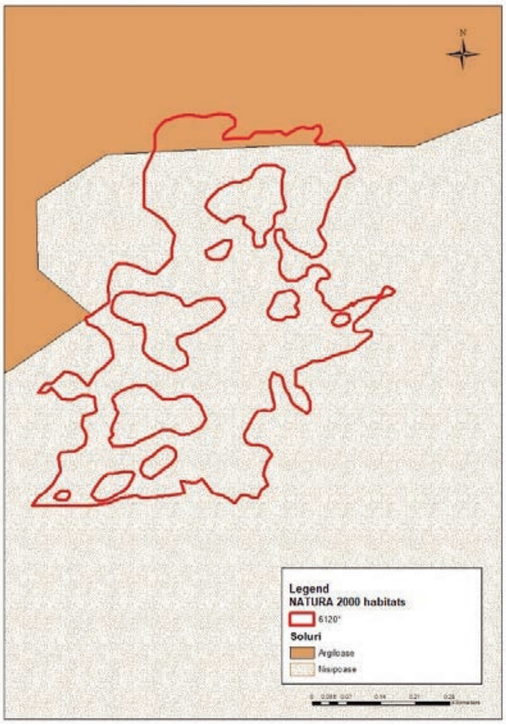


Figure 19. Soil type is an important parameter in identifying abiotic discontinuities used to identify ecosystems (e.g. sandy soils characterizing abiotic environment for habitat 6120 (EUNIS E1.1).

The map of national ecosystems is a working version resulting from automatic identification of EUNIS level 3 ecosystems based on predefined criteria according to accepted EUNIS typology, CLC and LPIS classes.

The assessment of the fairness degree and validation of the identification results of the types of ecosystems to be selected for the subsequent assessment of ecosystem services at national level is achieved by field validation activities, the final results of the ecosystem map being delivered after completion of field validation.

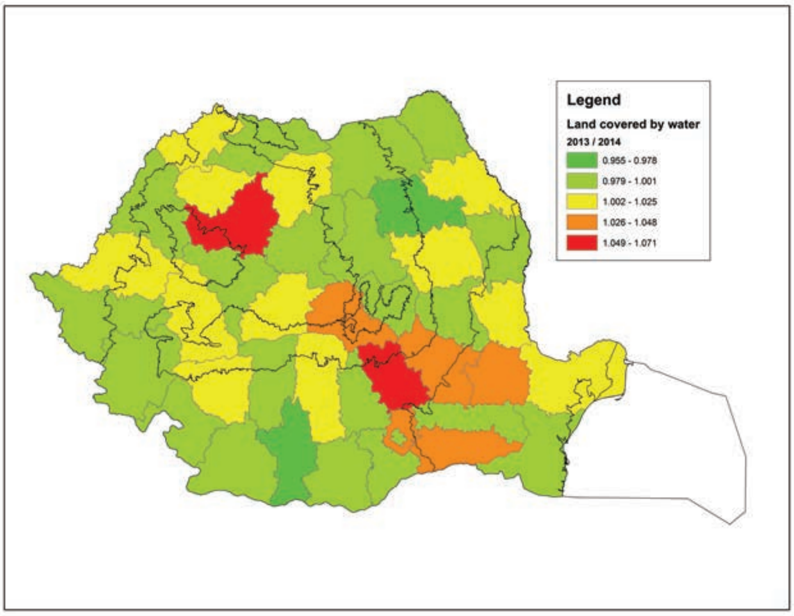
3.2. Mapping of ecosystem services

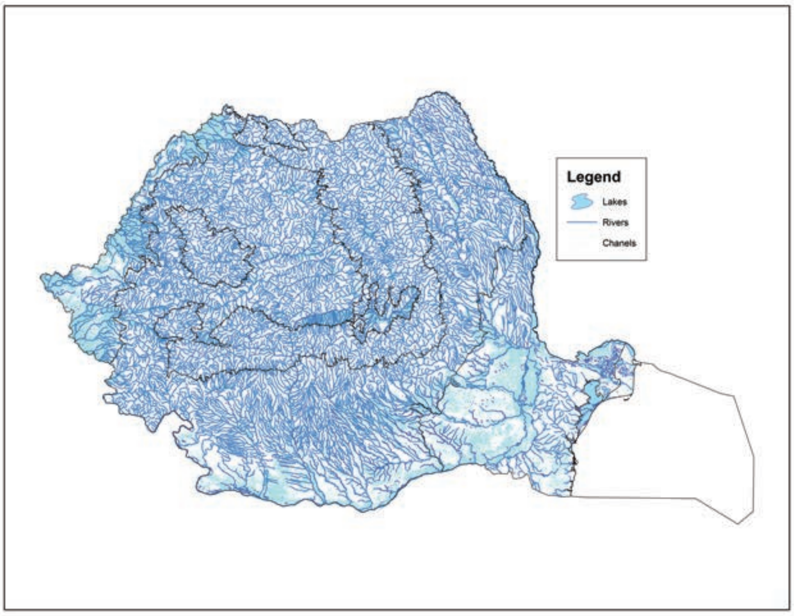
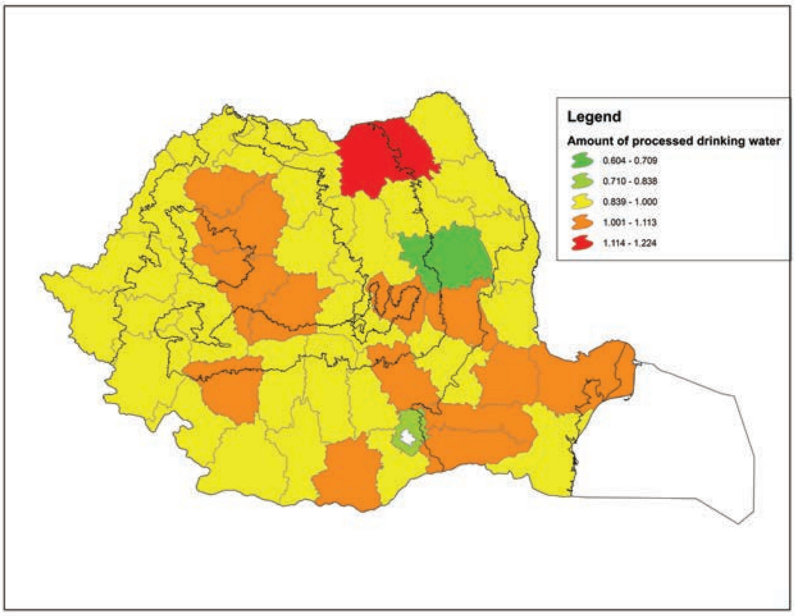
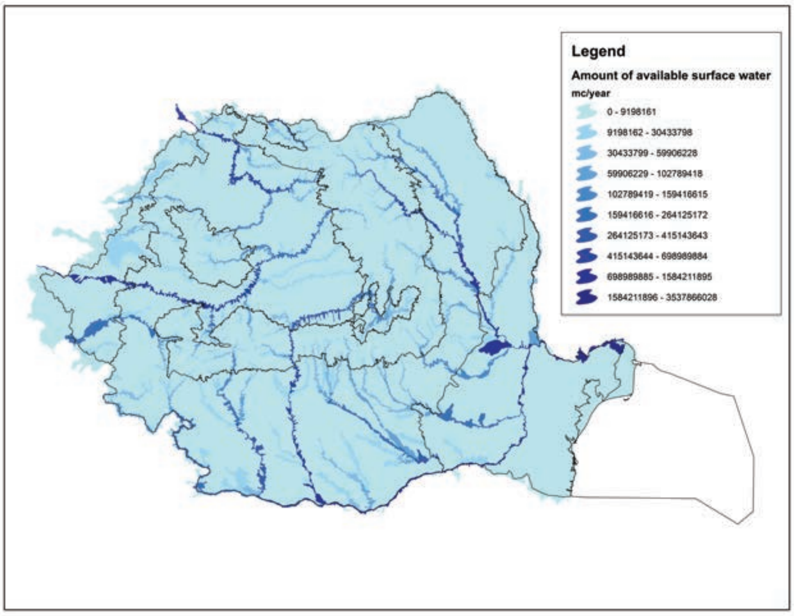
The national assessment and distribution of ecosystem services indicators values was carried out on 4 categories of ecosystems and 12 ecosystem services. We present a summary of the assessment maps of the indicators used in the cascade model applied for the assessment of ecosystem services.

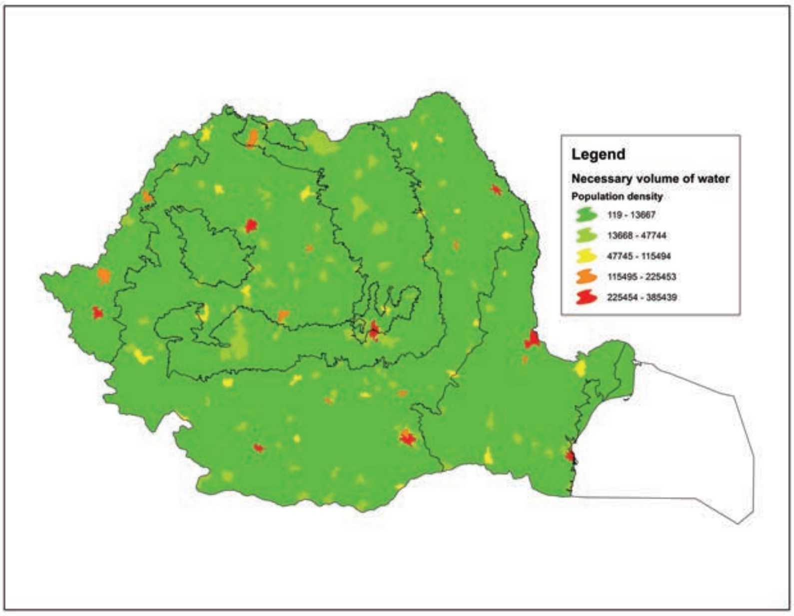
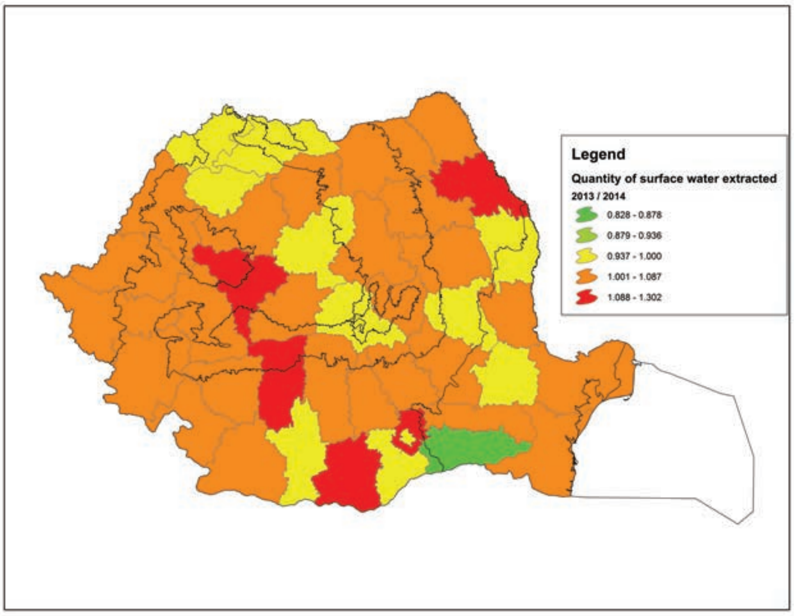
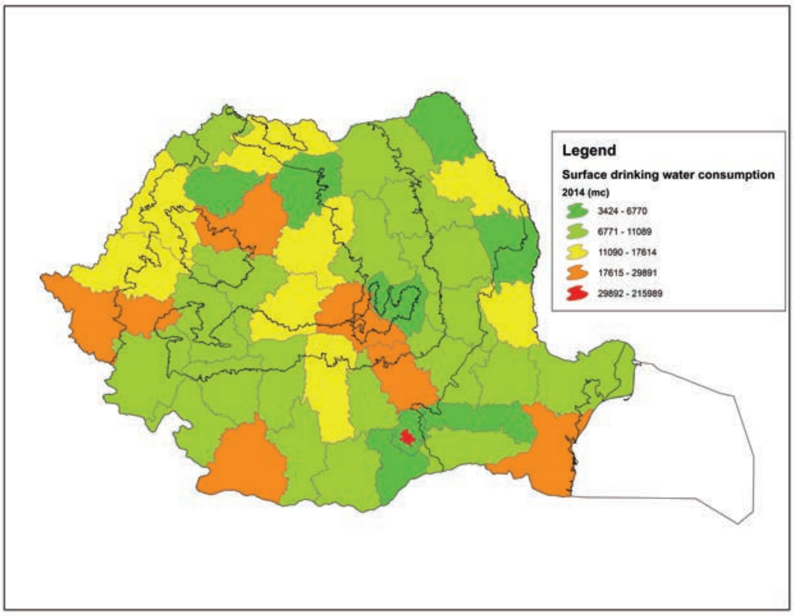
Aquatic ecosystems

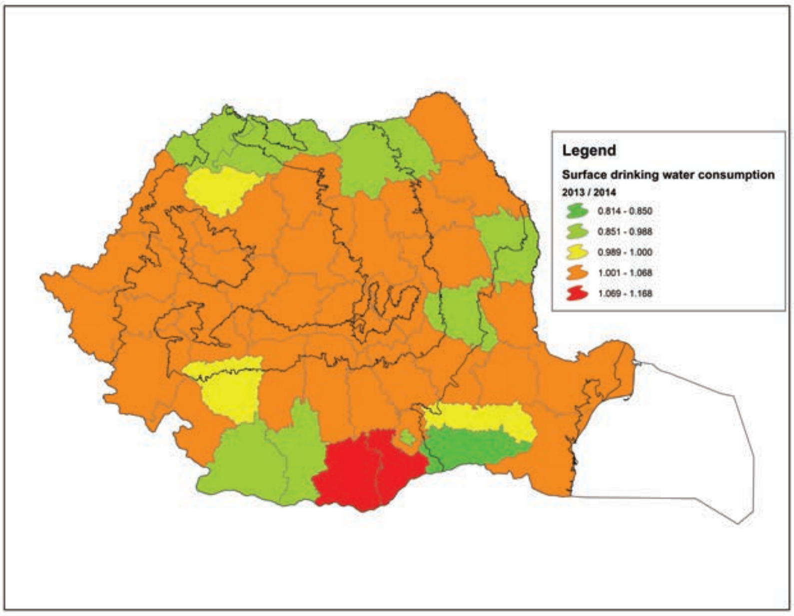
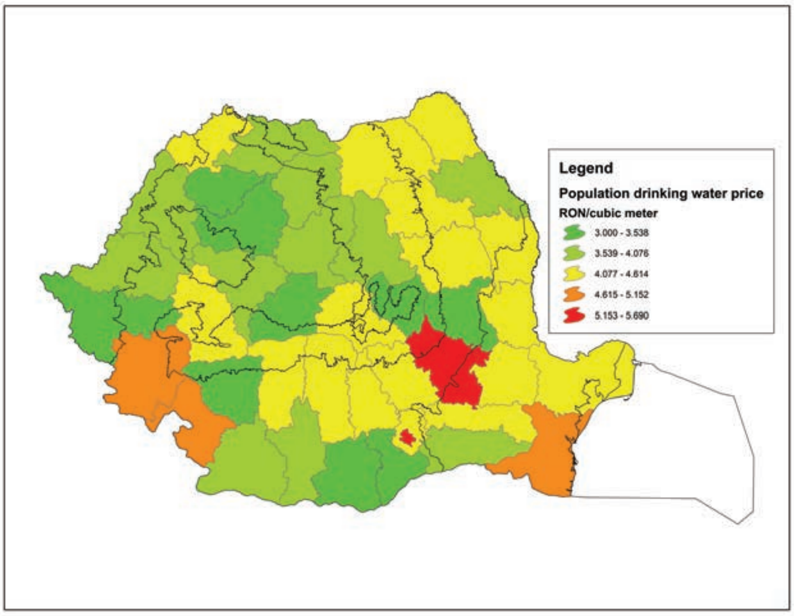
Provisioning services

Surface drinking water

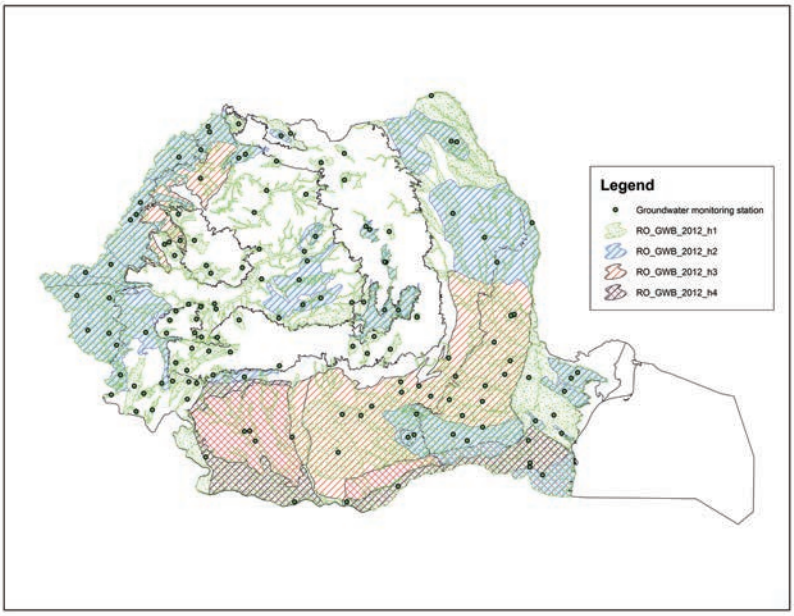
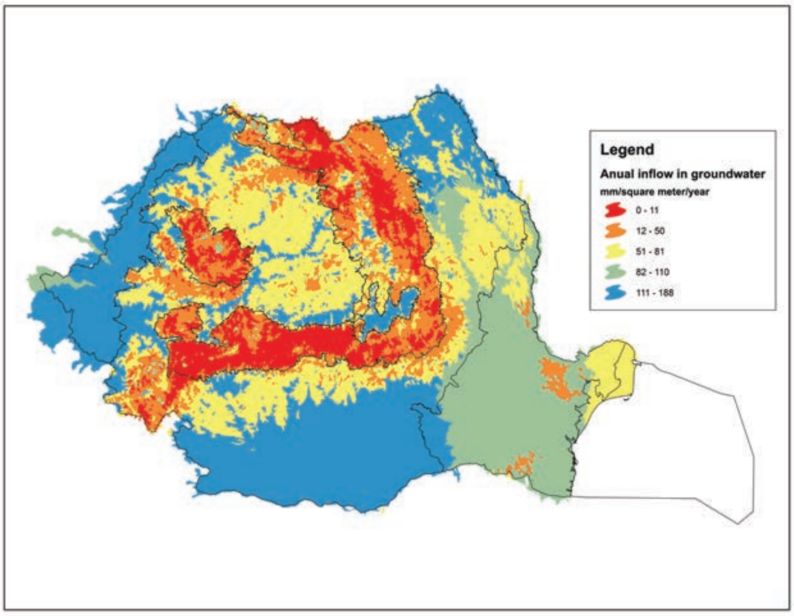
Indicator	Supply – Surface drinking water
1. Structural *Area of lands covered by water* *Area covered by water in Romania has grown from 2013 to 2014, especially in Olt and Neamt Counties where the recorded growth was up to 0.5%*	

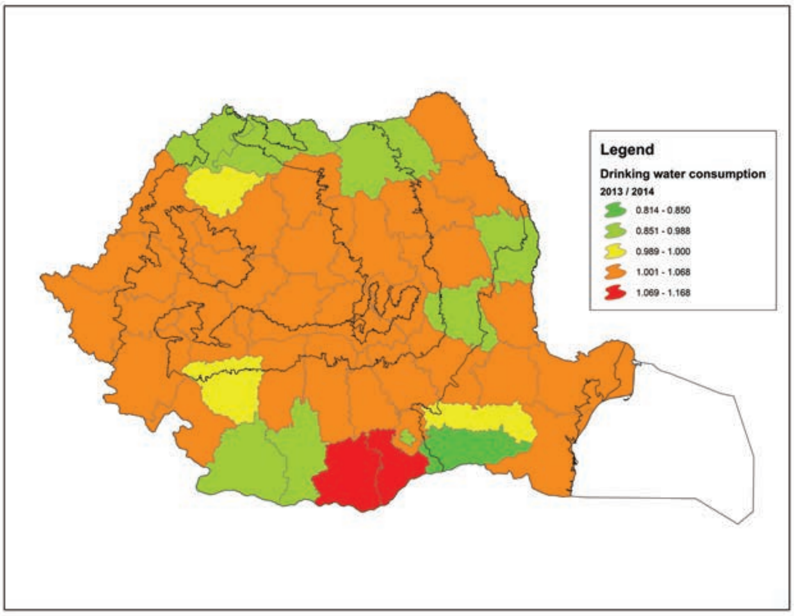
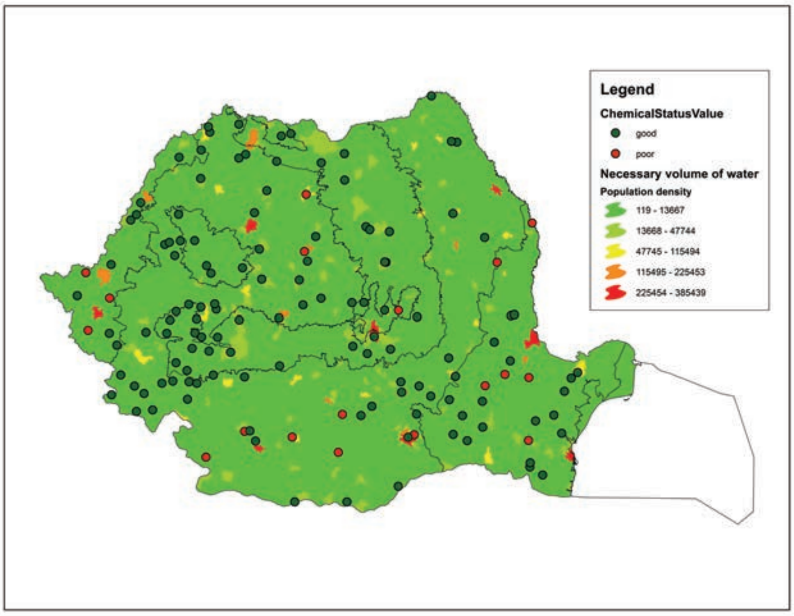
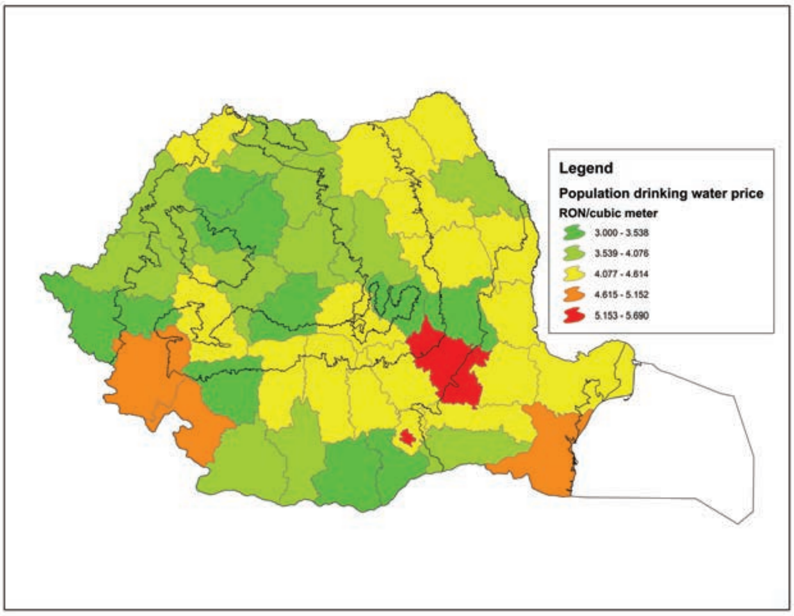
<table>
<tr><th>Indicator</th><th>Supply – Surface drinking water</th></tr>
<tr><td>Hydrographic network – rivers and lakes used as surface water sources</td><td>
</td></tr>
<tr><td>2. Functional –
Amount of processed drinking water</td><td>
</td></tr>
<tr><td>Amount of available surface water</td><td>
</td></tr>
</table>

<table>
<tr><th>Indicator</th><th>Supply – Surface drinking water</th></tr>
<tr><td>Necessary volume of water proportional to the population density</td><td>
</td></tr>
<tr><td>3. Evaluation –
Quantity of surface drinking water extracted</td><td>
</td></tr>
<tr><td>Surface drinking water consumption for households (2014)</td><td>
</td></tr>
</table>

<table>
<tr><th>Indicator</th><th>Supply – Surface drinking water</th></tr>
<tr><td>4. Benefit
Number of people directly benefiting from drinking water resources (households)</td><td>
</td></tr>
<tr><td>5. Value
Drinking water price for population</td><td>
</td></tr>
</table>

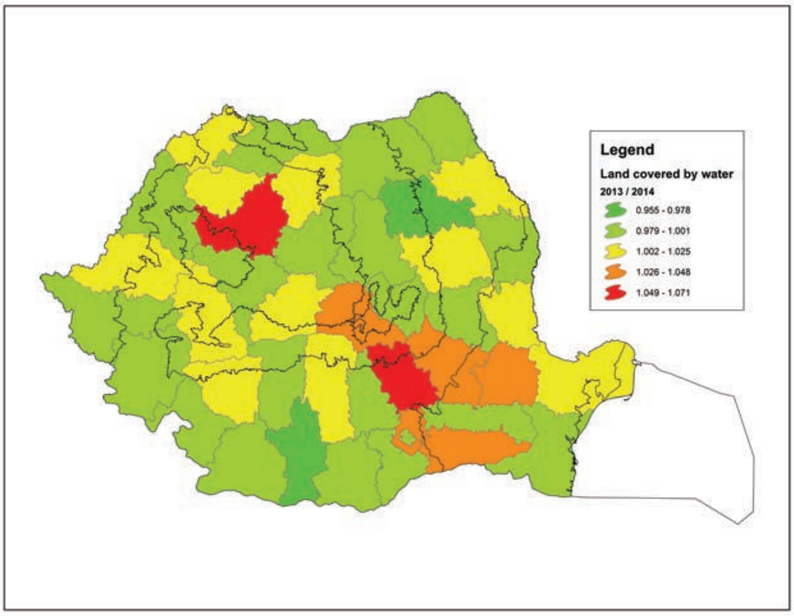
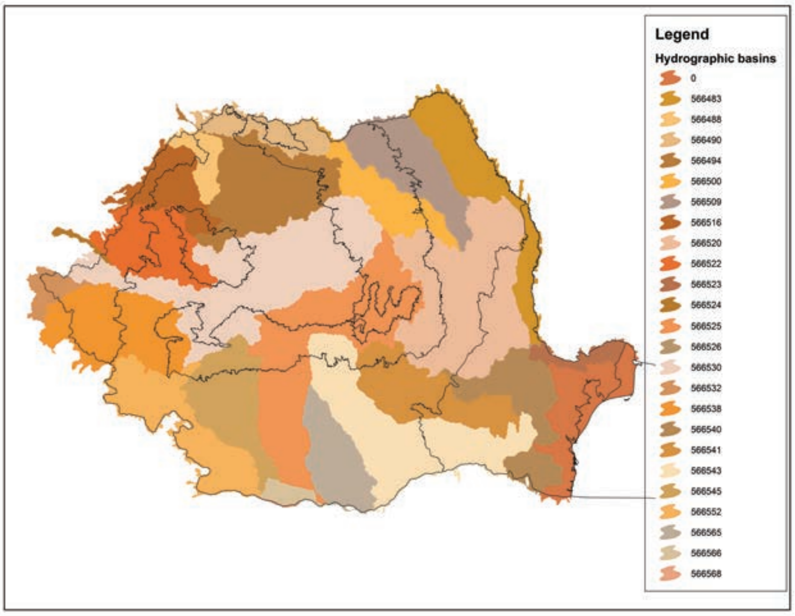
Underground drinking water

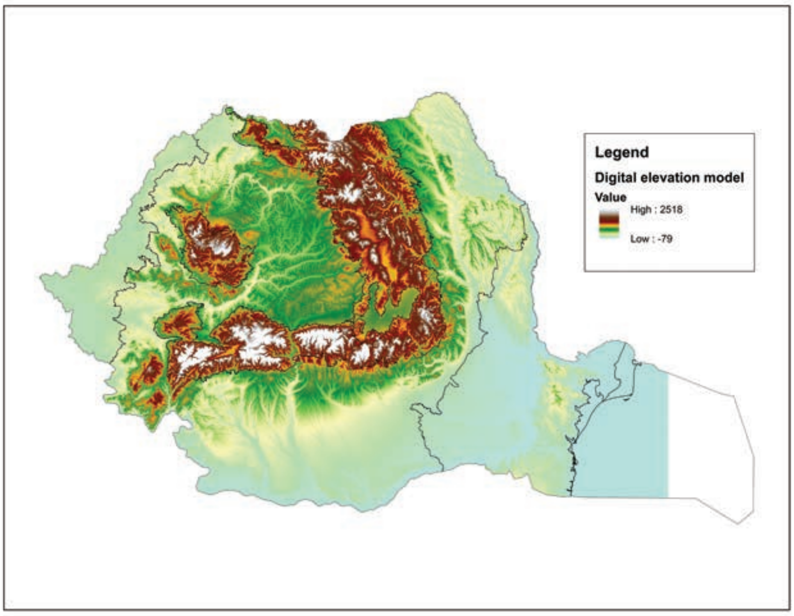
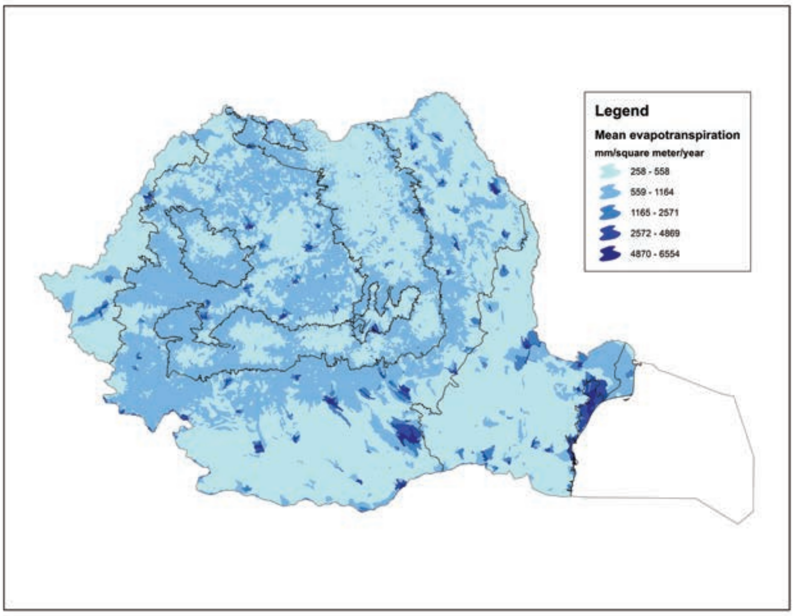
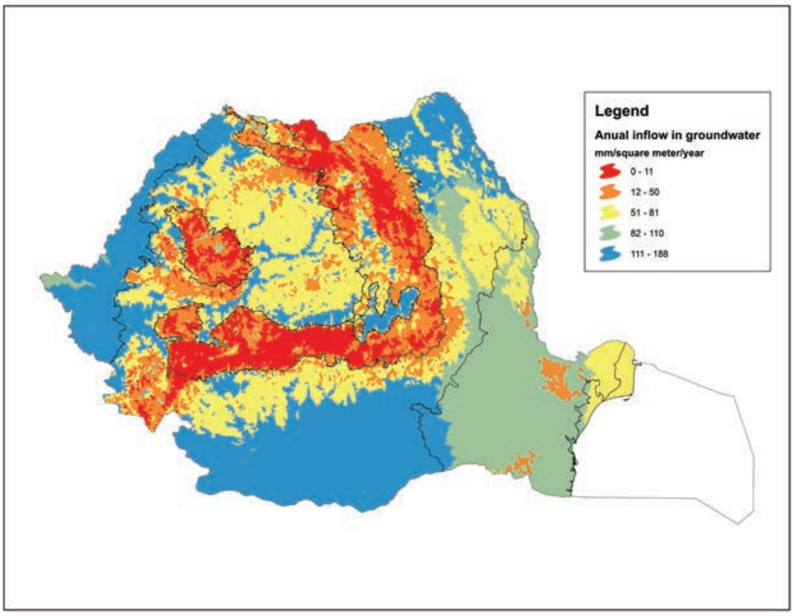
<table>
<tr><th>Indicator</th><th>Supply – Underground drinking water</th></tr>
<tr><td>1. Structural
Number of underground drinking water stations</td><td>
</td></tr>
<tr><td>2. Functional –
Available quantity of underground water</td><td>
</td></tr>
</table>

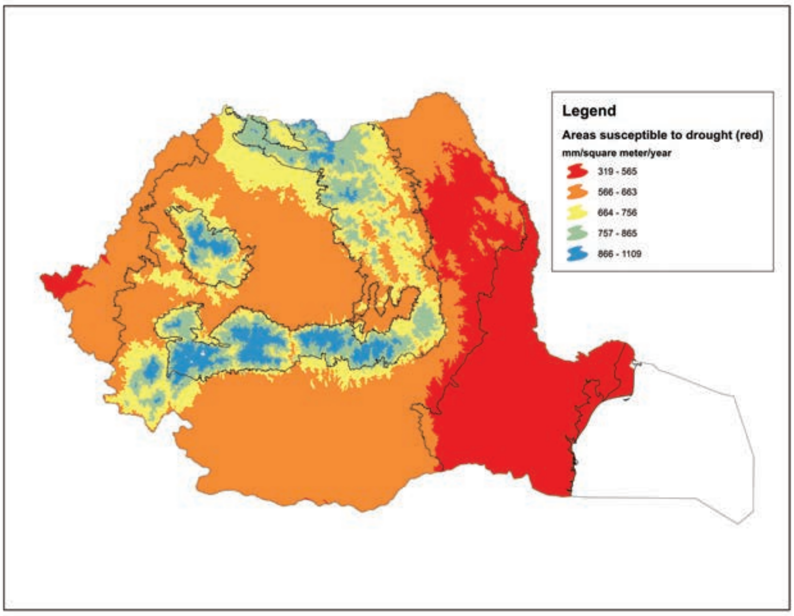
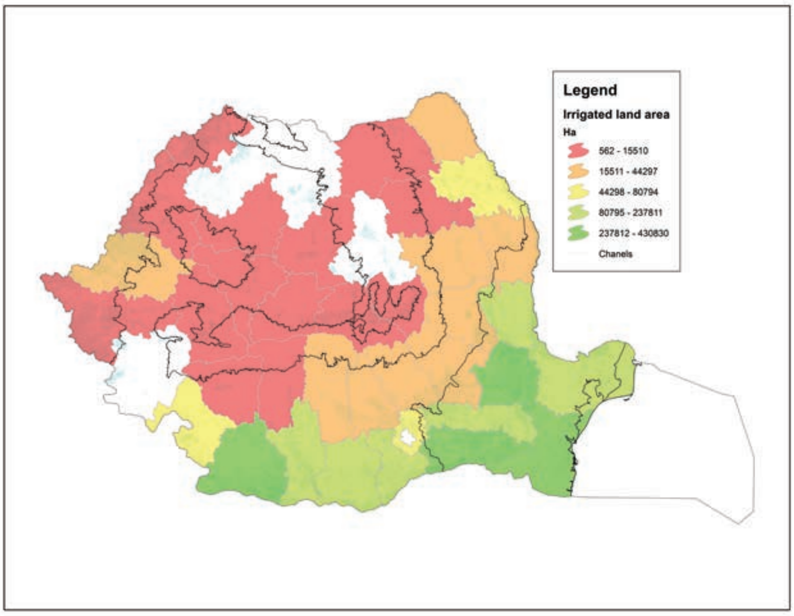
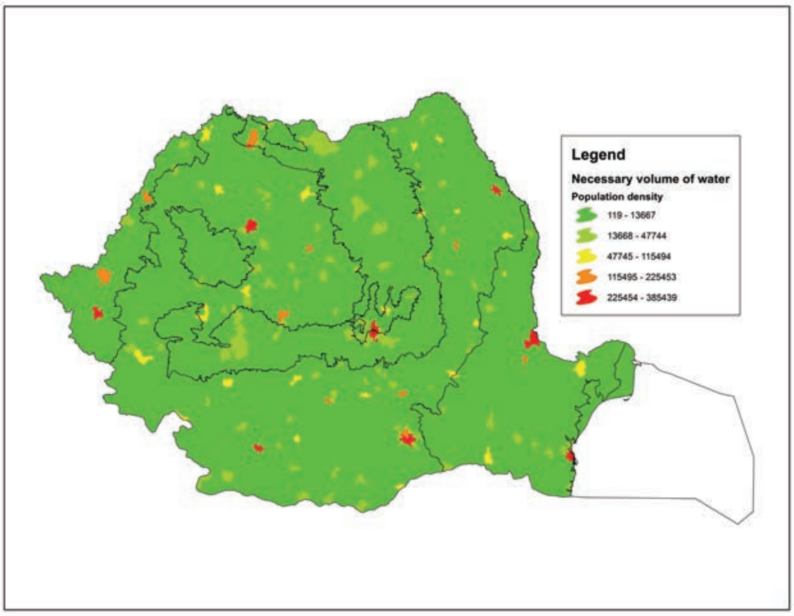
Indicator	Supply – Underground drinking water
3. Evaluation – *Quantity of drinking water extracted from underground sources*	
4. Benefit *Number of people directly benefiting from the underground resources of drinking water*	
5. Value *Drinking water price for population*	

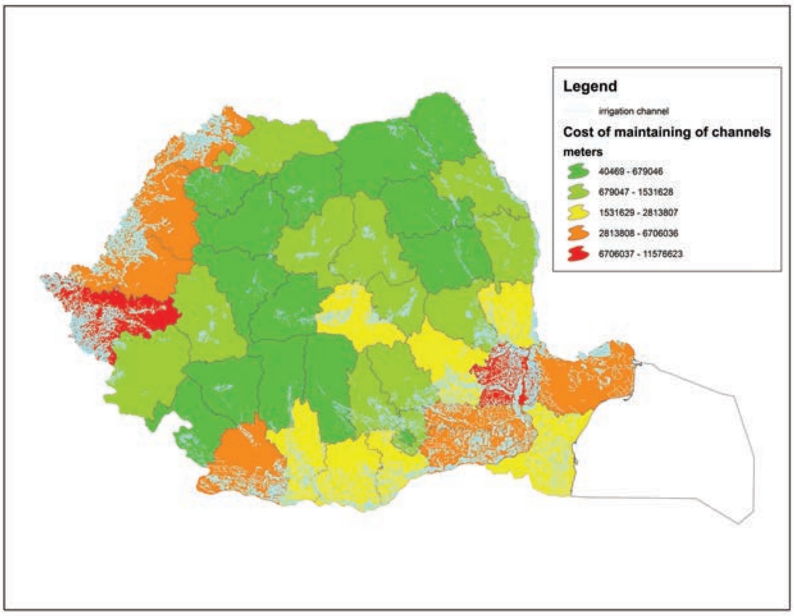
Regulating and maintenance services

Hydrological cycle and water volumes maintenance

Indicator	Hydrological cycle and water volumes maintenance
1. Structural *Area of lands covered by water* *Area covered by water in Romania has grown from 2013 to 2014, especially in the Neamt and Olt Counties where the recorded growth was up to 0.5%*	
Hydrographic basins distribution	

Indicator	Hydrological cycle and water volumes maintenance
Digital Elevation Model	
2. Functional – *Potential capacity of maintaining hydrological volumes is reflected by:* • *Maintaining the mean level of evapotranspiration* • *The potential of supplying the groundwater through infiltrations*	 

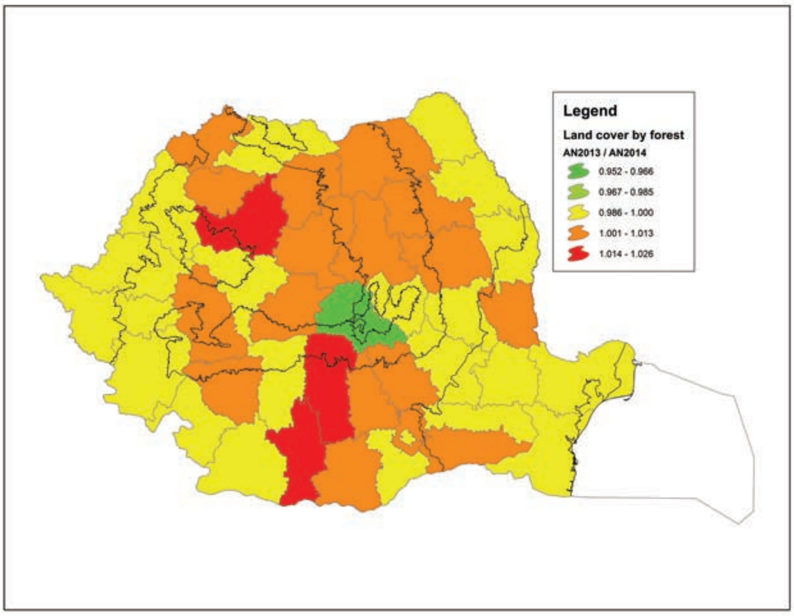
<table>
<tr><th>Indicator</th><th>Hydrological cycle and water volumes maintenance</th></tr>
<tr><td>Areas susceptible to drought – areas with low contribution of mean precipitation level (represented in red)</td><td>
</td></tr>
<tr><td>3. Evaluation –
Surface of ecosystems with medium or high potential of modifying the hydrological volumes. Indicator based on Land Use maps querying in areas with high level of drought/floods</td><td>
</td></tr>
<tr><td>4. Benefit
Number of people directly benefiting from negative effects reduction of water volumes changes over the seminatural and anthropic ecosystems
Indicator based on the level of population in the areas affected by drought / floods.</td><td>
</td></tr>
</table>

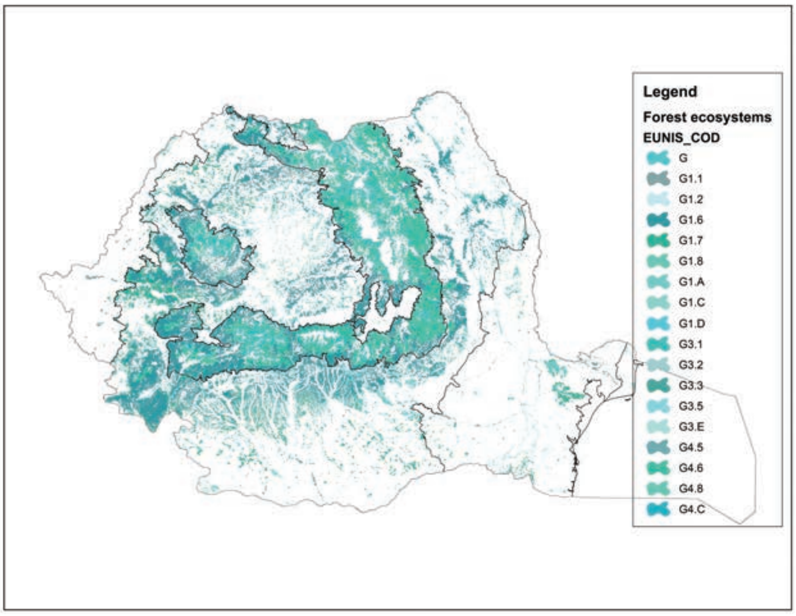
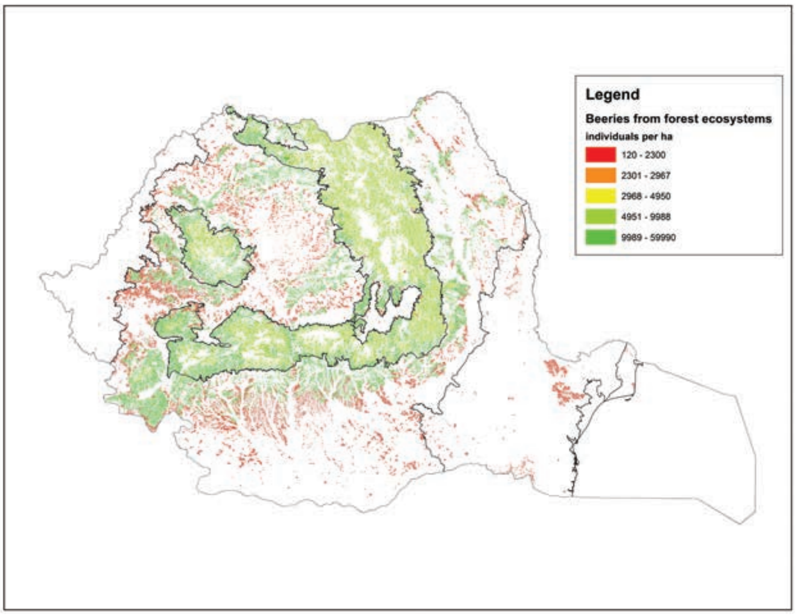
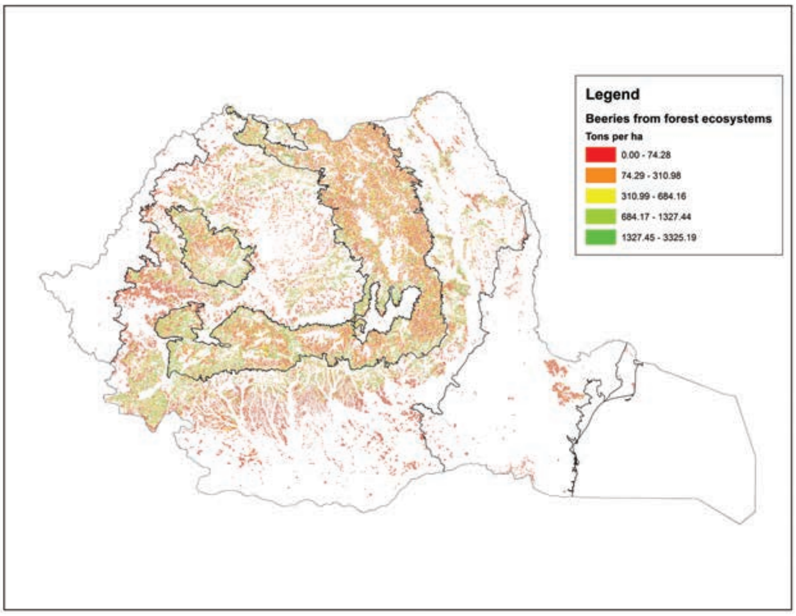
Indicator	Hydrological cycle and water volumes maintenance
5. Value *The cost of water volumes control through alternative methods (dams / irrigations)* *The area (in hectares) is expressed as a linear function of the mean costs per hectare*	

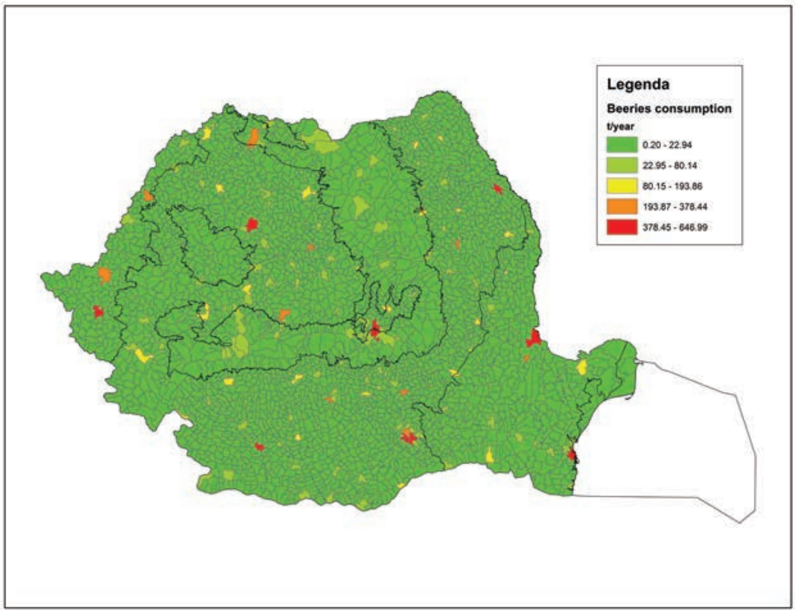
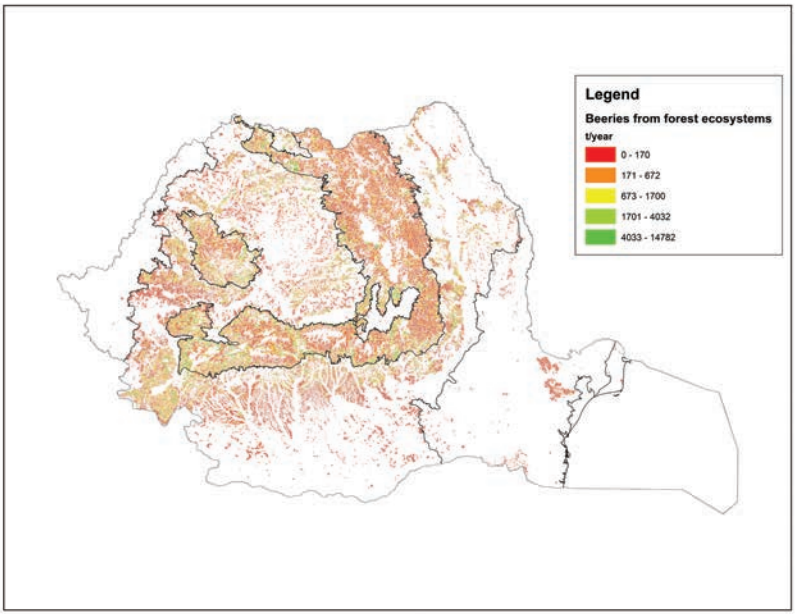
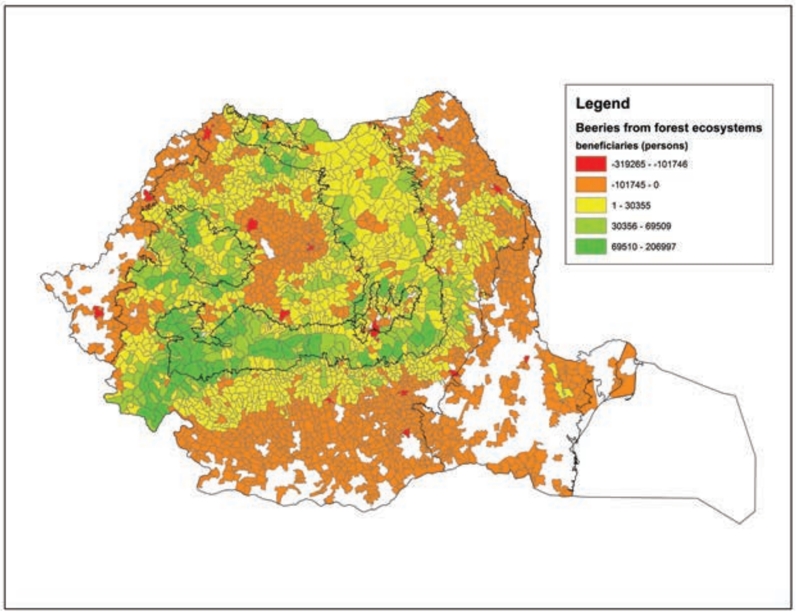
Forest ecosystems

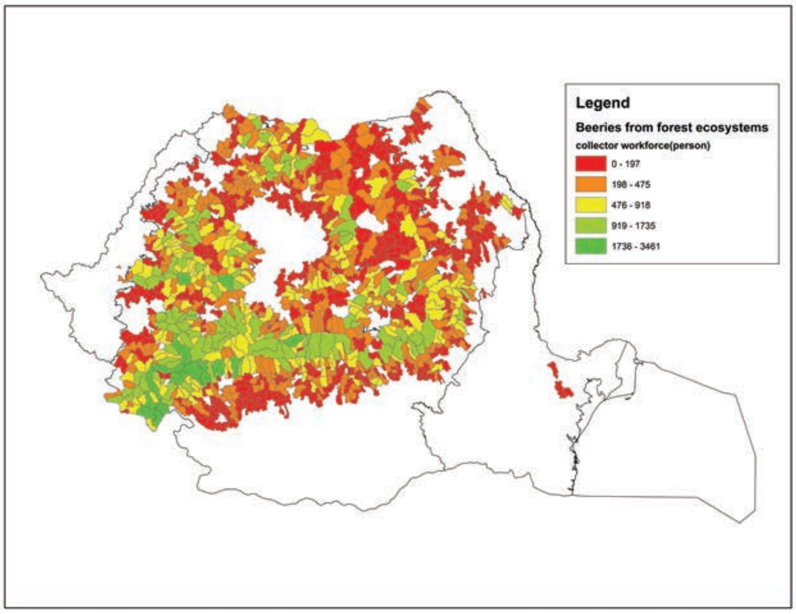
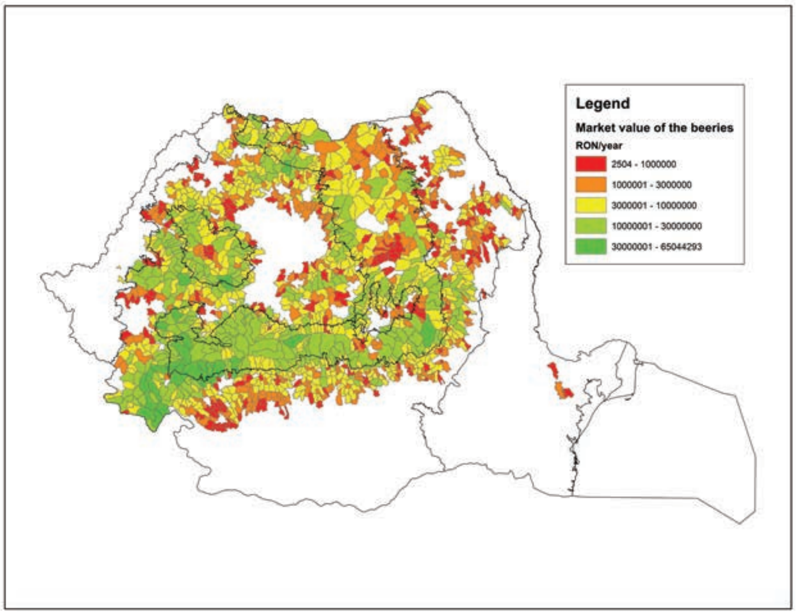
Provisioning services

Nutrition – Biomass – Wild plants and associated products

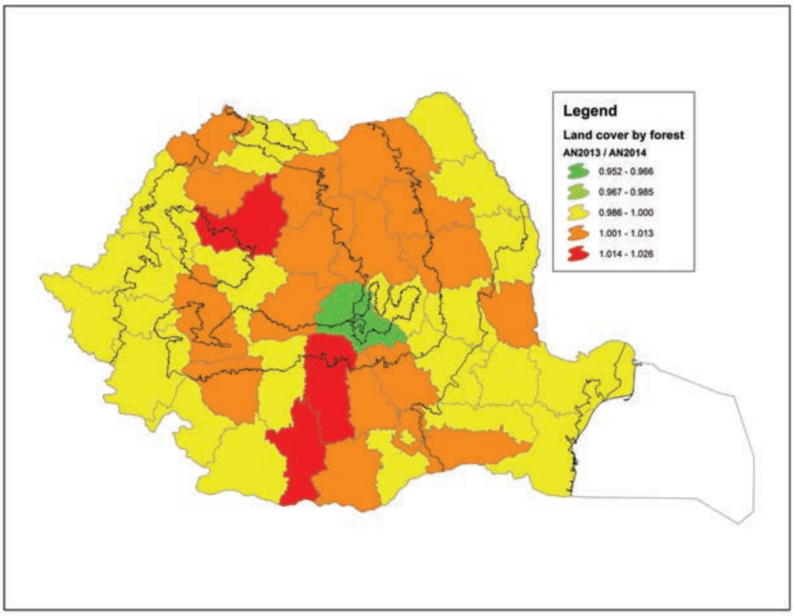
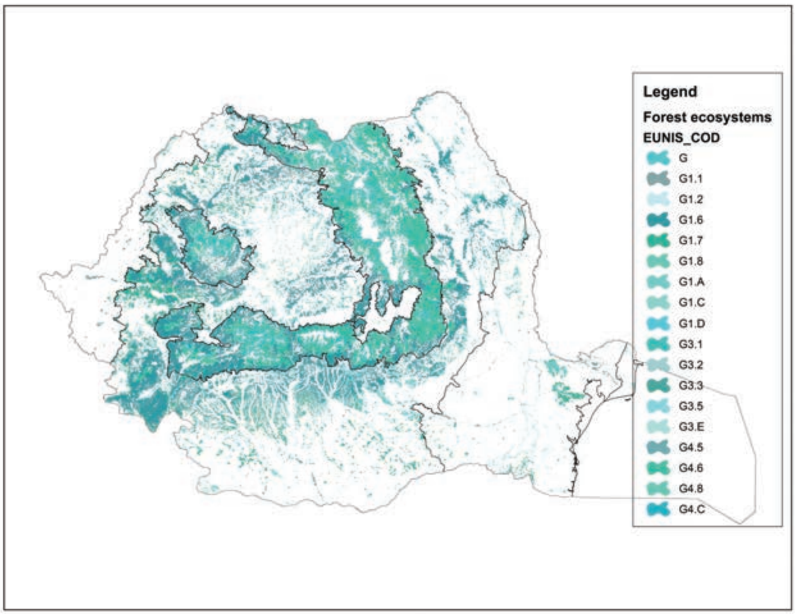
Indicator	*Nutrition – Biomass – Wild plants and associated products*
1. Structural *Area of the ecosystems expressed in hectares* Area of land covered by forest in Romania in 2014 has no significant changes compared to 2013. The biggest negative differences (in Olt, Argeș and Cluj counties) have not exceeded 5% and the positive ones (recorded in Brașov) have not exceeded 5%.	

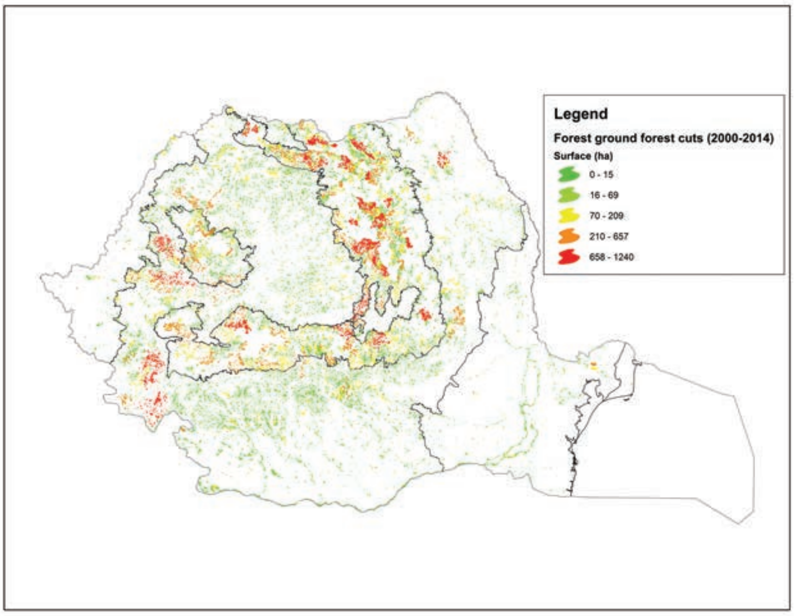
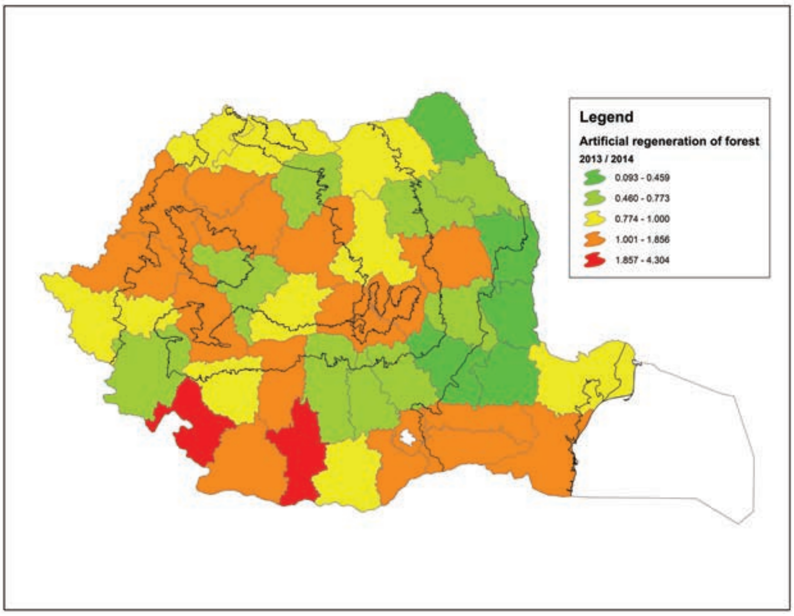
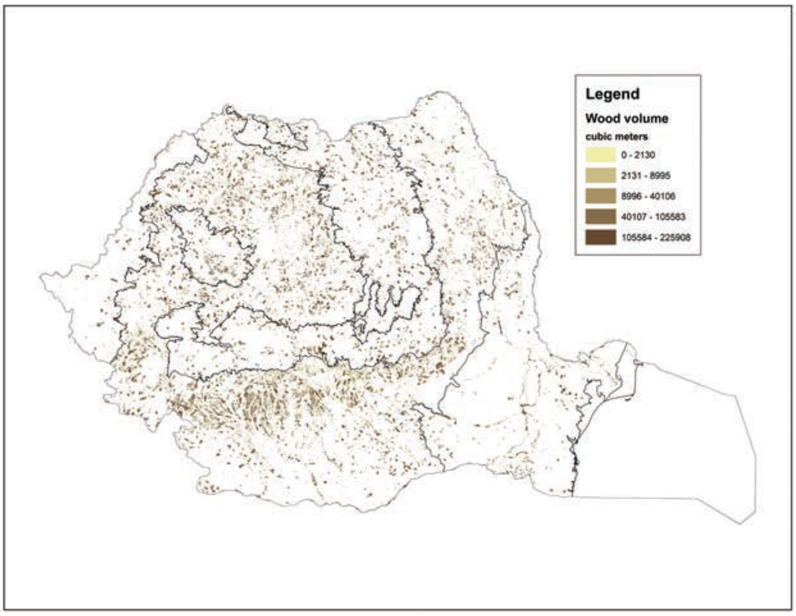
Indicator	*Nutrition – Biomass – Wild plants and associated products*
Forest ecosystems distribution	
2. Functional – Density of plants depending on the ecosystem type (individuals / hectare)	
Mean biomass per ha of berries (t)	

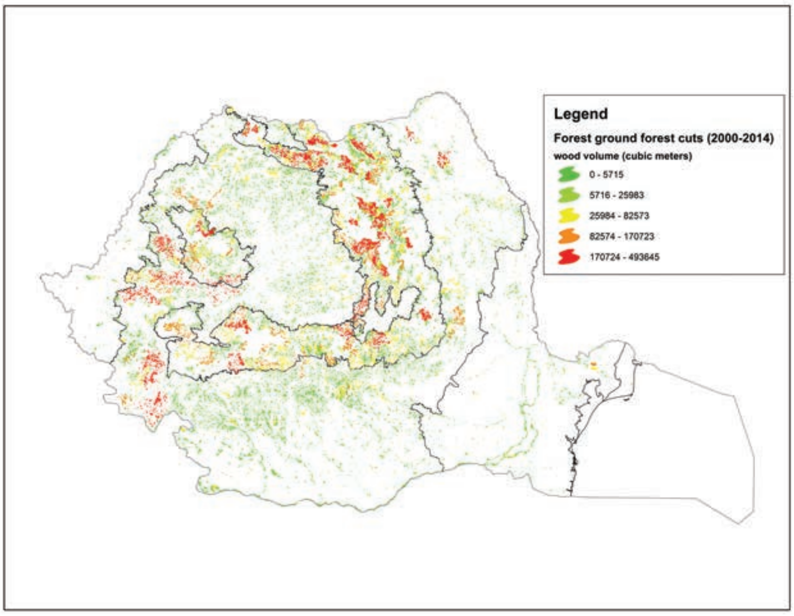
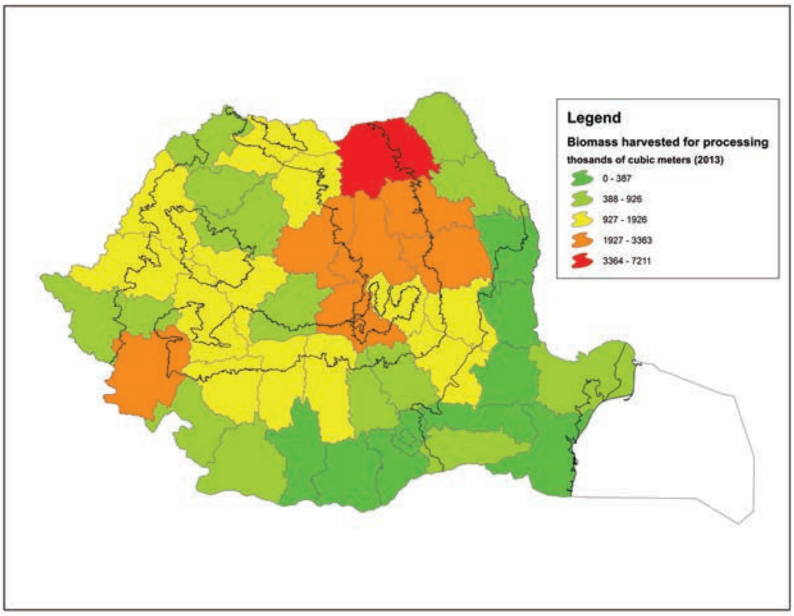
Indicator	*Nutrition – Biomass – Wild plants and associated products*
Mean consumed quantity per individual per year (kg/year) – according to the minimum monthly basked O.U,G, 217/2000 (~4.7 kg/month)	
3. Evaluation – Quantity of berry-based products provided by the forest ecosystems per year	
4. Benefit Number of people directly benefiting from the collected products (consumers).	

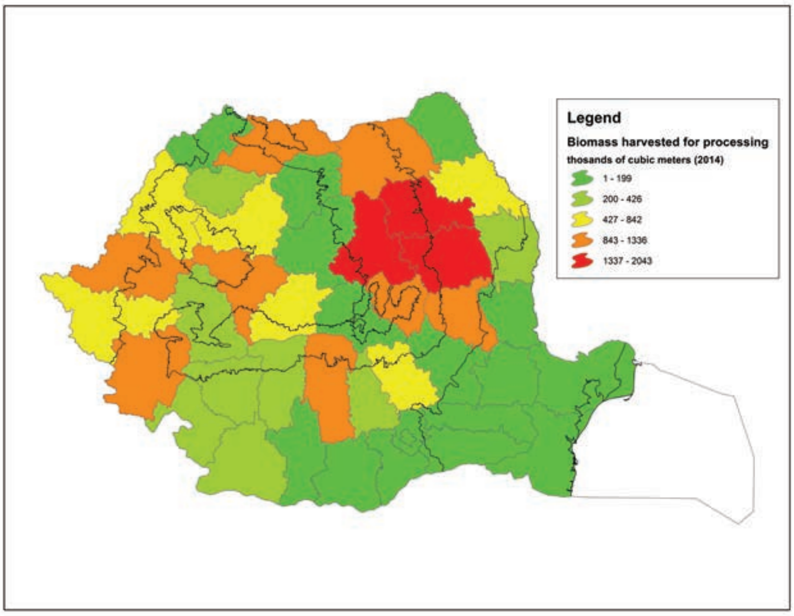
<table>
<tr><th>Indicator</th><th>Nutrition – Biomass – Wild plants and associated products</th></tr>
<tr><td>Number of people indirectly benefiting from work rewarding (gathering)</td><td>
</td></tr>
<tr><td>5. Value
Market value of non-wood products.
Market price of non-wood products (berries-kg).</td><td>
</td></tr>
</table>

Materials – Material fibers coming from plants

Indicator	*Materials – Material fibers coming from plants*
1. Structural *Area of the ecosystems expressed in hectares* Area of land covered by forest in Romania in 2014 has no significant changes compared to 2013. The biggest negative differences (in Olt, Argeș and Cluj counties) have not exceeded 5% and the positive ones (recorded in Brașov) have not exceeded 5%.	
Forest ecosystems distribution	

Indicator	*Materials – Material fibers coming from plants*
2. Functional – Forest area with ground level cuts 2000-2014 (ha)	
Areas with afforestation works (ha/year)	
3. Evaluation – *Wood volume quantity per ecosystem (cm) – information derived from the National Forestry Inventory using the forest ecosystems distribution.*	

<table>
<tr><th>Indicator</th><th>Materials – Material fibers coming from plants</th></tr>
<tr><td>Quantity of wood volume extracted directly or for processing from ground level cuts
(2000-2014) (cm)</td><td>
</td></tr>
<tr><td>Biomass quantity harvested / used directly for processing from other cuts (2013/2014/2015) (%)</td><td>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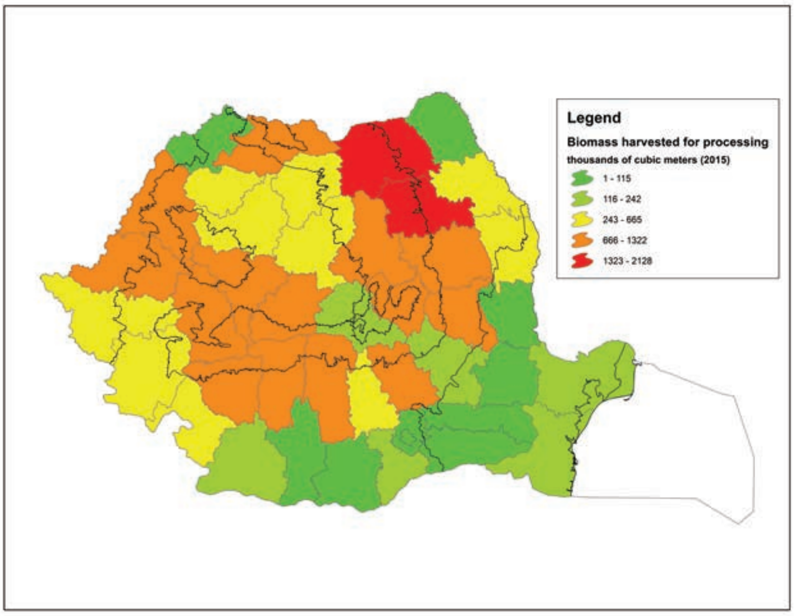
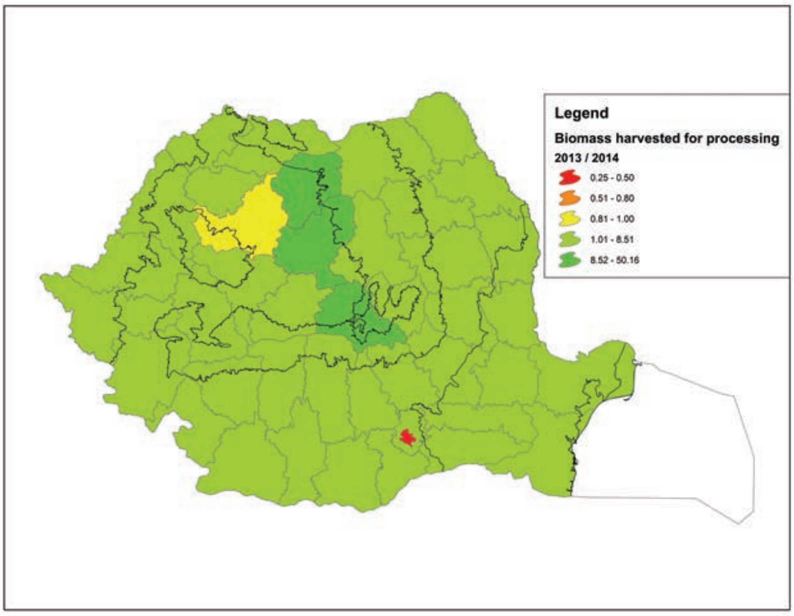
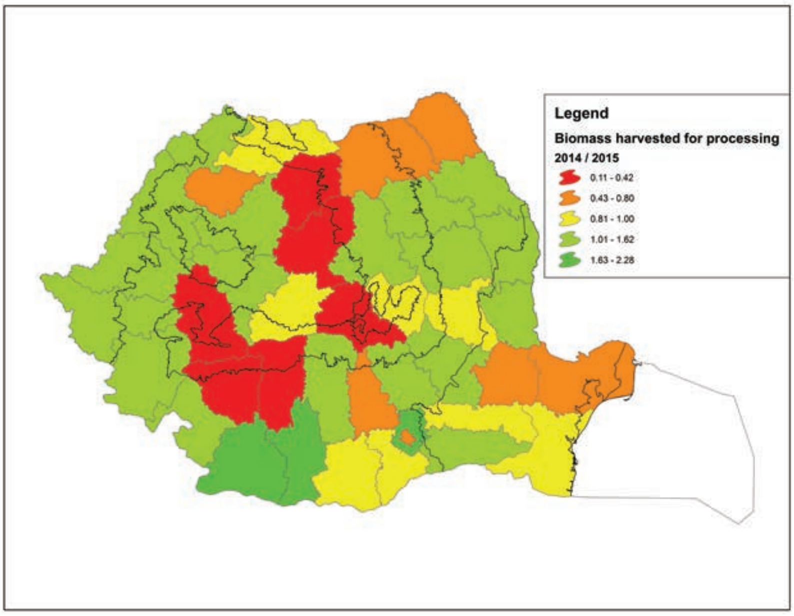
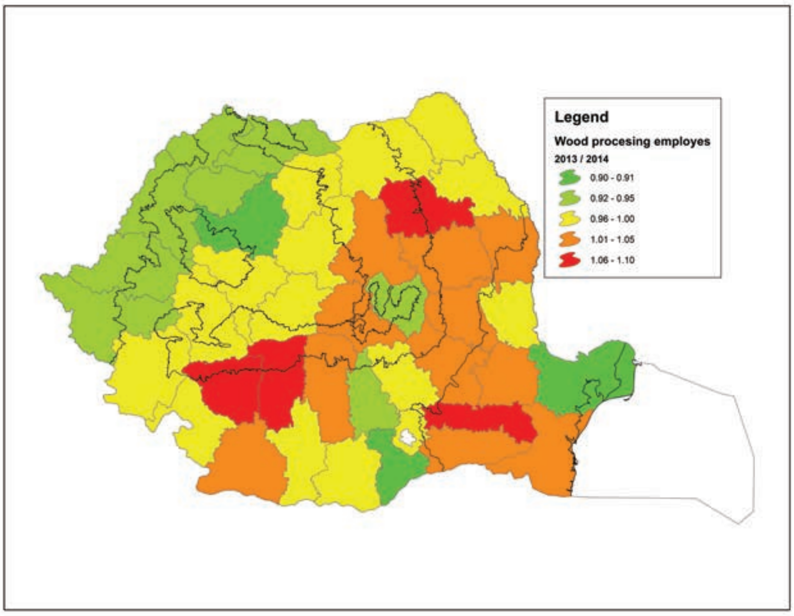
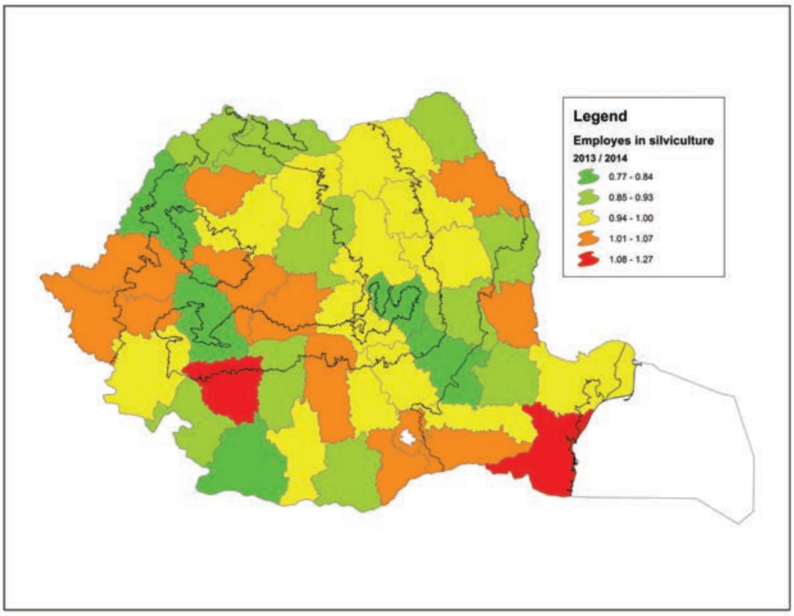
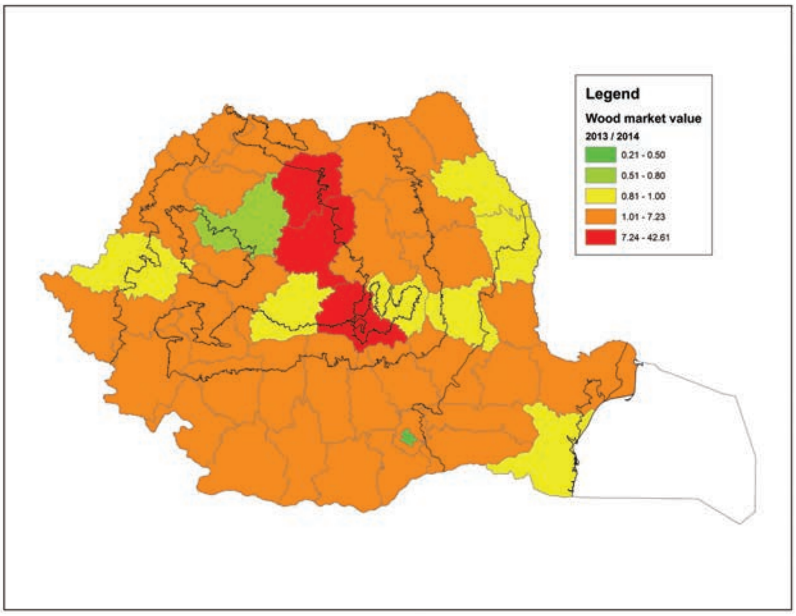
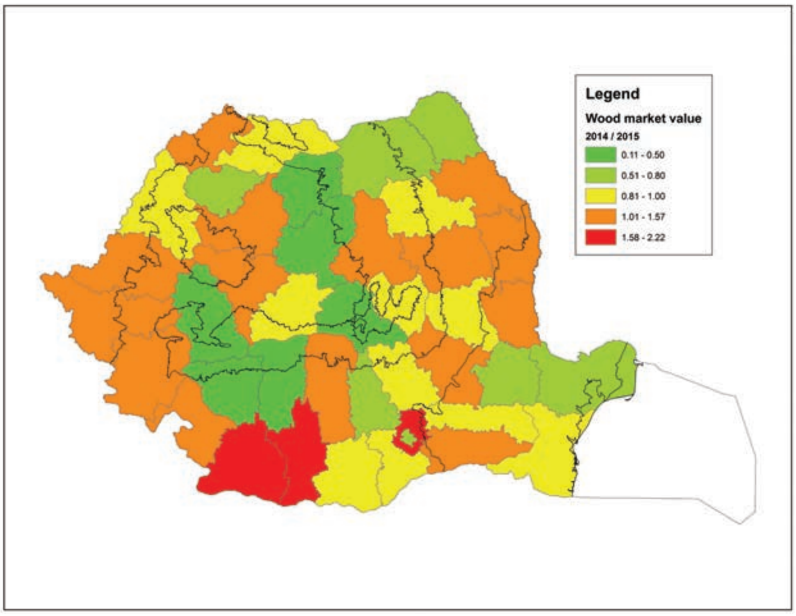
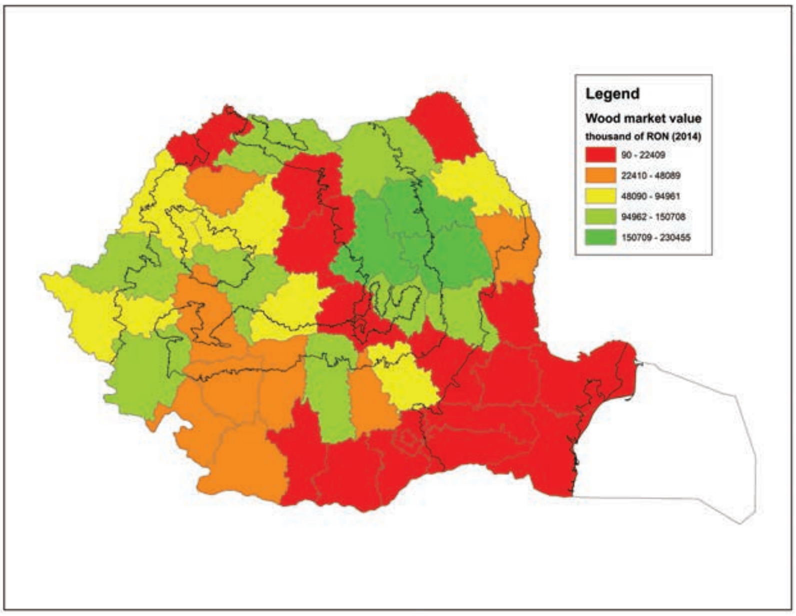
Indicator	***Materials – Material fibers coming from plants***





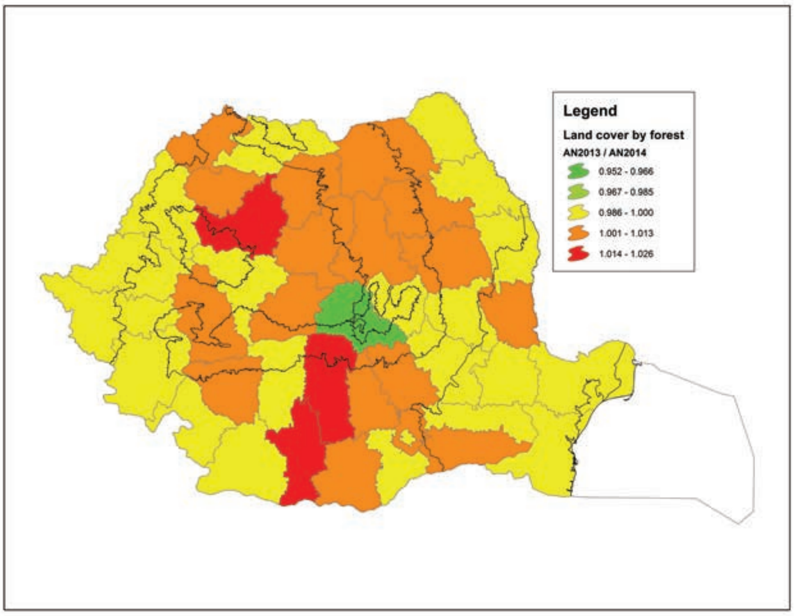
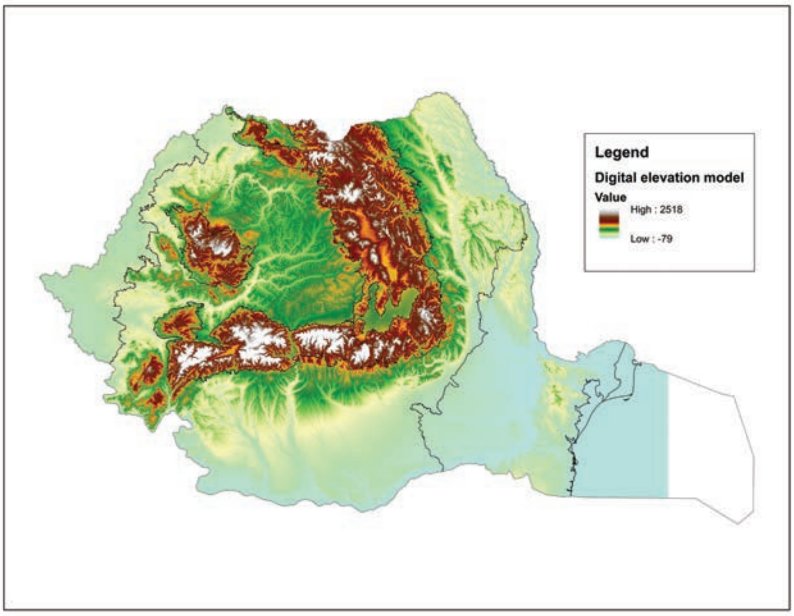


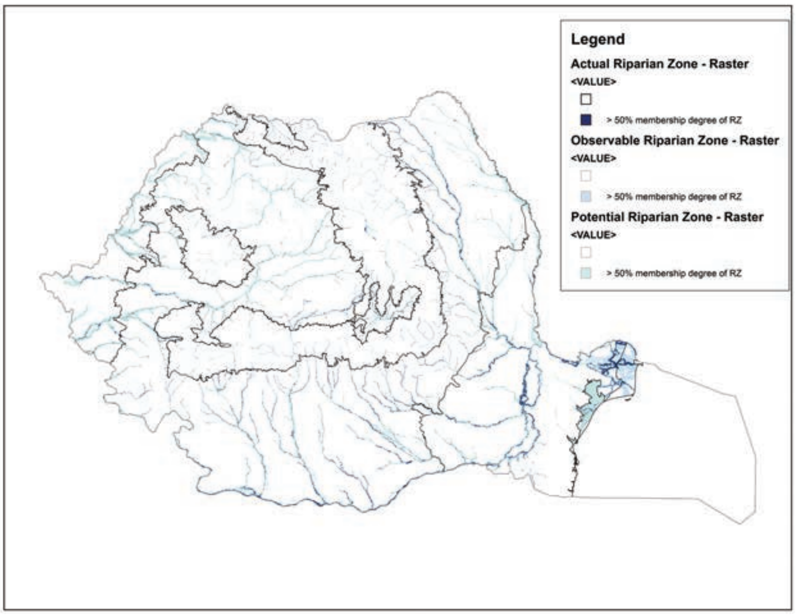
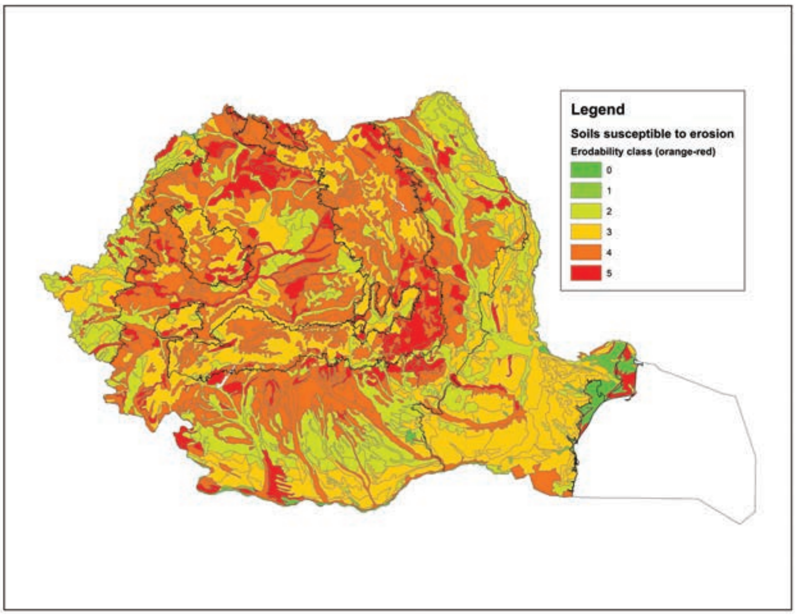
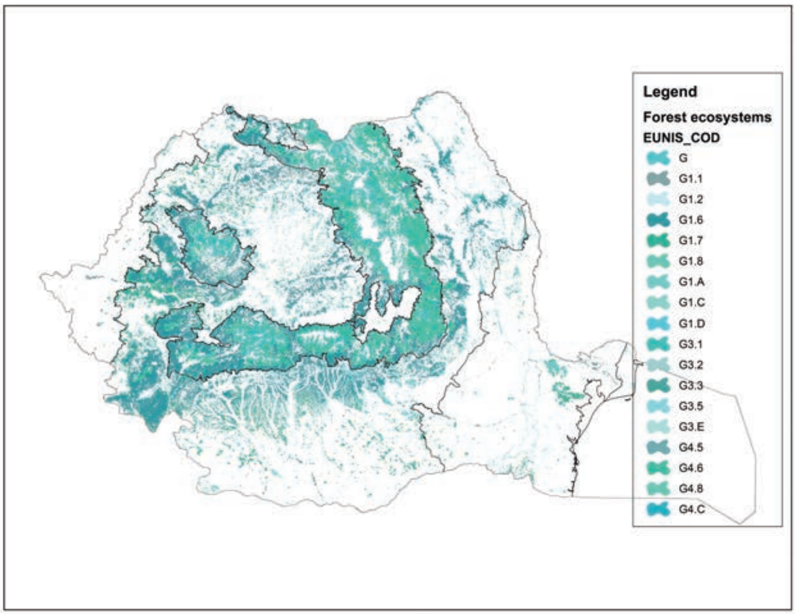
Indicator	*Materials – Material fibers coming from plants*
4. Benefit Number of people directly benefiting by resource using (people involved in wood products processing)	
Number of people hired in forestry. The human resource employed in the domains of agriculture, forestry and fishery has grown from 2013 to 2014 with up to 25% in some of the counties. Counties like Gorj or Constanta have accumulated losses up to 25%.	
5. Value *Wood market value* *(thousands of RON)*	

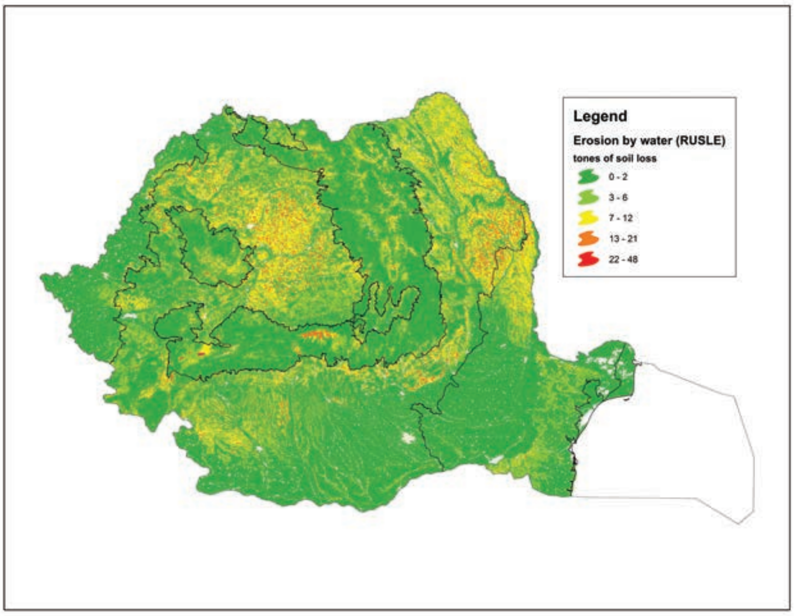
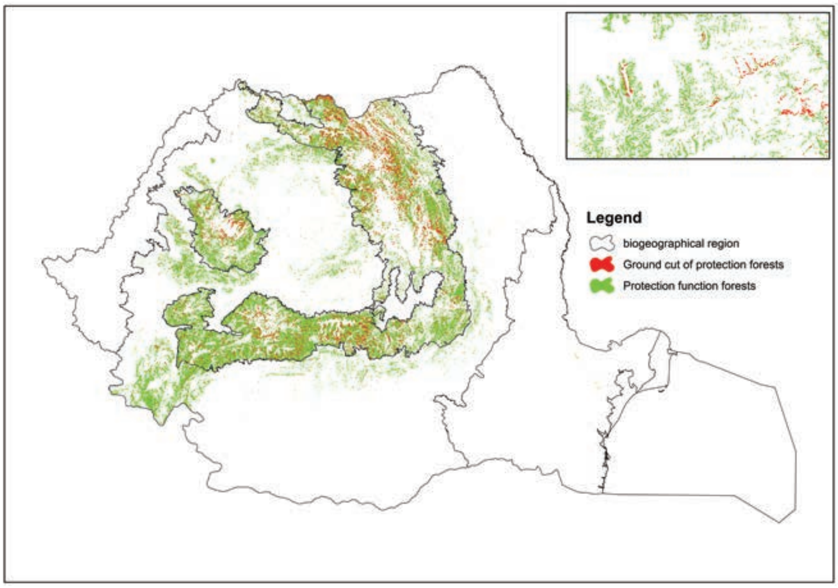
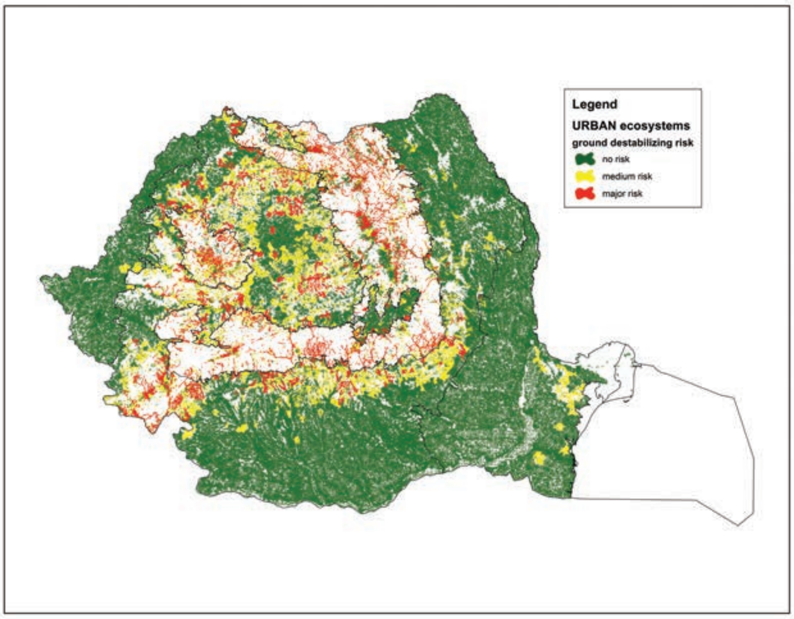
Indicator	*Materials – Material fibers coming from plants*
	 

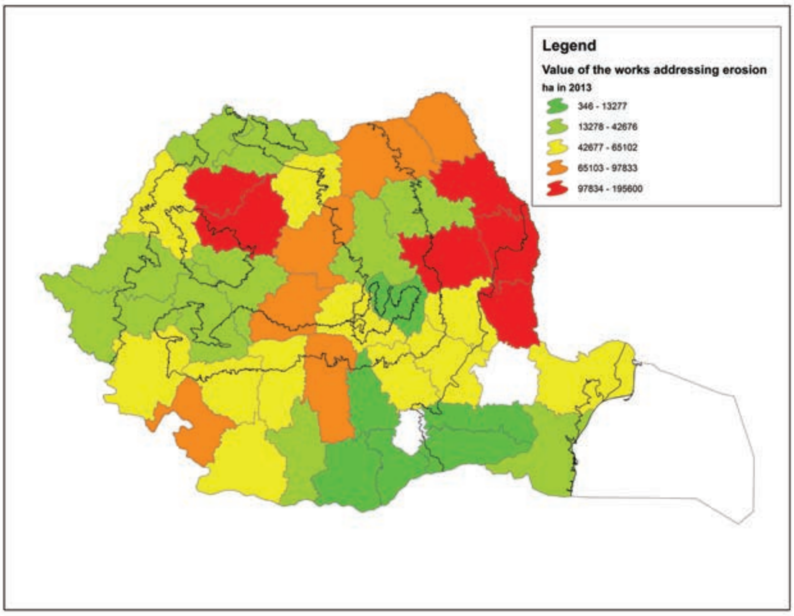
Regulating and maintenance services

Ground stabilizing and erosion control

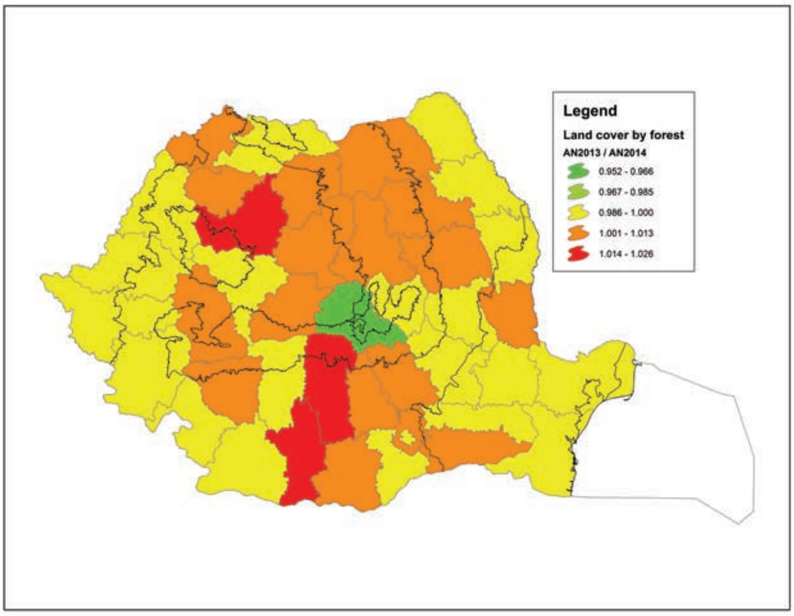
<table>
<tr><th>Indicator</th><th>Ground stabilizing and erosion control</th></tr>
<tr><td>1. Structural
Area of the ecosystems expressed in hectares
Area of land covered by forest in Romania in 2014 has no significant changes compared to 2013. The biggest negative differences (in Olt, Argeș and Cluj counties) have not exceeded 5% and the positive ones (recorded in Brașov) have not exceeded 5%.</td><td>
</td></tr>
<tr><td>Digital Elevation Model
Using the Digital Elevation Model to identify the areas with high risk of erosion, areas where the erosion control service has a significant impact over the population exposed to the risk</td><td>
</td></tr>
</table>

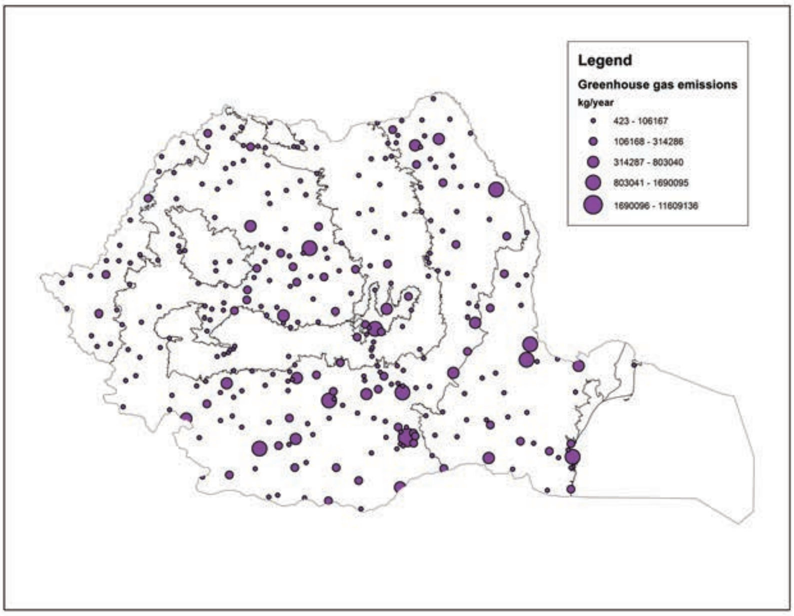
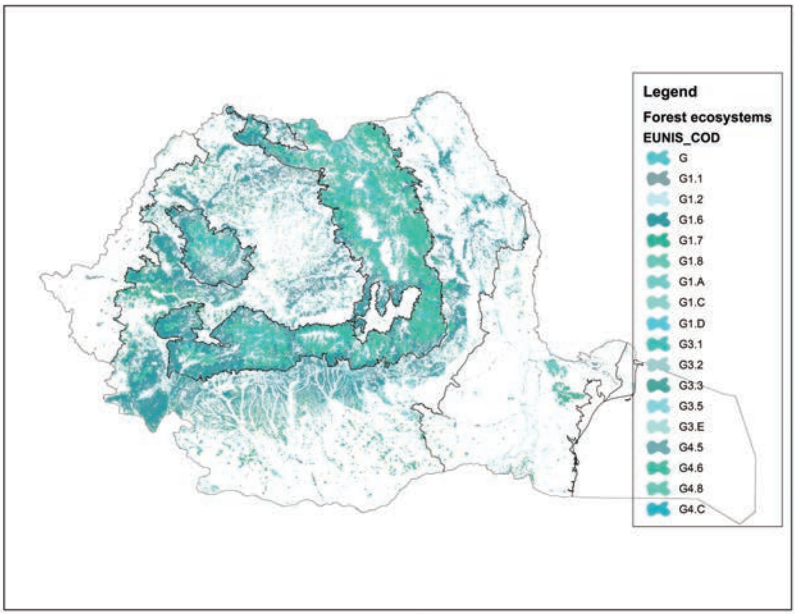
Indicator	*Ground stabilizing and erosion control*
Distribution of areas with flood risk	
Soils map *Indicates the areas with soils susceptible to erosion*	
2. Functional – *Density / type of forest* This indicator allows the visualization of the water retention potential and the reduction of the effects caused by torrents / floods	

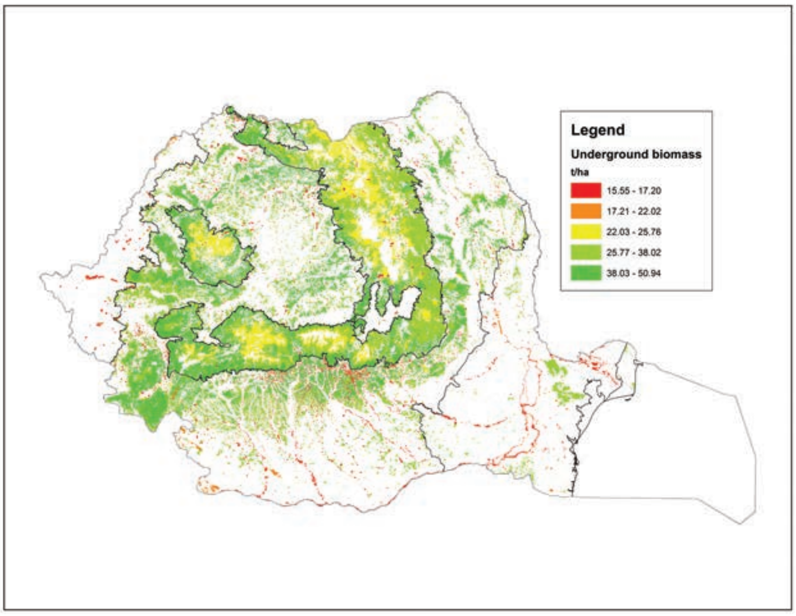
<table>
<tr><th>Indicator</th><th>Ground stabilizing and erosion control</th></tr>
<tr><td>3. Evaluation –
Map of erosion intensity (RUSLE)
Indicator allowing to visualize the areas where the erosion control service has the highest values</td><td>
</td></tr>
<tr><td>Map of forest ecosystems having a protection role in stabilizing the ground</td><td>
</td></tr>
<tr><td>4. Benefit
Number of people directly benefiting from minimizing the impact of the ground destabilizing processes.
Localities situated less than 500 m from forests with ground stabilizing role. The major risk is represented by forests with protection role being affected by ground level cuts.</td><td>
</td></tr>
</table>

Indicator	*Ground stabilizing and erosion control*
Value *The value of the works addressing erosion.* The map indicates the areas where the erosion control is done by specific works. One can observe the highest values in the Central Plateau of Moldavia and the Transilvanian Depression, as well as the Argeș, Mehedinți and Suceava Counties, all of them having a high rate of erosion. The costs of the works correspond to the ecosistemic service of erosion control.	

Global climate regulation by reducing the greenhouse gas emissions

Indicator	*Global climate regulation by reducing the greenhouse gas emissions*
1. Structural *Area of the ecosystems expressed in hectares* Area of land covered by forest in Romania in 2014 has no significant changes compared to 2013. The biggest negative differences (in Olt, Argeș and Cluj counties) have not exceeded 5% and the positive ones (recorded in Brașov) have not exceeded 5%.	

<table>
<tr><th>Indicator</th><th>Global climate regulation by reducing the greenhouse gas emissions</th></tr>
<tr><td>Greenhouse gas emissions</td><td>
</td></tr>
<tr><td>2. Functional –
Forest types
This indicator allows the visualization of the potential of carbon sequestration by biomass at ecosystem level</td><td>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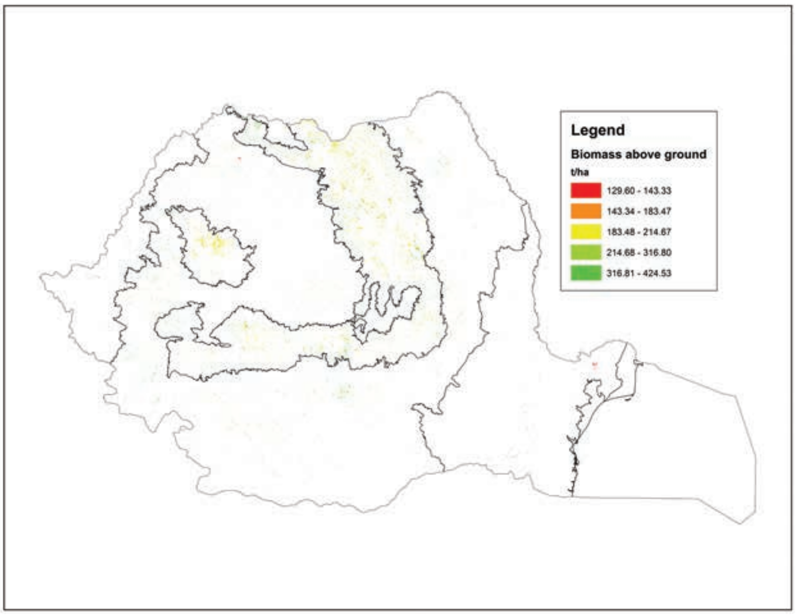
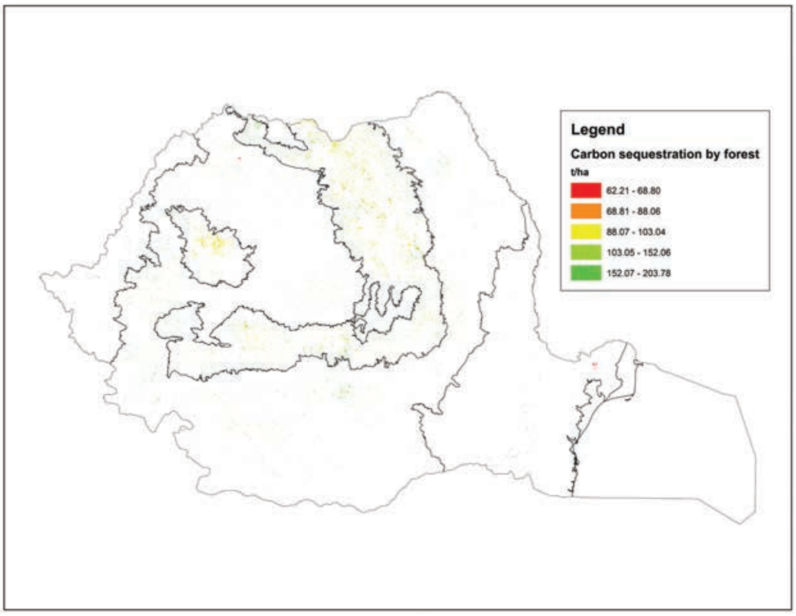
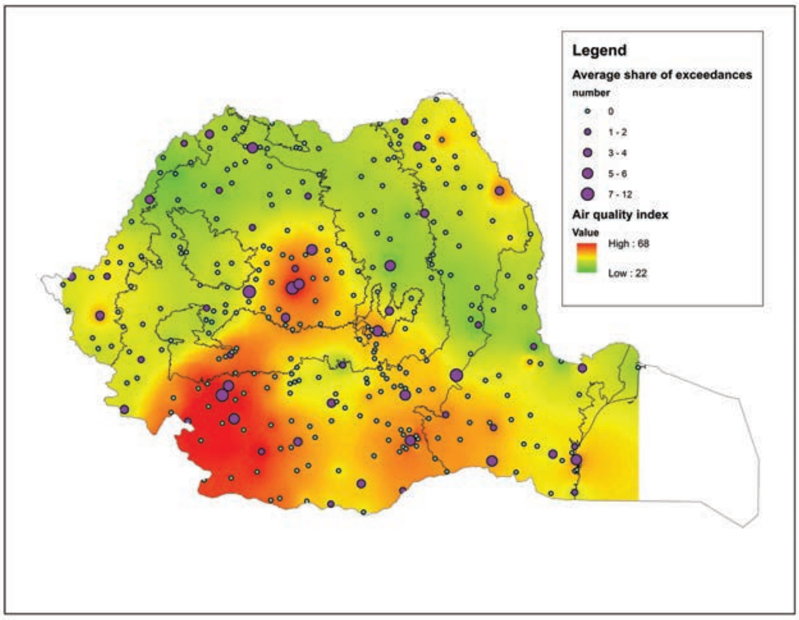
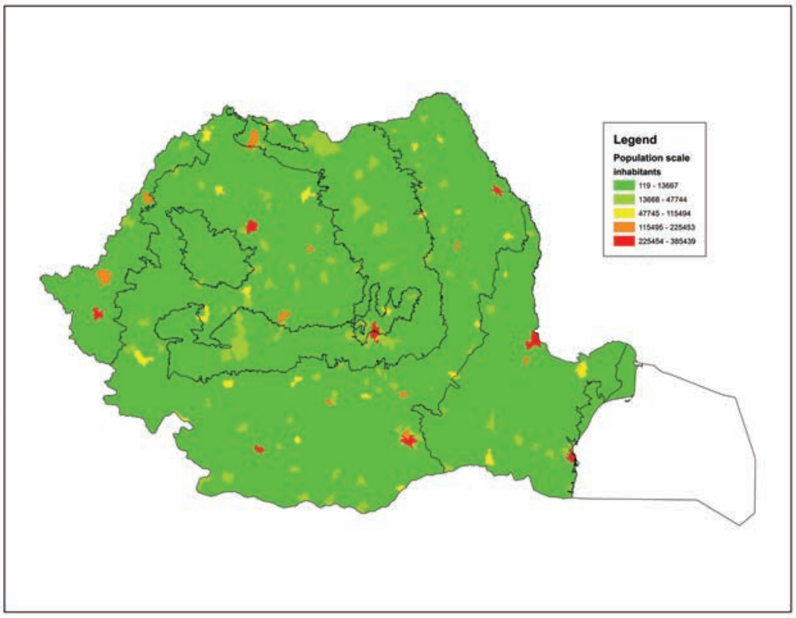
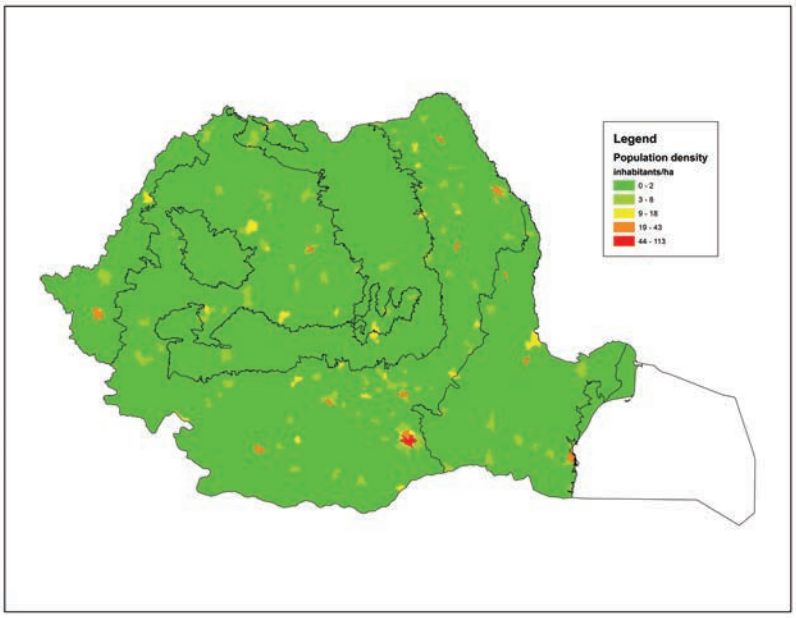
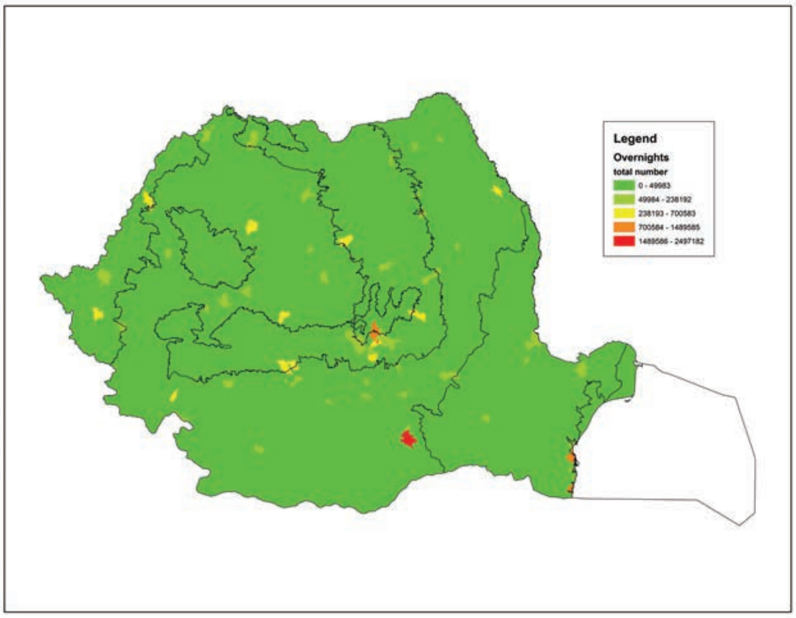
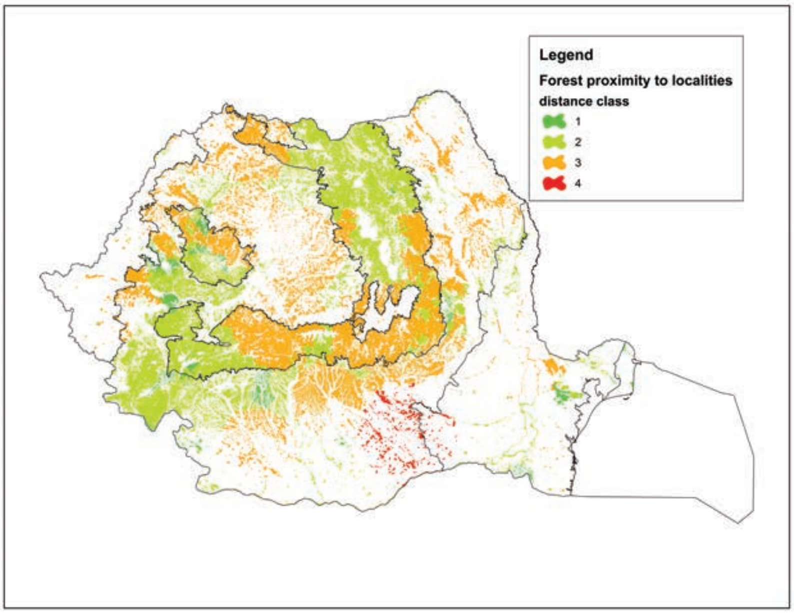
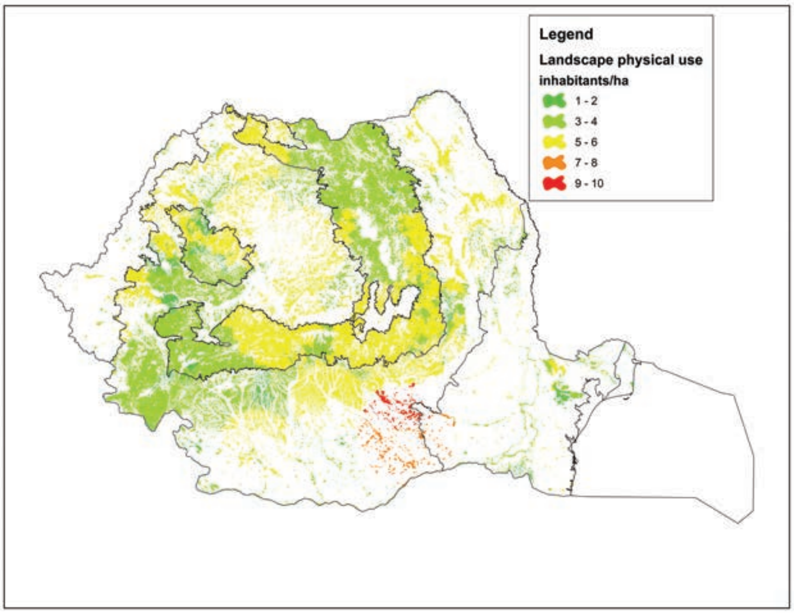
</table>

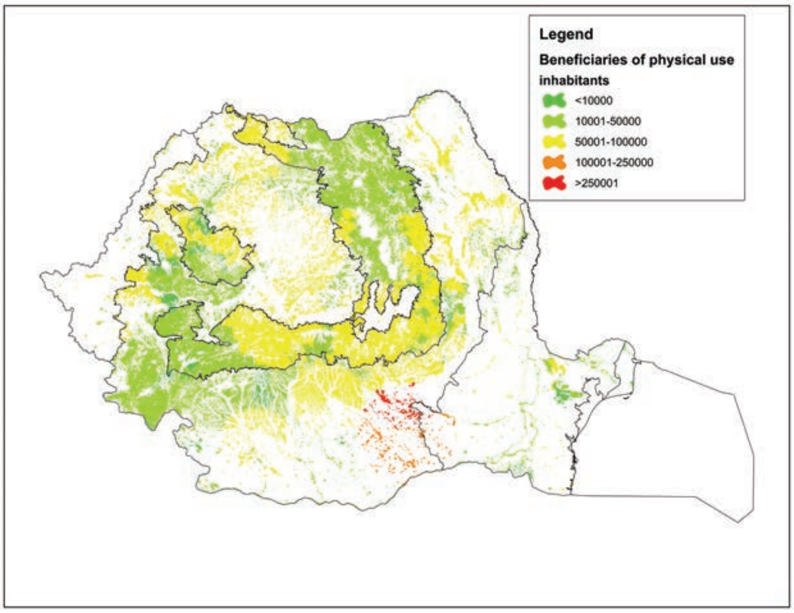
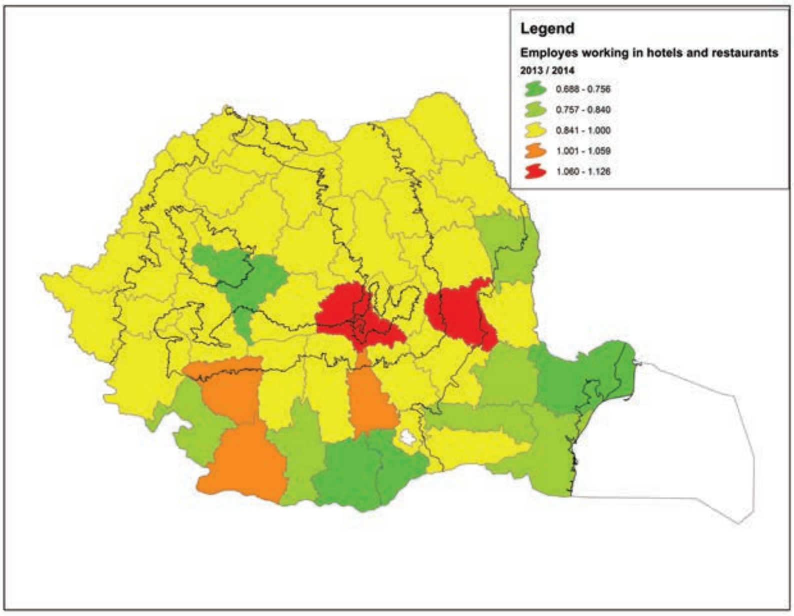
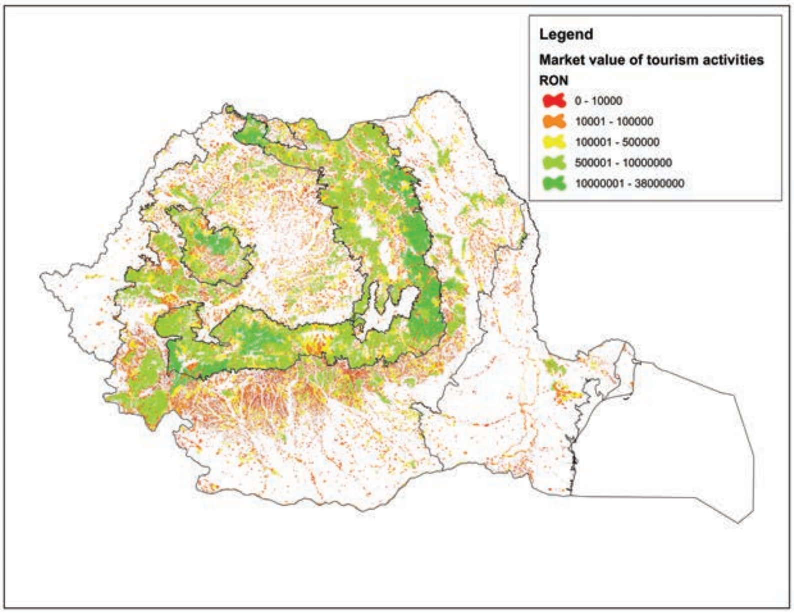
Indicator	***Global climate regulation by reducing the greenhouse gas emissions***
	
3. Evaluation – *Carbon sequestration quantity by forest ecosystems* Indicator allowing the visualization of areas with a higher level of carbon sequestration	
4. Benefit *Maintaining air quality* Air quality index shows the potential of maintaining the air quality and it may also flag high values at national level	

Cultural services

The physical use of the landscape in different natural environments

<table>
<tr><th>Indicator</th><th>The physical use of the landscape indifferent natural environments</th></tr>
<tr><td>1. Structural
Population scale</td><td>
</td></tr>
<tr><td>Population density</td><td>
</td></tr>
</table>

<table>
<tr><th>Indicator</th><th>The physical use of the landscape indifferent natural environments</th></tr>
<tr><td>Overnights</td><td>
</td></tr>
<tr><td>2. Functional –
Forest proximity to localities</td><td>
</td></tr>
<tr><td>3. Evaluation –
Areas of forest ecosystems with landscape physical use potential.</td><td>
</td></tr>
</table>

Indicator	The physical use of the landscape indifferent natural environments
4. Benefit Number of people benefiting from the physical use of the landscape	
Number of people indirectly benefiting from the physical use of the landscape	
5. Value *Market value of tourism activities for physical use of the landscape in the forest ecosystems.*	

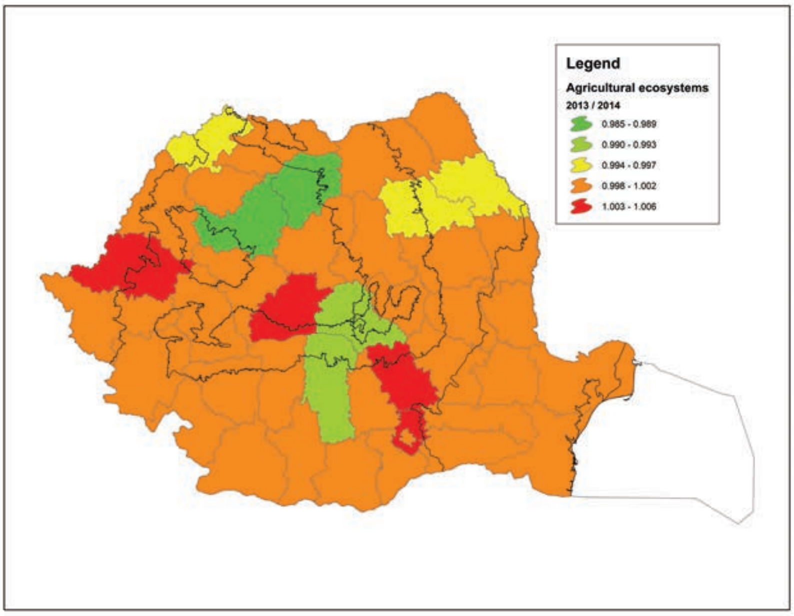
Agricultural ecosystems

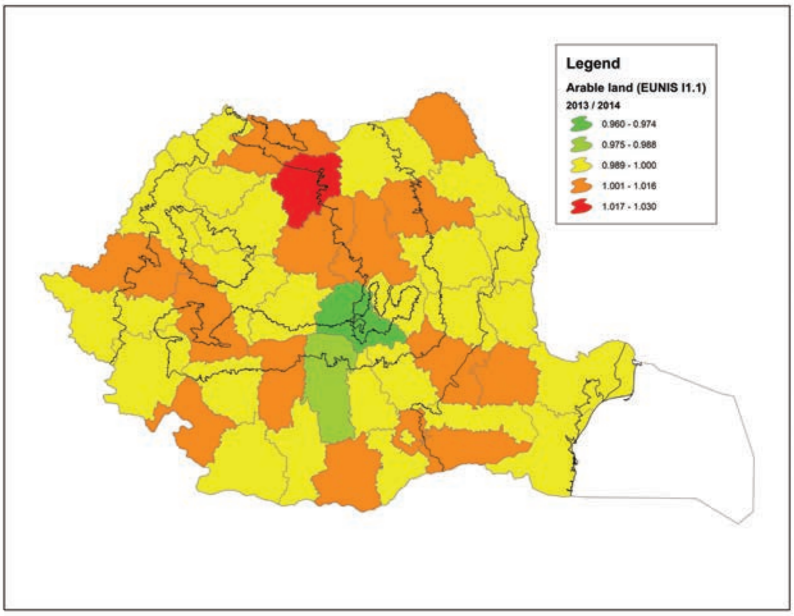
Provisioning services

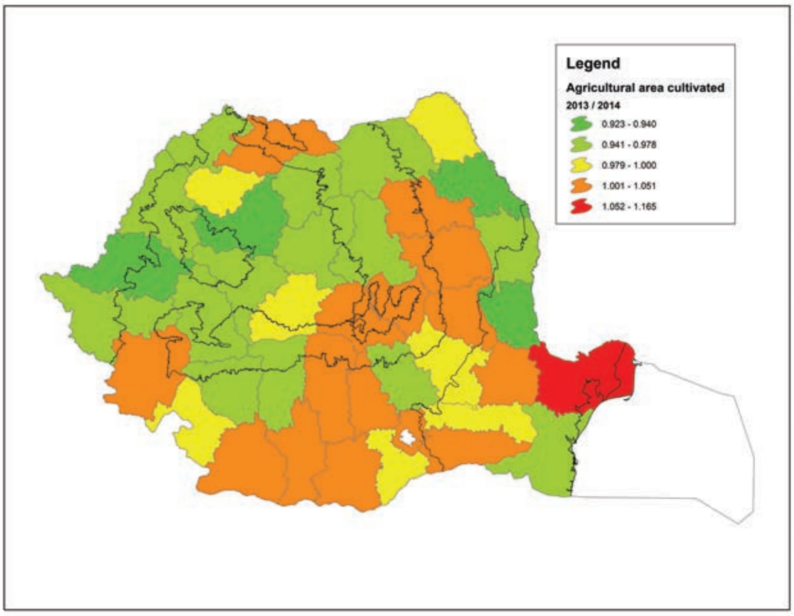
Nutrition – agricultural crops

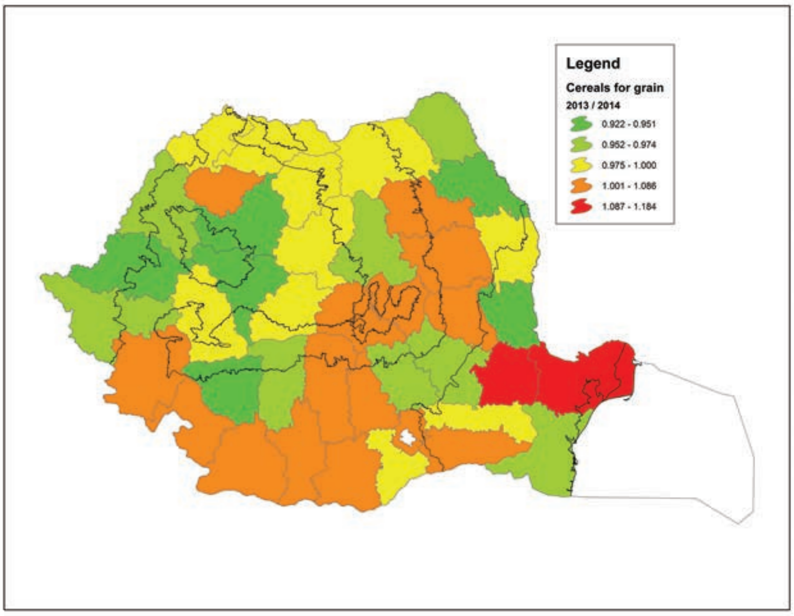
<table>
<tr><th>Indicator</th><th>Nutrition – Agricultural crops</th></tr>
<tr><td>1. Structural

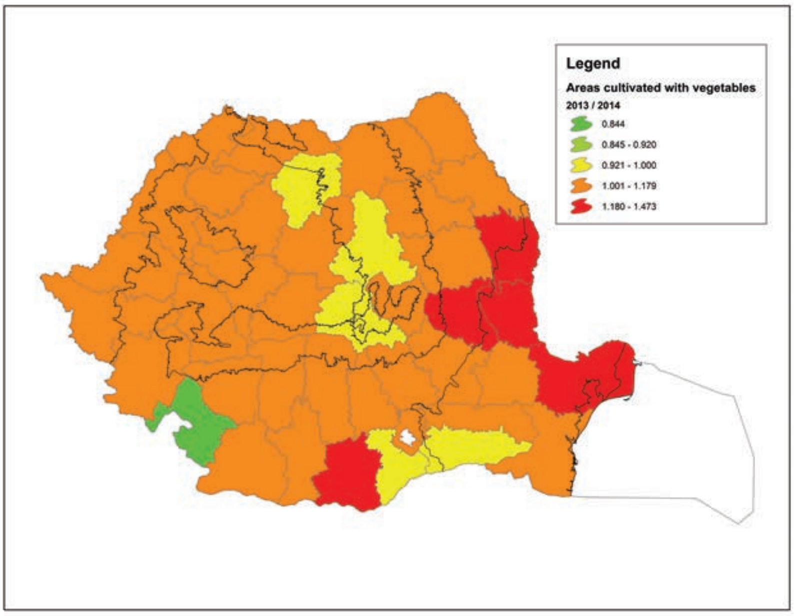
Agricultural ecosystems surface (ha)

It is to be noticed a low decrease in most of the counties and a growth with 1-2.5% in Cluj and Bistrița-Năsăud.</td><td>
</td></tr>
<tr><td>Agricultural ecosystems area – I1.1 Type (Ha)

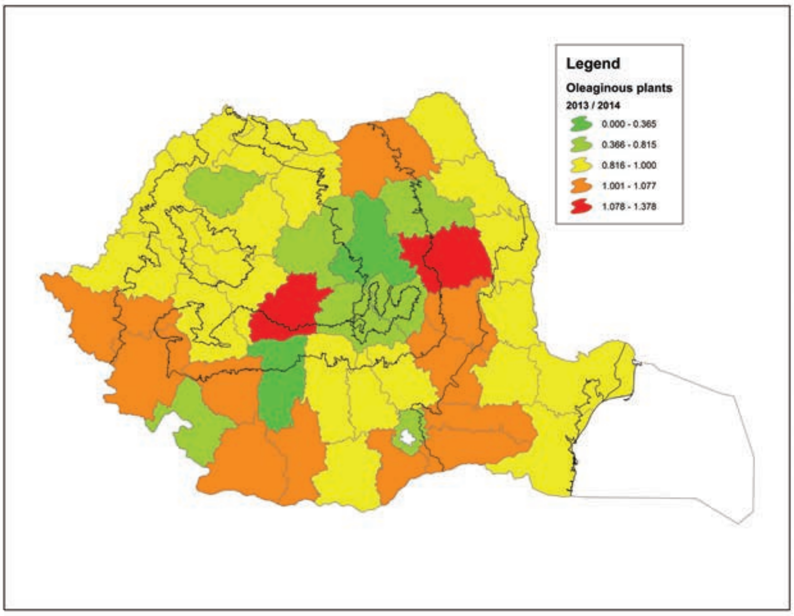
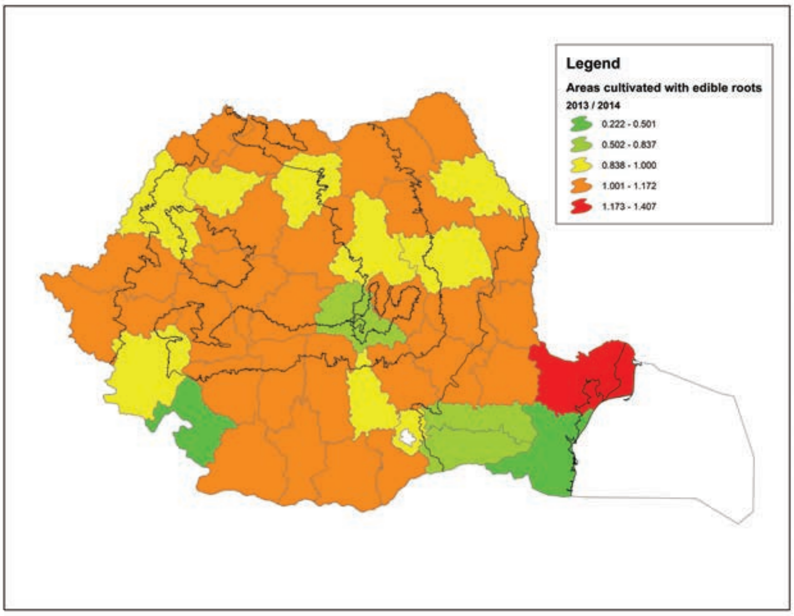
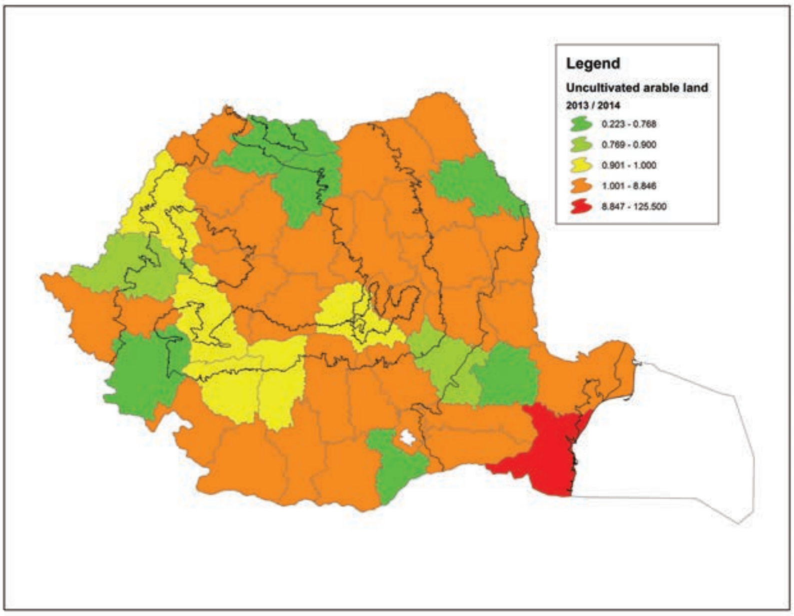
The ecosystems of type I1.1 having a significant weight of approx. 90% from the agricultural ecosystems have a relatively constant use level (yellow) in most of the counties.</td><td>
</td></tr>
</table>

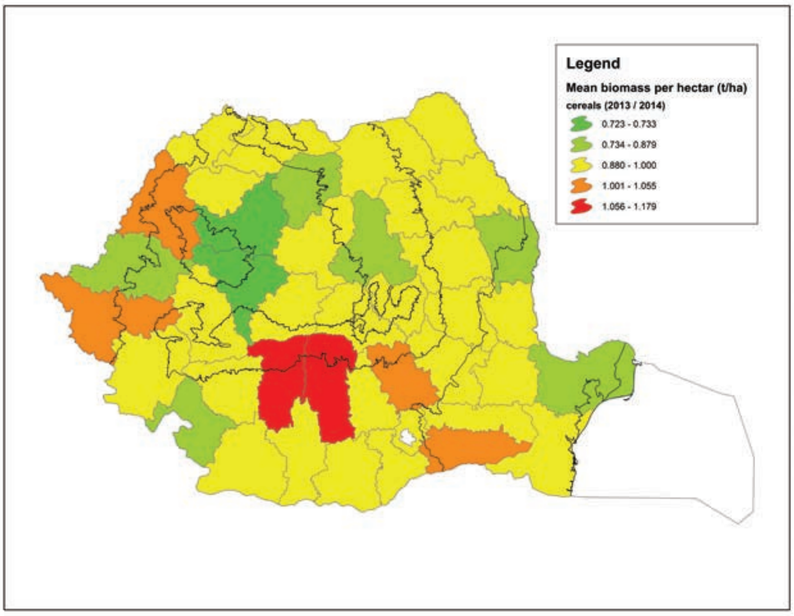
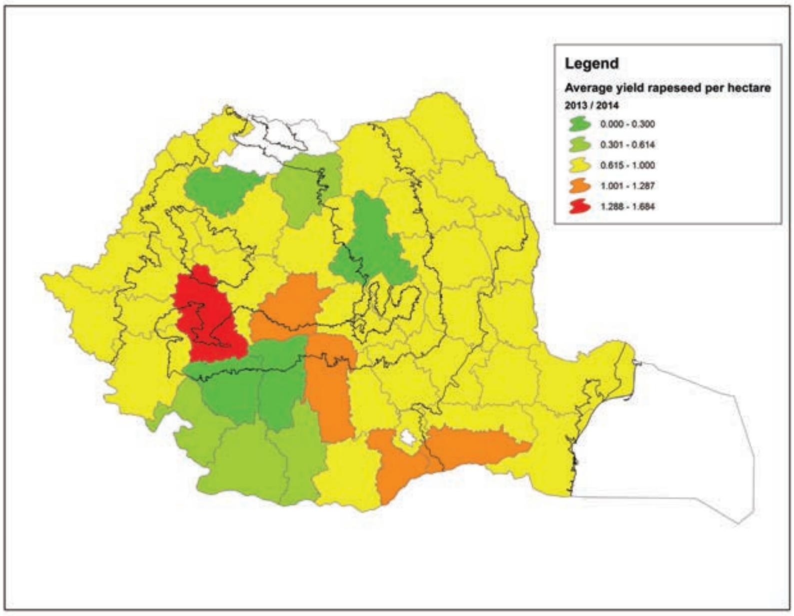
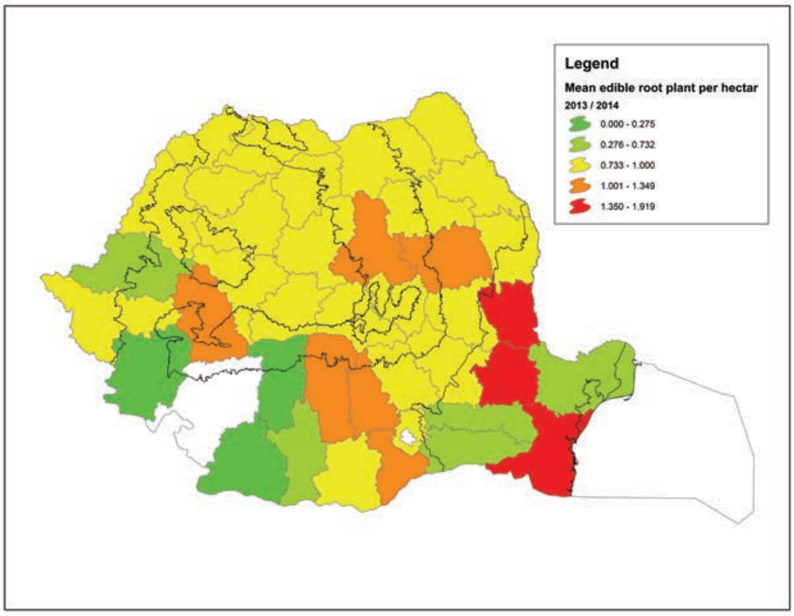
<table>
<tr><th>Indicator</th><th>Nutrition – Agricultural crops</th></tr>
<tr><td>The national trend is to maintain the areas cultivate in 2014 close to the ones cultivated in 2013, with some growth in Transilvania and some small loses in the southern part of the country. The county with the highest losses in what concerns the use of agricultural ecosystems is Tulcea for 2013 – 2014.</td><td>


</td></tr>
<tr><td>Areas cultivated with cereals for grains</td><td>


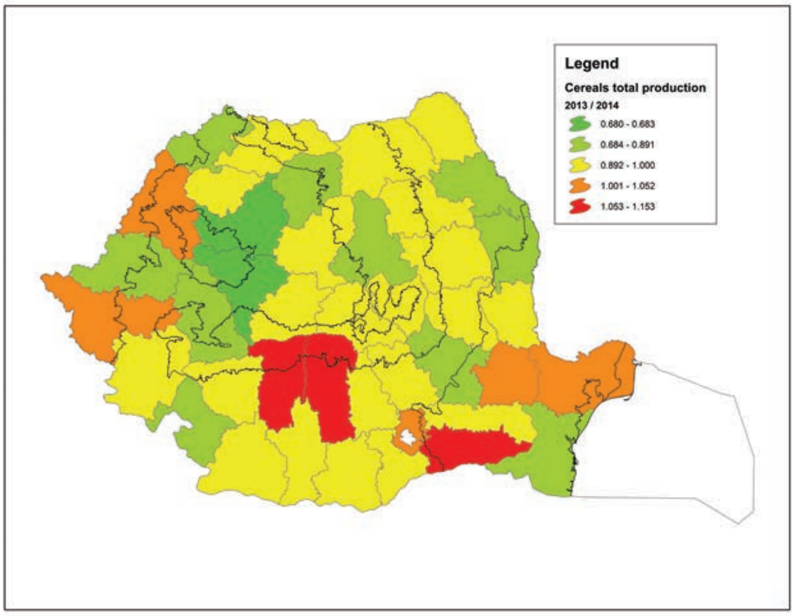
</td></tr>
<tr><td>Areas cultivated with vegetables</td><td>


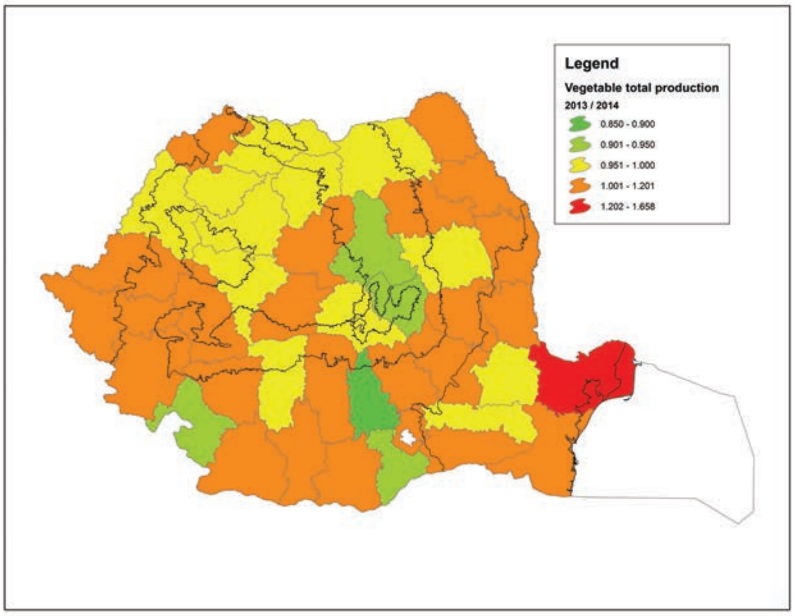
</td></tr>
</table>

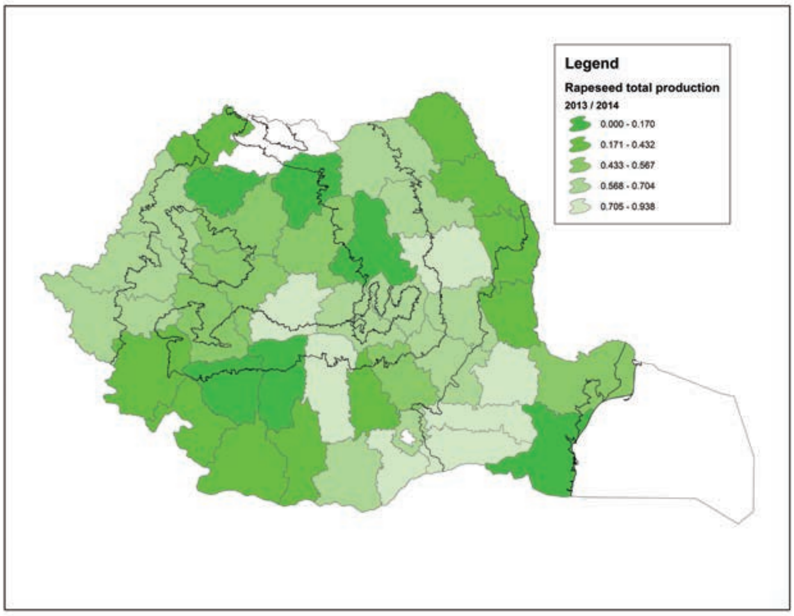
<table>
<tr><th>Indicator</th><th>Nutrition – Agricultural crops</th></tr>
<tr><td>Areas cultivated with oleaginous plants</td><td>
</td></tr>
<tr><td>Areas cultivated with edible roots</td><td>
</td></tr>
<tr><td>Uncultivated arable land (orange – red) shows a massive loss at 2014 level (compared to 2013).</td><td>
</td></tr>
</table>

<table>
<tr><th>Indicator</th><th>Nutrition – Agricultural crops</th></tr>
<tr><td>2. Functional –Mean biomass per hectare (t/ha)
Mean grain cereal production per hectare shows the maintaining of the capacity (predominant yellow)</td><td>
</td></tr>
<tr><td>Mean oleaginous plants production per hectare is maintaining (predominant yellow)</td><td>
</td></tr>
<tr><td>Mean edible root plant production is also maintaining (predominant yellow)</td><td>
</td></tr>
</table>

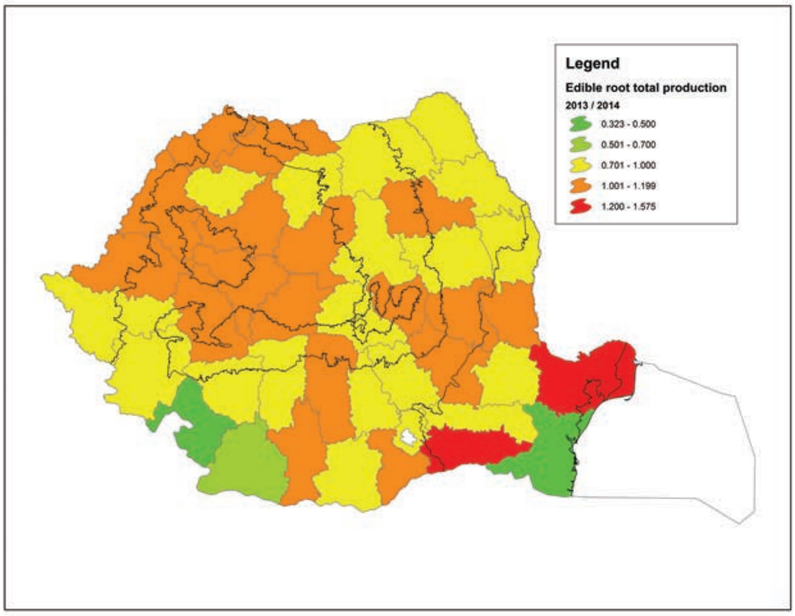
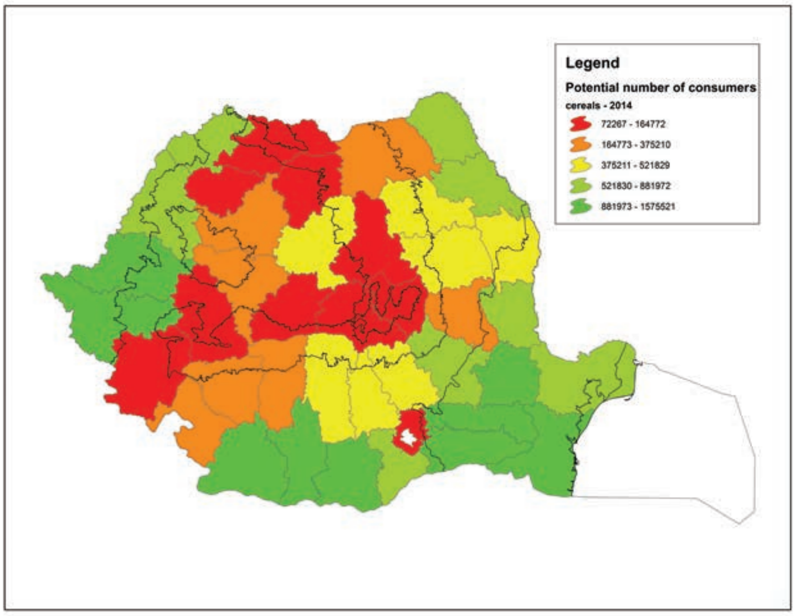
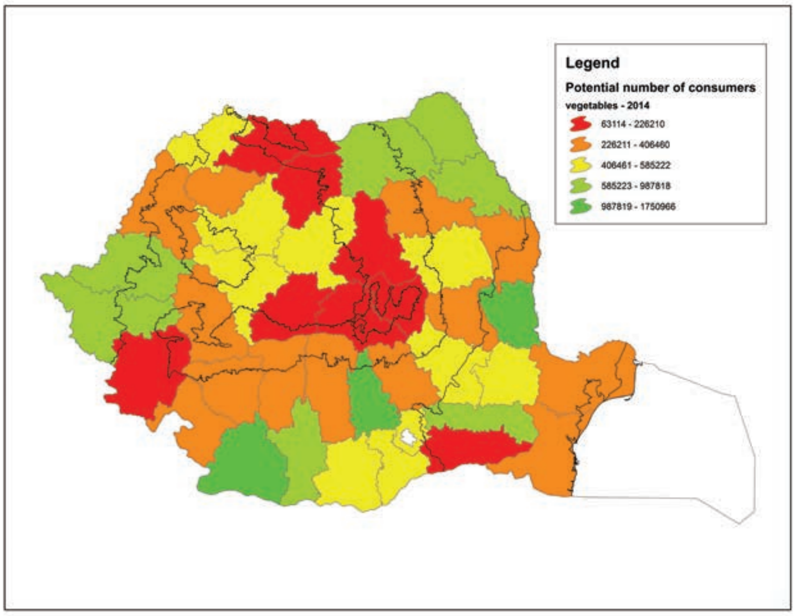
<table>
<tr><th>Indicator</th><th>Nutrition – Agricultural crops</th></tr>
<tr><td>3. Evaluation –Quantities of agricultural products (t)

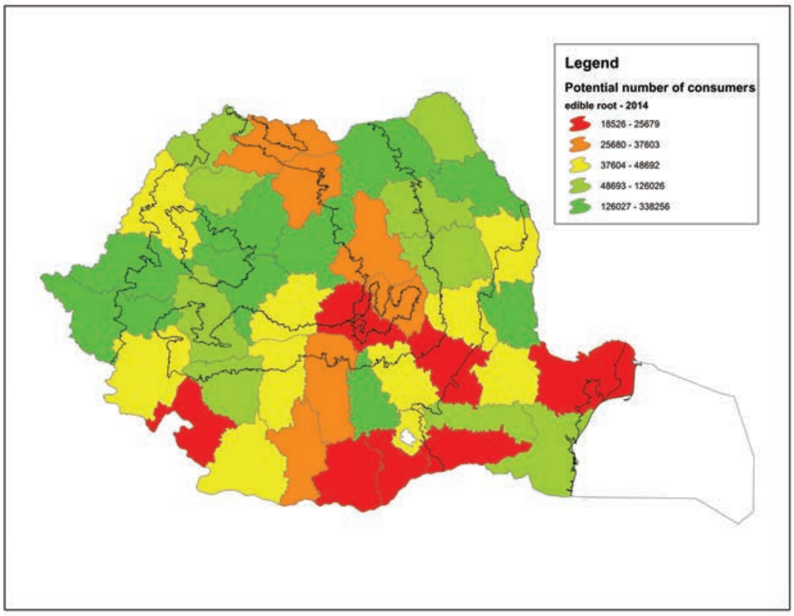
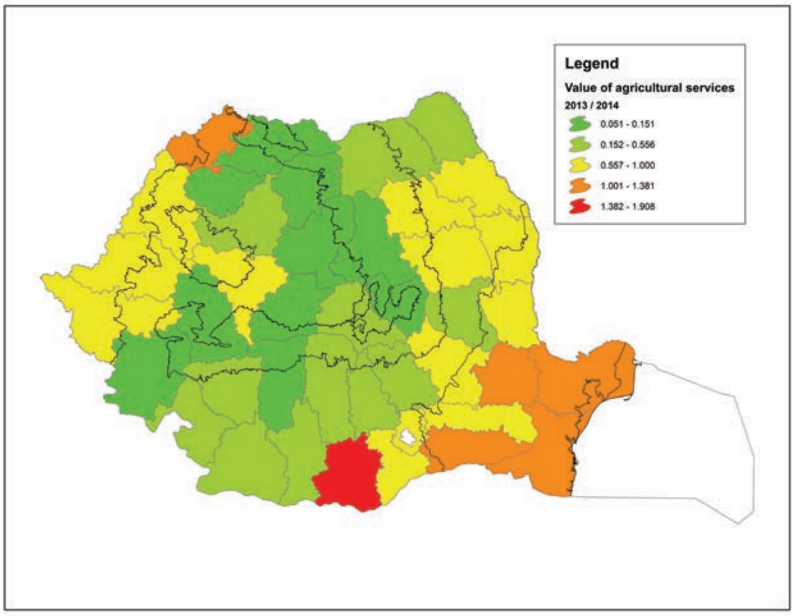
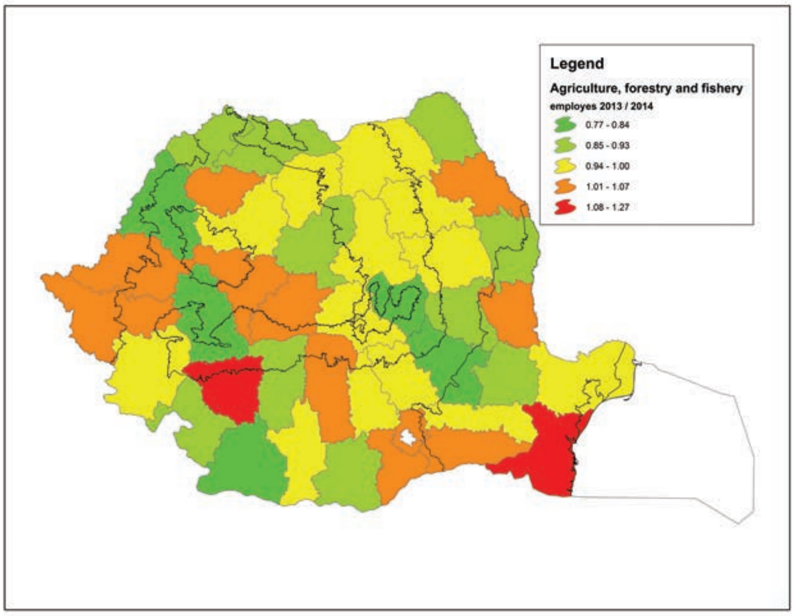
In what concerns the quantities of wheat products, the national trend respects the trend of mean production per hectare, with exceptions in Arad and Bihor counties which have recorded a higher efficiency per hectare.</td><td>


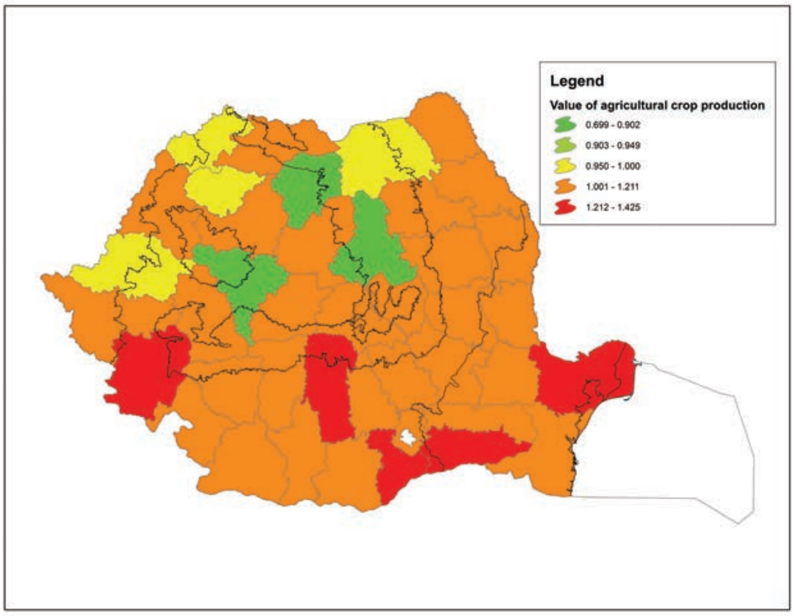
</td></tr>
<tr><td>Overall vegetable production is decreasing in most of the counties (orange)</td><td>


</td></tr>
<tr><td>Overall colza production increased at national level.</td><td>


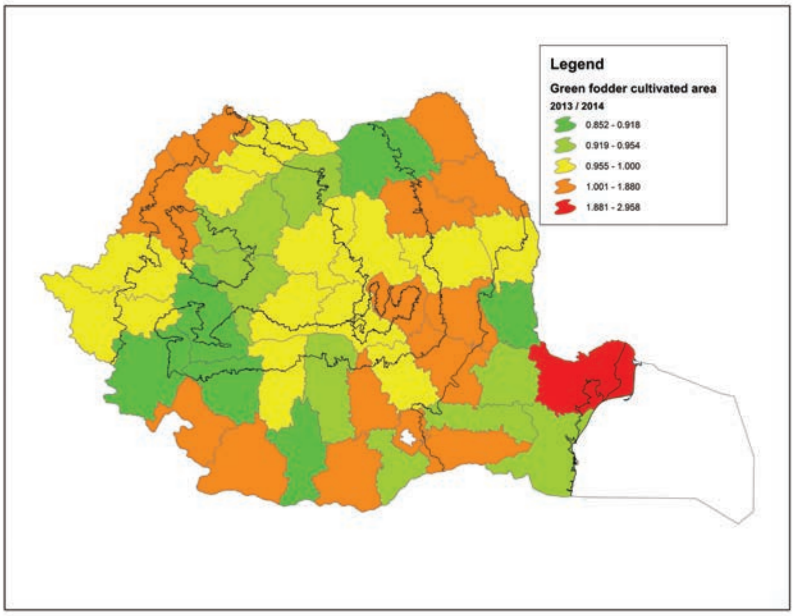
</td></tr>
</table>

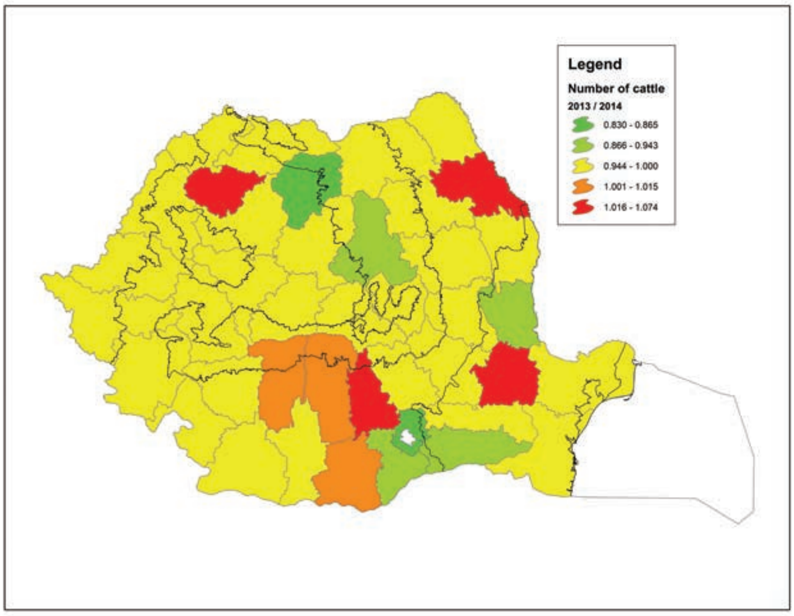
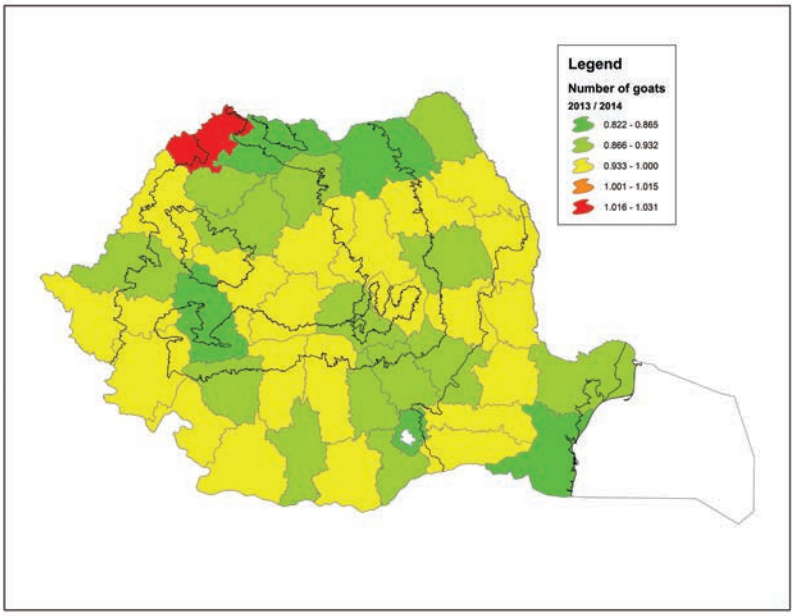
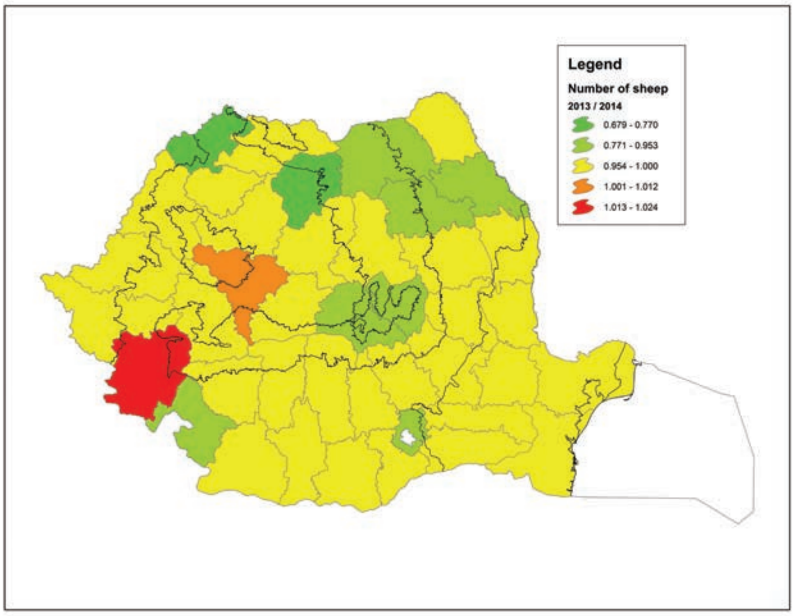
Indicator	Nutrition – Agricultural crops
Overall edible roots production.	
4. Benefit *Number of people benefiting from agricultural crops as food resource* Nutritional benefit of the agricultural crops like grains.	
Nutritional benefit of vegetable crops.	

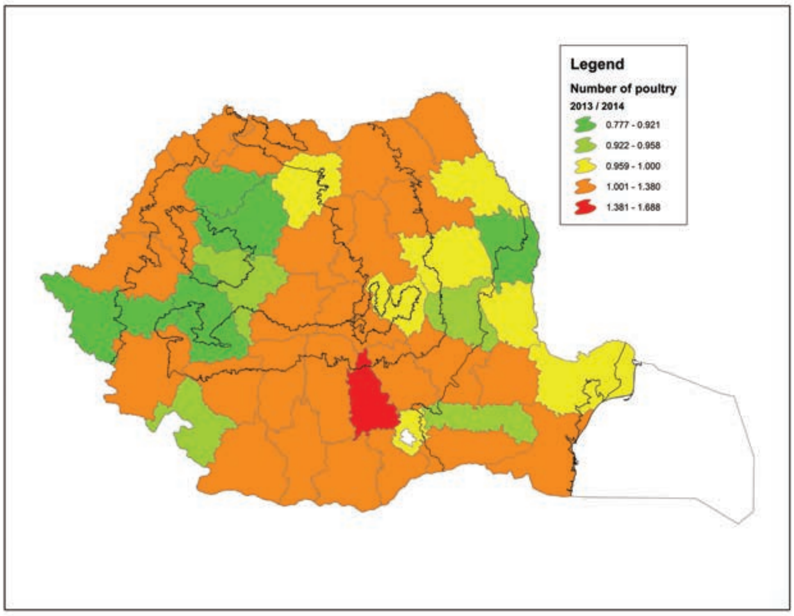
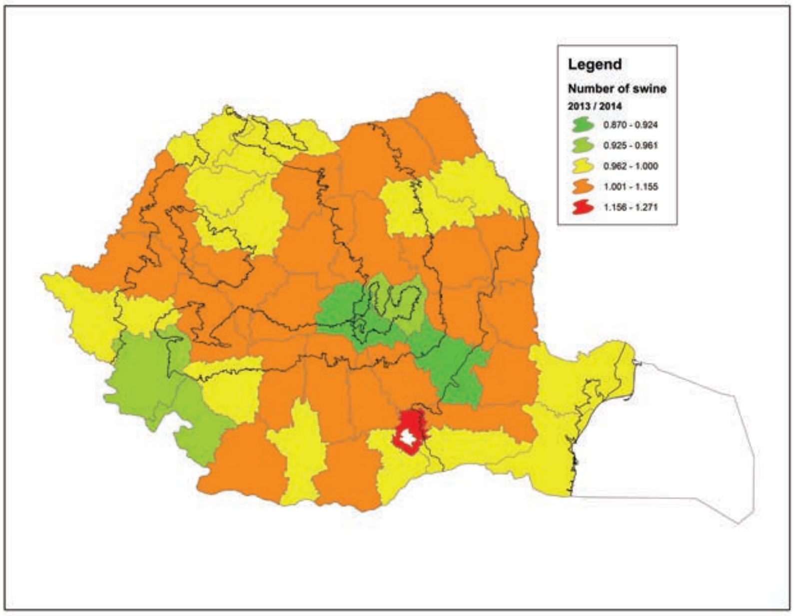
<table>
<tr><th>Indicator</th><th>Nutrition – Agricultural crops</th></tr>
<tr><td>Nutritional benefit of agricultural crops (edible roots).</td><td>
</td></tr>
<tr><td>Value of agricultural services
The benefit may be interpreted as the number of persons having direct benefits from the agricultural activities. The value of the agricultural services is an indicator which underlines the availability of jobs in the agricultural sector in an indirect way. One may notice a growth in the demand for agricultural services in the norther, center and southern part of the country, with an exception in Teleorman county.</td><td>
</td></tr>
<tr><td>Number of employees according to CAEN 2 – agriculture, forestry and fishery</td><td>
</td></tr>
</table>

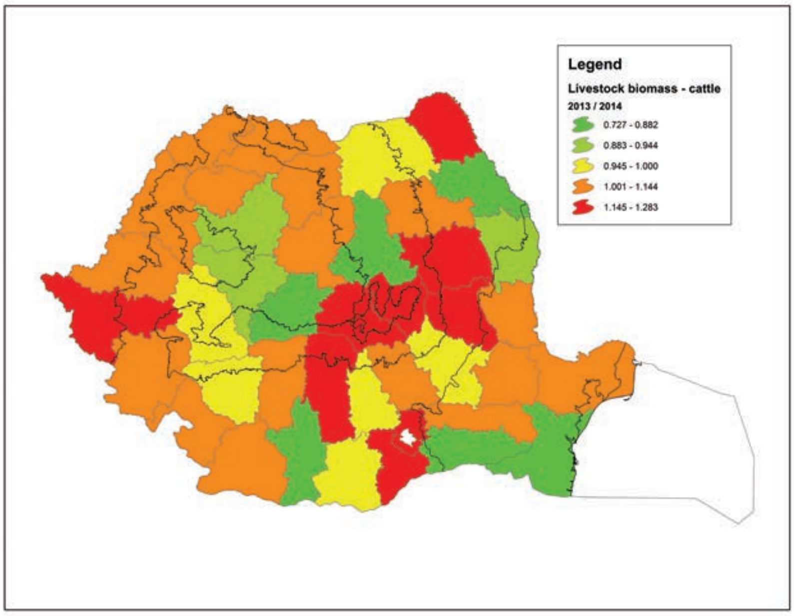
Indicator	Nutrition – Agricultural crops
5. Value *Value of the vegetal production* The value of the vegetal production, after the decrease of the costs for the establishment and maintenance of agricultural crops, has decreased also at national level from 2013 to 2014, with exceptions in the Hunedoara, Harghita and Bistrița-Năsăud Counties which have recorded growth of the associated vegetal production values.	

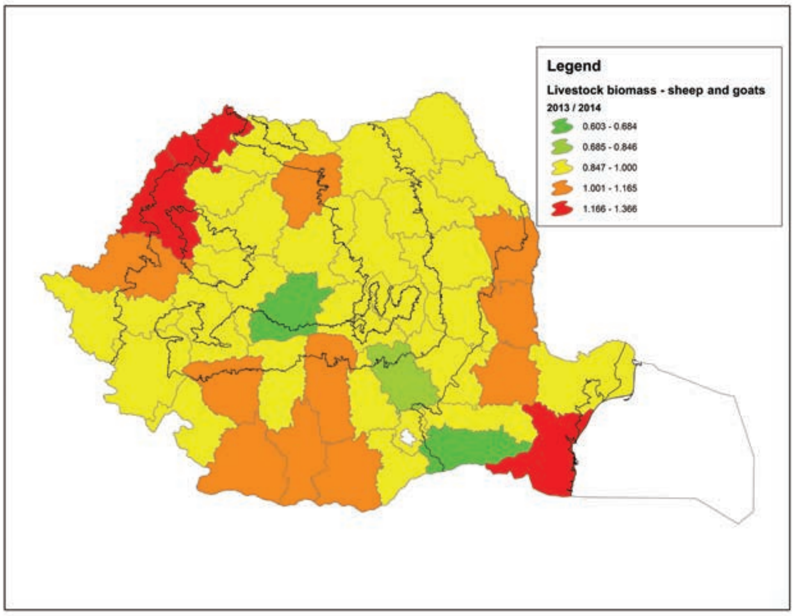
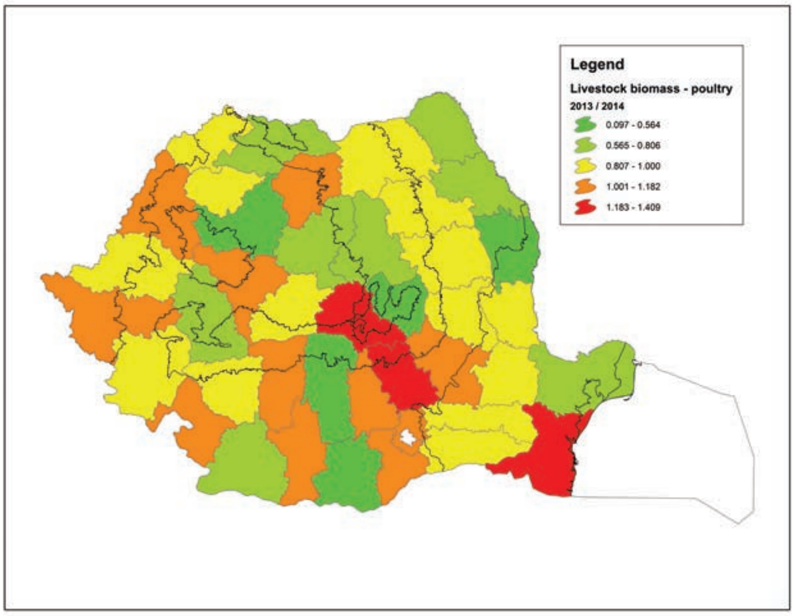
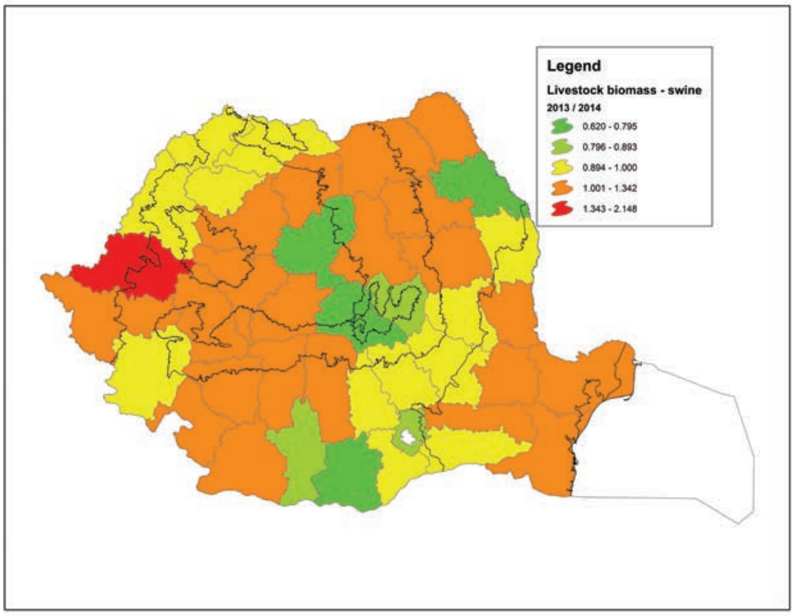
Nutrition – Farm animals and products

Indicator	Nutrition – Farm animals and products
1. Structural *Green fodder cultivated area* This is an indicator meant to show the weight of the allocated resources at county level for animal breeding and obtaining animal products. One can notice that most of the counties have a decrease of the agricultural areas dedicated to green fodder.	

<table>
<tr><th>Indicator</th><th>Nutrition – Farm animals and products</th></tr>
<tr><td>Number of farm animals
With respect to the number of animals, the cattle have a low growth tendency from 2013 to 2014.</td><td>
</td></tr>
<tr><td>Goats livestock has the highest increase, especially in the northern part of the country and in Dobrogea. (>20% from 2013 to 2014)</td><td>
</td></tr>
<tr><td>Sheep livestock is generally increaseing except for Caraș Serverin and Alba counties (<10% from 2013 to 2014)
Indicator variation between 2013 and 2014.</td><td>
</td></tr>
</table>

<table>
<tr><th>Indicator</th><th>Nutrition – Farm animals and products</th></tr>
<tr><td>Poultry livestock is generally decreasing (predominant orange).</td><td>
</td></tr>
<tr><td>Swine livestock has decreased at national level from 2013 to 2014, with some increases in Caraș-Severin, Mehedinți, Covasna, Buzău and Brașov.</td><td>
</td></tr>
<tr><td>2. Functional –
Biomass

Cattle biomass has generally decreased from 2013 to 2014 (up to 30% - red). Significant growth (>30%) reported in different counties shows an increase in the cattle farms’ efficiency, especially in the counties reporting lower effectives.</td><td>
</td></tr>
</table>

<table>
<tr><th>Indicator</th><th>Nutrition – Farm animals and products</th></tr>
<tr><td>Sheep and caprine biomass has generally increased from 2013 to 2014, in line with overall trend.</td><td>
</td></tr>
<tr><td>Poultry live weight is characterized by a local dynamic.</td><td>
</td></tr>
<tr><td>The swine live weight has decreased from 2013 to 2014, with the biggest decreases in Arad (>100%), but also increases (>40%) in Mureș, Brașov, Teleorman and Iași.</td><td>
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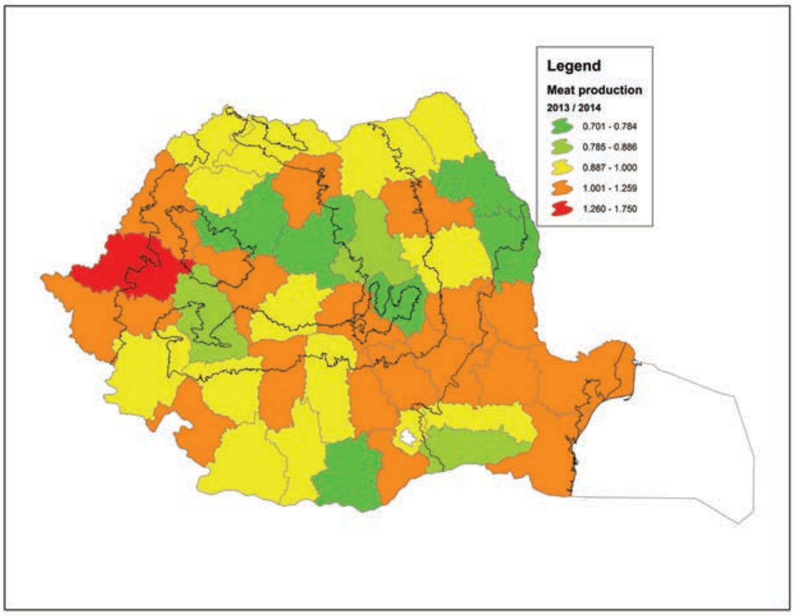
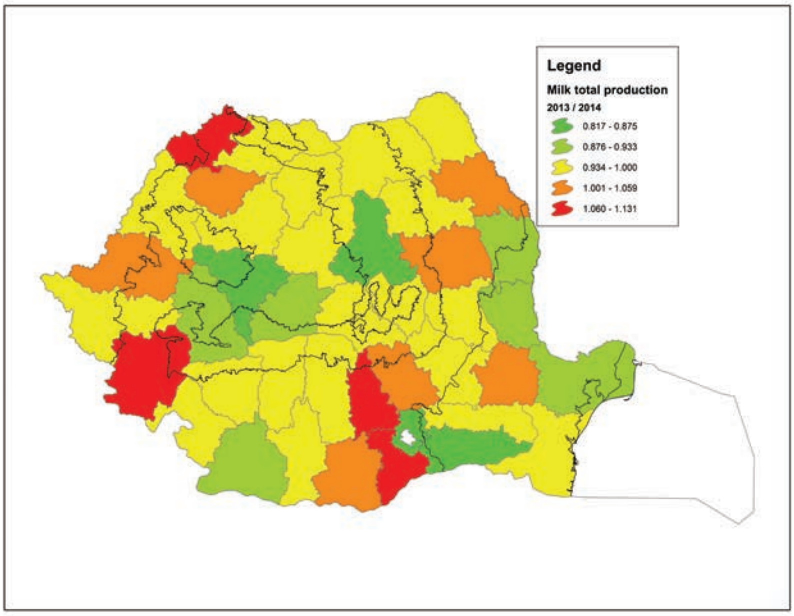
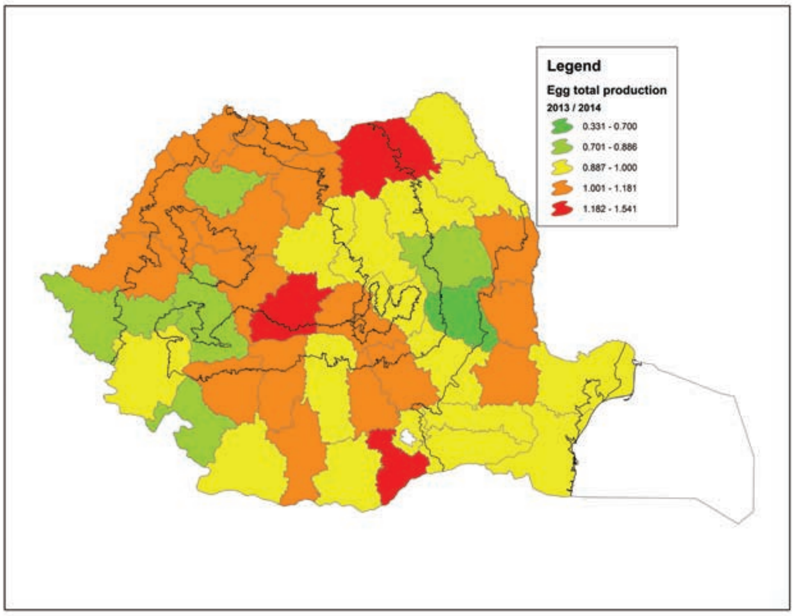
<table>
<tr><th>Indicator</th><th>Nutrition – Farm animals and products</th></tr>
<tr><td>3. Evaluation –
Quantity of agricultural products
Meet production at local level presents a low decrease tendency (orange).</td><td>


</td></tr>
<tr><td>Milk production is more or less the same at national level (yellow).</td><td>


</td></tr>
<tr><td>The egg production has a low decrease trend in the north-western part of the country and is maintaining in the center and eastern part.</td><td>


</td></tr>
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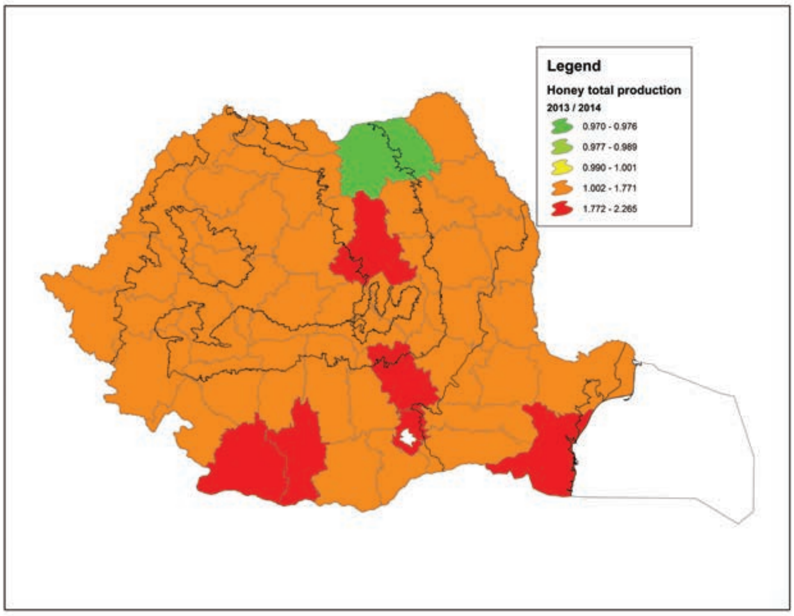
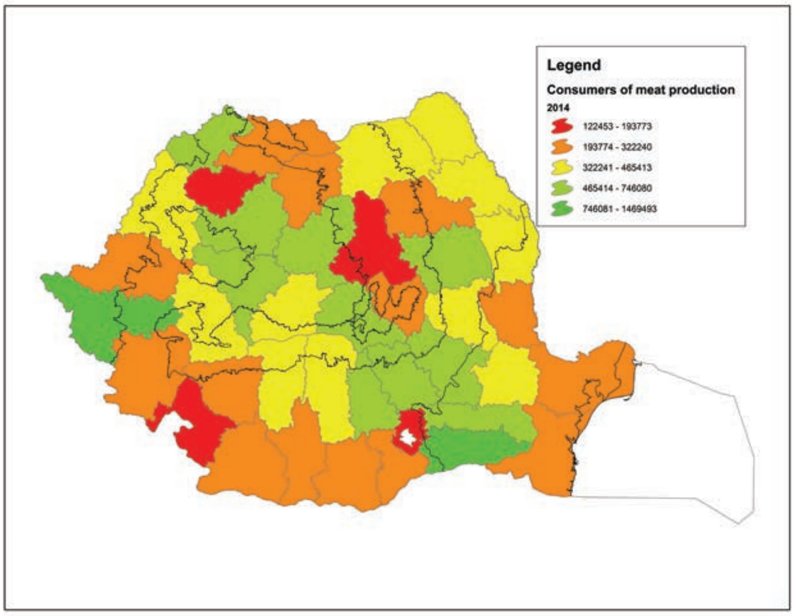
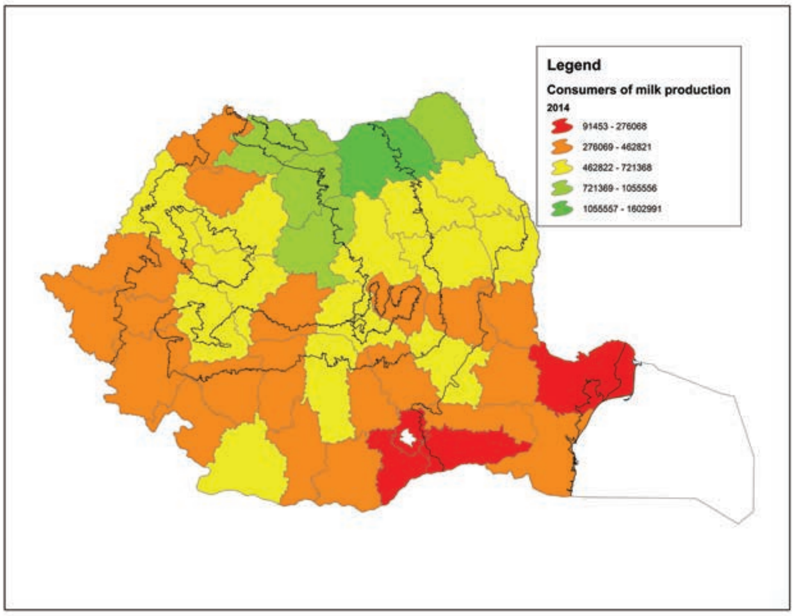
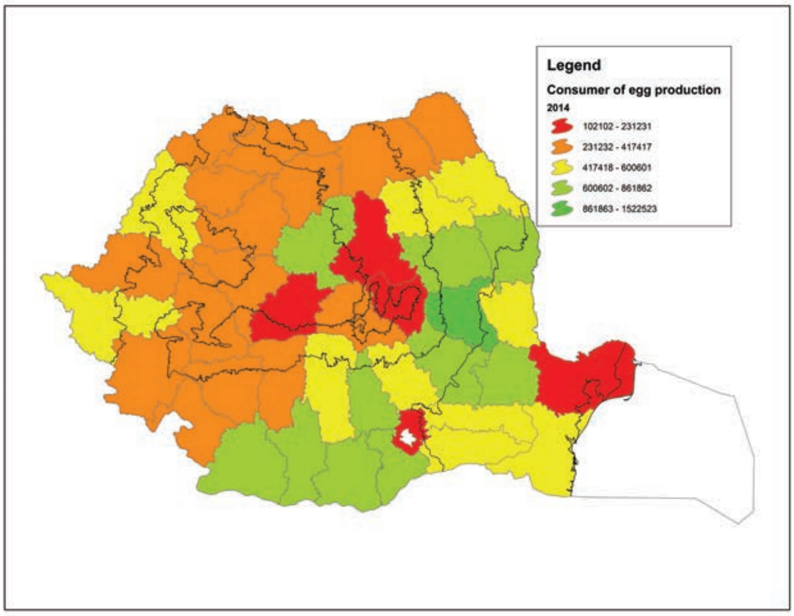
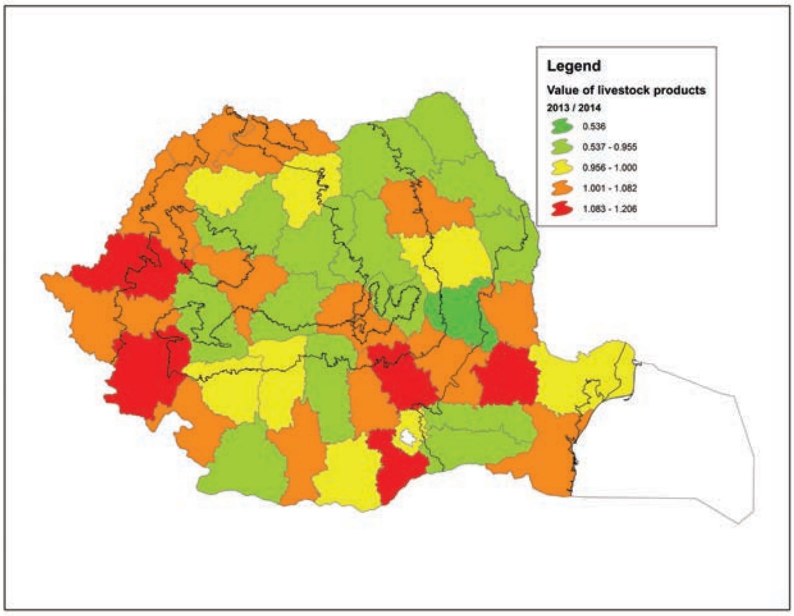
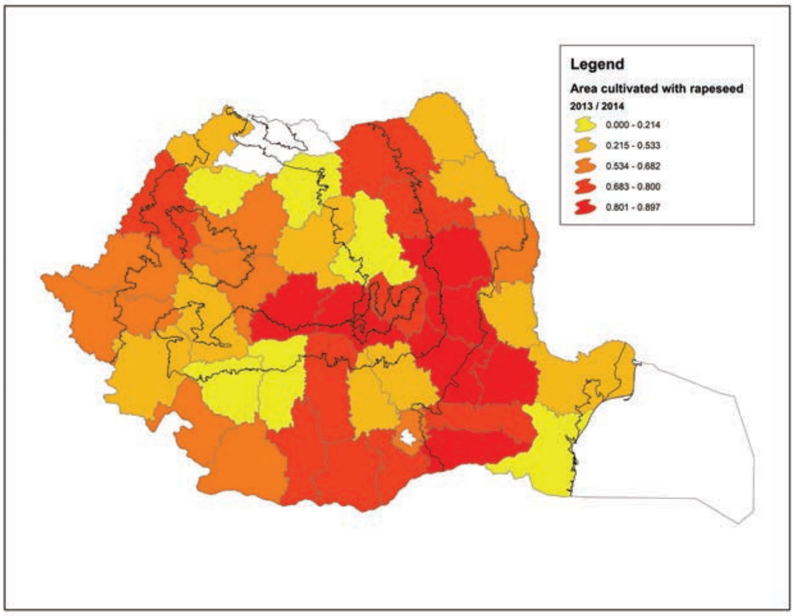
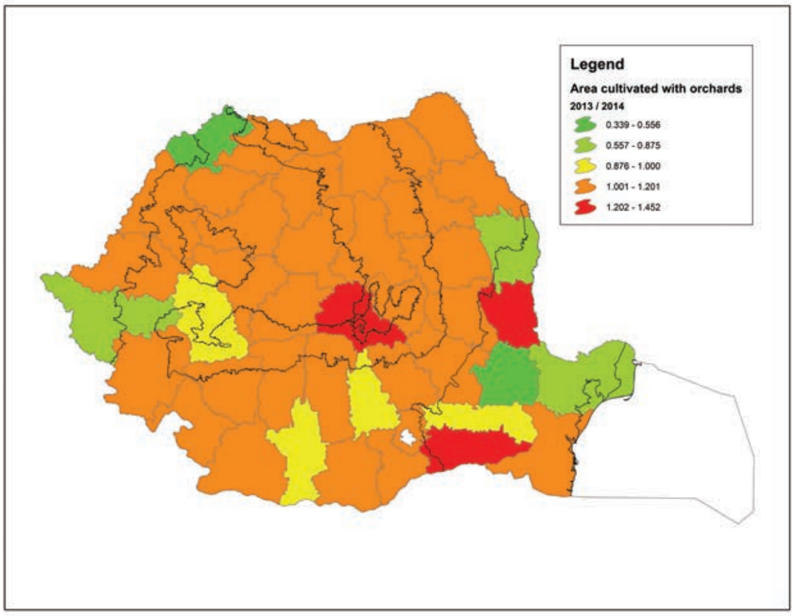
Indicator	Nutrition – Farm animals and products
The honey production is presenting a significant decrease at national level (orange and red).	
4. Benefit *Number of people benefiting from food resources* Benefit resulting from the use for nutrition purposes of meet resources stemming from animal farming.	
Benefit resulting from the use for nutrition purposes of milk resources stemming from animal farming.	

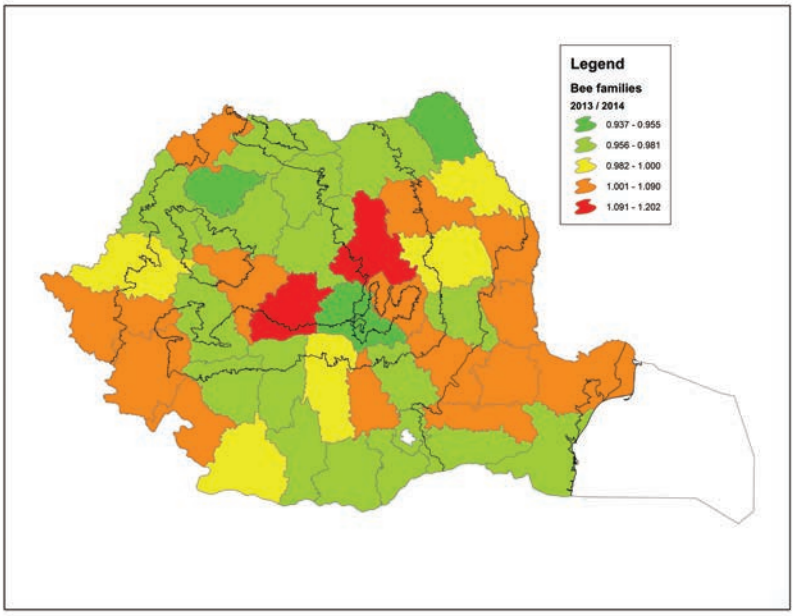
Indicator	Nutrition – Farm animals and products
Benefit resulting from the use for nutrition purposes of egg resources stemming from animal farming.	
5. Value *Value of animal production* The value of animal production has experienced a general growth from 2013 to 2014, with up to 50% in Vrancea county, while other counties (Arad, Caras-Severin, Giurgiu, Prahova and Galati) reported decreases of up to 20%.	

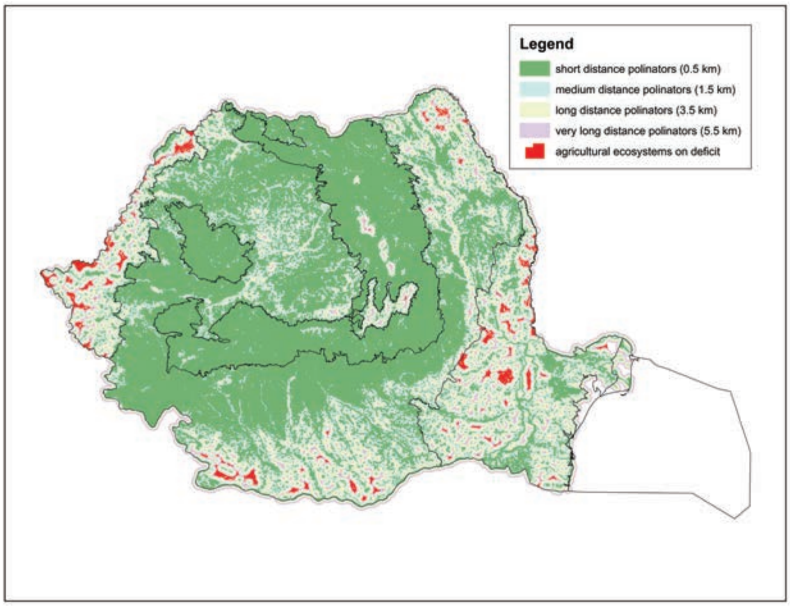
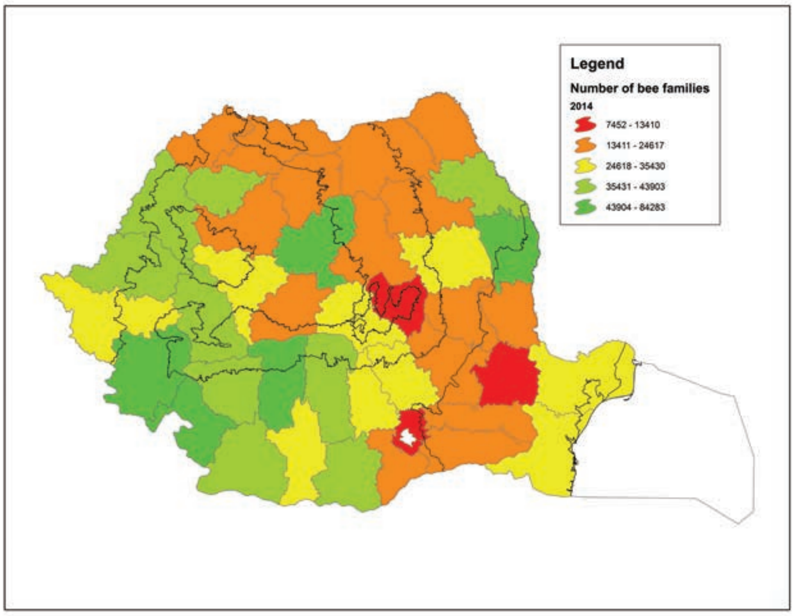
Regulating and maintenance services

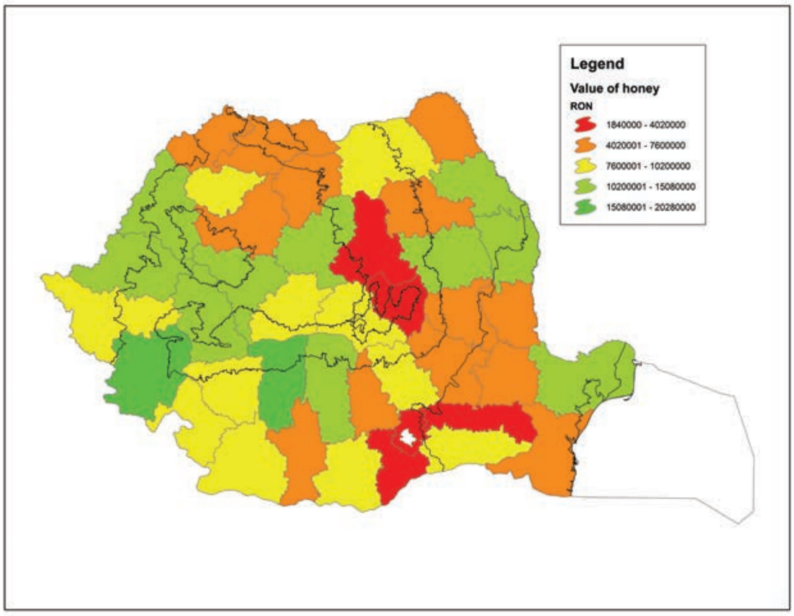
Pollination and seed dispersion

Indicator	Adjustment – Pollination and seed dispersion
1. Structural *Area cultivated with colza* Colza is just one example of cultivated plants which offer structural support for pollination. As it may be seen in the figure, in 2014 a national increase in the colza crops was reported.	
Areas cultivated with productive orchards Fruit orchards are one of the factors that influence the general market need of pollination services. The general trend in 2013-2014 was one of decrease in what concerns the areas cultivated with orchards.	

<table>
<tr><th>Indicator</th><th>Adjustment – Pollination and seed dispersion</th></tr>
<tr><td>2. Functional –
Potential capacity– Bee families

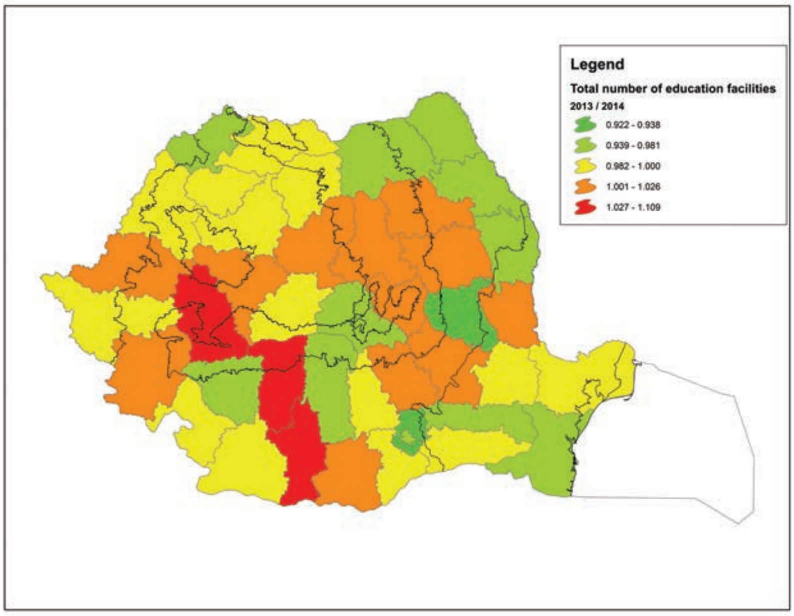
The number of bee families has increased with up to 7% from 2013 to 2014 with reductions of up to 20% in Harghita and Sibiu Counties.</td><td>
</td></tr>
<tr><td>3. Evaluation –
Evaluation of the pollination deficit.

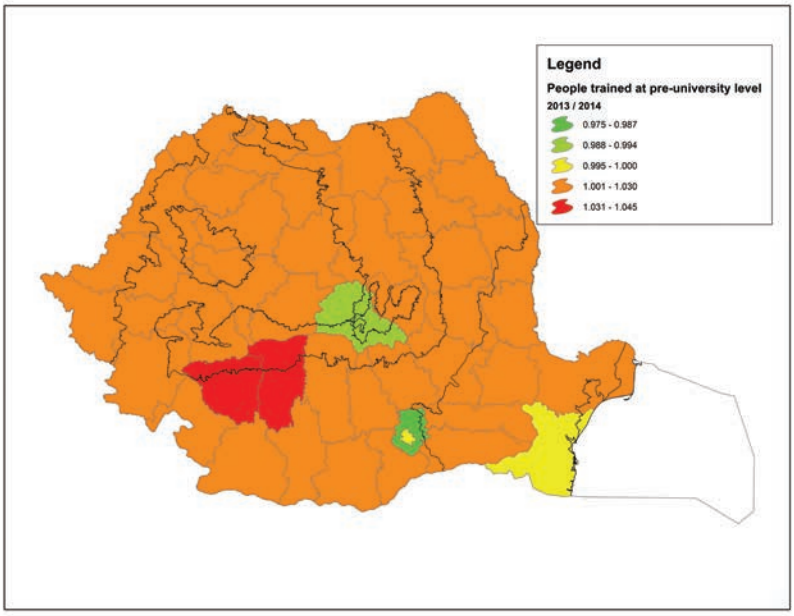
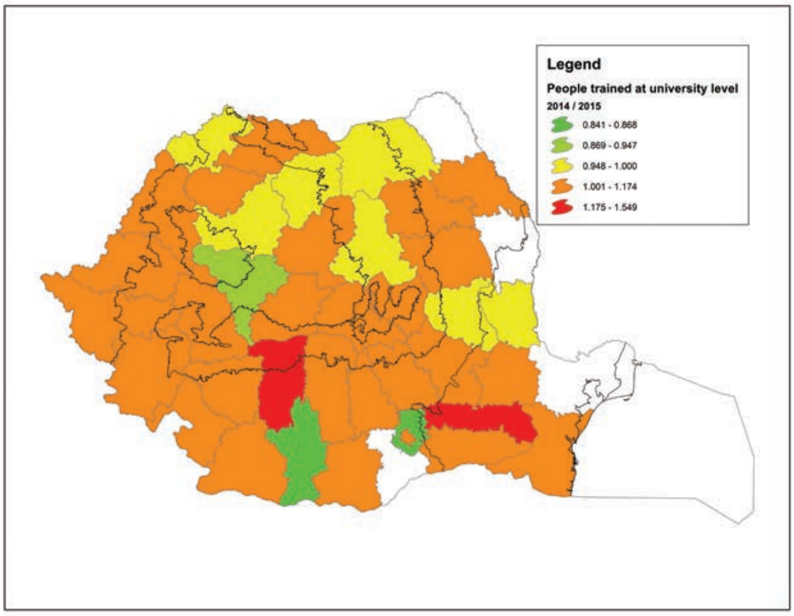
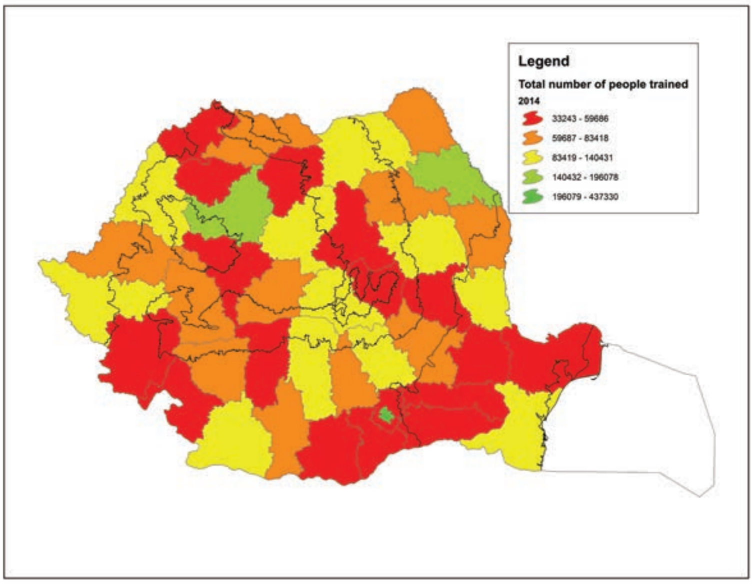
Agricultural fields which are dependent of pollination but present habitat characteristics with potential pollination deficit risk.</td><td>
</td></tr>
<tr><td>4. Benefit
Number of beekeepers / apiaries</td><td>
</td></tr>
</table>

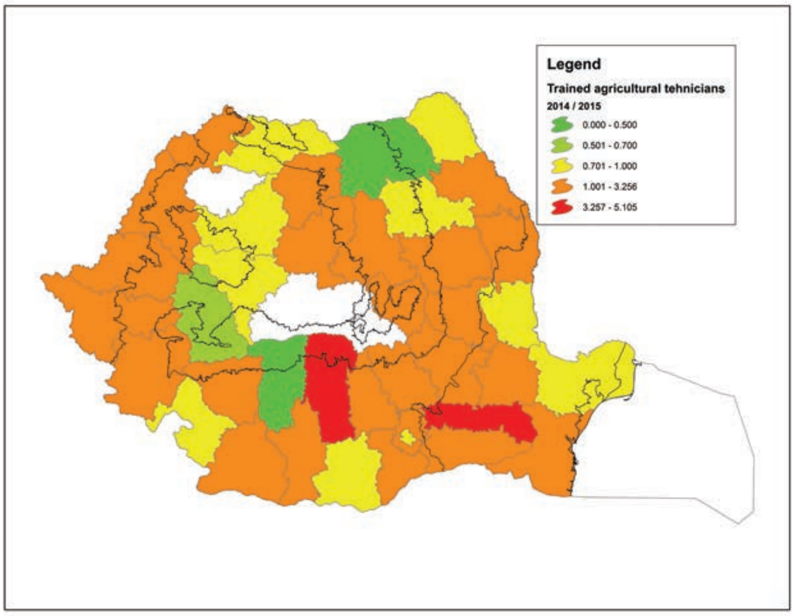
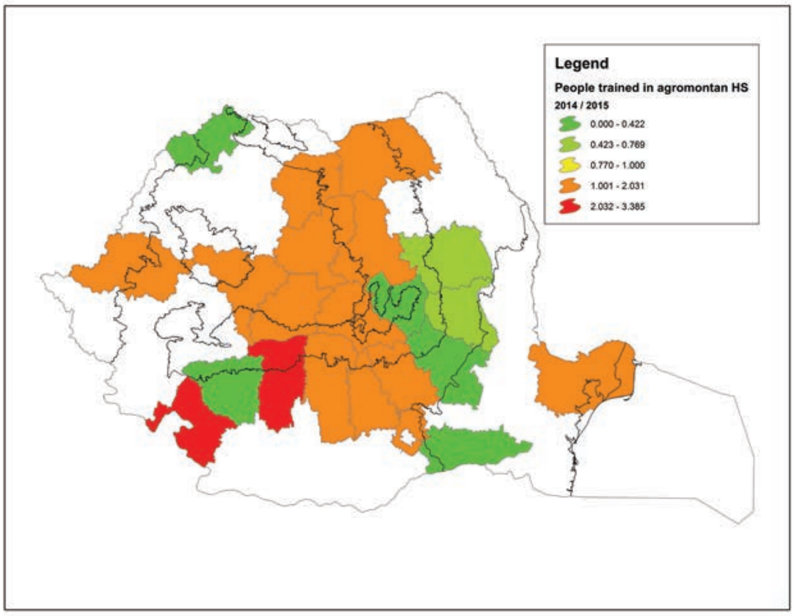
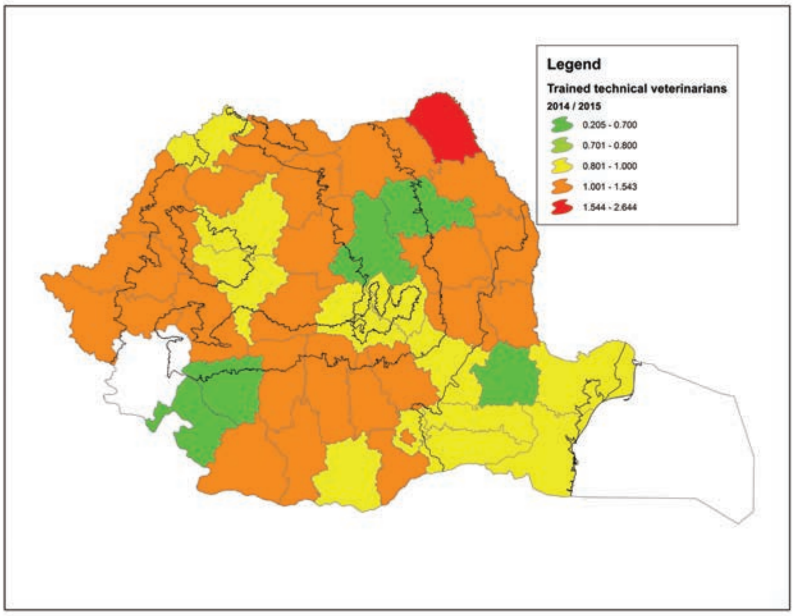
Indicator	Adjustment – Pollination and seed dispersion
5. Value *The value of honey production* The honey production has reported a general decrease of up to 200% in counties like Harghita, Constanța, Ilfov, Ialomița, Dolj, Olt. The only county reporting an increase in the production was Suceava with less than 5%.	

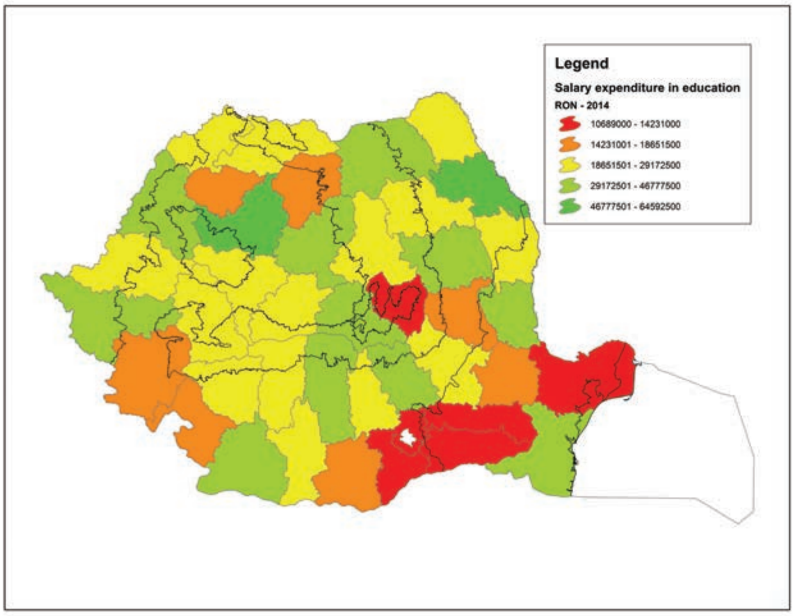
Cultural services

Education

Indicator	Cultural – Education
1. Structural *Number of education facilities*	

Indicator	Cultural – Education
2. Functional – *Number of people trained* Total number of students (pre-university studies)	
Total number of undergraduate and graduate students.	
3. Evaluation – *Number of trained persons*	

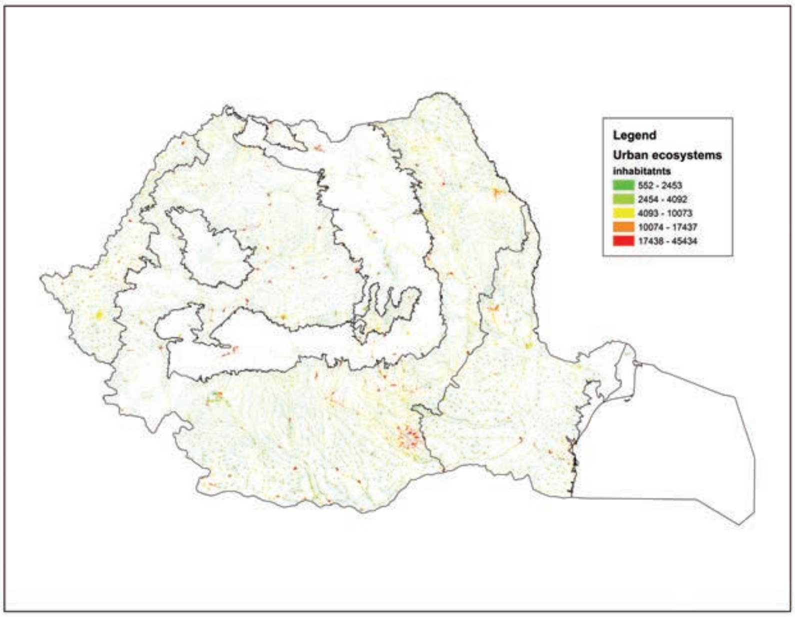
Indicator	Cultural – Education
4. Benefit *Number of trained people in different sectors*	
	
	

Indicator	Cultural – Education
5. Value *Value of educational programmes.* In what concerns the human resource training for agriculture, we have used the number of employees in the education sector as a synthetic indicator, as there was no other specific indicator available. This reflects that the financial offer for preparing the human resource is maintaining. One can also notice a slight dynamic at national level.	

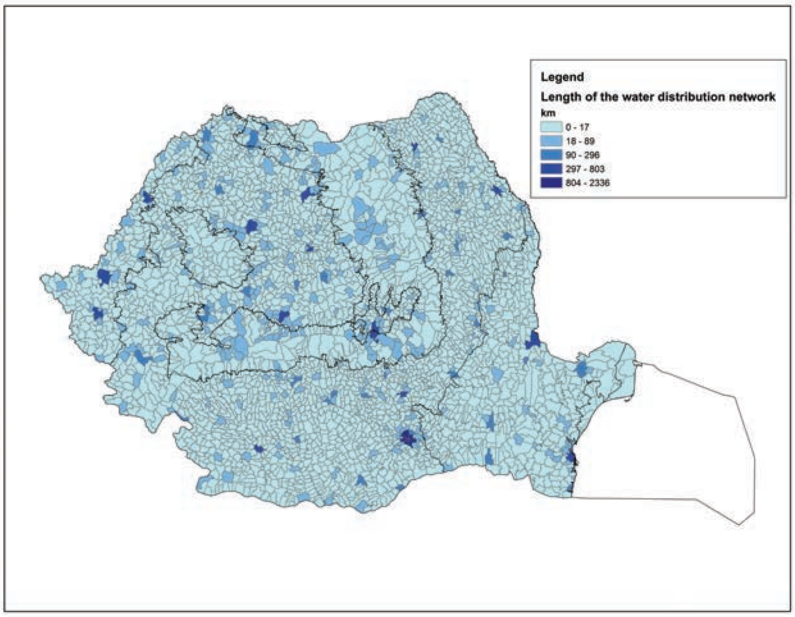
Urban ecosystems

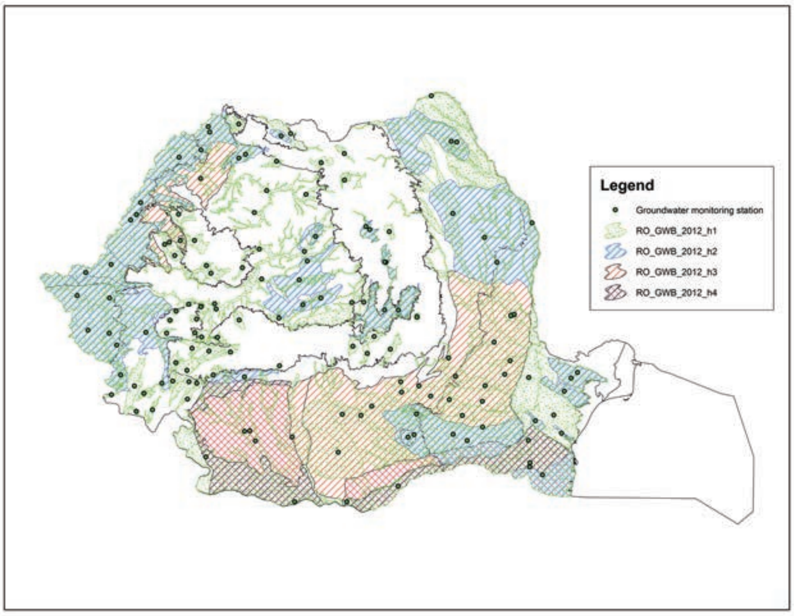
Provisioning services

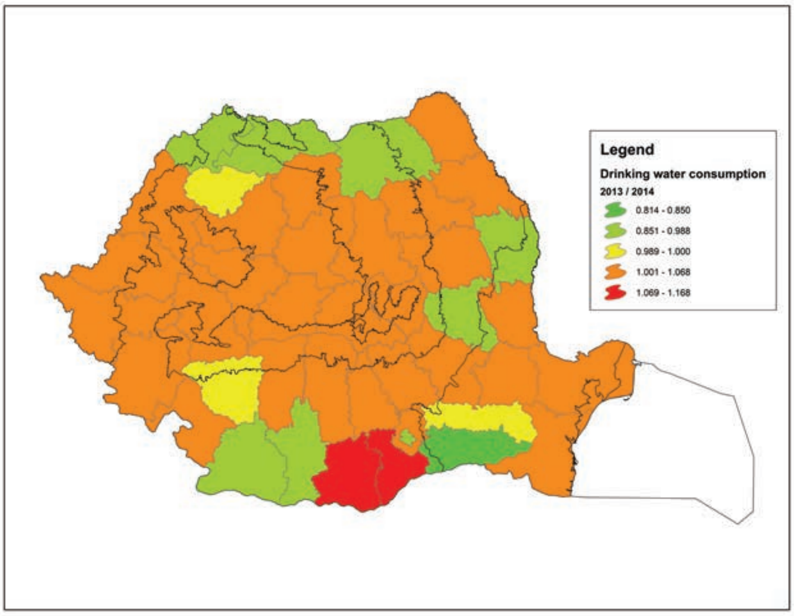
Resources – Underground drinking water

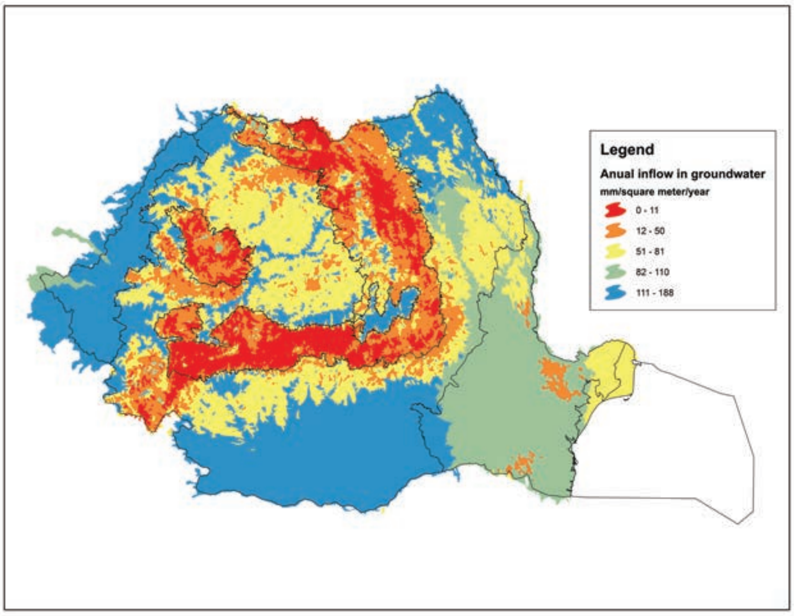
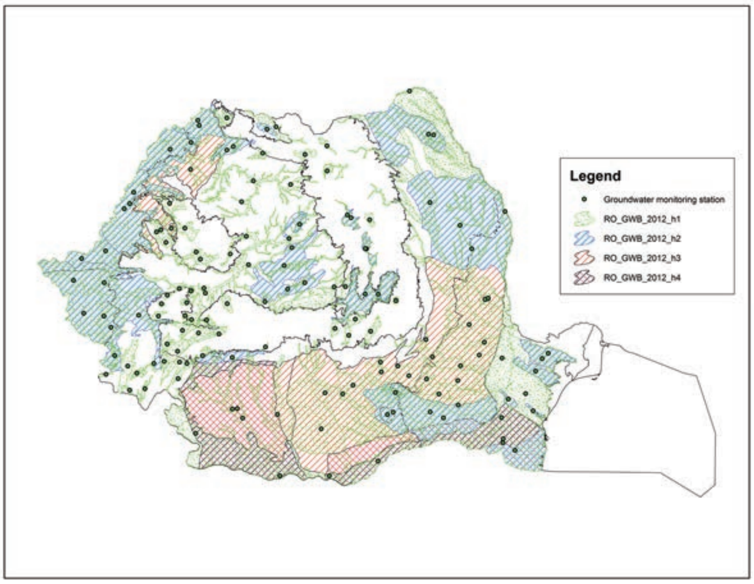
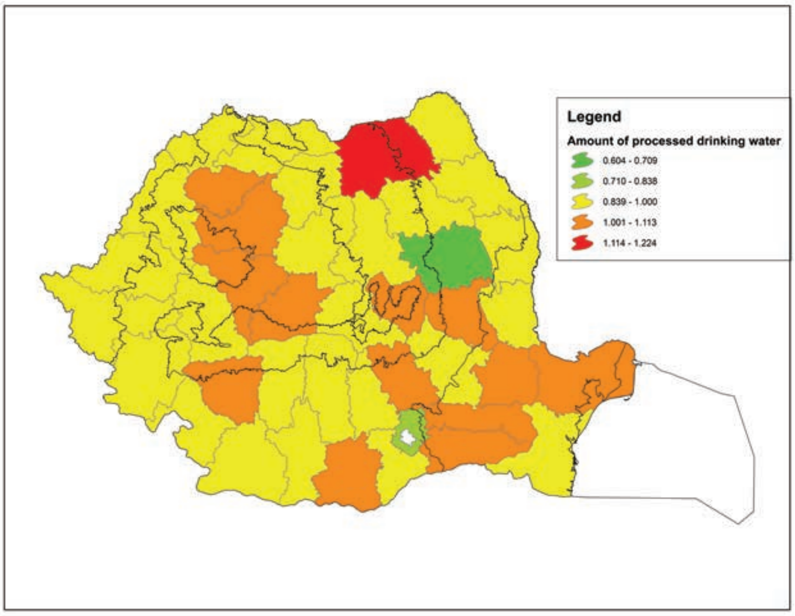
Indicator	*Resources – Underground drinking water*
1. Structural *Distribution of urban ecosystems and its population.* This indicator shows the pressure put on the hydrological component as well as the intensity of the demand for an exosystemic service of providing surface drinking water.	

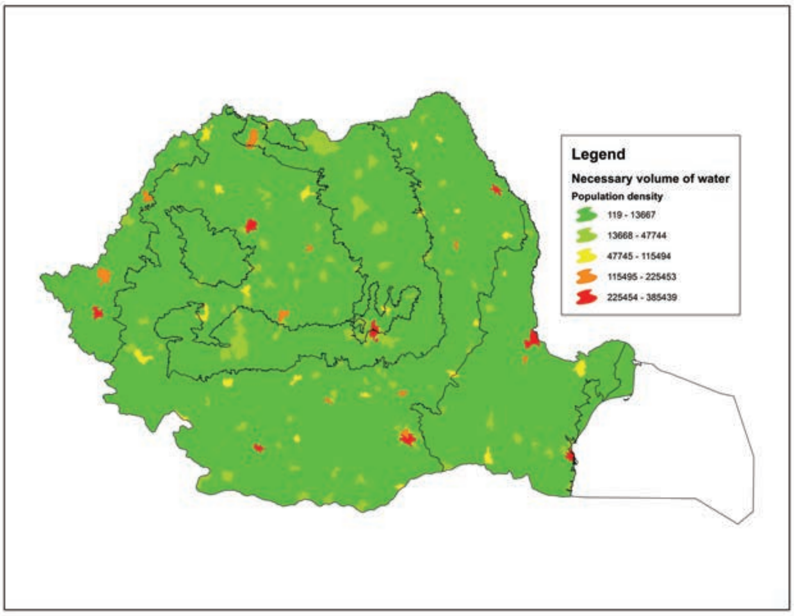
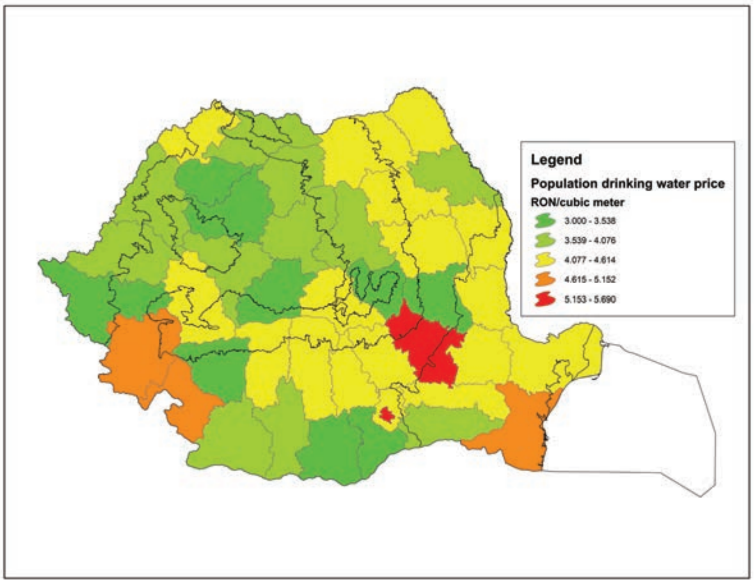
<table>
<tr><th>Indicator</th><th>Resources – Underground drinking water</th></tr>
<tr><td>Length of the drinking water network.

The figure shows the length of the water distribution network in the administrative units. The length of the network is correlated with the size of the population, the largest networks being the ones in Bucharest, Iasi, Timisoara, Arad and Cluj-Napoca.</td><td>
</td></tr>
<tr><td>Surface of underground water bodies.

(Macalet, R. 2008)</td><td>
</td></tr>
<tr><td>2. Functional –
Quantity of drinking water used per capita.

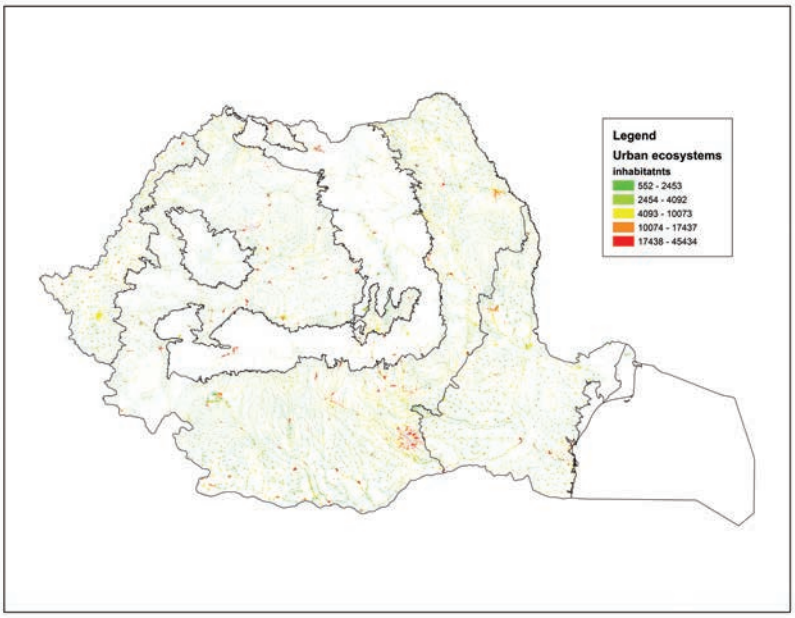
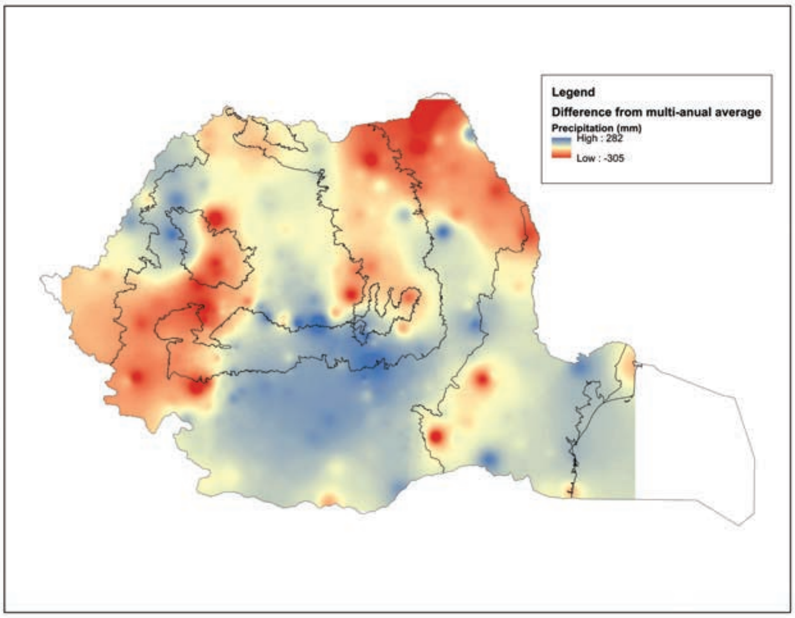
The national trend is to reduce the household water consumption level in 2014 by comparison to 2013, with few exceptions in the norther, southern and eastern part of the country. This is due to the population adopting efficient technologies with respect to water consumption in their households.</td><td>
</td></tr>
</table>

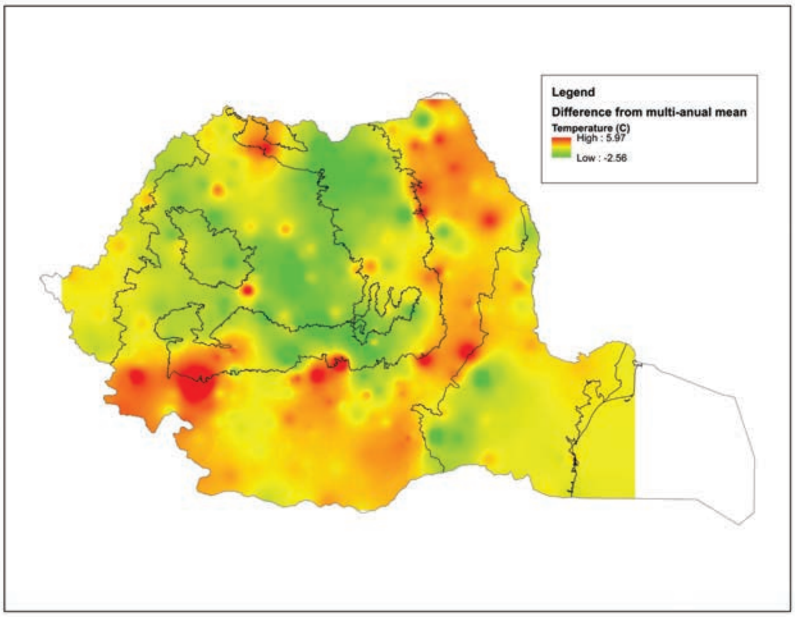
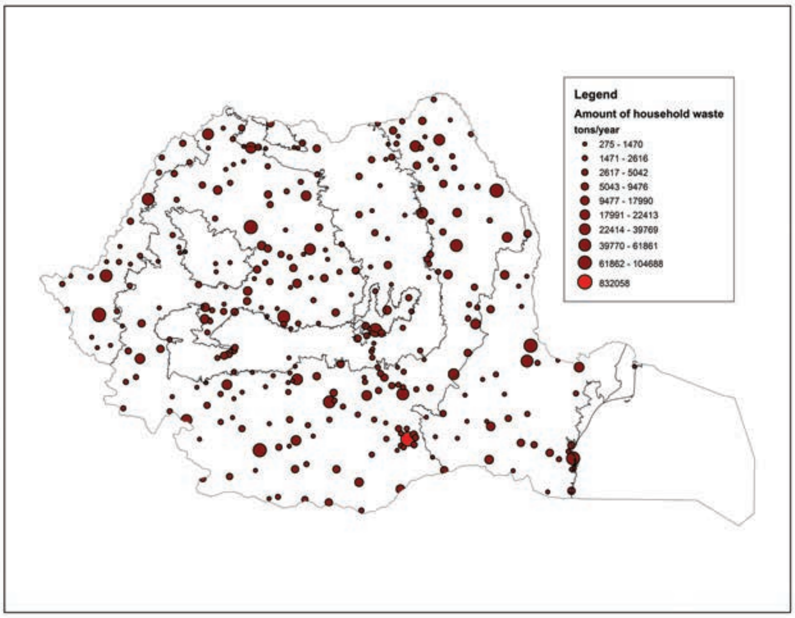
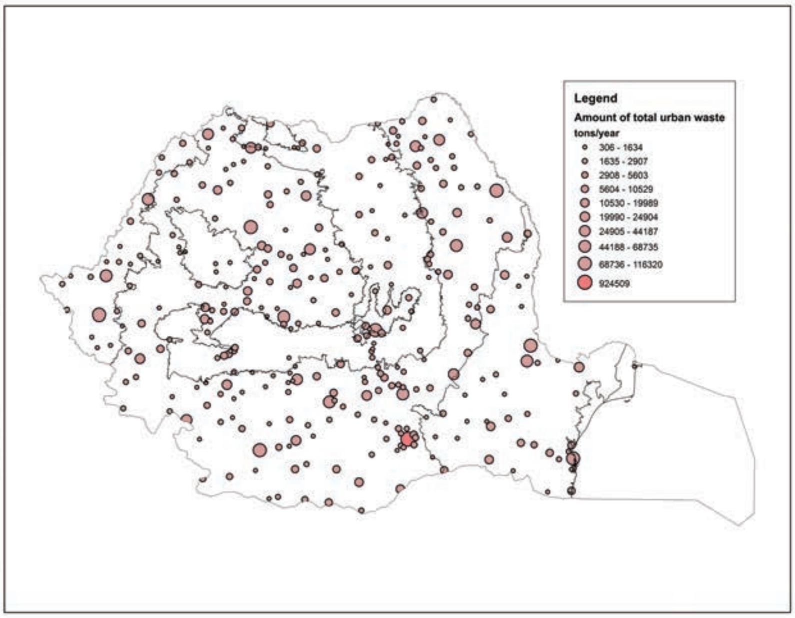
Indicator	*Resources – Underground drinking water*
Quantity of percolated water at specific hydrographic basin.	
3. Evaluation *Quantity of underground drinking water.*	
4. Benefit *Maintaining the quality of underground water / Capacity of processing the drinking water* The figure shows the capacity of the counties to process drinking water in 2014.	

Indicator	*Resources – Underground drinking water*
Population using underground drinking water.	
5. Value *Value of drinking water for population.*	

Regulating and maintenance services

Scent / noise / visual impact control

Indicator	*Scent / noise / visual impact control*
1. Structural *Distribution of urban ecosystems*	
Meteorological data (precipitation, temperature, wind speed and direction)	

<table>
<tr><th>Indicator</th><th>Scent / noise / visual impact control</th></tr>
<tr><td></td><td>
</td></tr>
<tr><td>Spatial distribution of potential visual / hearing / olfactory discomfort</td><td>
</td></tr>
<tr><td>2. Functional –
Quantity of generated waste</td><td>
</td></tr>
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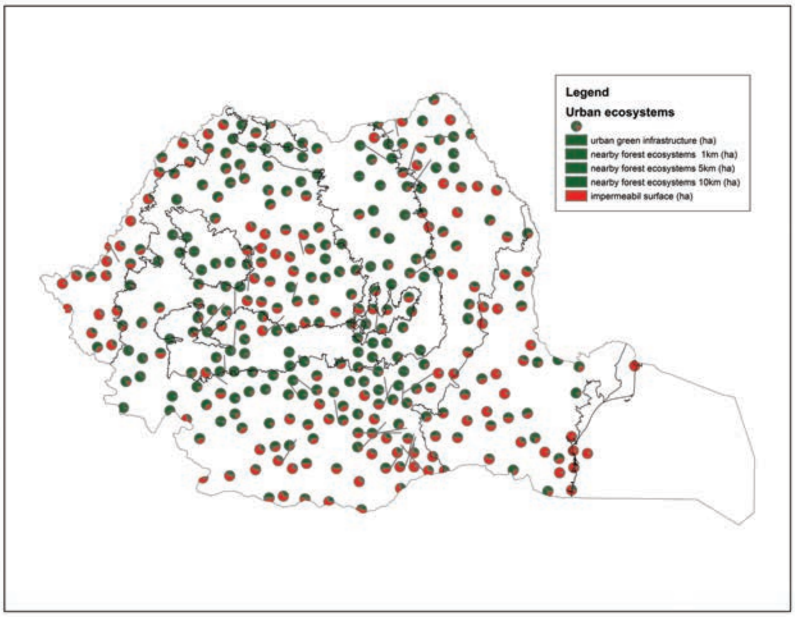
<table>
<tr><th>Indicator</th><th>Scent / noise / visual impact control</th></tr>
<tr><td>3. Evaluation –
Report of areas with olfactory, hearing and visual impact risk to areas of green infrastructure</td><td>
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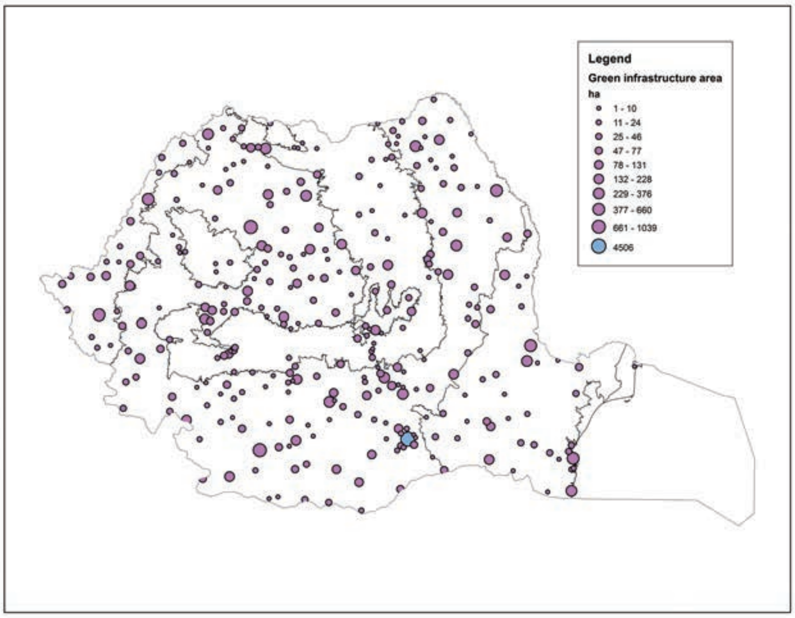
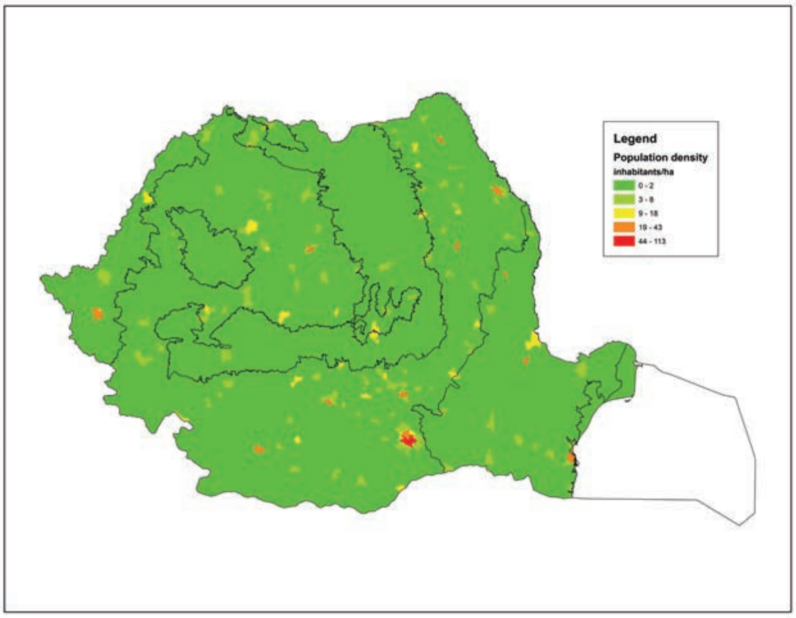
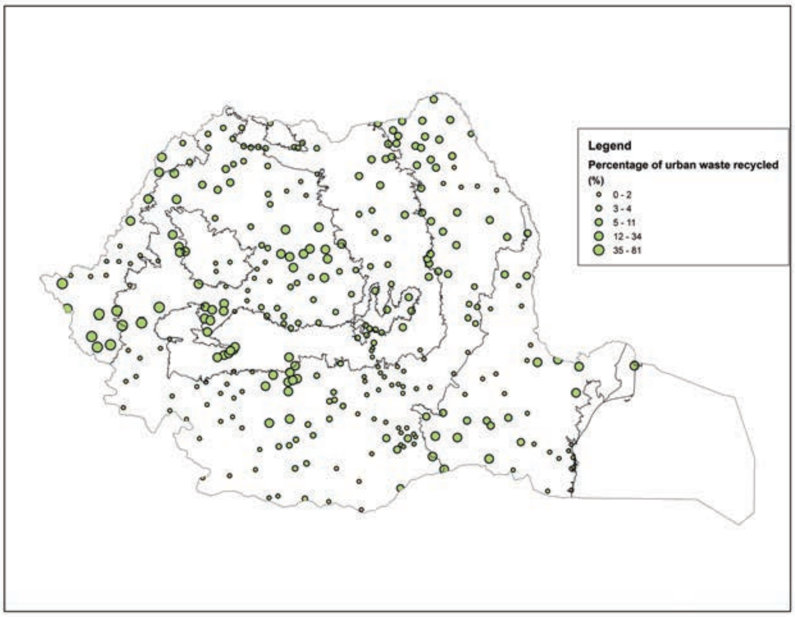
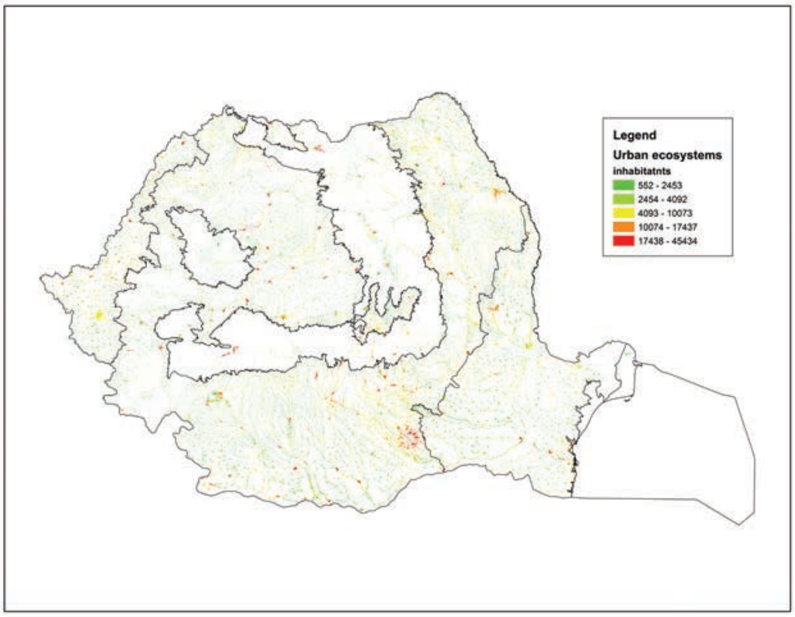
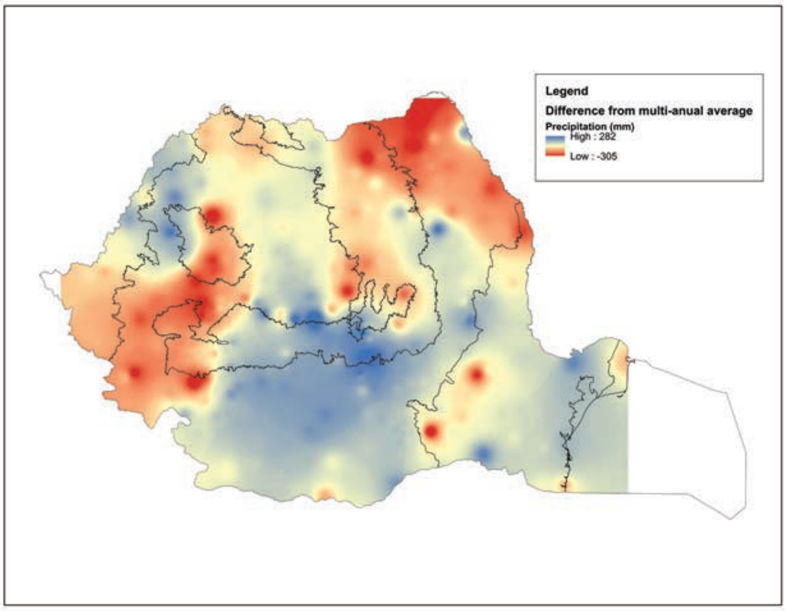
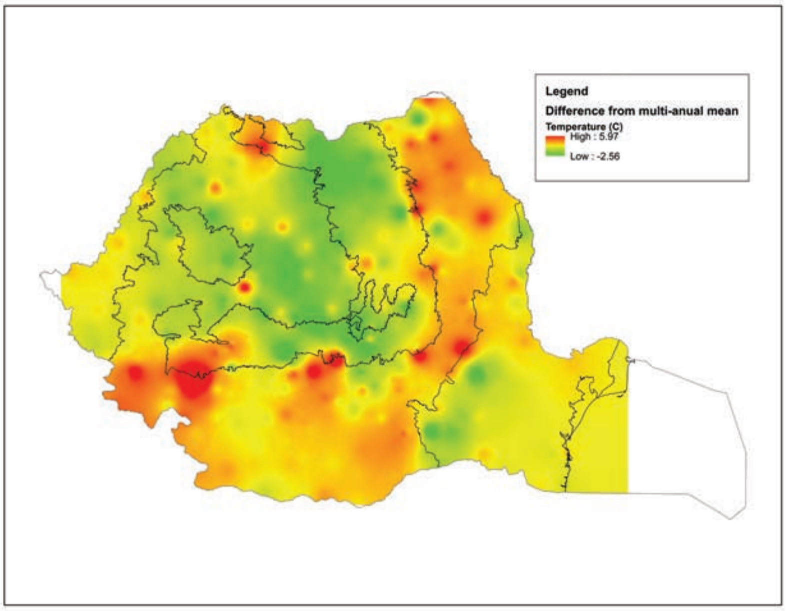
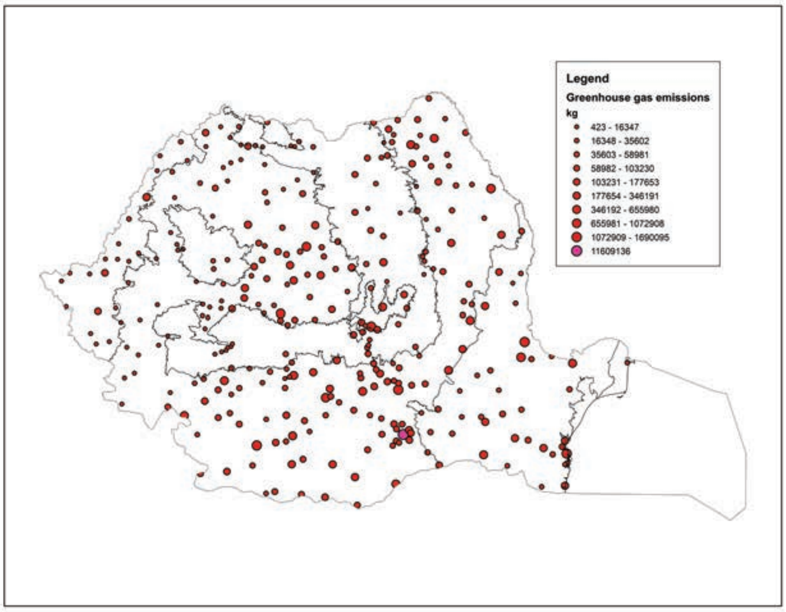
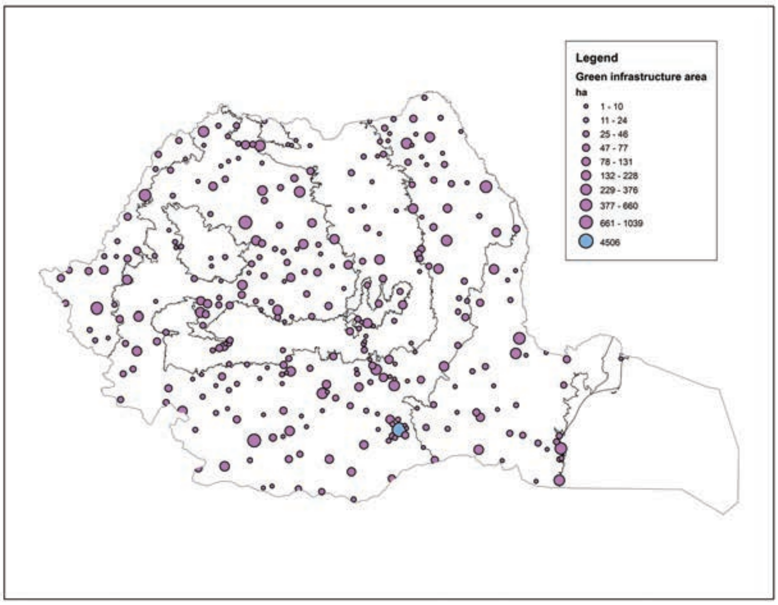
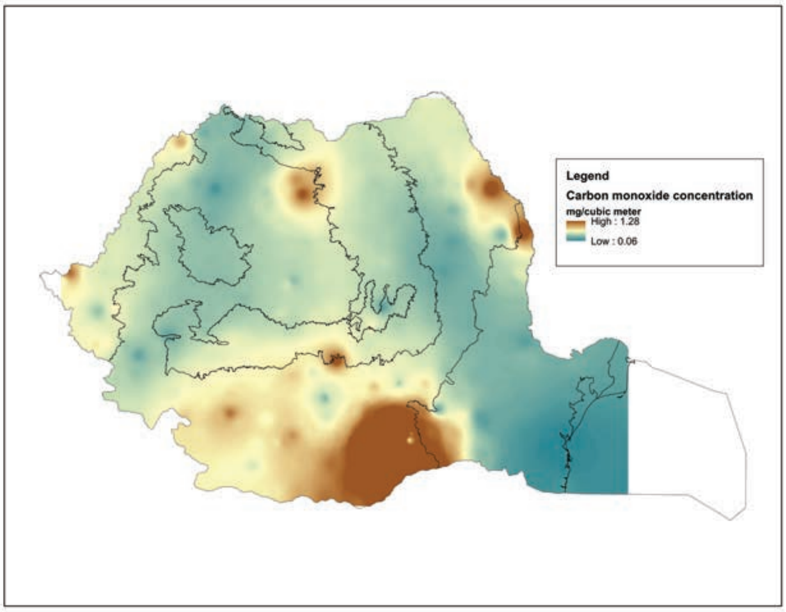
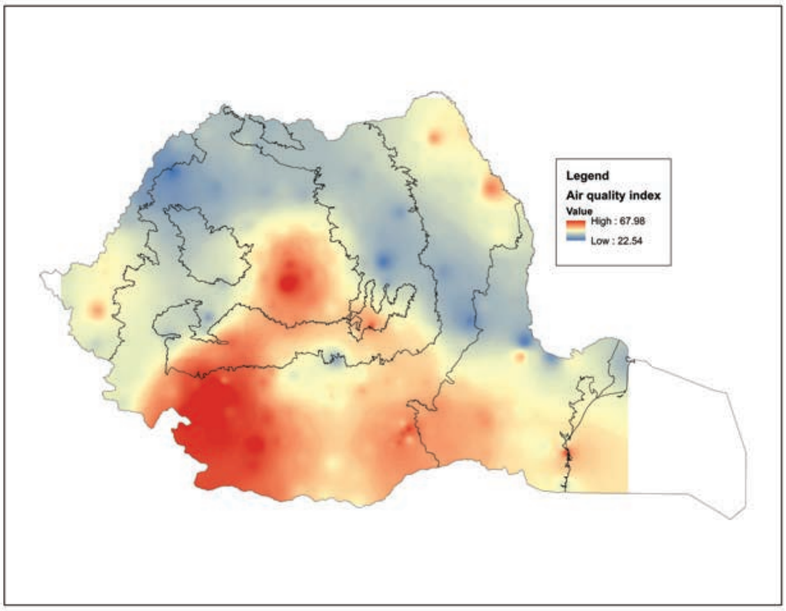
<tr><td>4. Benefit
Barrier effect of green infrastructure areas in mediating risk and residential areas</td><td>
</td></tr>
<tr><td>Population benefiting from scent, noise and visual impact control</td><td>
</td></tr>
</table>

Indicator	*Scent / noise / visual impact control*
5. Value *The cost of controlling scent / noise / visual impact through alternative methods (noise reduction panel costs, non-drinking water costs for watering household waste in order to maintain a low level of scent dispersion*	

Global climate regulation by reducing the concentration of greenhouse gas emissions

Indicator	*Global climate regulation by reducing the concentration of greenhouse gas emissions*
1. Structural *Distribution of urban ecosystems*	

Indicator	***Global climate regulation by reducing the concentration of greenhouse gas emissions***
Meteorological data (precipitation, temperature, wind speed and direction)	 
Distribution of areas with greenhouse gas emissions	

<table>
<tr><th>Indicator</th><th>Global climate regulation by reducing the concentration of greenhouse gas emissions</th></tr>
<tr><td>Area of green infrastructure elements</td><td>
</td></tr>
<tr><td>2. Functional –
Mean greenhouse gas emissions level</td><td>
</td></tr>
<tr><td>2. Evaluation –
Overall greenhouse gas emissions unable to be seized</td><td>
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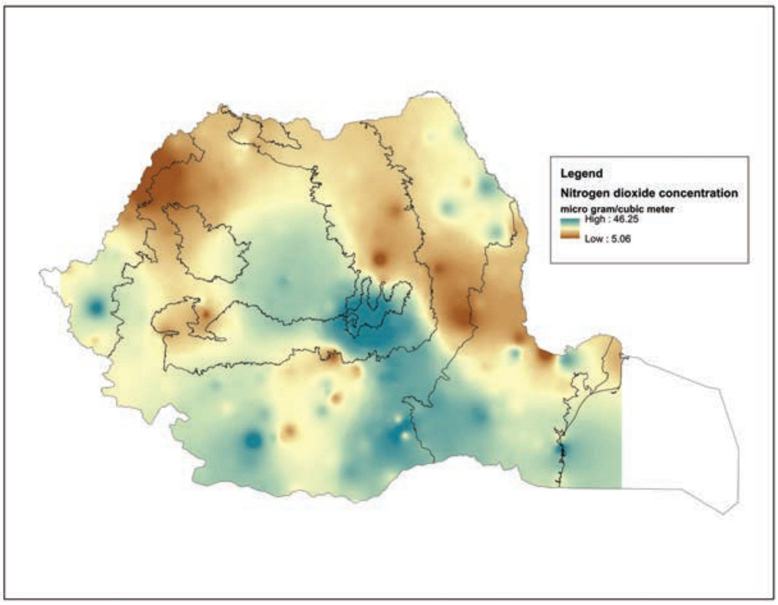
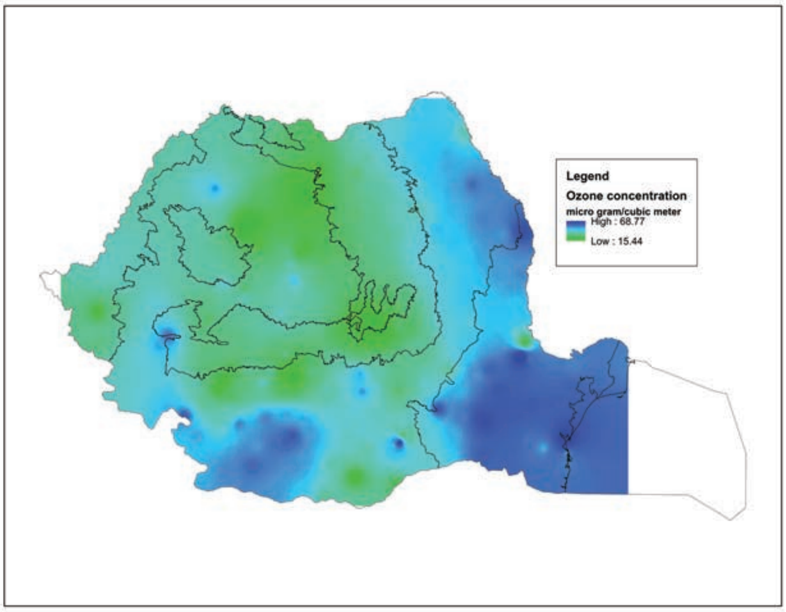
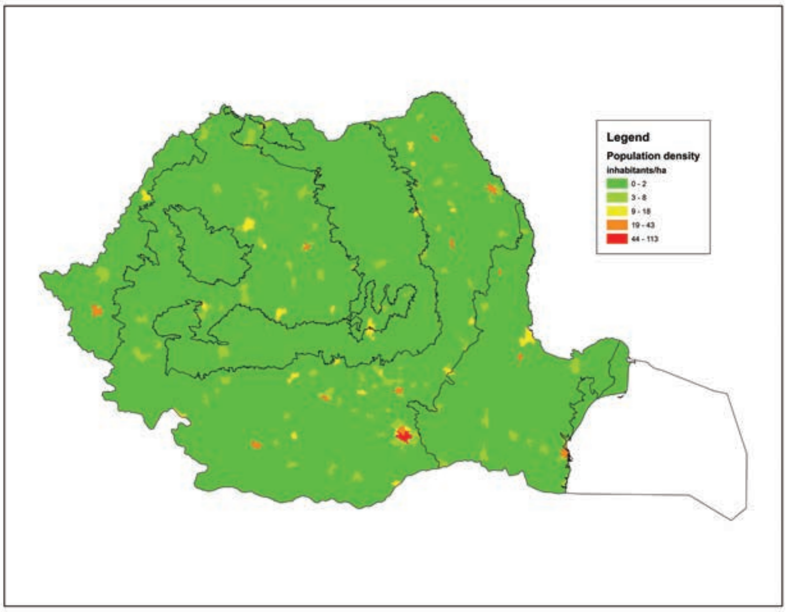
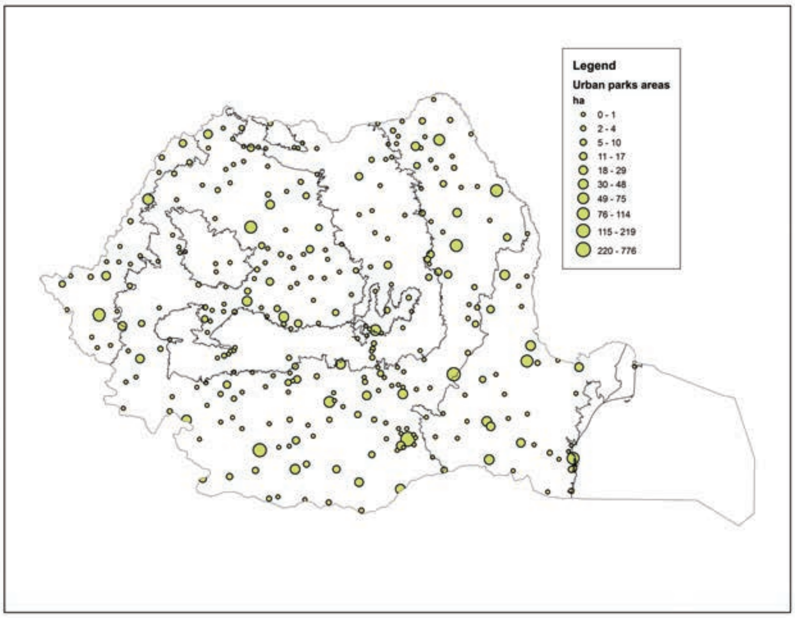
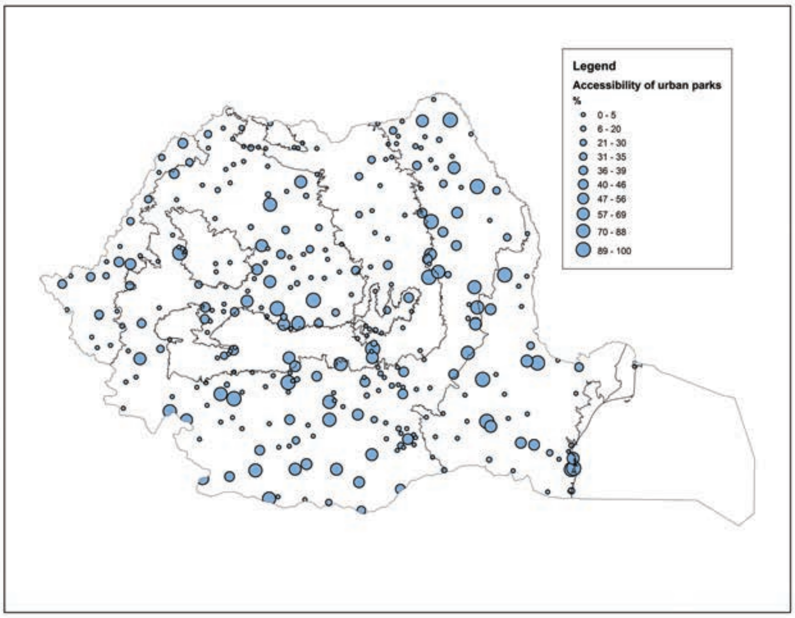
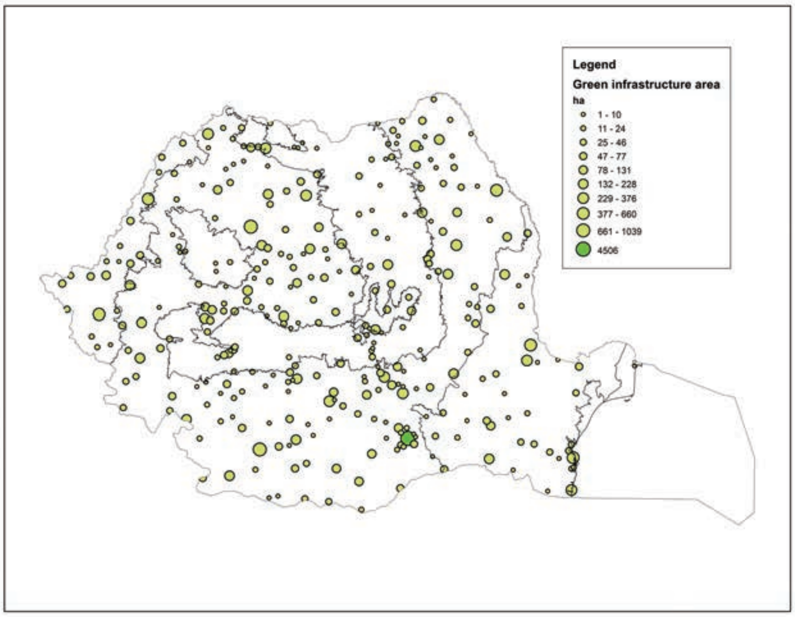
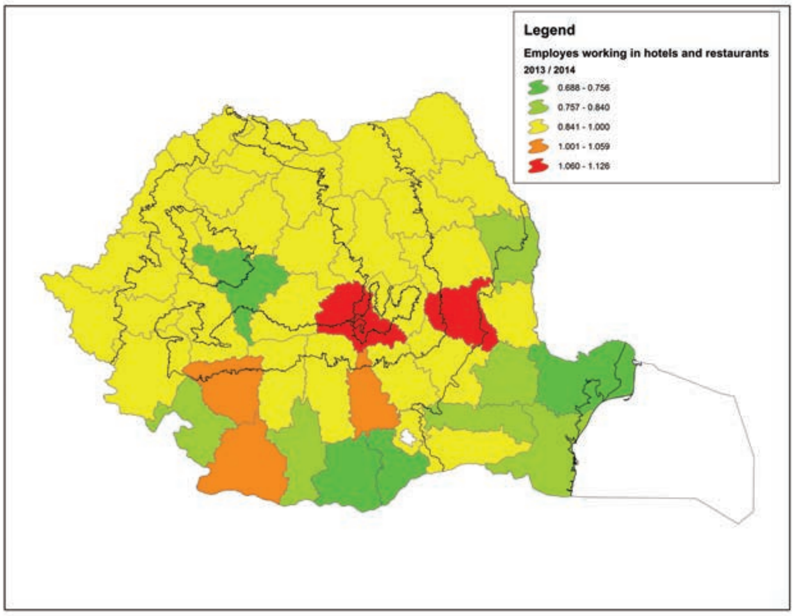
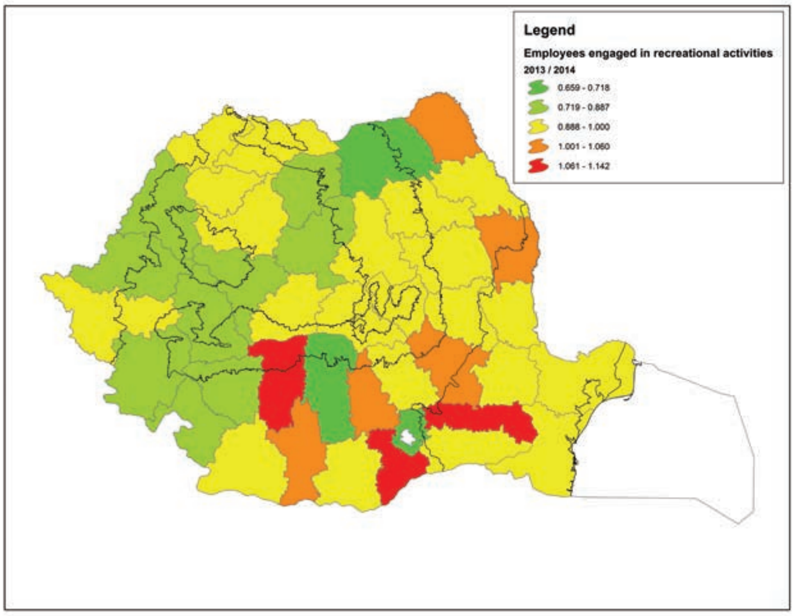
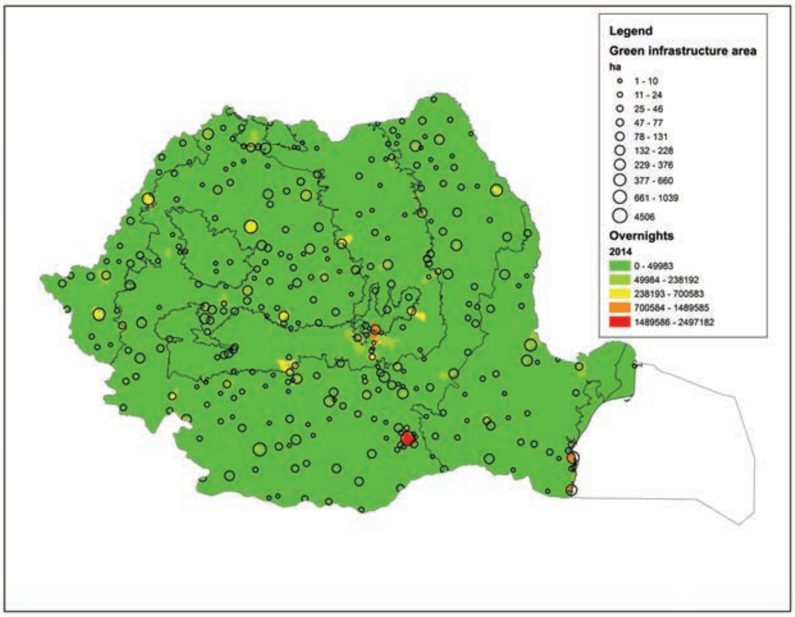
Indicator	***Global climate regulation by reducing the concentration of greenhouse gas emissions***
	
	
4. Benefit *Exposed population to specific greenhouse gas emissions risk*	

Cultural services

Esthetic

Indicator	***Esthetic***
1. Structural *Urban parks areas*	
2. Functional – *Accessibility to urban parks*	

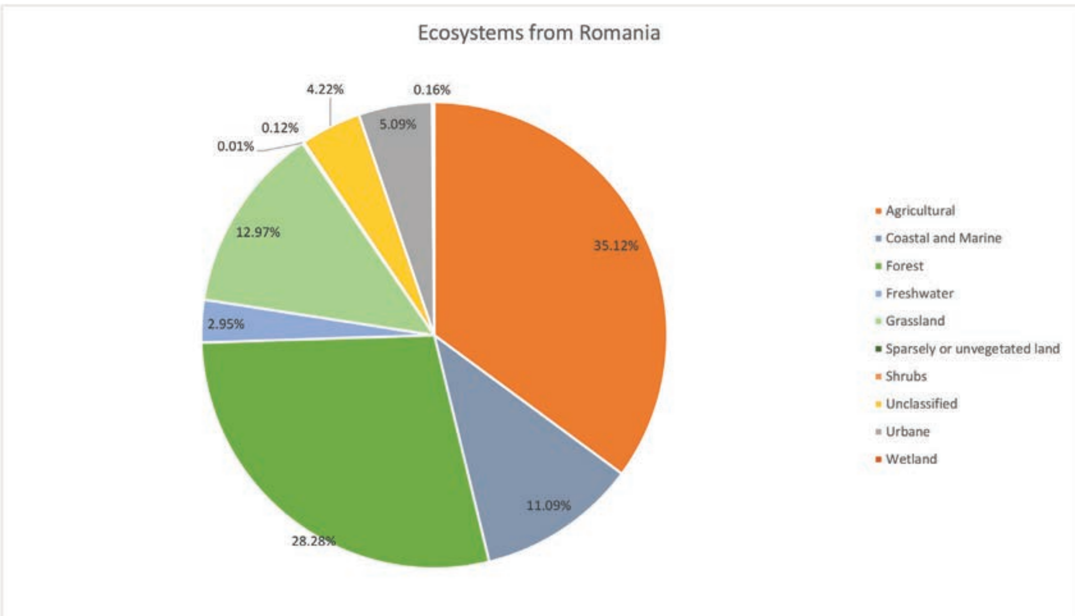
<table>
<tr><th>Indicator</th><th>Esthetic</th></tr>
<tr><td>3. Evaluation –
Green infrastructure areas</td><td>
</td></tr>
<tr><td>4. Benefit
Employees working in hotels and restaurants</td><td>
</td></tr>
<tr><td>Employees engaged in recreational activities</td><td>
</td></tr>
</table>

Indicator	*Esthetic*
5. Value *Use value, overnights in green infrastructure areas*	

3.3. Mapping results

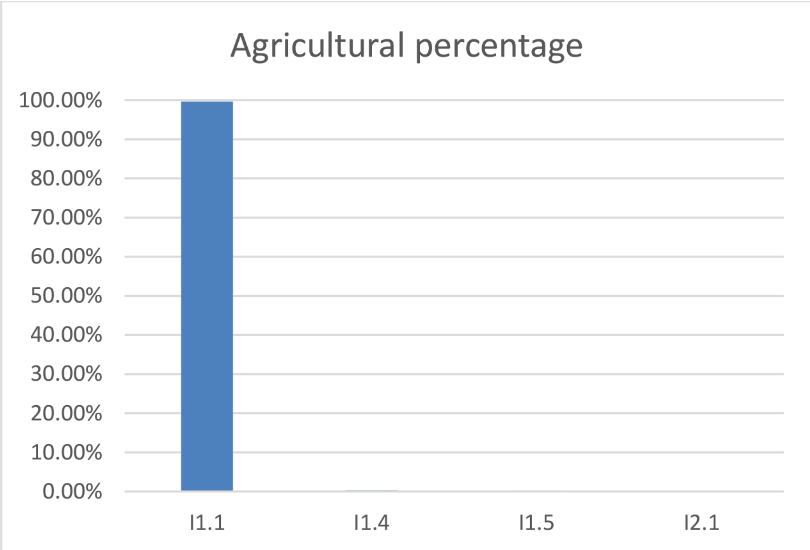
All 9 major ecosystem categories existing on the national level where evaluated and 79 EUNIS level classed where identified, with category 80 containing those that did not pertain to other categories (noted as "unclassified").

In conformity with the major categories, the following table shows the percentage allotted to each category, thus highlighting the ecosystems which are dominant as percentage of surface in the following order: agricultural 53.12%; forests 28.28%; grassland 12.97%; marine and coastal 11.09%; urban 5.09%; river and lakes 2.95%, wetlands 0.16%, shrubs 0.12%, sparsely or unvegetated land (0.01%) and 4.22% for ecosystems unclassified on the national level.



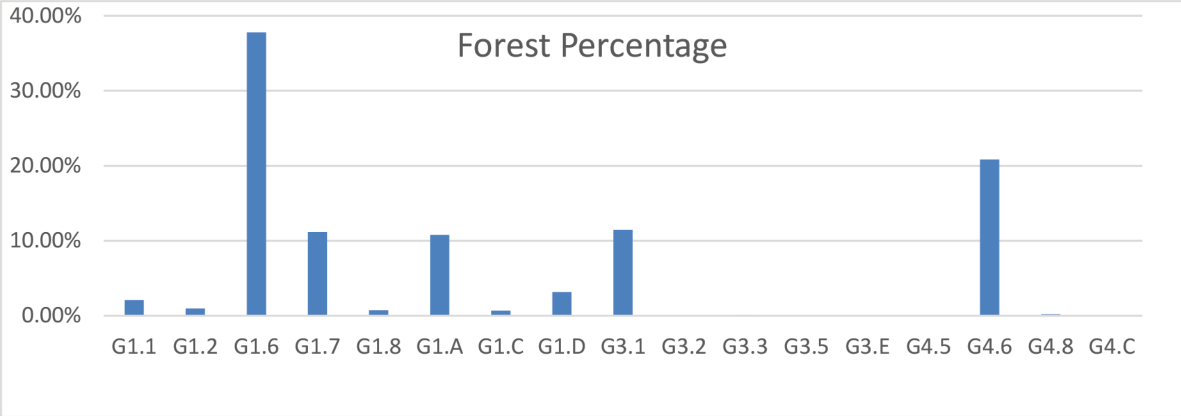
Agricultural ecosystems

EUNIS Code	Number	Surface (ha)	National percentage	Agricultural percentage
I1.1	518593	9381325.718	34.97%	99.58%
I1.4	3185	25245.77587	0.09%	0.27%
I1.5	739	14640.96168	0.05%	0.16%
I2.1	8	5.089478131	0.00%	0.00%

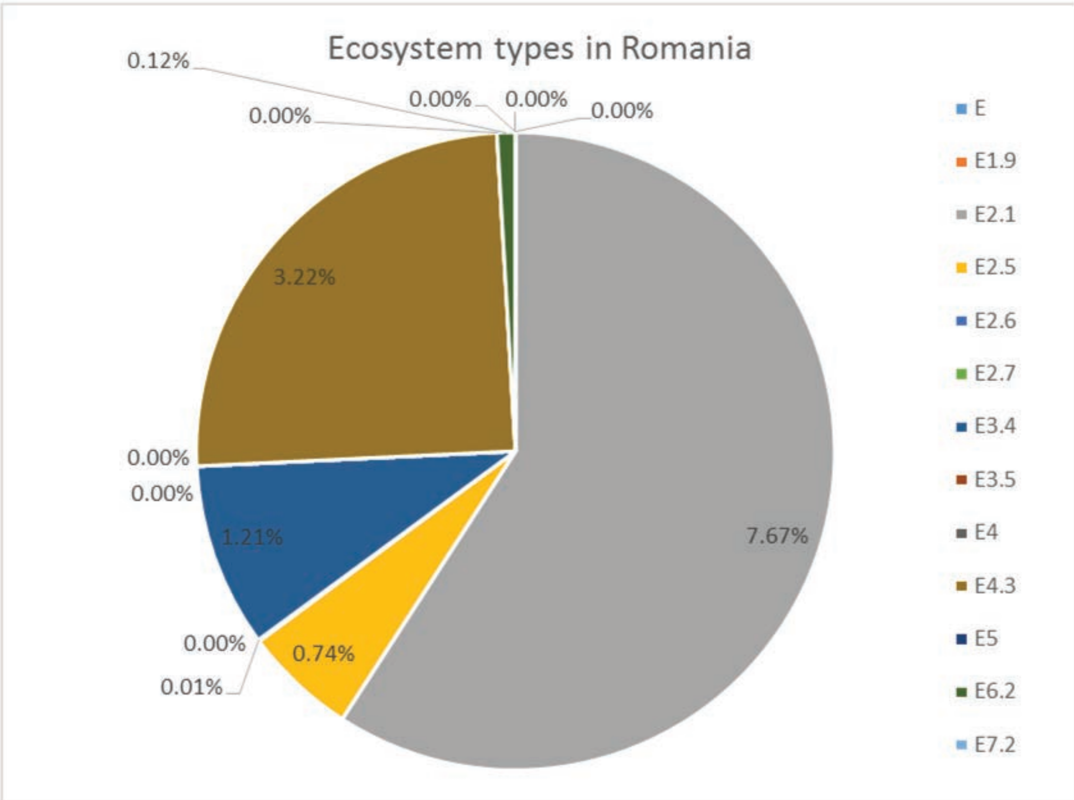


Forest ecosystems

EUNIS Code	Number	Surface (ha)	National percentage	Forest percentage
G1.1	21496	153880.35	0.57%	2.09%
G1.2	3113	69780.07	0.26%	0.95%
G1.6	75571	2775633.76	10.35%	37.78%
G1.7	42617	820221.22	3.06%	11.16%
G1.8	1732	52935.85	0.20%	0.72%
G1.A	18335	791042.50	2.95%	10.77%
G1.C	1418	49774.35	0.19%	0.68%
G1.D	39821	230914.38	0.86%	3.14%
G3.1	14084	840082.31	3.13%	11.43%
G3.2	22	2544.77	0.01%	0.03%
G3.3	168	8546.84	0.03%	0.12%
G3.5	82	4345.46	0.02%	0.06%
G3.E	1	94.56	0.00%	0.00%
G4.5	155	4002.29	0.01%	0.05%
G4.6	5712	1530891.71	5.71%	20.83%
G4.8	145	12911.17	0.05%	0.18%
G4.C	3	94.80	0.00%	0.00%

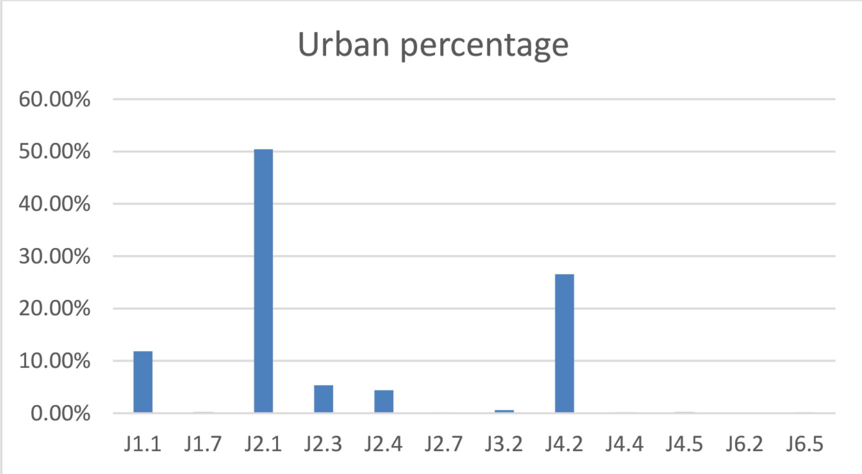


Grassland ecosystems



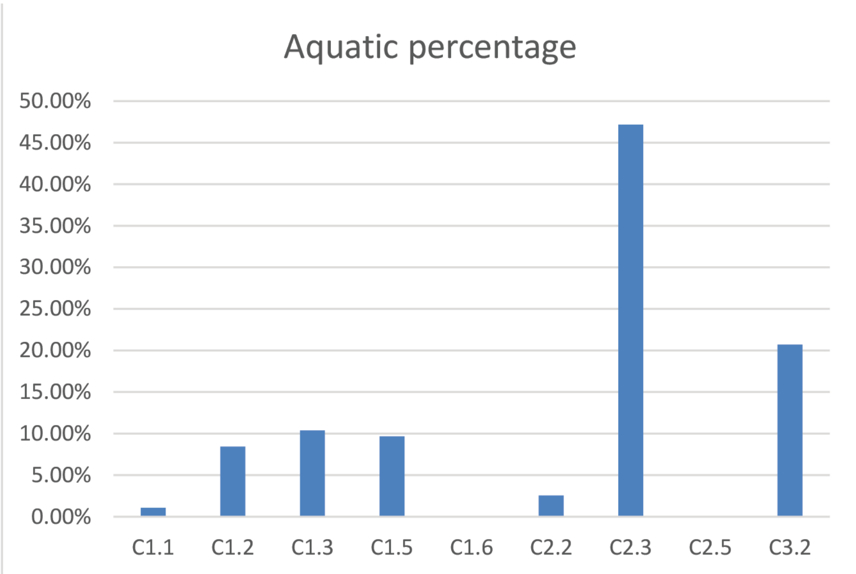
Urban ecosystems

EUNIS Code	Number	Surface (ha)	National percentage	Urban percentage
J1.1	33985	161161.6846	0.60%	11.81%
J1.7	641	3062.325413	0.01%	0.22%
J2.1	582099	688336.8131	2.57%	50.43%
J2.3	42890	72900.13976	0.27%	5.34%
J2.4	9041	60025.23255	0.22%	4.40%
J2.7	281	1275.672134	0.00%	0.09%
J3.2	79	7961.92053	0.03%	0.58%
J4.2	111811	362406.0992	1.35%	26.55%
J4.4	106	2258.142059	0.01%	0.17%
J4.5	225	2861.769035	0.01%	0.21%
J6.2	55	836.6080524	0.00%	0.06%
J6.5	131	1950.368838	0.01%	0.14%



Aquatic ecosystems

EUNIS Code	Number	Surface (ha)	National percentage	Aquatic percentage
C1.1	127	8438.24	0.03%	1.07%
C1.2	3420	66760.89	0.25%	8.44%
C1.3	1669	82165.56	0.31%	10.38%
C1.5	78	76475.89	0.29%	9.66%
C1.6	19	7.21	0.00%	0.00%
C2.2	6647	20231.27	0.08%	2.56%
C2.3	89042	373207.70	1.39%	47.16%
C2.5	29	96.92	0.00%	0.01%
C3.2	525	163903.40	0.61%	20.71%



3.4. Assessment of ecosystems and ecosystem services

The evaluation of ecosystems so that their productive capacity can be continuously monitored, in order to give them the possibility to provide specific (ecosystem) services indefinitely, represents an absolute necessity in order to define a model of economic development based on principles of green economy.

The evaluation of the condition of the ecosystems and the difference from reference, established as an optimum in the space-time evolution regarding the capacity of an ecosystem to provide ecosystem services at an optimal level, is necessary. Therefore, knowledge about the deviation from the optimum state of the ecosystems allows to highlight the existing degradation through specific structural and functional indicators.

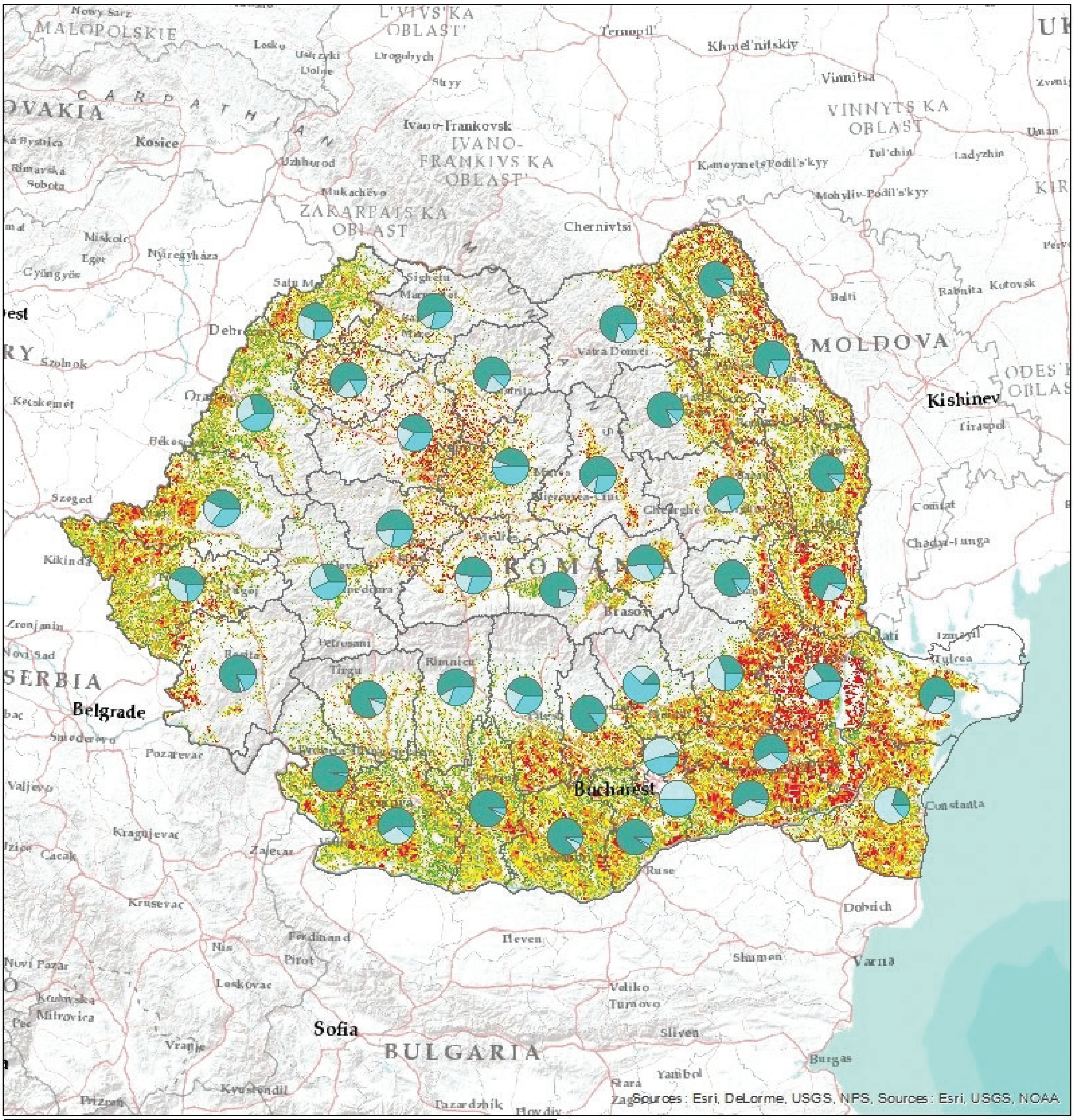
The evaluation of the condition of the ecosystem using the traffic-light method will allow to characterize it according to specific evaluation indicators so that the condition of the ecosystem is highlighted, i.e. maintaining or reducing its productive capacity, and also their tendencies.

According to the concepts of systemic ecology applied to data structures developed through the N4D project, an integrated analysis module was developed at the RO-MAES-DSS level, which allows for evaluating the condition of the ecosystem from its productive capacity standpoint, and for showing the means of degrading of ecosystem from the structural and/or functional standpoint as well.

3.5. Assessment results

The results of the evaluation demonstrate that Romania has significant potential in terms of the productive capacity of agricultural and forest ecosystems (see Figures 20, 21, 22, 23) but still there is an advanced degree of degradation of some of them amplified by current management.

Figure 20. Conclusion assessment map for service cultivated crops for nutrition



Legend

NUTS3

- Value_TEUR
- Export_TEUR
- Import_TEUR

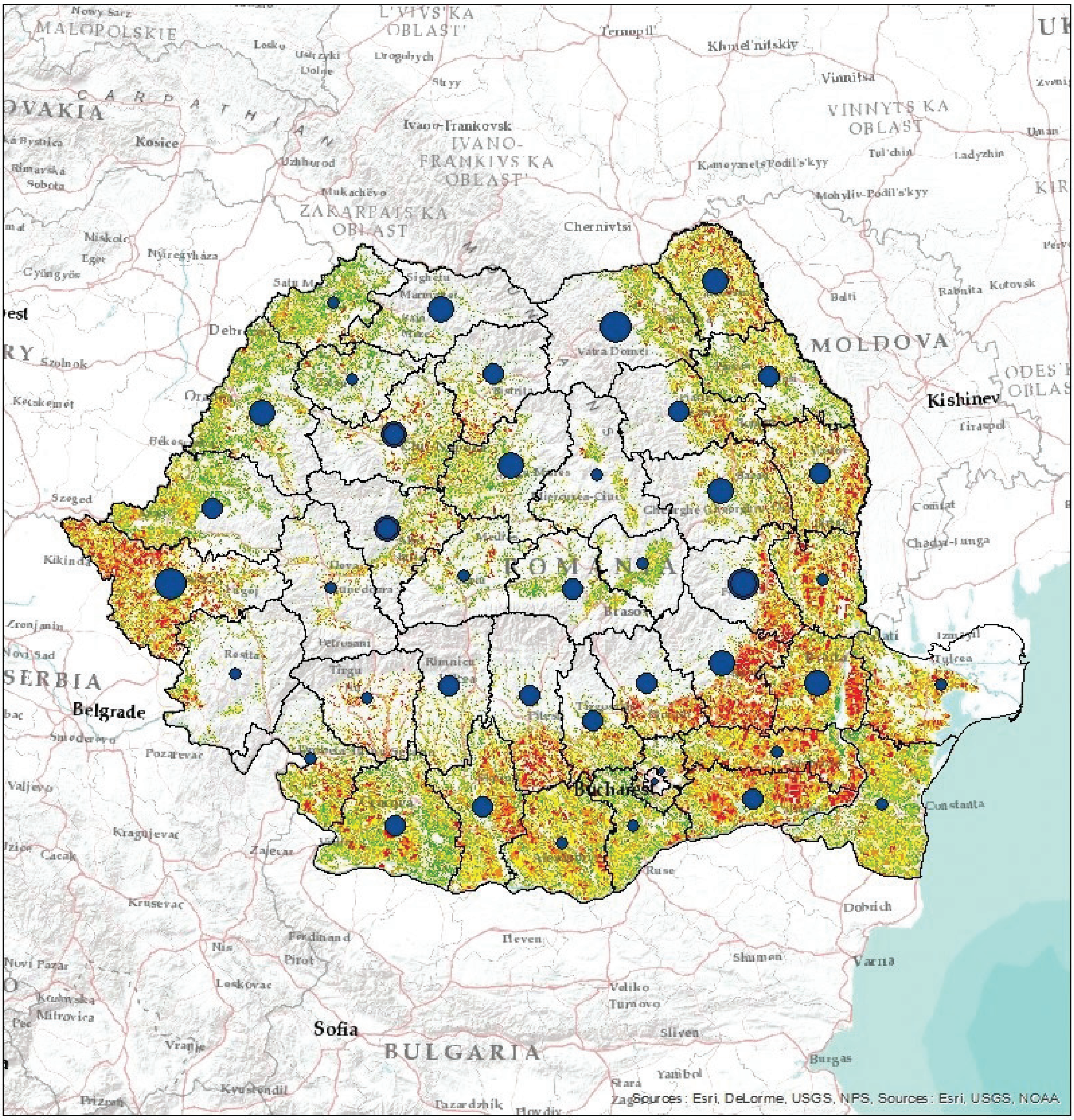
Agricultural ecosystems income_crops (TEUR)

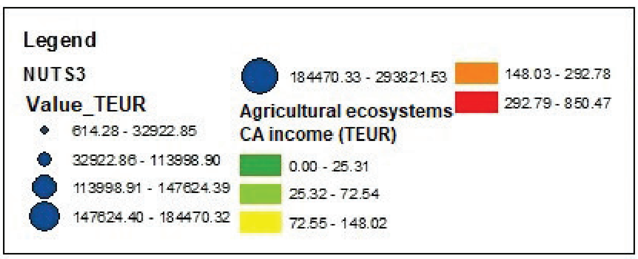
- 0.00 - 6.30
- 6.31 - 17.82
- 17.83 - 36.97
- 36.98 - 75.07
- 75.08 - 218.07

Provisioning services

Nutrition - Agricultural crops

Figure 21. Conclusion assessment map for service Reared animals and their outputs for nutrition





Provisioning services

Reared animals and their outputs for nutrition

ANPM WWF NINA rosa

Figure 22. Assessment map of soil loss through surface erosion (RUSLE 2015)

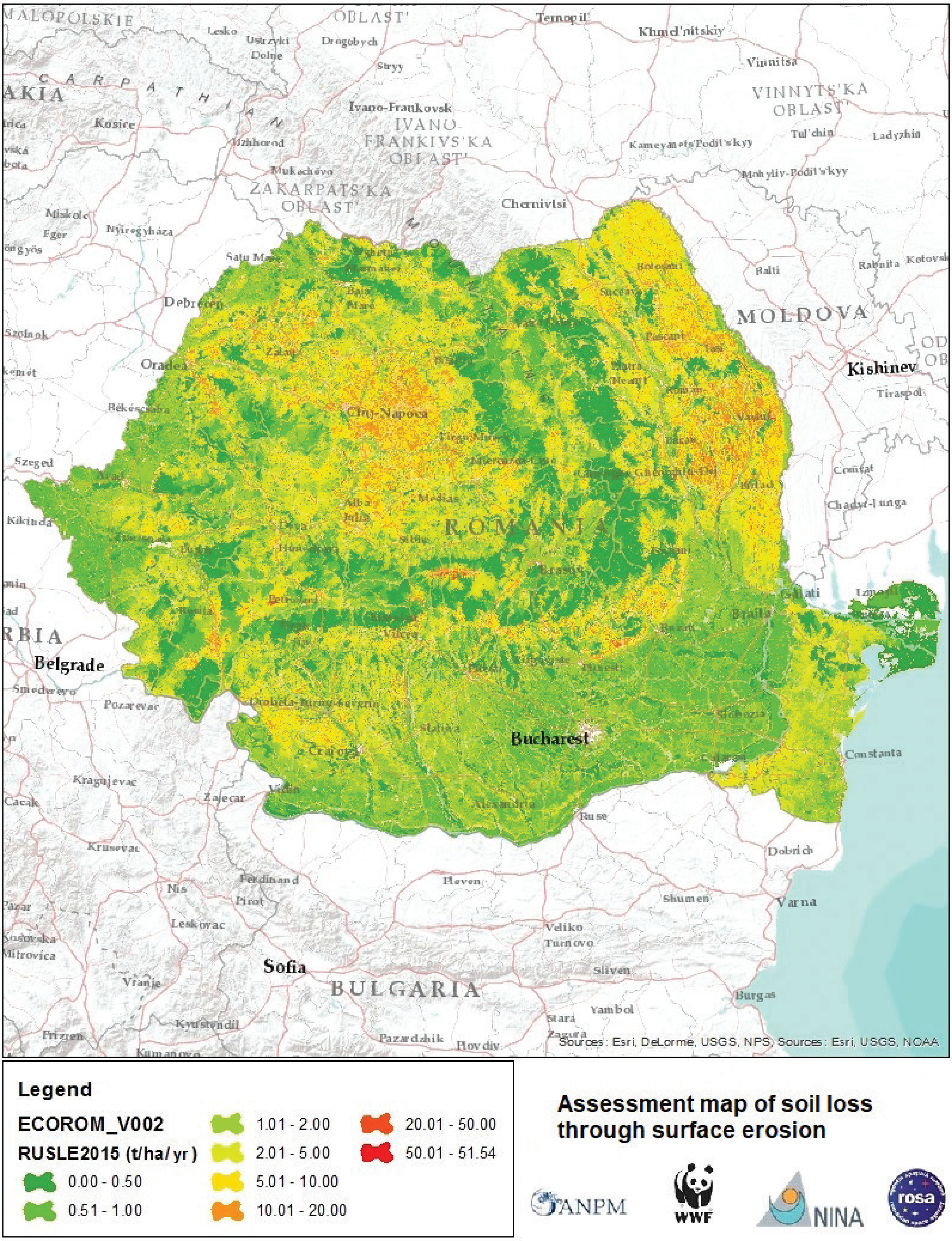
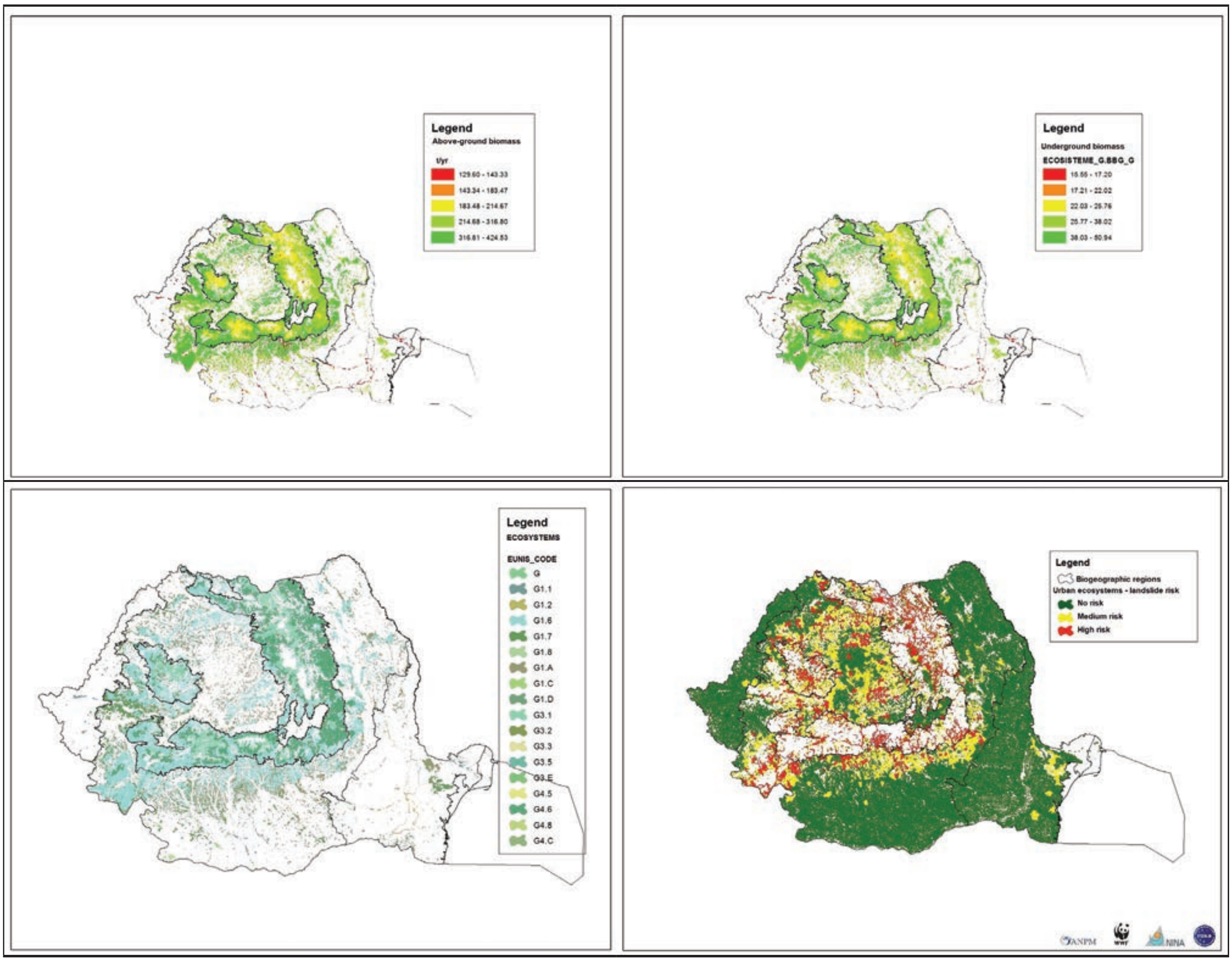


Figure 23. Forest ecosystems assessment map for productive capacity and risk for mass stabilization and control of erosion rates



3.6. Valuation of ecosystem services

Introduction

This report consists of one pilot case study of valuation of ecosystem services (ES) in Romania, i.e. economic valuation of forest ES based on reported national level statistics; and an overview of economic valuation approaches that have guided these analyses. By using and ES approach to structure the analysis, the case study aim to draw the attention to the variety of benefits that forest and wetland ecosystems generate, as a basis to inform the examination of alternative development pathways towards a greener economy.

The report consists of three sections. In the first part, we present current considerations of economic valuation of ecosystem services, up to date in the sense that it is informed by the ongoing work and experience in other ecosystem service assessments. Most weight will be on the advances within MAES related projects, i.e. EU funded projects to operationalize ES- assessment and valuation (OPENNESS and ESMERALDA), and published work under IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services) where the current membership includes 125 countries.

The background for the N4D project, of which this report is a part, is the headline target in the EU biodiversity strategy to 2020: "halting the loss of biodiversity and the degradation of ecosystem services in the EU by 2020, and restoring them as far as feasible, while stepping up the EU contribution to averting global biodiversity loss". Six sub-targets and 20 actions support this headline target. Action 5 requires "member states, with the assistance of the commission, to *map and assess the state of ecosystems and their services* (MAES) in their national territory by 2014, assess the economic values of such services, and promote the integration of these values into accounting and reporting systems at EU and national level by 2020".

Three main points can be made in connection with this. First, this EU target gives the concept ES some prominence, as was the case in the previous reports by the Millennium Assessment and The Economics of Ecosystem Services and Biodiversity (MA, 2003; TEEB, 2010). However, it is worth considering that the concept has received a fair amount of criticism, and although a full review of this discussion falls outside the scope of this report, some main points will be discussed. In particular, the monetary valuation component of the ES framework has been controversial. Nevertheless, since ES refers to the various areas of interaction between society and nature, economics is without doubt a critical domain in which these interactions take place. Second, the concept of economic value is ambiguous, as well as whose values are taken into account in the analysis. Although economic values frequently are associated with money, prices and willingness to pay, the notion is broader and exactly what economic value means has been the source of significant controversy. This debate will be the main focus of the theoretical section that follows below. Third, as indicated in the EU biodiversity strategy, the economic valuation of ecosystem services involves solving the important practical question that environmental data need to be integrated from different sources, such as data gathered in connection with the Birds and Habitat Directive, the Water Framework Directive, the Marine Strategy Framework Directive, as well as national monitoring programs. This can be an important challenge (Rusch et al. 2017), as data frequently are distributed among different institutions for whom data may seem of vital strategic importance, and data from different programs may be available at different temporal and spatial resolutions. This theme will recur several times in this report since access to data and to identify and select which ones were important and relevant ones has been among the most time consuming parts of these studies.

About economic valuation of ecosystem services

Within the EU-funded projects to operationalize the ES concept, several published papers reveal different perspectives. For instance, the OPENNESS project has produced two deliverables of direct relevance to this project: the "State-of-the- art report on integrated valuation of ecosystem services" (Gómez-Baggethun et al, 2014), and the "Framework for integration of valuation methods to assess ecosystem service policies" (Braat et al,2014). Under the umbrella of the OPENNESS project peer reviewed articles on valuation from different perspectives include Arias et al. (in press), Boeraeve et al. (2014), Bunse et al (2015), Gómez-Baggethun and Barton (2013), Gómez-Baggethun and Martín-López (2015), Gómez-Baggethun et al. (2016), Jacobs et al. (2016), Kallis et al. (2015) and Martín-López et al. (2014). These studies provide a wealth of information addressing the valuation-aspect of the ES framework. However, in the theoretical discussion in the coming section, more weight is put on simplicity, and the aim of providing a broad perspective, that will hopefully be helpful also for those not acquainted with the academic literature and jargon.

As mentioned in the introduction, the ES concept has become very prominent in the last decades as a framework to analyze socio-ecological systems. Specific to the approach is that it addresses the various interactions between humans and nature, and represents an anthropocentric perspective in the sense that it treats nature as valuable to the extent it provides benefits to humans. ES has always to a certain extent acknowledged value plurality, and acknowledged that not all values can be measured in monetary. However, there has been a perception among scientists from some disciplines that monetary valuation has been too influential and the ES concept too anthropocentric (see e.g. Silverton, 2015)[24]. The goal of this theoretical section is to highlight that the relevance of monetary values depends on the context and the purpose for which the valuation of ES is meant.

24 See also the response to Silverton by Potschin et al (2016).

Ecosystem services and value plurality

Although it is common to think of economic values in terms of money, the field of ecosystem services has already explored many different kinds of economic value. This is not a break with economic science: According to the most common definition of economics, dating back to Robbins (1932), "Economics is a science which studies human behavior as a relationship between ends and scarce means which have alternative uses". The essence of this definition is competing use of scarce resources, which means prioritization and trade-offs. Valuation arises from this prioritization; there is nothing in the definition by Robbins referring to monetary values. The English word valuation comes from the Latin word *valore*, which means to attach importance to something. Trade-offs might be described, when context allows, in monetary terms, but also qualitatively e.g. in terms of prioritization between different ecosystem services (if our knowledge allows) or more generally as a ranking between different options.

Robbins' definition of the science of economics leaves out important aspects. Understanding these omissions is key to understanding the different valuation methods, the controversies in the field of ES valuation and the situations in which monetary valuation can be relevant. The discussion that follows refers to three main dimensions of valuation studies, i) the relative weight given to individuals vs groups or the society, ii) information costs and iii) value pluralism vs value monism. Through the discussion of these three dimensions, the paradigm of neoclassical economics is used throughout as illustration. This is not because it is the only paradigm or the leading paradigm, but because it provides a theoretical benchmark for understanding when monetary valuation is appropriate.

The first dimension concerns the relative importance of individuals compared to the society or groups. In Robbins' definition of economics above, it is unclear whether we are dealing with prioritization made by or for individuals, or by or for social groups or the society. Are the preferences we prioritize individually formed, or do groups, society and culture significantly influence them? This is of course one of the main demarcation lines between different strands of political and ideological thinking. Neoclassical economics has an extreme focus on individuals, both regarding whose interests are given priority, and regarding the formation of preferences (see Sen, 1979; Daly, 1992). Theorists from a background in e.g. sociology would typically emphasize cultural influence.

The second dimension concerns information costs. Robbins' definition above does not say anything about prioritization or behavior in general, in the face of uncertainty. Neoclassical Economics in its simplest form assumes that anyone making a decision has all information and the ability to process this information in a sense similar to mathematical optimization. In the economic jargon, information costs are assumed to be zero.

As any introductory textbook in public finance will inform, the first welfare theorem says that if *individuals* behave as if they were optimizing their individual utility (in a mathematical sense, including some mathematical technical requirements) and information costs are zero in perfectly competitive markets, the outcome is *efficient* in the sense that no other outcome could make someone better off without someone else getting worse off. This includes the solution where one individual owns all the goods in the economy (this individual would be worse off if you attempt a more fair distribution). If society prefers a different distribution of goods, the second welfare theorem postulates that governments can achieve any wanted distribution by a one-time transfer, which means a change in the initial allocation of goods. Then according to this perspective, the transaction process in the markets will achieve the efficient outcome. Thus, Neoclassical theory tends to emphasize the role of market solutions. Under this particular set of assumptions, prices will be all the information consumers need to make rational choices.

However, we can assume that instead of the costless information from baseline neoclassical economics, knowledge may be local and the ability to process this information may be less than perfect – as profusely indicated by evidence (see e.g. Kahneman, 2011). In economic jargon, we now assume positive information costs. The value of markets in this context is that in markets, no one needs to possess all knowledge (Hayek, 1948), easing the need for centralized planning. This may explain the seemingly contradictory findings following the recommendation of neoclassical economics of market based solutions seems to be a success in terms of economic growth – in the limited GDP sense and in a temporal context (Maddison, 2007) although the underlying behavioral assumptions are certainly false if interpreted literally (Kahneman, 2011). Under the assumption of positive information costs, prices still ease the information problem for consumers – if prices reflect all costs, including costs on environment. Indeed, for strong believers in free markets like Hayek (ibid.), pricing is the *superior* way of providing information. However, as emphasized by Bromley (1990), what makes markets work successfully, i.e. the decentralization of decisions and knowledge, increases the cost of coordination when the side effects of this economic system in the form of negative impact on the environment accumulates. Thus, the policy recommendation of deregulation may in this case, contrary to what is expected, lead to increased need for regulation. For costs of side effects that can be readily assessed, information costs could be added to the market price, thus leading the price to provide the relevant simplification of information again. However, two general objections to this approach should be mentioned. First, prices reflect only the situation today, and fail to represent value for decisions in the future, (Vatn, 2012), i.e. future generations do not have an influence on current prices. In addition, current prices reflect current supply and demand, where the demand may be an unsustainable use of the system, which negatively affects the supply in the future. As an example, assume that harvest of fish is at unsustainable levels, i.e. overexploitation of fisheries. According to economic theory, prices will be higher if harvest is reduced for a given demand. Thus, if we use current market price as value in a system of unsustainable use, we will see the value less favorably than in the sustainable economy we are trying to reach (Kallis and Norgaard, 2009). The second objection relates to the fact that although prices simplify information, prices are not necessarily the relevant simplification. This is especially so for functional characteristics of ecosystems. Natural resources are most importantly interlinked in processes. Natural living systems are also characterized by discontinuities, i.e. we can have thresholds with abrupt changes when these thresholds are exceeded (Perrings, 1997). Hence, the information requirement for prices to inform accurately about the continued functioning of the system is huge. Again, side effects of the decentralized market structure may accumulate and increase, in turn, the need for interventions in the market.

The potential for prices to provide the relevant simplification of information is weakened further if we consider the third dimension mentioned in this section: Value monism vs value pluralism. The demand for value pluralism in environmental issues frequently comes in connection with moral values (Vatn, 2005), such as the rights of species to exist and the rights of future generations to enjoy and use nature. In issues like these, many will object to prices as a relevant measure of value. Value pluralism vs value monism has been a central dimension in the controversies around economic valuation, especially monetary valuation, and it has been claimed that this dimension is also reflected in the distinction between environmental economics and ecological economics: Value plurality is acknowledged as one of the founding principles of ecological economics (Martínez-Alier et al, 1998). On the other hand, it has been claimed that environmental economics largely acknowledge value monism (O'Neill et al, 2008), likely because environmental condition can often be evaluated with single indicators (e.g. Nitrogen concentration in water, atmospheric CO_2 concentration, CO_2 sequestration capacity).

Individual and societal values

Moral values may seem of less importance in a framework with extreme weight on individuals. A more radical departure from neoclassical economics allows the possibility that society or groups inform individual preferences, habits of thoughts and norms (see e.g. Daly, 1992; Vatn, 2005). This involves the possibility for different modes of rationality. Rationality in terms of what is best for the individual and rationality in terms of the group. This set of assumptions is necessary to understand a concept that has been discussed frequently in the literature on valuation, namely value articulating institutions (Jacobs, 1993; Vatn, 2005). The understanding of institutions in the Value Articulating Institutions (VAI) concept is broad, and does not only include formal institutions, but also habitual behavior within groups of people, like greeting by convention is done by a handshake in many cultures. Institutions in this broad sense may form or activate preferences, and the way we find it right to express them. In the description by Vatn (2005, pp.301-302), a VAI defines a set of rules concerning the value process. Rules for participation (who may participate, on what premises and how), rules for what counts as data (prices, weights, arguments, etc.) and rules for data handling. In the context of VAI then, the rule of participation of individuals according to neoclassical economics is through markets, and the environmental problems caused by individual decisions are viewed as a market failure. Further, the important data are prices. This is obviously a stylized description. However, an important point is that a valuation method with roots in the neoclassical paradigm that asks for willingness to pay provides a setting where the appropriate response is in terms of prices. Even if the respondent considers that the question is better answered in terms of what is best for society, the method constraints the value assessment to individually based rationality. In this sense, a valuation method is a VAI (Vatn, 2005).

In contrast, valuation methods like citizen juries and deliberative methods invites to think in terms of group rationality and data in form of arguments instead of prices. Thereby, the choice of method will largely determine the kind of values captured in the assessment. This raises the possibility that increased dominance of e.g. market-based valuation methods will increase the prevalence of individual rationality at the cost of common norms. The net effect in the case of, for instance, nature conservation will then depend on the relative importance of self-interest vs social norms when analyzing human-nature interactions. Some empirical studies support this hypothesis (e.g. Frey, 1997, Frey and Jegen, 2001). Historical observations also indicate that what a society finds acceptable to trade in markets vary, suggesting that norms may be of a dynamic nature. It has been argued that more self-interest based rationality erodes moral and civic goods worth caring about (Sandel, 2012). On the other hand, it could be argued, as one prominent neoclassical theorist reflected on that: "we do not wish to use up recklessly the scarce resource of altruistic motivation" (Arrow, 1972, pp.354-355). Followed to the extreme, the theory of VAI thus suggests that the choice of valuation method itself is at least partly a normative question. Following Norgaard (e.g.2009), we could also talk of a co-development of science and dominant ways of thinking, like a dominant market thinking could lead to scientific advances along this dimension of socioecological systems, but also reduce progress along other dimensions. In this context, one can understand Sandels' (2013) claim that in the question if a good should be allocated by market principles or not, economics is a poor guide.

The importance of context in ES valuation

If we accept value plurality, as the integrated valuation work in the OpenNESS project or the IPBES framework, it then follows that multiple ideas may be equally correct and still in conflict with each other (Mason 2006, 2013), which seems like complete agnosticism. The key to avoid this situation is context sensitivity when addressing an ES valuation problem. Context sensitivity has several aspects: First, we may talk of context sensitivity in terms of the relevance of the assumptions implied by the three major dimensions above. If the study concerns an individual business owner with reasonably good information, the neoclassical framework could be a reasonable point of departure, not because of the belief that the assumptions of the theory are true, but because they have comparatively less weight in determining outcomes, thereby providing a working model for the case at hand. If on the other hand the valuation concerns a national scale ES assessment, the assumptions of neoclassical economics would be of relatively little relevance.

A second aspect of context specificity concerns the prevailing norms and institutions in the region or country for which the assessment is done. Norms might be different in the UK and Romania, for instance, and the choice of methods should reflect these differences. It is important to understand the compatibility of the valuation or appraisal method with the governance context (Laurans and Mermet, 2014; Primmer et al, 2015). There is an important point in connection with this: One of the purposes of monetary valuation of ES that have underpinned the theory and practice in ES is to design instruments to correct for market failures, which makes sense if the point of departure is the assumptions of neo-classical economics and a context of market based solutions. However, there is nothing in the ES-framework that validates new institutions like Payment for Ecosystem Services (PES) in any situation or context.

The purpose of ES valuation

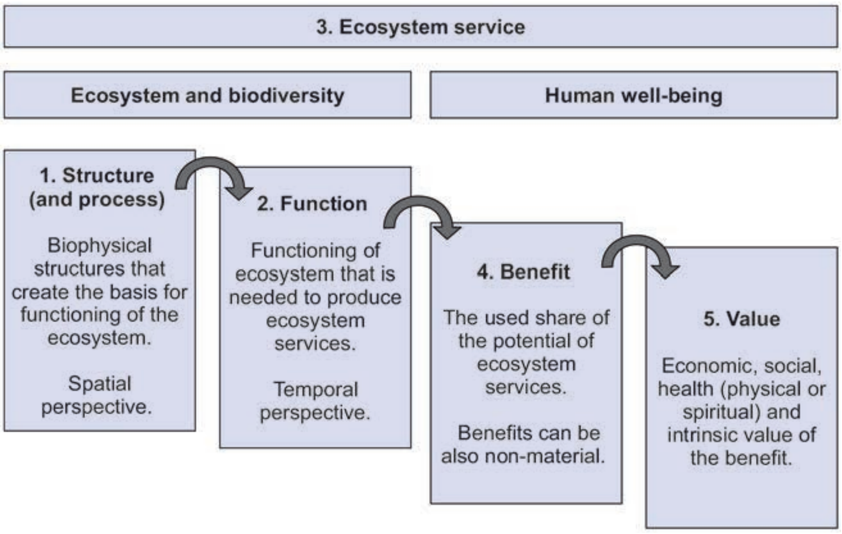
A third important question related to context concerns the purpose of the assessment or valuation. The important issue here refers to the required precision of the valuation exercise and the quality of the data that underpin the assessment. If the purpose is awareness-raising, the required precision is moderate, but in the cases of litigation, or legal processes, the required precision is very high (Gómez-Baggetun & Barton, 2014). Stated differently, if the purpose is awareness raising we could accept more imprecise numbers, more questions concerning value plurality and so forth.

In a comprehensive valuation, like in the context of national assessment of ES in Romania, it is clear that to only conduct monetary valuation, will be partial and potentially misleading. Thus, in such contexts it is usually argued for an integrated valuation approach that "…explicitly recognizes the ecological, sociocultural and monetary values of ecosystem services and their link to processes of decision making and planning" (Goméz-Baggethun et al. 2014). However, in terms of the dimension of information availability and information costs, this leads to fairly demanding information and data requirements.

As Barton et al. (2016) points out, methodological and measurement errors across conditionally dependent knowledge domains are cumulative, i.e. errors will accumulate as we assess and aggregate across the biophysical, sociocultural and monetary domains. Thus, even if integrated valuation of ES is clearly preferable from a value plurality perspective, we can probably expect that simpler approaches will be chosen because of information (data) and time constraints. Under this conditions, the assessments may be less policy relevant if important values are neglected. In addition, even if the integrated valuation is done, the uncertainty in the assessments can still be a constraint for policy and decision-making. This seems to be very consistent with the findings in review papers by Laureans et al (2013) and Martinez-Harms et al (2015) where they find that there is a general challenge for ES appraisal assessments to fulfill the promise of providing readily usable information for policy support.

In integrated assessments, a version of the cascade model (Haines-Young and Potschin, 2010) is has been commonly used, because it considers the different elements that encompass ES assessments, and its use is also recommended for mapping ESs to support decision making (Maes et al, 2012). The version that has informed this study largely follows Mononen et al (2015) and is depicted in Figure 24 below:

Figure 24. The cascade model (figure from Mononen et al, 2015).



This conceptual framework was obviously meant as a way of both addressing the values derived from ES as well as the ecological condition of the system that supports them. The practical use of it will be addressed in connection with the case studies below. Here we address the theoretical implications from the discussion above. In a strict sense, the valuation of ES, i.e. the importance that individuals, societal groups, or society at large attach to the benefits obtained from nature, is related to the last step in the cascade. However, the VAI framework described above (Vatn, 2005) indicates that there are a series of decisions along the different 'boxes' of the ES assessment following the Cascade model that involves values, including the choice of which values to elicit, of methodological tools and of which ES or benefits and beneficiaries to include (Vatn, 2009). As Jacobs et al (2016) point out, these choices imply "severe implication for the conceptualization of valuation, the valuation practice itself and the role taken by the scholars who perform the valuation". Hence, the question of valuing ES, requires of other considerations than the mere estimation of the economic and social value of the benefits derived from nature.

In the case of the MAES process in Romania, it is important to be aware of the implications, and to consider them in the analysis. For instance, the establishment of the scientific group, who are the members and which institutions they represent, define in part how ES are valued in the national assessment. Hence, if there is disagreement in the scientific community about which ES are important, the divergence of opinions should be transparent. Similarly, in the choice of indicators of benefits and values the question of benefits and values *for whom* should be transparent during the valuation process because different social groups can hold different values.

This brings us to the open-ended conclusion of this section. The discussion above is framed in terms of three important dimensions of the valuation context: i) the weight given to individuals vs groups in terms of who is making the decisions with an impact on nature, ii) the role of information costs when making these decisions, and related to the first dimension, iii) the consideration of value monism vs pluralism. One could ask whether there has been any progress in the field of ES valuation. Has knowledge advanced? Jacobs et al (2016) claim that the dust is setting on the nature valuation debate, that "from the applied perspective, the need for combining multiple disciplines and methods to represent the diverse set of values of nature is increasingly recognized".

However, the pathway of integrating science and policy for nature management still faces considerable obstacles. Cáceres et al (2016), for instance, ask why do "co-produced, policy relevant, adequately communicated science fails to influence policy implementation?" Above, the complexity of the problem in terms of uncertainty and conflicting values has been indicated as possible reasons. But Cáceres et al (ibid) test both information deficit and power dynamic models and conclude that it is the second that best describes the process in a forest protection case in Argentina. Berbés-Blázques et al (2016) claims that power relations largely mediate access, use and management of ecosystems, and yet the consideration of these aspects in ES science is incipient. It has already been discussed that value articulating institutions although relatively stable, can change. If power relations are important, surely these would influence the VAI as well. Then the dust may be setting several times. After all, the modern debate about value monism vs value pluralism is just a reverberation of the 19th century debate between John Stuart Mill and Jeremy Bentham, the latter commenting on Stuart Mill's utilitarian theory that the *utils* might be a good measure of peoples *wants* but not of their *beliefs*.

3.7. Monetary value assessment methods

In light of the preceding theoretical discussion, it is no wonder that the scientific inquiries into how individuals or societies value nature have resulted in different ways to categorize values. The main categorizations found include that in the total economic value (TEV) framework (Krutilla, 1967) that divides values into use and nonuse values, where use values include direct, indirect use and option values, and nonuse values include satisfaction from the existence of the nature good *per se*, or for future generations. In the TEEB-project, values are classified into ecological, sociocultural and monetary (Gómez-Baggethun and Martín-López, 2015). The IPBES-classification is even broader and operates with three value dimensions: intrinsic values (non- anthropocentric values), instrumental values that include all the use values in the TEV-framework, and relational values (Díaz et al 2015). Relational values emphasize relations between people and between people and nature. Relational values typically apply for cultural ecosystem services (Chan, 2016).

In this section, where monetary valuation methods are discussed in more detail, we thus mainly address the use values, or instrumental values according to the TEV and IPBES frameworks, respectively. As in the theoretical discussion above, this part will seek to strike a balance between a description that is reasonably easy to read for non-economists, but still precise enough. Technical guidelines for the different monetary valuation methods are readily accessible (see e.g. Bateman, 1999). In light of the discussion above, it should be born in mind that many of the monetary valuation techniques originate from the neoclassical economic tradition. Implications of this will be discussed as we proceed.

We will start with benefit-based models in 3.2, including measures of *stated preferences* or *revealed preferences.* Section 3.3 will cover cost-based methods, e.g. *opportunity costs*, *avoidance costs* and *damage costs*. Finally, section 3.4 will cover the benefit-transfer method.

Benefit-based methods

In benefit-based models, we either evaluate *stated preferences* or *revealed preferences*. The revealed preferences approaches can again be divided into direct and indirect methods, where the direct methods include use of market prices to value productivity gains or losses. An example could be an increase in forest productivity due to a reduction in the emissions of pollutants such as sulfur dioxide and nitrogen oxides. A monetary value of the reduced emission in this case, can be obtained by simply multiplying the physical changes in the forest e.g. increase in forest timber productivity) with the observed market price. This approach does not correct for adjustments in behavior or price, however, meaning that the value is correct only if consumers have restricted adaptability, and the changes in productivity are small enough not to affect the prices in a significant way. The method can be useful, but one needs to be aware that the assumptions may in some cases be wrong. In light of the discussion above, the method is applicable if there already is a market price; in this context monetary valuation may have social accept.

The Travel Cost (TC) method has been widely used to measure the economic value of recreational activities. The simple idea is that consumers are willing to pay in terms of time and transportation costs. In the simplest case, time can be valued according to average salaries and transport costs can be estimated according to average costs based on available information on distance to cities, public transport, fuel costs and so forth. In general, the travel cost method assumes that demand for trips to a specific site is dependent on travel costs, income, availability and characteristics of the site and prices of substitutes etc. Based on this, demand curves can be derived. The method could fail if travel is not perceived as a cost (e.g. enjoyed as part of the trip), if people combine purposes in the trip (travel to a nature park because it is close to some family) or if people enjoy the site so much that they choose to move close to it. However, it is possible to meet these challenges by conducting detailed surveys. This would increase the cost of applying the method. In addition, the value that results is a use-value and does not capture other values, e.g. intrinsic value of nature. If the non-use values are important, the method will thus underestimate the true value.

The Hedonic Pricing Method (HPM) is based on the idea discussed above, that prices provide simplified information. In many cases, market goods are traded at prices in which natural amenities are included, or internalized in the jargon. The classic example is property: The price of a house or summer house in natural surroundings is likely to be higher than a similar property without these surroundings. Or vice versa: the house close to the highway may be less expensive than a similar house away from the traffic nuisance. The HPM analysis starts with a regression of house prices against all their valuable characteristics and from this regression function the willingness to pay for a marginal change in these variables is assessed. HP data can be quite costly to collect, since residential property databases with enough data on all the necessary regressors is often lacking. Also in this model, the validity of the results may be questioned. For instance, in the case of neighboring beautiful scenery and a noisy highway, it is hard to calculate the effect we are interested in. This method also requires some competency; it is easy to forget an important confounding variable in the regression model, or to encounter collinearity. Conclusions in these cases would be spurious.

Turning to *stated preference methods* (SP), these methods estimate the value of the environmental good by constructing a hypothetical market for the good. The strong side to these methods is that the hypothetic nature makes it possible to ask questions about willingness to pay in cases where there are no markets or prices to observe. However, the hypothetical aspect has frequently been acknowledged as a potential weakness. Worse however, is that willingness to pay in these contexts seem to be partially motivated by moral issues or previous experience (Kahneman and Knetsch, 1992; Spash, 2006), thus it could be argued that the willingness to pay indicator should be partially understood as an indicator of sociocultural preferences, rather than market values (Chan et al, 2012).

The SP methods can be divided into direct and indirect approaches, where the direct Contingent Valuation (CV) method is by far the most used method, even though recently the more indirect method of Choice Experiments (CE) has become more popular. A CV survey constructs scenarios that can offer different possible future government actions. Frequently the respondent is offered a binary choice between two alternatives, one being the *status quo* policy compared to a second alternative policy with a cost greater than maintaining the status quo. The respondent is then faced with the hypothetical question that the government will impose the stated cost (e.g. increased taxes, higher prices associated with regulation, or user fees) if the alternative to the status quo is provided. The respondent then provides a "like" or not. This is a discrete choice setting, but multiple choices can also be used.

In *Choice Experiments* (CEs) individuals are ask to choose from alternative bundles instead of ranking them. Respondents are asked to pick their most favored out of three or more alternatives, and typically they will have multiple sets of questions.

In *Production Function* methods, economic values for ES that contribute to the production of commercially traded goods are estimated. The production function specifies the relation between "input" and "output", typically, the ES function and yield. This will be clearer through examples: One example may be pollination. The commercially traded good may be some fruit, and pollinators provide input in this production. The production function is specified first, i.e. the functional relationship between pollinators and production of fruit. Based on this production function it is then possible to estimate change in production when pollination changes. This change in production multiplied with the market price will then give a monetary value of pollination. This is benefit-based application of the production function method. It is also possible to have a cost-based application of the production function method. Cost-based methods will be covered in the next section, but as a prelude, an example of a cost-based application of the production function method will be given. The example concerns the end-product "clean drinking water". Possible inputs are water of different quality, content of chemicals, filtration technology, etc. The functional form will specify the need for chemical treatment or filtration for the different water qualities. Then, it is possible to assess the changes in costs with different changes in water quality. As clean water needs less input in terms of filtration and treatment, a value for the clean water is also an input.

The main limitations of methods based on production functions are first, they are only relevant for resources that can be meaningfully thought of as inputs in production systems, and second, it demands much scientific information about the relationship between quality/quantity of a resource and the outcomes (Åström et al. 2015). This will be particularly difficult when the natural resource we assess support the production of more than one product. Then, the production function must be carefully constructed so problems of double counting are avoided and potential trade-offs for end products are made clear (Barbier, 1998). In general, the production function will not include all functional relations in the ecosystems, and will thus provide only a part of the economic value. Depending on the concrete application, it may not be entirely evident that the final good (outcome) has a good correspondence with the different inputs. In the drinking water example, we already know that chemically treated water and natural spring water are not perfect substitutes, because there is a market and a price premium for the latter. Data requirements also include costs of relevant inputs and/or market prices for the end product.

Cost-based methods

The general idea in the cost-based methods is that the costs incurred in recreating the ES artificially provide a value of the ES. I.e. the costs of e.g. man-made water filtration is used for the value of natural water filtration. It is frequently considered as a second-best method in economics, where second best implies that some optimality conditions are not satisfied. The distinction between first- and second-best methods holds logically within the assumptions of neoclassical economics. However, in a setting with high uncertainty the logic seems to be of less relevance. In any case, it is considered appropriate in the context of regulating services in the TEEB guidelines (TEEB, 2015). Cost-based methods have been divided into different sub-categories of methods by different authors, but these categories overlap to a large extent. For instance, the cost of human-made flood control infra structure (e.g. dams, dikes) could be used as a value of the natural flood control of the forest cover in the watershed. If the flood risk of a particular area is known, people may choose to move away from the area, and these *avoidance costs* can also be considered as part of the value of the natural flood control. *Damage costs* could be e.g. the insurance value in flood events. Another important cost-based method is that of *opportunity costs*. Opportunity costs are net foregone income or benefit from not pursuing other options. For instance, if a forest area is protected and excluded from use, the opportunity cost of conservation are the forgone benefits of exploiting the forest. Thus, this commercial forest value is the opportunity costs of the conservation in this case.

The Shadow Price Method

The Shadow Price method builds on mathematical theory for constrained optimization. The core idea in intuitive terms is that whenever society imposes a set of (environmental) regulations, there is at least an implicit valuation. If a rule is imposed with maximum quotas for a certain species of fish for instance, this will mean that profit in optimum in this fishery will decrease. This is maybe the hardest technique to explain in a short section, but as it is a method that has been fairly much used, some main points will be mentioned:

Assume a simple consumer decision with only two alternatives of consumption x and y. This consumer wants to maximize his utility U from these two consumer goods, but the consumer also faces a budget constraint: The quantities of the two goods multiplied with their respective prices must be less than or equal to the budget *m*. For simplicity, equality will be assumed here. Thus in mathematical terms the consumer faces the optimization problem:

$$\max x, y\, U(x, y) \;\; s.t.\, p_x x + p_y y = m$$

Obviously, one of the ways of solving this is by formulating the Lagrangian function:

$$L(x, y, \mu) = U(x, y) - \mu(p_x x + p_y y - m)$$

Maximizing this function using the standard derivatives first order and second order conditions, we will find that the value of μ in optimum can be interpreted as the value of a marginal ("small") change in *m*, i.e. the budget. This is what frequently is called a shadow price or shadow cost, which will be expressed in units of the objective function per unit of the budget constraint. In this simple example, the problem is designed as a consumer problem, with a monetary budget, and thus monetary valuation is not a logical problem. If the "budget constraint" were related to biodiversity and the objective function was related to profit from land development, we would face the problem with value plurality again: We would face a shadow price measured in money per unit biodiversity. Because this method satisfies the optimality conditions, it is called a first-best method. In the TEEB documents (2015) it is mentioned that an advantage with the method is that the shadow price reflect true economic value or opportunity cost to society. However, in practical terms the difference between the shadow price method and cost-based methods may not be significant. If we observe someone incurring the costs of e.g. erosion control artificially, we can only say that the benefit from erosion control is *at least* as big as these costs, but not the exact value. The same holds for shadow prices in many cases. If an area of forest is protected, a constraint is imposed on the optimization problem for the forest owner. In the zero information cost-scenario, the shadow price *is equal* to the value of a small change in the value of the constraint, or the true economic value in TEEB-terms (2015). However, assume a value plurality scenario, and assume as is relevant in the Romanian context, that areas of forest are protected as genetic reserves. In this case the shadow price, in a properly constructed problem, will give an estimate of opportunity costs, e.g. market value of foregone forest harvest for small changes in protected area, but not the non-use values. Thus, in the value plurality scenario where the non-use values will be unaccounted for, the only reasonable interpretation is that the value of these genetic resources to society has to be *at least* as much as the shadow price, thus the same interpretation as in the cost-based methods. For much more details see Clark (2010).

Value transfer

The general idea in value transfer (VT) methods is that an existing value for an ES from a study site can be transferred and applied in another. VT is frequently called benefit transfer, but in principle both benefits and costs could be transferred. Ideally, one would use new primary studies, however as funding and time may be of concern VT might be justified. There are four categories of value transfer methods (TEEB, 2015): Unit VT, adjusted unit VT, value function transfer and meta-analytic transfer. In unit VT, the value of e.g. willingness to pay per household per year in one area is simply transferred to the new area. This could obviously be misleading if the new area is very different from the primary in terms of the various factors that can affect house pricing, such as average income. Adjusted VT seeks to compensate for these differences, for instance by adjusting for income, and in international context also Purchase Power Parity (PPP) which accounts for different levels of costs in different countries and exchange rate. The main weaknesses in VT and adjusted VT relate to the quality of the primary studies and the generalizations done in the transfer. The value function transfer and meta analytic transfer seek to mitigate this by transferring a more complex value function based on one or more similar studies (value function transfer) or and also by including several studies of different scope (size, characteristics) in the case of the meta analytical VT. This increased complexity also increases the cost of the method, thus reducing its main advantage. In general, three sources of errors have been pointed out in VT-methods (Brander et al, 2006). First, errors associated with the primary study. Valuation comes with uncertainty in general, and the quality of the primary study is obviously also important. Second, the errors in connection with the transfer: The potential differences in income has been mentioned; in addition there are the differences regarding environmental and physical characteristics. The third source of error is publication selection bias, a tendency for journals to publish methodologically interesting papers, while empirical valuation studies tend to be published in grey literature, PhD-theses etc.

3.8. Economic valuation of ecosystem services from Romanian forest using reported national statistics

Background

Forests cover more than 40% of the land surface in the EU and is the main repository for terrestrial biodiversity in Europe (EU commission, 2015). In addition to biodiversity, forests provide important ecosystem services (ES) to society such as purification of water and air, carbon sequestration, erosion control, wood provision for different purposes and important opportunities for recreation (ibid). Although the multiple functions of forests are increasingly recognized at EU level, the ecosystems, habitats, and species (i.e. the natural capital) that provide these benefits are reported to be degraded or lost due to human activity (EU, 2015). In part as a response to these impacts, the European Union's Biodiversity Strategy and the Forest strategy request member states, among other things, to ensure that national forest plans contribute to the adequate management of the Natura 2000 Network by 2020 (European Union, 2015). On this background several studies aiming to map forest ES have been conducted at European scale (e.g. Busetto et al, 2014), national scale (e.g. Spanish National Ecosystem Assessment, 2014) as well as several regional studies.

In Romania, forests cover roughly 26% of the land area, or almost 6.4 million hectares (ha) according to the National Institute of Statistics (NIS), and forests are intimately linked to the country's cultural, economic, social and historical development (FAO 2017). In Romania, the functional zoning system, implemented since 1954 in forest management, was based on the concept that Romanian forest should satisfy both the need for timber and for protection. Depending on their functionality, Romanian forests are classified as follows: (i) *forests with special protection functions*, having the role of maintaining and developing economic, social and scientific objectives; and (ii) *production and protection forests*, having the main role of producing timber for the wood processing industry, and a secondary protection role. The first group of forests (table 19) was divided into 5 subgroups, each subgroup having a lot of functional categories. In time, depending on the importance of the forests, their functions and the services they provide, and considering the importance of biodiversity conservation and forest adaptation to climate change, the *Romanian functional zoning system* developed continuously.

At the same time, forestry is an important economic sector in Romania. Romania had the largest forestry and logging workforce in Europe with 49 200 annual work units in 2010 (Eurostat, 2013). This reflects that forestry and logging in Romania is labor intensive, as removals per work unit or other measures of economic productivity are low (Eurostat, 2013). Gross value of forestry in Romania was reported to 521 million euros in 2005 and 898 million euros in 2010 (Eurostat, 2013). Romania also has some of the last remaining tracts of old growth forests in Europe, recognized for exceptional biodiversity with many endemic, rare and threatened species (Knorn et al. 2013). These forests, in relatively close proximity to a large number of people, also have the potential for important recreational values. At the same time, high population densities are often associated with infrastructure development and accessibility, and thus increasing the risk of logging by lowering opportunity costs (Schröter et al. *2017*)

Data and conceptual model

Our categorization of forest ecosystem services (ES) is based on the Common International Classification of Ecosystem Services (CICES), and indicators are organized according to the cascade model (Haines-Young and Potschin 2013). Our application of the cascade model is based on the national indicator framework from Finland found in Mononen et al. (2016).

The cascade model in Mononen et al (2016) has some alterations compared to the original cascade model. Level 3 has been used as a headline for the ES in question, as it is believed this improves communicability and that ES are adequately described through the set of indicators from steps 1 and 2 for the biophysical part, through steps 4 and 5 for the human well-being components. Steps 1 and 2 aim to address preconditions for continued provision of the ES, and steps 4 and 5, the societal dependence on the ES in question. Mononen et al (2016) also state that the chain of indicators aims "to demonstrate the stepwise social-ecological nature of ecosystem delivery". It could be argued that arrows in the opposite direction should also be included in figure 24. As an example, employment in forestry as an indicator or benefit, but can also be an indicator of overuse and ecosystem degradation in levels 1 and 2 if exploitation levels are not sustainable. In this report, in the cases where long-term data on all four levels, we will address the interdependencies between benefits and ecosystem condition to some extent. For instance, a typical indicator for step 1 could be area of suitable habitat for native biodiversity, e.g. ha of forest (of a particular type), or size of a wildlife population. Step 2 typically concerns productivity, e.g. growth rate of forests in m^3/ha. Step 3 is the benefit, and could be the actual harvest of wood in m^3. Step 4 are indicators of value for the benefit. This could be in terms of trade or employment, but in general, value will here be understood in a broad sense, reflecting the importance attached to the benefits generated by the forest (Díaz et al. 2015). Thus, values could also be of various kinds such as those related to human health.

For a complete assessment and valuation of ES from forests in Romania within this framework, there are a series of data constraints. These constraints concern the existence of data, the rights to use the data and the resolution of available data (spatially and temporally). It also includes linguistic problems for those who do not speak Romanian, as not all relevant information exists in English. For example, wood production is an important provisioning service in Romania, and for this ES there is good data at national level provided by the National Institute of Statistics (NIS), Eurostat and The Food and Agriculture Organization of the United Nations (FAO). In contrast, potentially important recreational values or values associated with nature based tourism are difficult to assess based on available data and only derived values can be provided. In addition, studies that can clarify what kind of values are the most appropriate are lacking. For instance, in the Finnish case, those ES for which markets and market based valuation forms already exist were considered to be best valued in monetary terms. However, although the ES of carbon sequestration has markets and can be given a monetary value, many stress the public good values of this ES (Mononen et al. 2016).

In forests belonging to the first functional goup" (G1) logging is not allowed except under very special circumstances. Approximately 53% of the National Forest Area (NFA) is classified as G1, and the different subcategories of G1 give a picture of important ES from forests in Romania. See table 19 below:

Table 19. Protected forests within G1 subgroups percentages

G1 subgroups	Description	% of G1	Area (ha)
G1.1	Protection of waters	31	1117240
G1.2	Protection of soil	42	1513680
G1.3	Protection against climatic and industrial harmful factors	6	216240
G1.4	Recreational	11	396440
G1.5	Scientific Interests, special genetic or ecological resources	10	360400
Total G1		100	3604000

Source: FAO, 2014

Table 20 outlines the main ES addressed below. It should be noted that the list would expand with increased data availability and with better understanding of structural and functional relations of some indicators provided by NIS. The ES category of nature-based tourism in table 20 includes the CICES categories of cultural ES "recreation" the indicators available are not sufficient for more precision. For some ES, including hunting and fishing, we do not have good indicators for steps 1 and 2 in the cascade model at present. These values will be summarized at the end.

It should be noted that many time series are available (at least for free) from 1990. Romania has had rapid changes in the institutions engaged in forest governance following the revolution in 1989, implying considerable challenges for management. For instance, from 1989 to 2009, almost 45 % of the forests were restituted to previous landowners (i.e. privatized) through a series of laws passed in 1991, 2000 and 2005. At the end of this restitution process, it is estimated that forests are owned by 800 000 different owners (Ioras and Abrudan 2006), which implies a huge change from a single state owner. It has been pointed out that this implied institutional and legal challenges (Stancioiu, Abrudan, and Dutca 2010). In addition, policies, legislation and regulations supporting sustainable forest management seem to be designed for the National level, and not at regional, county or local level (FAO 2014).

Table 20. Main ES discussed in the cascade framework below.

CICES		CASCADE			
Sec.,Div., Group	**Class**	**1-Structure**	**2-Function**	**4-Benefit**	**5-Value**
PS, Materials	Wood	Area (of productive) forest (ha)	Growth Rate (m3/ha) Annual Allowable Cut (AAC)	Logging m3/ha Employment	Trade. Value in Euros. Intrinsic.
		DATA: Statistics of forest cover available online at NIS from 1990 at county and national level. Broad-leaved and coniferous forest. Share of forest that is productive from NFI.	DATA: NFI	DATA: Timber volume statistics at county level from 1990 by timber type: resinous, beech, oak, various hardwood and various softwood (NIS). Exported volumes of round-wood yearly 1997-2014, 1964-1974, by timber types coniferous and non-coniferous (FAO[25]). Volumes for exported/imported sawn wood yearly 1964-2014 (FAO).	DATA: Sold wood reported in 1 000 Lei at NIS 1990-1995, in 1000m3 thereafter. Values for exported and imported volumes at FAO. Employment from Eurostat 2013, PwC, 2016.
RMS, Atmospheric composition	Climate regulation	Carbon storing habitats (ha)	Carbon balance, sequestration rate.	Mitigation of CO_2 emissions regulation, stable climate Contribution to reach Kyoto protocol targets.	Public good value of climate stability. Euro value of CO_2 price per ton.
		DATA: Forest cover NSI.Age structure of forest NFI (2008-2012 cycle).	DATA: Basd on literature review. See below.		GHG clearing market prices. Economic efficient prices from OECD.
CS, Physical and experiential interaction	Nature based tourism	Preferred natural areas (ha). Accessibility.		Experience. Participation in recreational activity.	Tourism revenue. Employment. Intrinsic.
		Statistics on arrivals and nights at *chalets* and *Mountain Resorts* at NIS. Available 1990-2015 for domestic and foreign tourists.		Number of arrivals and nights at chalets at NIS	Data for employment and revenue in World Travel and Tourism Council (2015) and data for expenditure from Eurostat 2017.

Note: NFI = National Forest Inventory, NSI = National Institute of Statistics. FAO = Food and Agriculture Organization of the United Nations, PS = Provisioning Services, RMS =Regulating and Maintenance Services and CS = Cultural Services, GHG: Green House Gases.

25 http://www.fao.org/forestry/statistics/en/

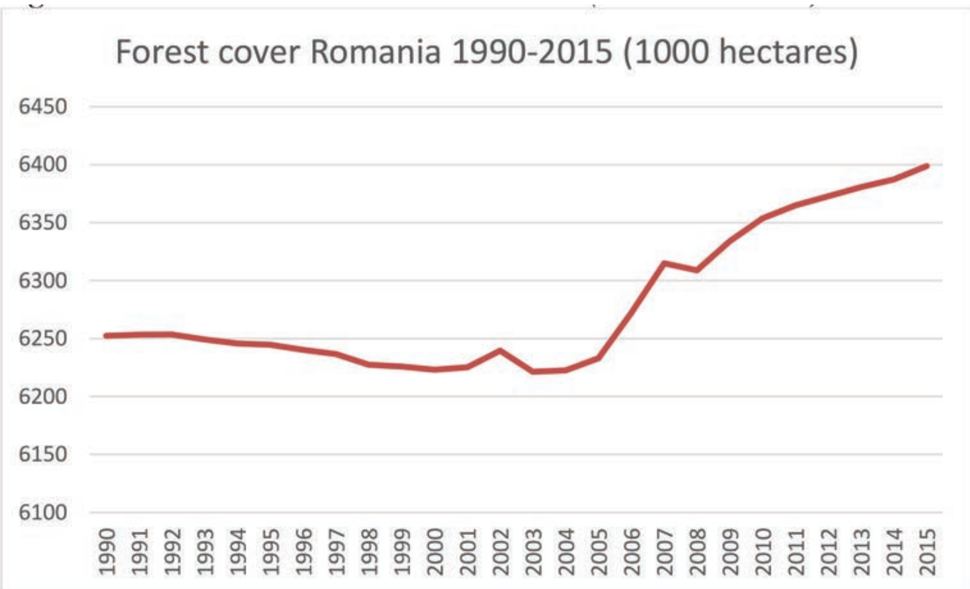
Status and trends of selected ES generated by Romanian forests.

Provisioning services: Timber

Biophysical indicators of forest stocks and condition (Level 1, structure)

NIS provides yearly data of forest cover in Romania from 1990 that is available online. This information can now be supplemented by satellite data. Statistics on forest cover in Romania in the last decade shows a slight increase (Figure 25) and forest area is now more than 6,4 million hectares. This amounts to approximately 29% of the total land area in Romania in 2015, considerably lower than the EU total forest cover of 38%.

Figure 25. Forest cover Romania 1990-2015 (in 1000 hectares). Source: NIS, 2017.



The increase in forest cover appears in large part to be due to afforestation and reforestation schemes (FAO 2014). According to Romsilva, 22300 ha of unused or degraded farmland were afforested between 1997 and 2011, and have the aim of to rehabilitate about 15000 ha annually on public land under their administration. In 2016, 14570 ha were regenerated, 8640 ha naturally and 5930 ha with planting (Romsilva, 2017).[26] Romsilva also supports private initiatives for afforestation of unfit farmland with technical advice. In addition to changes in the forest cover, changes in the structure of the standing stock (i.e. stand age class distributions) are robust indicators of shifts in logging regime and levels of extraction. An increase in the relative distribution of younger age-class indicates a decrement of the natural capital and has consequences on the functioning of the forest and on the capacity to generate ES. The National Forest Inventory (NFI) provides information on these trends based on five-year cycle inventories; the latest available is the 2008-2012 cycle.

A FAO document[27] also provides indications of changes in age structure. The report shows that in the last decades, harvesting rates in Romania have been larger than the Annual Allowable Cut (AAC), which would lead to changes in the long-term capacity to produce timber by reducing future AAC. According to the same document, these trends of unsustainable use have been halted. Forests in Romania now, whether owned by the National Forest Administration (NFA) Romsilva or by private owners are managed

26 http://www.rosilva.ro/articole/prezentare_generala__p_131.htm
27 http://www.fao.org/docrep/w3722E/w3722e23.htm

according to forest management plans (FMP) which are reviewed every ten years and are in principle based on ecological sustainability (Stancioiu, Abrudan, and Dutca 2010).

Regarding forest composition, it has been documented that the effects of past management practices can linger for a long time (Munteanu et al. 2015; Munteanu et al. 2016). The trend in Romania in the last 120 years is of an increased homogenization of the spatial distribution of tree species, and more even-aged stands (Munteanu et al. 2015). Thus, the time series starting from 1990 is rather short to evaluate this kind of impacts.

Forest cover, age structure and tree species composition are all forest structures that influence wood volume. We are not aware of any available time series of age structure of forests in Romania with national coverage. Data from the Romanian National Forest Inventory (the 2008-2012 cycle) shows connections between species, age and volume per ha. Table 21 below shows different wood volumes for different forest types in three different historical regions in Romania. Table 22 shows wood volumes (m^3/ha) for different age groups, and table 23 shows percentages (of surface) of different age classes in the three regions.

Table 21. Wood Volumes (m3/ha) for different species and historical regions in Romania.

Forest	Transilvania	Tara-Rom	Moldova	Average
Spruce	344	388	458	388
Fagus (Beech)	396	388	422	398
Oak	293	221	287	264
Hard Broadleaves	209	154	207	191
Soft Broadleaves	249	232	255	243

NFI, 2008-2012 cycle

Table 22. Wood volumes (m3/ha) for different age groups for three different historical regions in Romania.

	Age								
Region	**<20**	**40**	**60**	**80**	**100**	**120**	**140**	**160**	**>160**
Transilvania	55	215	311	394	450	466	523	560	618
Tara-Rom	76	196	271	351	415	461	502	508	511
Moldovia	57	242	362	416	527	574	513	531	535
Average	63	216	310	387	459	491	515	558	558

NFI, 2008-2012 cycle

Table 23. Percentage of surface of age classes in three different historical regions in Romania

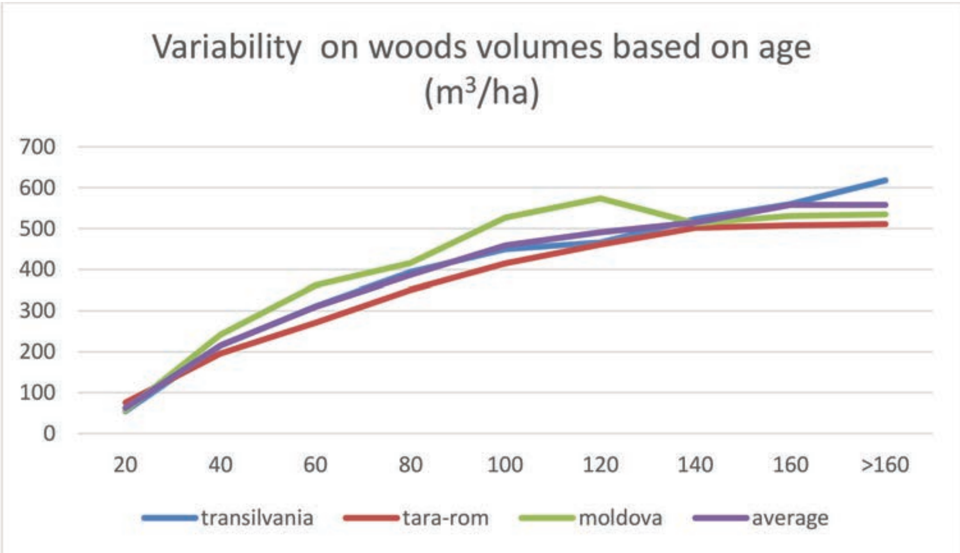
	Age								
Region	**<20**	**40**	**60**	**80**	**100**	**120**	**140**	**160**	**>160**
Transilvania	13,08	21,05	18,45	18,66	14,23	8,52	3,62	1,64	0,76
Tara-Rom	18,67	21,05	19,72	16,39	11,29	6,6	3,38	1,94	0,48
Moldovia	10,69	20.51	18,55	14,93	14,46	10,18	5,4	3,43	1,86
Average	14,15	21,02	18,91	16,66	13,33	8,43	4,13	2,34	1,03

NFI, 2008-2012 cycle.

Figure 26 below shows the relationship between age and wood volume, indicating that wood volume scales in a non-linear way with age, with more rapid increase in the young classes, and reaching a plateau at around 130 yr. The figure also shows that there are geographical differences in age structure and wood volume, with Moldova having an above average percentage of old growth forest, i.e. all forest classes older than 100 years. In contrast, Tara-Țara Românească shows above average percentages of age classes under 20 years, indicating a comparatively stronger logging pressure in this region in recent decades. Both Țara Românească and Transilvania have lower percentages of forest older than 140 years than the national average.

In addition, different species are associated with different volumes per hectare. Using this information, as well as the information on forest cover in Romania, it is possible to make estimates of wood volume. The newest NFI data reports 322m^3 per hectare or 2,221 million m^3 in total.

Figure 26. Distribution of wood volumes based on forest stand age. Source: NFI.



Biophysical indicators of timber production (Level 2, function)

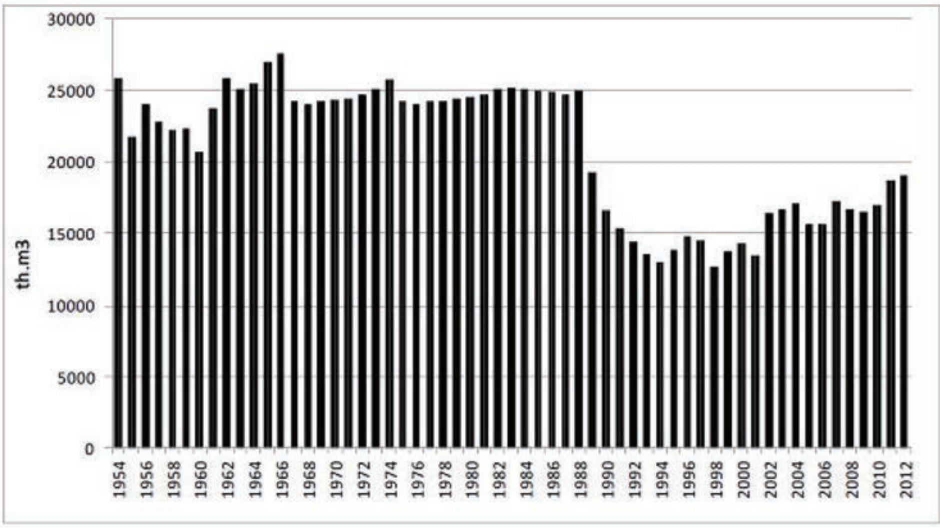
The latest official estimate of forest average net annual increment is 5,6 m^3 ha/year, which is based on NFI (1985). An updated value is being developed at the moment of writing this report, based on the latest NFI 5 year inventory cycle (2012-2016).

Indicators of benefits generated by timber production (Level 4, benefits)

Data provided by NIS, and those reported in FAO (2014) render information about harvested volumes of wood (See figure 27 below). As mentioned, data from 1990 is available at NIS. In order to get information about longer time series figure 27 below is found in a Romanian report to the EU commission.[28] The information still builds on NIS-data.

28 Information on LULUCF actions in Romania. Report under Art 10 of Decision 529/2013 of European Parliament and the Council. Submission to the European Commision. Bucharest, 2015.

Figure 27. Wood harvest (m3) Romania 1954 – 2012. Data from NIS, figure from Romanian report to the EU commission (see footnote 6 above).



Following the cascade structure of indicators, employment could be considered both as a benefit and as an indicator of economic value. Here employment will be considered under cascade level 5, economic value.

Indicators of economic value of timber (Level 5, value)

This section will deal with economic values of production forest. Other values associated with forest ecosystems in Romania will be addressed below. Romania had the largest forestry and logging workforce in Europe in 2010 with 49200 annual work units (Eurostat, 2013). This reflects that forestry practices and logging in Romania are labor intensive, as removals per work unit or other measures of productivity are low (Eurostat, 2013).

The gross value of forestry in Romania was reported to be 521 and 898 million euros in 2005 and 2010, respectively (Eurostat, 2013). With direct and indirect effects included, the forestry sector contribute with 1,7 billion euros to the state budget, and with about 3,5% of the Gross Domestic Product (GDP) according to a report by PwC Romania (PwC, 2016). This report states that 128000 people are directly employed in the forestry sector and other 186 000 in related sectors. (For the sake of comparison with reported statistics, note that the Eurostat statistics are converted to annual work units).

According to the PwC-report, there is a development potential in the forestry sector in Romania (PwC 2016). However, this potential is viewed through a higher extractive pressure rather than increasing the forest productive capacity through management practices. PwC (2016) attribute the low productivity of the sector to outdated harvest technology and lack of infrastructure such as forest roads. Even if forest cover has increased according to the NIS, the available forest areas for harvest has decreased by 18 % since 1990 (PwC, 2016), which is likely a consequence of a high extraction level of mature forest in this period. Harvest technology and forest roads may be improved; however, the current forest cover of around 29% is below the target (40%) set by the Natura 2000 program, and the estimates and prognoses seem to disregard current AAC standards based on the ecological capacity of the forest to generate economic benefits. Another study criticizes Romanian forest management for having overly long rotation times, both regarding forestry and carbon sequestration (Bouriaud et al. 2016), without taking in to account that Romanian forestry promotes natural regeneration and the maintenance of forest stands with stable and sustainable structures. However, a FAO report (2014) stresses that "Romania attaches a great importance to sustainable forest management ensuring the integrity of forest land and even expanding forest area, which is an already constant target of forest policy. Providing functional stability and higher efficiency of forest ecosystems in order to ensure biosphere stability are basic principles of forest management in our country" (FAO 2014, p.60).

According to FAO statistics of trade, Romania was a net importer of round wood in 2014, a net importer of coniferous wood and a net exporter of non-coniferous wood. See table below:

Table 24. Romanian wood trade.

Category.	Volume	Value
Exported round wood (2014)	529,7	49362,05
Exported coniferous (2014)	214,5	22400,58
Exported non-coniferous (2014).	112,33	16622,55
Imported round wood (2014).	1629,45	87150,78
Imported coniferous	917	59712,46
Imported non-coniferous.	90,65	10147,97

Source: FAO, 2017. Units: Volume in 1000m³, and values in 1000 euros (converted from USD using exchange rate 1 USD= 0,80128 euro), source: http://ec.europa.eu/budget/contracts_grants/info_contracts/inforeuro/index_en.cfm

Regulating and Maintenance Services (RMS): Climate regulation

Indicators of forest stocks and condition for climate regulation (Level 1, structure)

For the structural step in the cascade model, we need area of carbon storing habitats, in our case, forests, which we have discussed above.

Carbon sequestration capacity, i.e. the ability to absorb carbon from the atmosphere, is a function of wood volume and growth. Sequestration of carbon has become an important question in light of climate change, consequently much effort has been dedicated to estimate carbon content in different kinds of wood, and carbon emissions associated with different forestry practices. Carbon content in wood has been estimated to be 0,912 tones CO_2/ m^3 of wood in boreal forests and 1,459 tones CO_2/ m^3 of wood in temperate forests, with 1 ton of carbon being equivalent to 3,67 tons of CO_2 (Vass and Elofsson 2016). With the wood volume data from the National Forest Inventory this would translate into an average of ca 450 tons of CO_2 per hectare. There are official guidelines for reporting of stored carbon (IPPC good practice guidelines for LULUCF, 2012). For Romania this is calculated as Above-Ground Biomass (million tons) = Total Above Ground volume including branches x Wood density. The guidelines provide a conversion factor from standing stems to Total Above Ground volume of 1,2. Wood density which is given as 0,48 for coniferous and 0,52 for broadleaf forest, respectively. The guidelines also distinguish between forest growing in cold temperate moist and warm temperate dry climatic regions. These guidelines are likely to change with the improvement of estimates, and given the considerable cover of forest in Romania, the end estimate is highly sensitive to assumptions of both wood volume per ha and carbon content in different kinds of wood.

The capacity of old-growth forest to sequester CO_2 is generally underestimated, particularly because the role of the understory vegetation and soil organic matter decomposition of slow-growth forest species (Wardle et al. 2012) are generally not considered in carbon accounts. It has been claimed that old growth forests in the Carpathians Mountain region store more carbon per unit area than any other ecosystem or forest successional stage and that old growth forests in Carpathians store more carbon than younger and managed forests (Knorn et al. 2013). For a comprehensive biological review see Luyssaert and coauthors (Luyssaert et al. 2008). This complexity regarding structural properties of carbon storage is not unique, also in other ES like e.g. water purification, or reduction of air pollution, understanding of complex processes is required.

The reported Carbon Storage for Romanian forests is provided in table 25 below.

Table 25. Total (soil and above ground) carbon Storage Romanian Forests 1990-2015. (Million tons).

Year	1990	2000	2005	2010	2015
Carbon Storage.	1105,43	1104,44	1108,80	1129,82	1381,04

Source: FAO, 2014.

Indicators of climate regulation function (Level 2, function)

Forests will be a carbon sink if increase in living biomass exceeds carbon losses due to plant respiration, and biomass decomposition and combustion due to fires. Partly due to the ability of forests to sequester carbon, land use, land use change and forestry (LULUCF) is defined by the United Nations Climate Secretariat as a "greenhouse gas inventory sector that covers emissions and removals of greenhouse gases resulting from direct human –induced land use, land use change and forestry activities". According to the United Nations Climate Secretariat [29], Romanian forests had a net annual sink of 18455,6 Gg in 1989, and of 22462,5 Gg of CO_2 equivalents in 2012. The total CO_2 emissions in 2012 in Romania were 83860,6 Gg, so maintaining forest stands and cover considerably contributes to the magnitude of available carbon credits for trade under European offsetting mechanisms. It is reported significant changes in the net annual sink in Romania since the 90'ies due to changes in wood harvest (see figure 27 above) and also reforestation and afforestation schemes. Table 26 below shows contributions from LULUCF in selected categories in Romania for 2012. Land converted to settlements and land converted to other land both contributes positively to emissions, because they involve conversion from forest. "Forest land remaining forest land" is a complex category that according to the IPPC reflects changes in carbon stock from five carbon pools, biomass below and above ground, dead wood, litter, soil organic matter as well as non-CO2 emissions from those pools.

Table 26. Contribution of selected land sub categories to LULUCF annual net sink in Romania 2012.

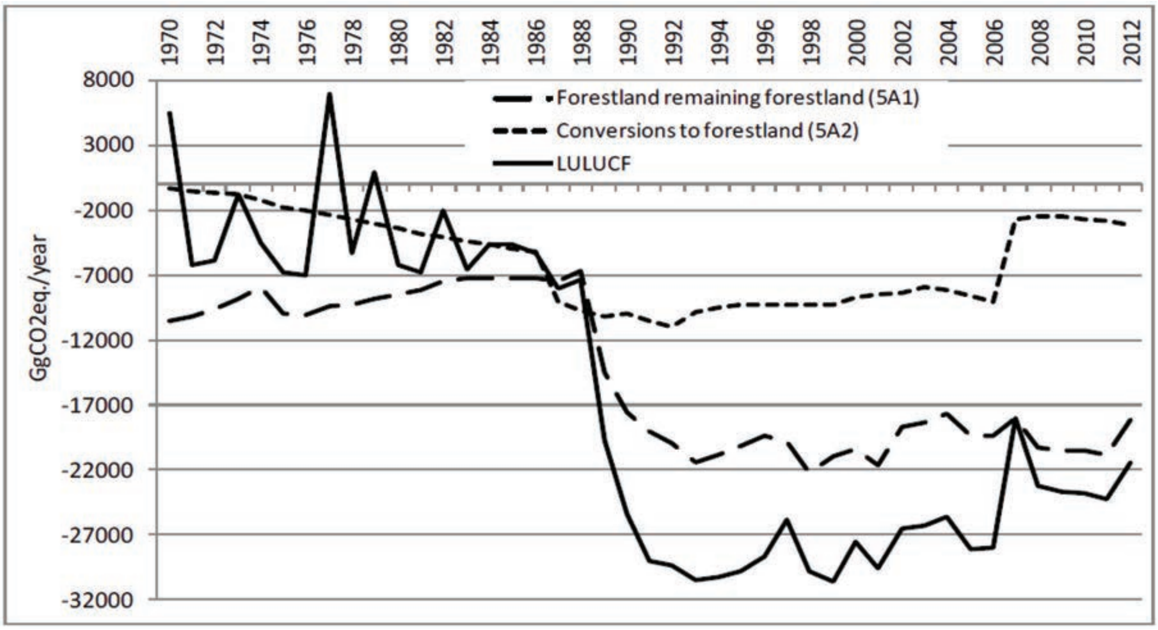
Sink and Source Categories	Emissions "+" / Removals "-"
5A1 Forest Land Remaining Forest Land	-19672,3
5A2 Land Converted to Forest Land	-3047,7
5E2 Land converted to settlements	410,9
5F2 Land converted to other land	767,4

Source: Information on LULUCF actions in Romania. Report under Art 10 of Decision 529/2013 of European Parliament and the Council. Submission to the European Commission. Bucharest, 2015.

Observing the changes in wood harvest from 1989, (see figure 27 above) it is not surprising that LULUCF contributions in Romania have changed over time. Figure 28 below shows these changes from 1970-2012.

29 (https://unfccc.int/files/ghg_emissions_data/application/pdf/rou_ghg_profile.pdf

Figure 28. Trends in Romanian GHG inventory for LULUCF and its main contributors from 1970-2012.



Source: Information on LULUCF actions in Romania. Report under Art 10 of Decision 529/2013 of European Parliament and the Council. Submission to the European Commission. Bucharest, 2015.

Indicators of climate regulation benefits (Level 4, benefits)

The main benefit one could identify is to actually avoid harmful climate change. Obviously, the extent to which Romanian forests contribute to this is a complex issue and will not be discussed here.

The LULUCF sector is removing 27% of CO_2 emissions produced by other sectors from 2000 -2011. There are different possible strategies to reach the targets in the Kyoto protocol, and net positive change in forest carbon storage is a strategy that has been highlighted as a cost efficient way of achieving this, e.g. compared to developing renewable energy (Capros et al. 2012; Münnich Vass 2017; Vass and Elofsson 2016; World Bank 2015). However, there are capacity constraints. The World Bank report (2015) states that forestry can provide additional abatement of 1 828 kt CO_2 per year at a total cost of 115 million euros during the period 2015-2050.

It is also important to note that the baseline for Romania according to the Kyoto protocol is 1989.

Indicators of economic value of climate regulation by forest (Level 5, value)

First, it could be noticed that the target set under the Kyoto Protocol of a maximum temperature increase of 2^{o} C can be regarded as a value, since to a large extent this target is the product of a negotiated agreement between nations.

Economic values will here be provided based on the market method, i.e. on observable prices in carbon quotas and off-sets markets. This is not straight forward, however, and the limitations will be discussed in the following section.

The Kyoto protocol introduced so-called Assigned Amount Units (AAUs). One AAU gives a country the right to emit one ton of CO_2e. In principle, each country with an emission reduction commitment, received AAUs corresponding to the amount they were allowed to emit in the first commitment period (2008-2012). Those countries that are part of the relevant Kyoto commitment period with an emissions reduction target are allowed to trade AAUs. Romania had a surplus after the first commitment period corresponding to 669 Mt of CO_2e. Thus, from 2012 there was a potential for Romania to sell AAUs to countries that were part of the second commitment period from 2012.

EU has introduced EU Emissions Trading System (EU ETS) as an important part of the strategy to meet Kyoto requirements. The EU ETS system places a cap on emissions from heavy industry and the power sector, which cover approximately 50% of EU emissions. Under this system EU allowances (EUAs) can be traded among companies. By design, each EUA is equivalent to a corresponding AAU and is also shadowed by one in the central EU registry.

The Clean Development Mechanism (CDM) the Kyoto protocol established was essentially designed for the developed countries that were part of the commitment period. According to the Paris Agreement, the CDM will from 2020 be replaced with a Sustainable Development Mechanism (SDM) where all countries are expected to take part.

All implications of this will not be discussed here. The important point is that trading of AAUs and EUAs takes place in a changing institutional structure, however, some important aspects will be highlighted. First, The Kyoto protocol allows countries to count net changes in gas emissions/sequestration from afforestation, reforestation, (improved) forest management and deforestation and it seems like this will continue in the European context. All European Union member states are committed under the Kyoto protocol to ensure that accounted greenhouse gas (GHF) emissions from land use are entirely compensated by an equivalent removal of CO_2 from the atmosphere through actions in the sector up to 2020. A legislative process in EU is under way to renew these commitments after 2020, with a legislative proposal delivered from the Commission to the Parliament and the Council on 20th of July 2016, and in this proposal the flexibility to buy and sell net removals to other member states are highlighted. (SOER 2015) [30]. Second, as mentioned above the EU ETS systems originally placed caps on heavy industry and energy producers. Some companies, like airlines, have been exempted, and only 50% of emissions were covered. In phase three (2013-2020) more sectors are included (EU commission, 2017). Third, the caps on emissions, i.e. the total allowance, will decrease so total emission decrease over time. Fourth, all EUAs should now be auctioned by default, rather than given away for free (EU commission, 2017)[31]. Fifth, there is some debate if an AAU surplus from the first commitment period of the Kyoto protocol should be transferred to the next period in full, as this will make later commitments easier. In summary of this section, although changes are to some extent unpredictable, it seems like market prices are relevant. If total emission allowance decrease, more sectors and all permits are auctioned, we could also see increased prices, although a surplus from the first commitment periods could keep price pressure down.

Variability in the price for AAUs /EUAs add uncertainty to the calculation of economic value of offsetting CO_2 emissions. Market based valuation should give a first best estimate according to standard economic theory. However, few believe that carbon markets are yet efficient in this sense. For instance, according to the OECD (OECD 2017) the lower end estimates of an economic efficient price of AAUs are around 30 euros. However, as shown above, not all sectors have been included in the cap system, and the OECD estimates that only 10% of CO_2 emissions within the member countries actually need to pay this much. The AAU price has fluctuated largely. For instance, a peak price of around 30 euros occurred in 2006, but was near zero through much of 2007, and, there has been considerable fluctuation in later years. In some studies, the price of one ton of CO_2 in 2050 is forecasted to be extremely high if emission targets are to be met. For instance, they have been estimated to be 306 euros (Münnich Vass 2017), between 240 and 1127 euros (median 521) in (Knopf et al. 2013) and between 147 and 370 euros in (Capros et al. 2012).

30 https://www.eea.europa.eu/soer-2015/countries-comparison/climate-change-mitigation
31 https://ec.europa.eu/clima/policies/forests/lulucf_en

Based on these estimates, values of carbon sequestered by Romanian forests are given within a range of 5 to 300 euro. This value, the value of carbon sequestration (*VCS*) will be a simple linear function of price *p* and the part of the total carbon sequestration that qualifies, thus:

Table 27. Values of the contribution of Romanian forestry to the mitigation of CO2 emissions according to the Greenhouse gas inventory for different levels of net CO2 contributions and price of 1 ton CO2.

CO2 compensation (tons of CO_2)	EUR 5	EUR 10	EUR 30	EUR 50	EUR 100	EUR 200	EUR 300
18 455 600	92,28	184,56	553,67	922,78	1 845,56	3 691,12	5 536,68
20 000 000	100	200	600	1 000	2 000	4 000	6 000
22 462 500	112,32	224,63	673,88	1 123,13	2 246,25	4 492,5	6 738,75
25 000 000	125	250	750	1 125	2 500	5 000	7 500

Source: Contributions from Romanian forestry in 1989 and 2012 from United Nations Climate Secretariat, 2017. Hypothetical prices based on OECD, 2017. Units: 1 ton of CO_2, and values in mill. EUR.

These values are highly context dependent. Future carbon prices are subject to economic, technological and political uncertainty. We see that for 1989, with a level of net contributions to carbon accounts of 18 455 600 tons, and a realistic short-term price of EUR 5-10, the value for mitigating CO_2 emissions result in an economic value between 90 and 185 million euros. Considering 2012 CO_2 sequestration levels and the same prices, the value would be between 112 and 225 million euros. For comparative reasons, the Eurostat data show a gross value of forestry in Romania of 898 million euros in 2010 (989, 24 million euros in inflation adjusted 2012 number).

Based on these numbers, it seems that with the most conservative price estimates of 5 to 10 euros per ton, the monetary value of carbon sequestration would compare to 10-20% of the gross value of forestry. If the price comes closer to the efficient price according to the OECD (30 euros per ton), carbon sequestration by forests would have a value of approximately 68% of the gross value of forestry. If model simulated future prices like 300 euros per ton of CO_2 should turn true, carbon sequestration could become a significant source of income for Romania if the flexibility to trade quotas with other EU countries is increased.

A World Bank blog reports[32] that Romania collected about 260 million euros from selling carbon credits 2013-2014, and that they hope to generate about 2 billion euros in the period 2016-2020. In light of this the numbers provided above seem relevant. However, it should be stressed that what is shown above is that Romanian forests contribute with "negative" emissions. If Romania depended on the negative forest contribution to achieve Kyoto targets, the monetary values above would be relatively precise, since the alternative for Romania would be to buy AAUs. However, Romania will have no problems meeting Kyoto obligations. Institutional developments with increased flexibility to buy and sell quotas, which may be a probable outcome, will also increase validity of the monetary values above.

Cultural ES: Physical and experiential interaction with environment, nature-based tourism.

32 https://blogs.worldbank.org/climatechange/new-bike-lanes-and-metro-stations-bucharest-paid-carbon-credits

Indicators of forest condition related to recreation and tourism (Level 1, structure)

This is a service where values are potentially large, but where data to conduct adequate valuation is difficult to find, which is common for the valuation of this ecosystem service. A paper considering a framework for national indicators in the EU states that high quality indicators for cultural forest ecosystem services are not available (Maes et al. 2016) .

Relevant indicators for the structural level could be area of forest related touristic attractions. As a start point, one could note that the total forest area protected for recreational purposes (no logging except special circumstances) is roughly 396 000 ha (FAO 2014). However, areas protected for recreational purposes will provide many other services, and touristic activities can be compatible with several of the other protection categories, as well as moderate timber harvest.

The focus in this report is on a selection of ES that are important economically, and where data is available. Nature based tourism is one such potential ES. We do not have the data to develop indicators for recreational values. However, in the following section concerning structural qualities relevant for nature-based tourism, the discussion will obviously be relevant also for the categories of recreational services, and provision of habitat for native biodiversity.

With approximately 210000 ha of old growth forest, Romania has more old-growth forest cover than any other central European country, and some of the last old growth forest types in Europe. The recreational value of old growth forests has no substitutions, so simple economic arguments based on scarcity could suggest a potentially large economic value of these forests (Krutilla 1967) both at national and regional scales.

Structural habitat features are the biophysical characteristics more strongly associated with quality for recreational activities (Harrison et al. 2014), and old-growth forests have the potential to offer opportunities for recreation, in addition to offering other services such as the provision of habitat for native wildlife and flora, and a series of regulating services. Old-growth forest provide habitats for the largest European populations of brown bear (*Ursus arctos*), gray wolf (*Canis lupus*) and Lynx (*Lynx lynx*), the old growth forests in the Romanian Carpathians have been recognized for exceptional biodiversity including many endemic, rare and threatened species (Ioras and Abrudan 2006). Becoming extremely rare in Europe, these old growth forests have a very high conservation value both nationally and regionally e.g. at EU-level and hold a large potential for nature-based tourism. Old growth forest is characterized by more than stand age, and includes features such as large old trees, presence of deadwood components, dominance by late successional tree species, complexity of tree canopy and more (see Knorn et al, 2013, and references therein). It is estimated that old growth forest covered 2 million ha in Romania at the end of the 19th century, declining to 700000 ha in 1945 and to 400000 ha in 1984 (Veen et al. 2010). A study conducted between 2001 and 2004 estimated old growth forest to cover 210000 ha (ibid.), indicating a reduction of 90% the surface in a period of approximately 100 years.

The preceding section obviously relates to provision of habitats for native biodiversity, and it is equally relevant for recreation and for tourism.

Another kind of structural information that will be exploited in the following is availability and capacity of accommodation in natural areas. There is data at NIS for arrivals and nights at Chalets (a kind of accommodation that includes hunting and fishing chalets) and arrivals a mountain resorts. The underlying assumption in the following is that tourists using these facilities care about forest at least to some extent. Combined with the habitat information above, it seems plausible that there is room for a spectrum of nature-based tourism in Romania, from extremely nature-based (e.g. bird and wildlife watching) to activities more loosely connected to nature in general or forests in particular.

Indicators of nature based tourism function (Level 2, function)

There are no ecological functional relations for cultural services. It has been claimed that "the function indicator for nature-based tourism, as for all other cultural services, is the same: Natural events and phenology" (Mononen et al. 2016). Mononen et al then (2016) point out the importance of the stability of the landscapes and of seasonal changes, like e.g. the burst of autumn foliage. This is obviously important. However, with cultural services it also seems necessary to ask for functional relations with respect to the human dimension of the ES, such as what is the level of awareness about the service or of the demand for the service. Indicators of demand of recreation services are often related to the number of people who enjoy nature and/or engage in activities related to experiencing nature or that have nature as a setting, and of the variety of activities conducted.

Surveys done in (Dumitras, Ariton, and Merce 2011; Dumitras and Dragoi 2006) asked visitors to National Parks if they considered a list of threatened species in the park they visited as "useful information"[33]. Only the visitors at Domogled National Park considered this useful, while visitors at Bucegi and Cozia expressed a complete disagreement, i.e. they considered this list not useful. This could mean that awareness of biodiversity conservation issues is relatively low. A strategic report about the potential for ecotourism in Romania (Popescu and Zamfir 2011) states that there has been an increase in nature-based tourism in the Country, with about 20000 tourists every year estimated for these activity. Unfortunately, updated numbers have not been available.

Indicators of benefits from nature-based tourism from (Level 4, benefits)

The benefits of nature based tourism and recreation in nature are manifold, from experience to health benefits. In any case, a natural indicator of the magnitude of these benefits is the number of tourists and visitors associated with areas with important natural qualities. There are no such statistics readily available for Romania, however. In fact, knowledge about tourism activities specifically associated to forests and their qualities are generally lacking (Bori-Sanz and Niskanen 2002). It has been pointed out that a consistent monitoring of the number and origin of people who visit national parks across the EU could be a first step (Maes et al. 2016). In Romania, this would also hold for important "Natural Parks" like Bucegi and Natura 2000 areas.

With the data available, we need to use broader statistics and make an approximate estimation of the magnitude of the economic importance of nature-based tourism activities in the Romania; some calculations will be done here for illustrative purposes rather than a comprehensive assessment of the importance tourism related to forests.

There are data of accommodation capacity at hotels, hostels and other facilities. (NIS, 2017). Two of these series seem relevant for our purpose. One provides the number of tourist chalets, and the other arrivals at mountain resorts. The category 'chalet' includes "accommodation, meals and other services necessary for tourists hiking or at rest in mountain areas, nature reserves, spa resorts and other tourist attractions" (NIS, 2017). It also includes hunt and fishing chalets (NIS, 2017). The number of these chalets (the statistics only consider those with capacity for more than 10 guests) is low. It declined from 226 in 1990 to 108 in 2007, but has had a steady increase since 2008, reaching 194. However, it is stated that 'fishing' and 'hunting' chalets have been assimilated into the data without specifying dates, thus the increase from 2007 onwards may reflect a change of accommodation class definition. In addition, like other time series starting in 1990, it is hard to judge the effect of the institutional changes that have taken place in the Country from 1989.

Not surprisingly, the number of arrivals and overnight stays in these chalets are also low. The number of overnight stays in these chalets was 576410 in 1991, declining to 128573 in 2005, and in 2016 the number was 215087. This number is low. In a survey

33 «Useful information»,the term used by the authors, is vague. It is here interpreted as an indicator of interest or awareness.

done by park managers in Piatra Craului National Park (PCNP) in 2003, they documented 90000 visitors in the summer season alone (Candrea and Bouriaud 2009).

Statistics of *arrivals* in these facilities show that June – September are the months with highest visitation, see figure 29a below for domestic and figure 29b for foreign arrivals. For the foreign arrivals, we notice that the numbers are much smaller but the seasonal effects are the same.

Figure 29a. Domestic tourist arrivals at chalets per month. Source: NIS, 2017. The high spikes corresponds to the month of August from 2010 and 2016, and the smaller spikes correspond to December.

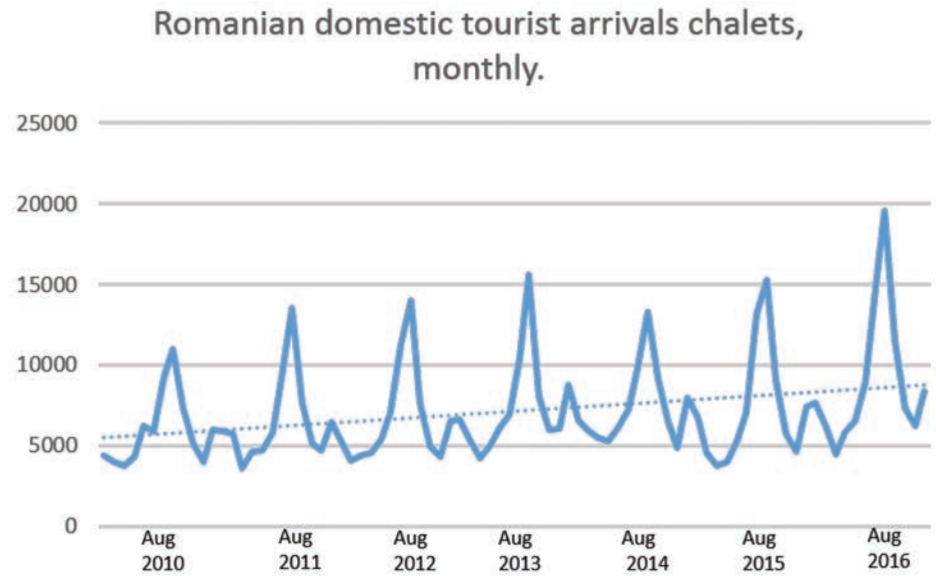
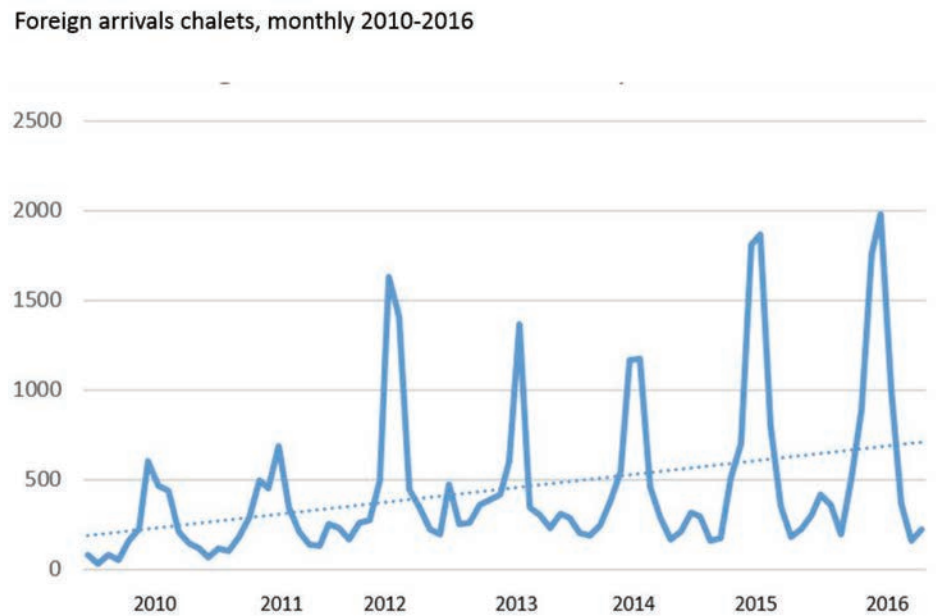
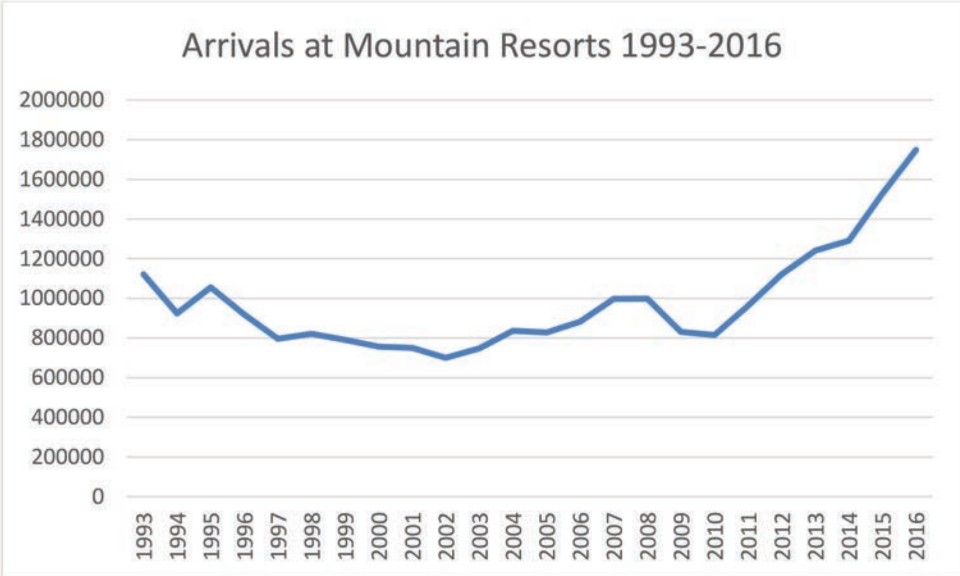


Figure 29b. Foreign tourist arrivals at chalets per month. Source: NIS, 2017.



The other relevant time series at NIS that we consider is that of "arrivals of tourists accommodated in the structure of tourist reception by tourist destinations and tourist type" (NIS, 2017) for the category mountain resorts. Compared to chalets, the numbers are much higher, and show an increasing trend in the last years. See figure 30 below.

Figure 30. Arraivals at mountain resorts between 1993 and 2016. Source: National Institute of Statistics Romania, 2017.



Combined, these indicators indicate that there is a considerable amount of people that enjoy benefits from forests in Romania. In using overnight stays as an indicator, we follow (Mononen et al. 2016). However, it is important to be aware of several weaknesses with this indicator.

First, mountain resorts will likely include many tourists interested in other things than forests *per se*, like ski lifts and similar facilities. Still, these tourists likely have benefits from the natural setting provided by surrounding forests, since recreational landscapes and nature tourism rely on the maintenance of forested land where recreation and tourism takes place (Bori-Sanz and Niskanen 2002). However, studies regarding the importance of forests for these mountain resorts is needed, and generally to separate the effect of forests from effects of other variables. For instance, hedonic pricing studies could explore differences in demand for mountain resorts with different qualities of forests. Second, different types of beneficiaries are not included, such as including day visits, and distinguishing the importance of recreational and tourism activities associated with day visits, is one such important distinction. Several popular National Parks or Natural Parks in Romania are within relative close proximity to large population centers and tourists may choose to spend the nights at other centers than those in the vicinity of the visited area.

If data were available to separate the ES of recreation from tourism, one could say that day visits represent recreation like in Mononen et al (2016). In the Piatra Craiului National Park (PCNP), a survey conducted by park managers in 2003 shows that 17 % of the visitors spent only one day in the area (Candrea and Bouriaud 2009), thus not using any accommodation. The summer this survey was conducted, 90000 people visited PCNP. A different survey at PCNP in 2010 showed that 60 % of the tourist used tents (Popa et al. 2013). These tourists will obviously also some economic impact in the area, but statistics of these amounts do not exist. A consistent monitoring of visitors in protected areas as proposed in Maes et al (2016) could obviously be helpful in this respect. However, in general, it is possible to access the protected areas in Romania without paying or registering so this monitoring scheme would require considerable planning and implementation resources. The NIS have statistics of average stay of tourists in mountain areas from 1995 to 2008, with an average of 4,8 days (NIS, 2017).

Based on the information in this section, some crude calculations can be made. See table 28 below. Both chalet and mountain resort time series can be useful to estimate economic impacts of tourist activities, since they carry different information, although research is necessary to better interpret the statistics considering the different properties of the facilities. The two indicators may give information on different forest users. For instance, an interesting hypothesis to explore is whether chalet users have more intense preferences related to forests, biodiversity and other aspects of nature based tourism than visitors using other accommodation facilities. Further, both indicators are likely to exclude an unknown percentage of day visitors and tourists who sleep in tents, table 28 below shows the number of expected visitors considering underestimations of 30%, 50%, and 60% for the total number of beneficiaries.

For the economic valuation in the next section, the mountain resort indicator will be used. Given the information that 90000 people visited PCNP one summer in 2003, we will see from the table below that the chalet indicator will significantly underestimate number of beneficiaries relevant for the valuation.

Table 28. Number of beneficiaries for chalet and mountain resort indicators.

Number of beneficiaries for chalet and mountain resort indicators.				
	Number of persons (arrivals) NIS, 2017	**+ 30% (total only)**	**+50% (total only)**	**+60% (total only)**
Chalet 1995	209213 total 206519 Romanian	271977	313820	334741
Chalet 2000	116574 total 114092 Romanian	151546	174861	186518
Chalet 2005	64480 total 59800 Romanian	83824	96720	103168
Chalet 2010	73992 total 71395 Romanian 2597 Foreign	96190	110988	118388
Chalet 2015	94976 total 87503 Romanian 7473 foreign	123469	142464	151962
Mountain Resort 1995	1055885 total 983632 Romanian 72253 Foreign	1372650	1583827	1689416
Mountain Resort 2000	756380 total 668521 Romanian 87859 foreign	983294	1134570	1210208
Mountain Resort 2005	827952 total 715230 Romanian 112722 foreign	1076338	1241928	1324723
Mountain resort 2010	814973 total 728320 Romanian 86653 foreign	1059465	1222459	1303957
Mountain resort 2015	1528583 total 1356404 Rom 172179 foreign	1987158	2292874	2445733
Average Chalet	111847 total	145401	167770	178955
Average Mountain R	996755 total	1295781	1495132	1594808

Source: Time series for Chalet arrivals and mountain resort arrivals 1995-2015 NIS, 2017.

Indicators of economic value of nature-based tourism (Level 5, value)

Obviously, when the indicators for benefit are uncertain, it follows that values based on these indicators are also uncertain. In this section, the mountain resort indicator will be used for two purposes. The first will be very concrete. Based on actual numbers of arrivals, data of average stay from NIS, and data of average expenditure from Eurostat, the value generated by this group will be calculated. This value will thus not include those who sleep in tents, day visits, people renting rooms from private, etc. However, the indicator will also be used as a point of departure for some provide some indications of values generated from nature-based tourism more generally.

As mentioned above, according to NIS statistics from 1995-2008, the average stay of tourists in mountain areas was 4,8 days (NIS, 2017). The survey from PCNP in 2003 referred to above found that among 90000 arrivals in the summer season, 17% spent 1 day, 44% spent 2-3 days, 30% spent from 4 days to a week , and 9 % spent more than a week (Candrea and Bouriaud 2009). Eurostat defines short trips as 1-3 nights, and long trips as 4 nights or more, and according to this 59% of Romanian trips were short domestic trips, and 34,5% long domestic trips (Eurostat, 2017).

According to Eurostat, average expenditure per *trip* in Romania (i.e. including at least one night) is 91 euros, and average costs per night is 24 euros (Eurostat, 2017- data from 2014). Accommodation is the largest part of the budget. Those sleeping in tents or with friends or relatives will thus spend considerably less. A study from Maramures (Ceroni 2007) estimates a daily expenditure of 27,1 euros or 37,6 euros in 2014 prices (CPI from NSI, 2017). This estimate is used in other work regarding Bucegi Natural Park, Cozia National Park, Domogled National Park, Piatra Craiului National Park and Portile de Fier Natural Park (Dumitras, Ariton, and Merce 2011; Dumitras and Dragoi 2006). The Maramures Mountains is used as a case study in (Popa et al. 2016) and Piatra Craiului is used in Popa et al (2013). These studies all report an estimate of 27,1 euros of daily expenditures per visitor based on (Ceroni 2007), although they all argue that it is a conservative value. Several of these same studies compare to a study that estimated daily expenditures of 54 euros per day (74,9 euros in 2014 prices) under what they claim are similar economic conditions (Getzner 2009).

We also know that a share of the tourists are foreign, who spend more on average. Popescu and Zamfir (2011) state that foreign ecotourists often have longer stays (at least a week) and spend 70-100 euros per day, including accommodation, meals, travel and guide. Most of the foreign tourists are from Europe (NIS, 2017), and the average expenditure in EU-28 on outbound trips is 747 euro (Eurostat, 2017). Among the mountain resort arrivals, approximately 10% are foreign tourists. Local tourists typically participate in "short term programs" of ecotourism according to Popescu and Zamfir (2011) presumably meaning shorter stays (fewer nights).

The above numbers indicate uncertainty about the economic value of tourism in forested landscapes including and near protected areas. For instance, with daily expenditure of 38-75 euros, and average trip expenditure of 91 euros, we observe that either the estimated average stay of 4,8 days is high, or the tourists in Maramures in the study by Ceroni (2007) had higher than average daily expenditures, but that seems at odds with the literature referred to above. The expenditure generated by the tourists arrived at mountain resorts will thus be estimated for a range of values (see table 29 below). Scenario 1 takes the statistics at face value, i.e. Romanians spend 91 euros per trip and foreigners 747 euros, while scenario 2 assumes a higher cost of 185 euros per trip for domestic trips. Scenario 2 may be relevant since the accommodation is the same for domestic and for foreign tourists, and accommodation is the largest part of the tourist budget according to Eurostat. Romanians in Popescu and Zamfir (2011) had shorter stays, thus scenario 2 has lower expenditures for domestic tourists.

Table 29. Estimates of total expenditures by mountain resort tourists in Romania.

Total expenditures by mountain resort tourists. (Euros). Scenario 1: Domestic travel 91 euros per trip, foreign 747 euros. Scenario 2: Domestic travel 185 euros, foreign 747 euros.					
Total arrivals	**Arrivals at MR 1995**	**Arrivals at MR 2000**	**Arrival at MR 2005**	**Arrivals at MR 2010**	**Arrivals at MR 2015**
Domestic	1055885	756380	827952	814973	1528583
Foreign	983632	668521	715230	728320	1356404
	72253	87859	112722	86653	172179
Expenditure Scenario 1:					
Domestic	89510512	60835411	65085930	66277120	123432764
Foreign	53972991	65630673	84203334	64729791	128617713
Total	143483503	126466084	149289264	131006911	252050477
Expenditure Scenario 2:					
Domestic	181971920	123676385	132317550	134739200	250934740
Foreign	53972991	65630673	84203334	64729791	128617713
Total	235944911	189307058	216520884	199468991	379552453

The calculations in table 29 are for illustrative purposes only. In scenario 1, domestic and foreign tourists contribute roughly equally to total expenditures. This seems unrealistic when we know that accommodation is the same, i.e. mountain resort, for both domestic and foreign tourists, and the number of domestic tourists generally is much higher. In scenario 2 the average contribution of foreigners is 32,5%. Domestic travel accounted for approximately 62,7 % of the total income from tourism in Romania in 2014 (World Travel &Tourism Council 2015). The higher numbers here may be realistic given that accommodation is the same, and the number of domestic tourists generally is much higher. Intuitively scenario 2 seems more reasonable, but there is not much data to back the claim. It seems like the minimum value for total expenditure in mountain resorts, i.e.126,5 million euros, (in 2000 and scenario 1) can be assumed to be unrealistically low depending on both a low number of tourists, and the low spending of domestic tourists under scenario 1. The maximum obtained of 379, 5 million euros (2015, scenario 2) obviously depends partly on the large number of arrivals in 2015. Thus, a range of values for expenditures from mountain resort tourists from 160-250 million euros / year can be guesstimated.

According to Eurostat (2017) total domestic tourism expenditure in Romania in 2014 was 1496 million euros. Our estimate of 160 – 250 million euros would then be between 10% and 16% of the total expenditure generated from nature-based tourism. If this is realistic depends on empirical data. An unreferenced claim in (Popescu and Zamfir 2011) states that the share of Romanian tourists interested in nature based tourism represents about 20% of the total, and they claim that nature is important for the foreign tourists.

As discussed so far, the arrivals at mountain resorts certainly provide an indication about economic expenditures generated by nature based tourists. One could probably model a more general population of tourists around this time series, accounting for seasonal changes (probably less tents in winter), demographics and general economic variables. We do not have data for this exercise at present. However, for illustration we can assume the following: First, the total population related to nature-based tourism will be considerably larger than the group that is included in the statistics for accommodation at mountain resorts. Some will use tents and some will be on day trips etc. We have no way to assess how much larger the group is, but for the illustration just assume it is the double, i.e. 100% larger than the group we have statistics for that choose mountain resort accommodation.

Then this general population is between 1,5 and 3 million people (1995-2015), 750000 to 1,5 million more than the mountain resort population, respectively (based on statistics reported in table 28). Let us assume that these have rather short stays and low spending to accommodate day trips. Instead of the 91 euro per trip estimate from Eurostat, we assume a more conservative expenditure of 50 euros per trip. We then get an additional 37,5 -75 million euros in expenditures compared to only the expenditures from those who chose mountain resort accommodation. Thus, extremely conservative estimates establish a minimum expenditure from nature-based tourism of around 200 to 300 million euros.

According to a recent report from the World Travel & Tourism Council (2015), tourism contributed directly with 1,6% of total GDP in Romania in 2014. Tourism directly supported 205000 jobs and had an indirect effect of around 467 500 jobs (5,5% of total employment). If nature-based tourism contributes with up to 20% of this, the amount would be quite significant. However, given the uncertain status of the indicators strong conclusions are unwarranted. What could be said, however, is that nature resources in Romania is a possible significant attraction for nature-based tourism.

Other ecosystem services

Provisioning Services

Data on other provisioning services from Romanian forests for which we have partial information is provided in table 30 below.

Table 30. Other provisioning services.

ES	Structural level	Functional level	Benefits	Economic value
Fish	Area of waters and ponds in forests (FAO, 2014) (836,8 ha in 2012).		Recreation Nature-based tourism.	2498322 euro (NIS, 2017-2015 data) From angling?
Other wood products (ornamental trees, shrubs, Christmas trees, osier willow)	Area of forests for other wood products	Production. Unknown.	Cultural, esthetical, volume produced.	Yearly time series* at NIS. 2015: 608490 euro
Berries	Area of forest with suitable habitat	Production. Unknown.	Tons of berries collected, NIS. Yearly* 2015 value: 3 481,9 tons.	Lei 22745100 (5497969 euro) (FAO, 2014 for 2010)
Game (hunting)	Area of suitable habitat for game species.	Population growth rate after natural mortality and predation.	Recreation. Cultural values associated with hunting.	Yearly at NIS* 1329445
Truffles and other edible mushrooms	Area of suitable habitat.		Recreation. Tons yearly* at NIS. 2015: 542,7	FAO, 2014: 2225,7 (1000 lei, 2010) (537998 euros)
Other Non-Wood products (medicinal and aromatic plants, refreshing juices)	Area.	Production. Data?		Yearly at NIS* 2015: 731156 euro
Seeds	Area	Production. Data?	Volumes yearly* at NIS. 2015: 7 tons.	Data unknown.

ES	Structural level	Functional level	Benefits	Economic value
Honey	Area	Production	Volumes	Yearly at NIS* 2015: 2230 euro.
Other sales.#				Yearly at NIS* 2015: 10907170 euro.

 # Other sales include "merchandise bocsa charcoal, confiscation of the wood to the amount received, exclusively-awards/incentives-according to the legislation in force; receipts from Hipica activity, agricultural products to be supplied to various consumers; granulated food" (NIS,2017).

**these series had county level resolution until 2010, National level. Yearly resolution after 2010, not necessarily yearly at county level.*

Cultural, and maintenance and regulating services

As explained above, the Forest Law in Romania establishes a detailed typology of forest functions that can be mapped onto the regulating and cultural services classes of the CICES classification (Haines-Young and Potschin 2013) (For full table see Appendix 1). See table 31 below for indicators for regulating services: We use as a general indicator for value, in the sense of importance (Jacobs & Martín López et al, *forthcoming*) here, the *area* designated for different protective purposes.

Table 31. Other regulating services.

National Categories for protective function,n	1990 (1000ha)	2000 (1000ha)	2015 (1000ha)
Protection of Water	699,3	1052	1070
Protection of Soils	939,6	1433	1420
Protection against climatic and industrial damage	109,3	166,5	170
Scientific and biodiversity conservation	196,7	308	320

Source: FAO 2014

It is possible to give these areas a monetary value. For instance, the 1070 ha designated for protection of water resources could be used for different purposes, like for timber production. When the area is protected, this possibility is (temporarily) lost, so an estimation of economic value could be the opportunity costs of foregone income from logging. However, any such calculation would require an integrated broader assessment since logging would have effects on net carbon emissions and the capacity of the forest to act as carbon sink, and to generate recreational possibilities and tourism activities. Several such trade-offs can be identified. E.g. the use of wood can substitute fossil fuels and other carbon intensive materials but can reduce the carbon stock in the forest. Importantly, it has been pointed out that in most semi-natural forests in Europe, efforts to promote carbon sequestration and biodiversity are mutually supportive (EEA, 2015)[34]. Optimal climate change mitigation strategies depend on sustainable forest management and will vary from place to place taking into account regional and local conditions. As such, protecting these forests should be a high priority in order to protect their generally large carbon stocks (EEA, 2015). As discussed above, the option of including the net value of the carbon absorbed by forests into emission trading and reduction targets is currently under consideration. Increased flexibility in emission trading would mean reduced costs of forest conservation, however a significant workforce is employed in logging implying important trade-offs that need to be assessed at both local and national scale.

34 https://www.eea.europa.eu/soer-2015/europe/forests

3.9. Summary of results

The Main results and sources are given in table 32 below:

Table 32. Data availability and values for some important ecosystem services generated by forests in Romania (national level).

Category	Volumes	Value	Unit value	Source
Total contribution of forestry to GDP (2015)		3,5	%	PwC, 2016.
Gross Value of forestry (2010)		898 (1031,6)	EUR mill (CPI adjusted)	Eurostat, 2013
Annual Work Units in Forestry and logging	49200 AWU			Eurostat, 2013
Employment in forestry (2016)	128000 People			PwC, 2016
Forest and ornamental nursery seedlings	15166 (1000 pieces)			NIS, 2017.
Other wood products (ornamental trees, shrubs, Christmas trees, osier willow)		608490	EUR	NIS, 2017.
Seeds	7 tons			NIS, 2017.
Berry Species	3481,9 tons 2015	22745100 5497969	lei (2010) euros (2010)	NIS, 2017. (Volumes) FAO, 2014 Values.
Truffles and other edible mushrooms	542,7 tons	2225,7	1000 lei	FAO, 2017 (Values) NIS. 2017.(Volumes)
Other Non-Wood products (medicinal and aromatic plants, refreshing juices)		731156	EUR	NIS, 2017.
Hunting Products		1329445	EUR	NIS, 2017.
Fishing Products		2498322	EUR	NIS, 2017.
Beekeeping Products (Honey)		2230	EUR	NIS, 2017.
Other Sales*		10907170	EUR	NIS, 2017.
Nature-based tourism		160-300	Mill EUR	Qualified estimates.
Carbon Sequestration		92-250	Mill EUR	See table 27 above. short term prices

*Other sales include "merchandise bocsa charcoal, confiscation of the wood to the amount received, exclusively-awards/incentives-according to the legislation in force; receipts from Hipica activity, agricultural products to be supplied to various consumers; granulated food" (NIS,2017).

Chapter 4
Decision Support System

The development of the DSS component is an integral part of the activities of the N4D project it with the aim to map and evaluate key ecosystems and ecosystem services in Romania, thus creating a framework for the assessment of ecosystems at national level process to continue after the completion of this project.

Moreover, the project supports the development of decision-makers' capacity and policy-makers to take over and use the results of the MAES process and to raise stakeholders awareness of natural resource management.

The main beneficiary of the project results are the following target groups, to which other organizations and user groups will be able to join, as the results of the project and of the DSS components developed and expanded subsequently:

- Government institutions
- Scientific organizations
- NGOs
- Specialists and independent experts
- Media

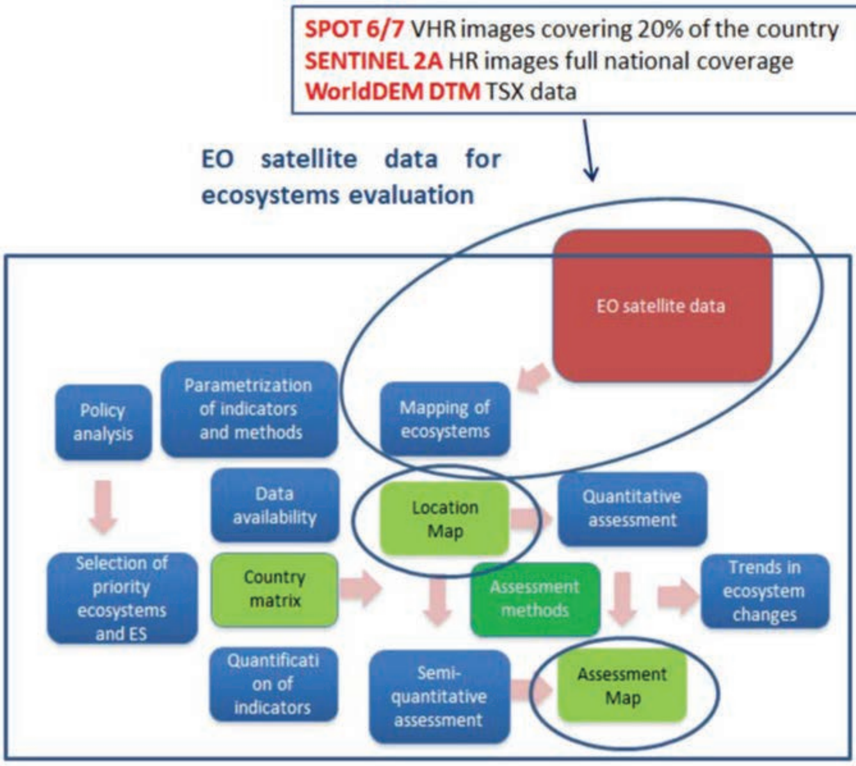
In order to ensure the sustainability of the project results and their efficient use in the decision making processes carried out by the NAPM beneficiary, a first component of a decision support system (DSS) was developed, integrating the current operational requirements for the protection of the natural capital identified in the N4D project.

DSS software application integrates with Integrated Environmental Information System (SIM), developed at NEPA, ensuring the compatibility of the two systems. Data Components of Integrated Environmental Information System - SIM were extended within N4D project mainly by integrating satellite data and common lists specific to nature conservation (species, habitats, protected areas etc.).

The RO-MAES-DSS will integrate with SIM at the following levels:

- NEPA Portal for DSS user authentication;
- GIS server-based on ArcGIS Server and specific processing services for displaying and processing of georeferenced data;
- Lists and catalogues/common lists for maintaining quality standards and uniform interpretation of data in any system;
- Messaging System as a unique and approved mechanism for communicating with DSS stakeholders;
- Catalogues and existing code lists maintained within the SIM;
- Data display services for integration with other systems.

Figure 31. Expanding the SIM by adding components developed within the N4D project



The SIM (an Integrated Environmental System platform) will also be expanded by storing intermediate results generated by DSS, providing extensive analysis possibilities (Figure 31).

RO-MAES-DSS allows the development of some analysis processes that may vary in complexity from simple analysis based on data viewing in various combinations to analysis based on predefined scenarios (Table 33), using appropriate algorithms and mathematical models to respond to operational needs of maintaining the quality of natural ecosystems and planning the necessary investments.

Table 33. Predefined reports

Report No.	Description / detailes	
1	Ecosystem distribution	Report on ecosystem distribution at national/ regional/ site level
2	Ecosystems status	Report on ecosystems status – biophysical assessment at national/ regional/ site level
3	Ecosystem assessment	Report on ecosystem services provided by each type of ecosystem
4	Level of degradation (of ecosystems)	Report on degraded ecosystems based on the level of ecosystem services provided by each type of ecosystem compared with the specific reference values
5	Management solutions	Report on management solutions analysis by generating assessment maps of ecosystem services at local level
6	Ecosystem services valuation	Report on economic assessment methods implementation by generating economic assessment maps of ecosystem services at the local level
7	Integration of Natura 2000 sites	Report on integrity of Natura2000 sites network that allows characterization of ecosystem distribution, their biophysical state and from here the state of degradation at national / bioregion / Natura 2000 sites level

Considering the stage of implementation of the MAES process in Romania, at this stage the DSS contains the components necessary to allow the processes of analysis and evaluation of ecosystems at least at the next three levels:

- visual analysis of ecosystems specific data in various combinations, making measurements and displaying a set of predefined reports;
- performing ecosystems analysis based on spatial and non-spatial criteria using interactive tools to define analysis criteria (query-builder);
- ecosystem assessment and estimation of ecosystem-specific indicators, including the development of some analysis based on "what-if" scenarios type in order to estimate the impacts of ecosystem changes on these indicators.

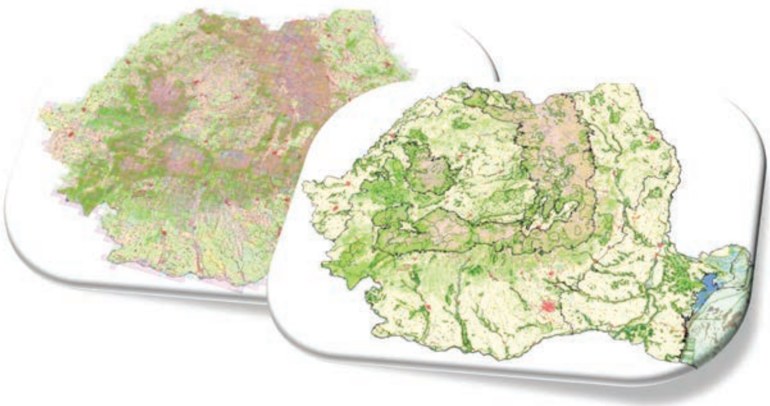
DSS will use stored and structured data according to a preliminary model that includes:

- distribution of ecosystems;
- ecosystem assessment;
- administrative-territorial units;
- protected natural areas;
- biogeographical regions;
- Natura 2000 sites;
- nomenclatures (classification of ecosystems, ecosystem services etc.).

The main input data for the analysis mentioned above are the CLM-Country Location Map and the Assessment Map of the ecosystems (ASM). The ASM means the geographic distribution of ecosystem services specific indicators (Figure 32).

Taking into account the needs for further expansion and permanent use of updated datasets, all data used in DSS (ecosystem distribution, ecosystem assessments, other data) will be exposed as web services that comply with OGC (WMS, WFS, WCS).

Figure 32. Biodiversity data used within DSS - Distribution Species and Habitats, Protected Natural Areas



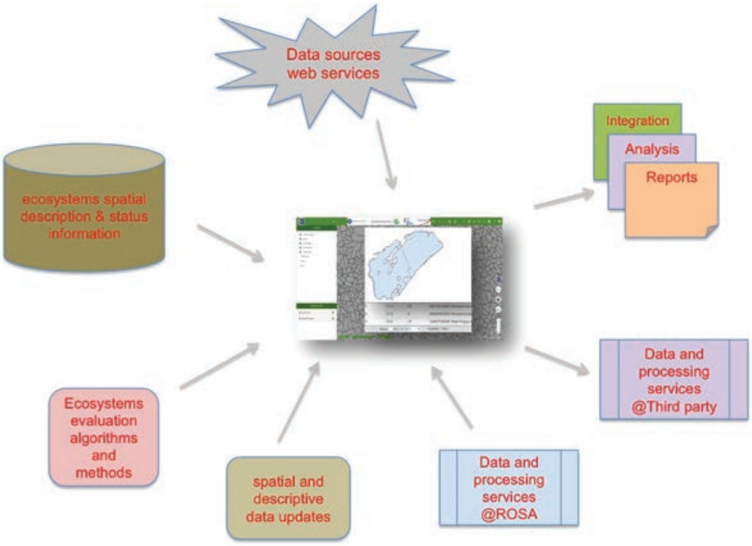
Implementation Concept and Workflows covered

The current implementation of DSS (see figure 33 below):

- Provide access to a set of tools allowing simplified as well as complex analysis by means of standard GIS interface and predefined reports;
- Use thematic and reference data published as web services (OGC Compliant) by mandated organizations participating in the national SDI;
- Demo version developed based on core information represented by the Country Location and Assessment Maps developed in the N4D project
- Architecture and technology enabling further extension and scaling given current / considering future categories of users;

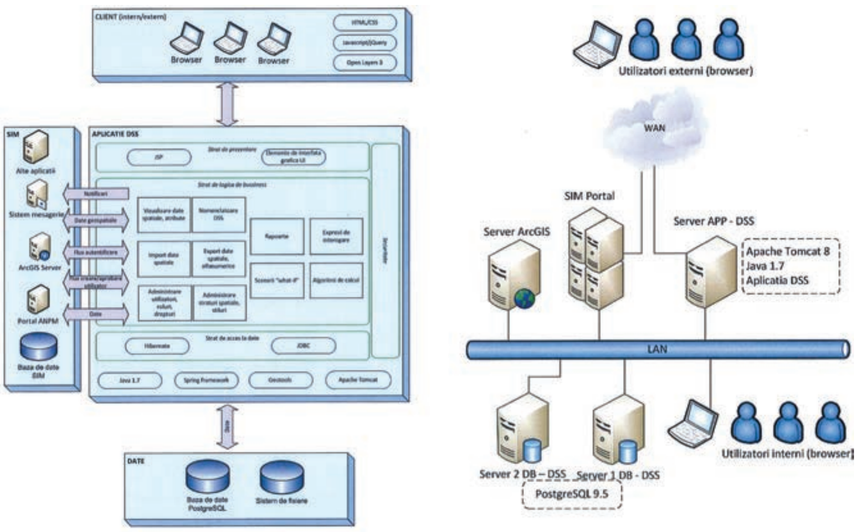
- A first entry point on the way to exploiting the MAES concepts and knowledge base and provide feedback on the main resources being developed;
- Allow direct participation and contribution of the scientific community to the decision process based on shared knowledge and shared data.

Figure 33. DSS Implementation Concept



Given the operational requirements and implementation concept adopted, the architecture solution and technology environment selected had to answer in an apropriate manner to these demands (see figure 34 below).

Figure 34. DSS Architecture and Technology Map



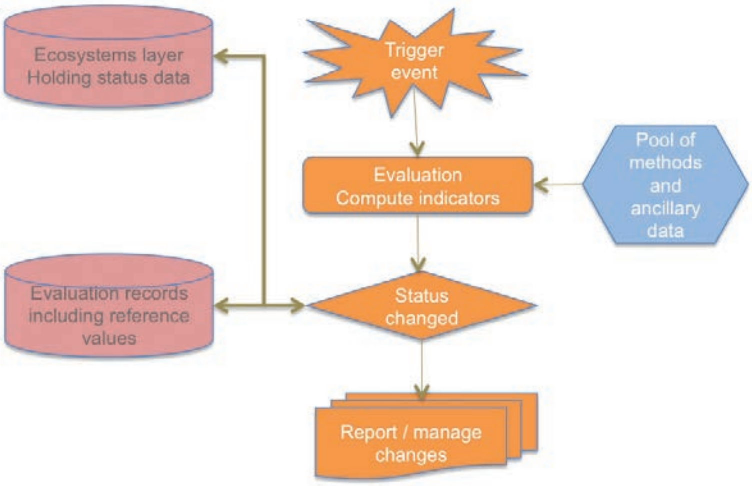
The core data used (see table 34 below) in the current implementation of DSS is resuming mapping and assessment of the ecosystems as well as the status evaluation and impact on different types of changes on ecosystems state.

Table 34. DSS core data

Ecosystems layer	store spatial and descriptive data related to ecosystems: current limits (polygon), biophysical and degradation status,
Degradation status	history of degradation status including date of evaluation and reason of status change; allows retrieval of status evolution record per ecosystem
Biophysical status	history of biophysical status including date of evaluation and reason of status change; allows retrieval of status evolution record per ecosystem
Services evaluation	evaluation of different indicator related to ecosystem services, including date of evaluation indicator value and method
Economic evaluation	evaluation of the economic value attached to ecosystems, including date of evaluation and method
Ecosystem impact	indicate impact of ecosystem change due to various human interventions e.g. transform agriculture field into residential area
Phenomena impact	indicate impact of various phenomena like fires, drought, flood on ecosystems biophysical and degradation status

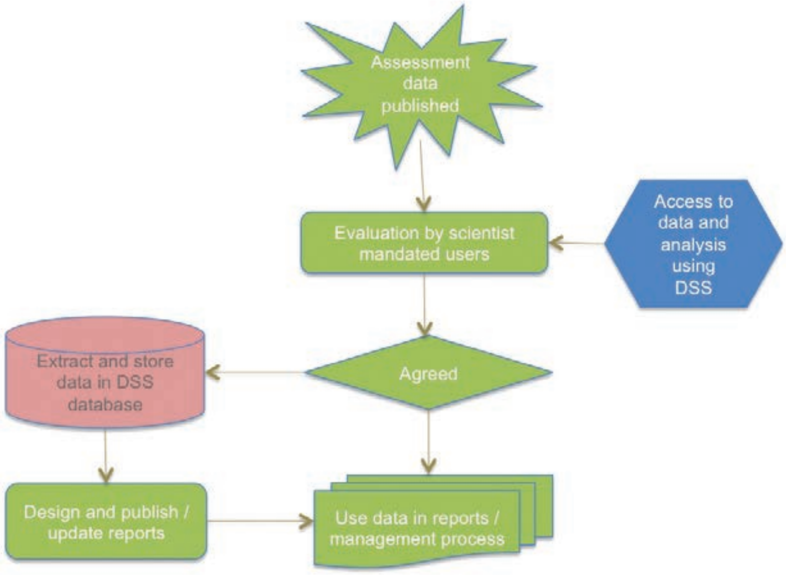
Ecosystems degradation and biophysical status is evaluated based on indicators values estimated based on specific methods. Due to the need to keep history of the ecosystems status and degradation, the DSS database sores records of indicators values estimated at different moments in time (see the schema below).

Figure 35. Ecosystems status evaluation



Ecosystem assessment data integration into the DSS database is done after agreement among scientists / authorized users based on existing data – satellite, elevation, biodiversity, other data – accessed by means of DSS; once the agreement exist, assessment data is registered into the DSS database for further analysis and decision support

Figure 36. Ecosystems assessment workflow



RO-MAES-DSS is configured so that other data sources outside NEPA to be used, and allows access to RO-MAES-DSS both inside and outside NEPA. Registration of RO-MAES-DSS users will be done through a specific form (eForm_DSS). User authentication is through the NEPA portal and the existing SAP component within the SIM. Once logged in, users have associated roles that give them access rights to system resources; when you are not logged in, the application gives you visualization access of the published data within the system. User interface elements are displayed in both Romanian and English.

The visual analysis component allows:

- to display and analyze existing datasets at the time of deployment and the possibility of later configuration to access other data sources;
- to access and display data in vector, raster and alphanumeric format using predefined symbol sets;
- specific map usage operations: zoom in, zoom out, identification, transparency;
- to view alphanumeric details associated with spatial objects in the added layers;
- to print and save generated data / tables / maps in Excel, Word, PDF or shp format, as applicable;
- to generate and display the predefined reports in table 33, described in the paragraphs below;
- to save the work sessions in Web Map Context (WMC) format, to publish and share the documents other users.

RO-MAES-DSS users can run complex analysis with spatial and non-spatial criteria using interactive query-builder tools to define analysis phrases.

RO-MAES-DSS users can access:

- graphical interface to interactively define query phrases (query builder);
- and run the corresponding queries and perform the analysis using the existing data from the application, as well as subsequent datasets;
- published queries from other users;
- results of the analysis displayed in graphical and tabular form within the visual analysis component described above.

Scenario based analysis

To run a “what if” scenario type, users can:

- Indicate the spatial description of the phenomenon being analyzed by selecting a .shp or .kml file
- set the parameters values for the analysis and save the set of parameters;
- resume the analysis after partial change of parameters.

The current RO-MAES-DSS version allows you to run two types of scenarios:

- impact assessment when a certain type of ecosystem (EUNIS classification) is substituted by another one defined by the user;
- assessment of the impact of different drivers on ecosystems from an certain area of interest.

Chapter 5
Conclusions

To **stimulate the transition towards a Sustainable Green Economy**, Romanian policy and decision makers have the opportunity to understand the socio-economic and environmental advantages that such a transition brings **to address the crisis and challenges of the 21st century and achieve Sustainable Development**. Ranked among countries with High Human Development Index in 2014 and a deficit of 0.4 gh between national Ecological Footprint and Biocapacity in 2012, **Romania is still in the position to choose** the most suitable development model to grant the well-being of its population based on equality. However, this opportunity will not continue for too long if public policies are not adjusted accordingly.

First of all, it is necessary to integrate the **Ecosystem Approach** into decision and policy making since it is a way of making choices that manage human activities sustainably. It aims at ensuring economic prosperity in the long-term as a result of sustainable management of ecosystems and use of natural resources. It has developed from the recognition that ecosystems provide benefits to people in the form of ecosystems services and that human-beings are part of an ecosystem dynamic since they use it and thus have an impact on its capacity to deliver ecosystem services. Thus, human-beings are responsible for influencing positively or negatively their future economic prosperity and the Ecosystem Approach identifies **3 pillars of action**: integrated management, that is combined management of ecosystems and natural resources as well as human activities in a sustainable way; strong stakeholders' participation; and, understanding and consideration of ecosystems functions and the ecosystem services they provide.

It follows that **mainstreaming** the Ecosystem Approach **into policies is fundamental** to **reduce the impact of human activities on ecosystems and ecosystem services**, and to **achieve policy objectives in a sustainable, equitable and effective way**, overall **setting the path towards the transition to a Sustainable Green Economy**. In fact, sectoral and horizontal policies can create important opportunities to progress on the integration of ecosystem services, meaning that the ecosystems capacity to provide ecosystems services is maintained or enhanced (if necessary) and preserved; the paradigm of a Sustainable Green Economy itself is one of such opportunities since it refers to a shift to an economic model that significantly reduces environmental risks and respects ecological limits while improving human well-being and social equity.[35]

Recent policy commitments towards a Sustainable Green Economy have been the reform of environmentally harmful subsidies under the Strategic Plan for Biodiversity 2011-2020 and in the G20 as well as the development of ecosystem services economic accounts based on the United Nations System of Environmental and Economic Accounts (UN-SEEA). Worldwide examples and experience is increasingly showing that integrating nature's value into national, regional and local economies and into the functioning of different economic sectors is a critical part of the transition to a Sustainable Green Economy, delivering multiple benefits that support economic growth and sustainability as well as human well-being in an equitable way. As a matter of fact, by making the costs related to the loss of biodiversity and ecosystem services an integral part of the functioning of economic systems and encouraging the application of nature-based solutions, "green" jobs and innovations, the resource efficiency and long-term sustainability of different policy sectors can be improved (examples are cost-effective means for water saving measures

35 http://ec.europa.eu/environment/pubs/pdf/factsheets/maes/en.pdf

resulting from ecosystem service based water management and leading to increasing water efficiency, a cost-effective way for maintaining food security based on protecting the abundance and diversity of natural pollinators rather than having to replace natural pollination by artificial alternatives, etc).[36] Obviously, **capacity building and moral integrity are fundamental to avoid falling into ordinary greening measures that pursue growth as the ultimate goal regardless of planetary boundaries and social equity**. There is no single recipe for the transition to a Sustainable Green Economy and it will proceed on different development paths for different countries since it depends on an area's natural assets, economy and society, and priorities.

Second of all, it is necessary to integrate **MAES process results** into decision and policy making since they provide knowledge about the functioning of ecosystems and their capacity to deliver ecosystem services that support and are essential for life on earth. Making decisions without taking into account such knowledge leads to policies that harm the country's natural capital and consequently its social and financial forms of capital. Performing a National Ecosysstems Assessment is closely linked with the Ecosystem Approach since it is a precondition for Good Ecosystems Governance.

Although the main responsibility for the MAES process in front of the EC lies in the Ministry of Environment (MoE), and in the National Environmental Protection Agency (NEPA) given its delegated responsibilities for implementing the MAES process at national level, **all ministries in Romania are encouraged to play a role in the transition towards a Sustainable Green Economy**, in particular those in charge with policy sectors dealing with natural resources use and management including water, forestry, agriculture and rural development, fisheries and aquaculture, marine, biodiversity, transport, regional development, territorial planning, energy, climate change mitigation, but also air, soil, tourism, climate change adaptation, and sustainable development.

Several tools have been already developed and tested to support policy and decision makers in the transition to a Sustainable Green Economy. **Decision Support Systems** (DSS) are particularly useful to model the impact of human actions on ecosystems and their services and take alternative choices. The N4D project has developed a RO-MAES-DSS complementary with the Integrated Environmental System (SIM – Sistem Integrat de Mediu) managed by NEPA, which uses MAES process results for analyzing development decisions.

In conclusion, **this report can be used by key governmental stakeholders to continue the MAES process in Romania after the N4D project is over in April 2017, and to implement necessary policy changes for Good Ecosystems Governance to achieve a Sustainable Green Economy and human well-being in the context of Sustainable Development. This report builds the case for pursuing Sustainable Green Economy in Romania, analyses whether Romanian policies stimulate the transition towards a Sustainable Green Economy, and provides recommendations aimed at improving policy and decision making.**

36 Idem

Chapter 6
Glossary

Assessment: The analysis and review of information for the purpose of helping someone in a position of responsibility to evaluate possible actions or think about a problem. Assessment means assembling, summarising, organising, interpreting, and possibly reconciling pieces of existing knowledge and communicating them so that they are relevant and helpful to an intelligent but inexpert decision-maker (Parson, 1995).

Assets: Economic resources (TEEB, 2010).

Benefits: Positive change in wellbeing from the fulfilment of needs and wants (TEEB, 2010).

Biodiversity: The variability among living organisms from all sources, including inter alia terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part, this includes diversity within species, between species, and of ecosystems (cf. Article 2 of the Convention on Biological Diversity, 1992).

Biophysical structure: The architecture of an ecosystem as a result of the interaction between the abiotic, physical environment and the biotic communities, in particular vegetation.

Biophysical valuation: A method that derives values from measurements of the physical costs (e.g., surface requirements, labor, biophysical processes, material inputs).

Conservation status (of a natural habitat): The sum of the influences acting on a natural habitat and its typical species that may affect its long-term natural distribution, structure and functions as well as the long-term survival of its typical species (EEC, 1992).

Conservation status (of a species): The sum of the influences acting on the species concerned that may affect the long-term distribution and abundance of its populations (EEC, 1992).

Drivers of change: Any natural or human-induced factor that directly or indirectly causes a change in an ecosystem. A direct driver of change unequivocally influences ecosystem processes and can therefore be identified and measured to differing degrees of accuracy; an indirect driver of change operates by altering the level or rate of change of one or more direct drivers (MA, 2005).

Ecological value: Non-monetary assessment of ecosystem integrity, health, or resilience, all of which are important indicators to determine critical thresholds and minimum requirements for ecosystem service provision (TEEB, 2010).

Economic valuation: The process of expressing a value for a particular good or service in a certain context (e.g., of decision-making) in monetary terms (TEEB, 2010).

Ecosystem assessment: A social process through which the findings of science concerning the causes of ecosystem change, their consequences for human well-being, and management and policy options are brought to bear on the needs of decision-makers (UK NEA, 2011).

Ecosystem degradation: A persistent reduction in the capacity to provide ecosystem services (MA, 2005).

Ecosystem function: Subset of the interactions between biophysical structures, biodiversity and ecosystem processes that underpin the capacity of an ecosystem to provide ecosystem services (TEEB, 2010).

Ecosystem process: Any change or reaction which occurs within ecosystems, physical, chemical or biological. Ecosystem processes include decomposition, production, nutrient cycling, and fluxes of nutrients and energy (MA, 2005).

Ecosystem service: The benefits that people obtain from ecosystems (MA, 2005). The direct and indirect contributions of ecosystems to human wellbeing (TEEB, 2010).

Ecosystem state: The physical, chemical and biological condition of an ecosystem at a particular point in time.

Ecosystem status: A classification of ecosystem state among several well-defined categories. It is usually measured against time and compared to an agreed target in EU environmental directives (e.g. HD, WFD, MSFD).

Ecosystem: A dynamic complex of plant, animal, and microorganism communities and their non-living environment interacting as a functional unit (MA, 2005). For practical purposes it is important to define the spatial dimensions of concern.

Energy inputs: Subsidies added to ecosystems such as fertilizers, fossil fuel, or labour that are required to turn ecosystem functions into ecosystem services and benefits.

Functional traits: A feature of an organism that has demonstrable links to the organism's function.

Green Economy is "one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. It is low carbon, resource efficient and socially inclusive"(UNEP). Another **definition** for green economy offered **by the Green Economy Coalition** defines green economy as "a resilient economy that provides a better quality of life for all within the ecological limits of the planet".

Habitat: The physical location or type of environment in which an organism or biological population lives or occurs. Terrestrial or aquatic areas distinguished by geographic, abiotic and biotic features, whether entirely natural or seminatural.

Human well-being: A context- and situation dependent state, comprising basic material for a good life, freedom and choice, health and bodily well-being, good social relations, security, peace of mind, and spiritual experience (MA, 2005).

Indicator: Observed value representative of a phenomenon to study. In general, indicators quantify information by aggregating different and multiple data. The resulting information is therefore synthesized.

Natural Capital is the world's stock of natural resources, which includes geology, soils, air, water and all living organisms. Natural capital assets provide people with a wide range of free goods and services, often called ecosystem services, which underpin our economy and society and some of which even make human life possible

Restoration: Refers to the process of actively managing the recovery of an ecosystem that has been degraded, damaged or destroyed as a means of sustaining ecosystem resilience and conserving biodiversity (CBD, 2012).

Socio-economic system: Our society (which includes institutions that manage ecosystems, users that use their services and stakeholders that influence ecosystems)

Value: The contribution of an action or object to user-specified goals, objectives, or conditions (MA, 2005).

Appendix 1

The functional zoning system of Romanian forests

No.	Group/Subgroup/Category	Function type
G.1	Forest vegetation with special protection functions	
1.1	Forests with functions for water's protection	
1.1.a	Forests located in areas for protection of potable and industrial mineral water sources	2
1.1.b	Forests located on immediate slopes of reservoirs and natural lakes	3
1.1.c	Forests located on rivers and streams slopes from mountain and hills areas, that supply the natural lakes and reservoirs	4
1.1.d	Forests from Danube delta and floodplain (islets and shore without embankment-shore area) and those located in river floodplains	4
1.1.e	Forests located in lower riverbeds	3
1.1.f	Forests located in embankment-shore area form Danube Delta and internal meadow of the rivers	3
1.1.g	Forests from watersheds or with high transport of deposits	3
1.1.h	Forests for protection of springs which are water supply source for trout farms and forest located on immediate slopes of trout farms, with minimum area of 110 ha	2
1.2	Forests with functions for protection of soil and terrains	
1.2.a	Forests located on rocks, debris and in terrains with deep erosion, with active landslides, also on terrains with big slopes	2
1.2.b	Forests located in rugged terrain bordering the public roads of great interest and normal railroads	2
1.2.c	Forests located on terrains with very high vulnerability to erosion and landslides	3
1.2.d	Forests around the hydrotechnical constructions located in rugged terrain areas or area exposed to erosion and landslides	2
1.2.e	Forest plantations and spontaneous forest vegetation located on degraded lands or on unconsolidated mobile sands	2
1.2.f	Forest vegetation located in avalanche formation areas and their lanes	2
1.2.g	Forests located on consolidated mobile sands	3
1.2.h	Forests located on areas with landslides	2
1.2.i	Forests located on permanently swampy terrains	2
1.2.j	Forests around terrestrial mines area and quarries, and prone of erosion areas	2
1.2.k	Forests located in karst areas	3
1.2.l	Forests located on lithologic substrate with very high vulnerability to erosion and landslides	4

No.	Group/Subgroup/Category	Function type
1.3	Forests with protection functions against damaging climatic factors and pests	
1.3.a	Forests located in steppe and external forest-steppe	2
1.3.b	Forests located on the Black Sea vicinity and seashore lakes	2
1.3.c	Forests located in internal forest-steppe	3
1.3.d	Forest belts located around plain lakes and ponds	2
1.3.e	Forest shelterbelts for the protection of farmland, roads and railroads, industrial objectives and settlements	2
1.3.f	Forests located at high altitude with bad regeneration conditions	2
1.3.g	Bunches of forest spread at low altitude	3
1.3.h	Forests located in strongly affected by atmospheric pollution areas	2
1.3.i	Forests located in medium affected by atmospheric pollution areas	3
1.3.j	Forests located near dumps of sterile, ash and other residuals	2
1.3.k	Forests from alpine and subalpine regions, and also mountain areas, bordering the alpine region	2
1.3.l	Pinus mugo associations and natural clearings from subalpine floor	2
1.4	Forests with recreational functions	
1.4.a	Forests specially planned for leisure purpose (forest parks)	2
1.4.b	Forests destinated as green areas around the settlements	3
1.4.c	Forests around the spa and climatic resorts and sanatoriums	3
1.4.d	Forests located along the communication ways of great tourism interest	2
1.4.e	Forests around cultural monuments	2
1.4.f	Forests which protects special objectives	2
1.5	Forests of scientific interest and gene pool protection	
1.5.a	Forests destinated for genetic resources conservation	1
1.5.b	Forests proposed for temporary protection	2
1.5.c	Forests established as natural reservations	1
1.5.d	Forests established as scientific reservations	1
1.5.e	Forests established as landscape reservations	1
1.5.f	Forests for protection of natural monuments	2
1.5.g	Forests destinated for scientific research	2
1.5.h	Forests established as seed reservations	2
1.5.i	Forests established for protection of fauna species	2
1.5.j	Century-old, virgin and semi-virgin forest with high value	2
1.5.k	Dendrological parks and arboretum	2

No.	Group/Subgroup/Category	Function type
1.5.l	Forests from national parks not included in functional categories 1.5 a,c,d,e	1
1.5.m	Forests from biosphere reservations not included in functional categories 1.5 a,c,d,e	4
1.5.n	Forests from natural parks not included in functional categories 1.5 a,c,d,e	4
G.2	Forest vegetation with protection and production functions	
	Forests with timber production functions	
2.1.a	Forests destinated for production of resonance wood, veneer and fingerboard wood	5
2.1.b	Forests destinated for timber wood production	6
2.1.c	Forests established for cellulose wood, rural construction and other higher uses.	6
2.2	Forests with priority functions destinated to game species life	
2.2.a	Forests of game species interest	6

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