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# INTEGRATING ECOSYSTEM SERVICE ASSESSMENT AS A TOOL TO SUPPORT DECISION-MAKING IN THE FRAMEWORK OF ENVIRONMENTAL IMPACT ASSESSMENT

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ABSTRACT: In the current legal system concerning the environmental legislation in Poland, environmental impact assessment (EIA) constitutes an essential tool for the protection of ecosystems. A report that is being prepared within EIA includes different methods to assess the impact of a given project on the environment. The combination of the currently used methods and ecosystem services assessment may allow for a better understanding of the consequences of the environmental change. This article presents the theoretical framework of integrating the ecosystem services assessment into the EIA procedure and its use in a report on the environmental impact assessment of a given project.

KEY WORDS: environmental impact assessment, ecosystem services, Poland, integrated approach

## Introduction

It is important to maintain high critical point of preservation of a healthy environment, after which the destroyed ecosystem will cease to provide the services on which we depend (TEEB, 2011). The need to stop the loss of biodiversity is highlighted in the second target of the EU Biodiversity Strategy 2014-2020 (European Commission, 2011). It is also expressed in the Polish Programme for conservation and sustainable use of biodiversity (Resolution No. 213 Of the Council of Ministers, 2015). The environmental impact assessment (EIA) and strategic environmental assessment (SEA) constitute two legally binding tools suitable for combating these problems (European Commission, 2013). The purpose of conducting the impact assessments is to optimize the decision-making process on economic, social or other activities negatively affecting human health and quality of life, as well as more general environmental conditions, including species diversity and sustainability of ecosystems (Engel, 2009).

The aim of this study is to investigate the possibility of integrating the environmental impact assessments and the concept of ecosystem services in order to improve the practice of environmental impact assessments by taking advantage of current methods and approaches applied in ecosystem service assessments. It is also our aim to contribute to the scientific debate on the integration of the ecosystem service concept into environmental impact assessment. We assumed that the environmental impact assessment procedure and the concept of ecosystem services have a convergent goal, which is striving to preserve the environment for present and future generations. Moreover, the scope of environmental data acquired at the stage of preparation of the EIA report largely coincide with the data needed to evaluate the ecosystem services. We performed a desk research based on a comparison of the scope of required assessments by the legislation on environmental impact assessments (The act of 3rd October 2008 on the Provision of Information on the Environment and its Protection, Public Participation in Environmental Protection and Environmental Impact Assessments, legal status: 15.10.2016) with the literature review of ecosystem services assessment.

## The use ecosystem service concept for environmental impact assessment

The concept of ecosystem services concept explains the relationship between society and nature by the use of the notion of the benefits that people derive from ecosystems (MEA, 2005). It enables to recognize the relationship between basic ecological and economic concepts, and the combined analysis of these two subsystems, which in turn leads to a unified presentation of economic and ecological assessments (Solon, 2016). It can also serve as a tool to inform local communities and politicians about the relationship between human and nature and the need for sustainable development (Solon, 2016). In this regard, environmental policy should be based on well-established ecological facts and mechanisms to support decision-making. The EIA allows for the assessment of the impacts of various human activities on the environment. The design and assessment of the impacts of the different investment scenarios might include the anticipated future provision of ecosystem services (Esmail, Geneletti, 2017). The investment may affect the relative mix of ecosystem services within its impact area as well as trade-offs among them (Geneletti, 2013). The implementation of ecosystem service assessment has been conducted for various case studies across the globe (Partidario, 2016). The results prove that ecosystem service approach may help address some current problems with environmental assessment practice (Baker et al., 2013). In particular, the integration of ecosystem service may improve the identification of impacts and its significance for affected communities and their well-being (Rosa, Sanchez, 2016).

## Environmental Impact Assessment – the basic tool of environmental protection

The environmental impact assessment in Poland is a basic tool for environmental protection and prevention of negative impact on natural environment. The EIA procedure is regulated by the act of 3rd October 2008 on the Provision of Information on the Environment and its Protection, Public Participation in Environmental Protection and Environmental Impact Assessments. The law provides an administrative procedure for a planned investment that may have negative effects on the environment. One of the elements of this procedure is a report on the environmental impacts. The environmental impact assessment includes the preparation and verification of the report, obtaining the required opinions and agreements with administrative bodies and ensuring public participation in the procedure. According to the art. 66 point. 1 of the act of 3rd October 2008 the EIA report shall contain a descrip-

tion of the planned project, the characteristics of the natural elements of the environment within the scope of the expected impact of the planned project, a description of investment options taking into account the specific features of the project or its impact as well as the comparison of variants in terms of impact on the environment. The report shall also contain the methods that were used to carry out the assessment. The methodology concerning different scenarios of the impacts of an investment must include permanent, temporary, reversible, irreversible, direct, indirect, and cumulative impacts. The assessment of environmental conditions and projected impacts is prepared in relation to people (especially human health), plants, animals, fungi and natural habitats, protected areas and ecological corridors, water, air, climate noise, climate change, soil and surface of the earth, including the mass movements of the earth, the landscape, material assets, monuments and cultural landscape, as well as the interactions between these elements.

## Integrating ES to the EIA procedure

There have been several attempts to integrate ecosystem service concept in environmental impact assessments (Partidario, Gomes, 2013). This integration in the field of strategic environmental assessment (SEA) has been well described by prof. Geneletti (2014), especially for SEA in the field of spatial planning (Geneletti, 2011). In our contribution, we have combined steps of the EIA procedure in Poland (the assessment of the impact of an individual investment) and the main steps of the assessment of ecosystem services (table 1).

The general ecosystem service assessment framework designed for impact assessment (Landsberg et al., 2013) fits the EIA procedure in Poland. The theoretical framework of integration indicates the steps where ES may complement and enlarge the EIA. ES assessment may be conducted at the early steps of the EIA procedure to consider the potential impact of the investment on the provision of ecosystem services and to support decision-making of the environmental protection authority on the scope of the assessment. In the scoping step of the EIA, the ES assessment requires public consultation to prioritize relevant ecosystem services. That is an additional action to what is required by the Polish law. In the case of the full procedure of EIA, the public consultations are expected to be held after the EIA report is delivered. Therefore, the integration of ES approach into EIA may improve

**Table 1.** Integration of the steps in assessments of environmental impact and ecosystem services

| Steps of the EIA procedure, according to the Polish Law | | Main steps of the ES assessment for EIA | Detailed steps of the ES assessment for EIA |
|---|---|---|---|
| The investment proposal, the initial location | | – | – |
| Screening – the initial diagnosis of whether an investment requires a full EIA procedure (including the EIA report) | | – | The possibility of using ES concept to estimate which ecosystems will be impacted by an investment and an initial estimate of the changes in the supply of services |
| Opinion of the environmental protection authority (The General or Regional Directorate for Environmental Protection), together with the scope of the report | | – | The possibility of mapping of ES by the nature protection authority |
| Scoping – the determination of the scope of the report (for investments for which the report is required) | | 1.Identify relevant ecosystem services<br>2. Prioritize relevant ecosystem services – (stakeholder consultations)<br>3. Define the scope and information needs of the ecosystem service assessment | 1.1. Identify ecosystems the project could impact<br>1.2. Identify ecosystem services the project could impact<br>1.3 Identify potentially affected ecosystem service beneficiaries and benefits<br>2.1 Identify ecosystem services for which project impacts could affect the ability of others to derive benefits<br>2.2 Identify ecosystem services that are important to beneficiaries' livelihoods, health, safety, or culture<br>2.3 Identify ecosystem services for which beneficiaries have no viable alternatives<br>3.1 Delineate the precise ecosystem service impact assessment area (with relation to the scope set in the previous step)<br>3.2 Identify indicators of project impact on ecosystem services |
| COLLECTION OF INFORMATION | Description of the environmental impact within the project's scope (components according to the law or in accordance with the decision on the scope of the report) | 4.Establish the baseline for priority ecosystem services | 4.1 Assess current ecosystem service supply and demand<br>4.2 Assess sustainability of current ecosystem service demand |
| | Assessment of the projected (potential) impacts of different scenarios of the project (variants may concern: location / different technology and the business as usual (which in some cases may also have a negative impact) | 5. Assess project impacts on priority ecosystem services in different scenarios<br>(5b – optional) Value the project impacts on priority ecosystem services | 5.1 Predict project impacts on ecosystem service supply based on at least 2 different scenarios<br>5.2 Predict project impacts on ecosystem service demand based on at least 2 different scenarios<br>(5b.) Conduct the valuation based on the predicted impacts on ecosystem service supply and demand based on at least 2 different scenarios |
| | Impact assessment on Natura 2000 sites | 5. Assess project impacts on priority ecosystem services in different scenarios<br>(5b – optional) Value the project impacts on priority ecosystem services | 5.1 Predict project impacts on ecosystem service supply based on at least 2 different scenarios<br>5.2 Predict project impacts on ecosystem service demand based on at least 2 different scenarios<br>(5b.) Conduct the valuation based on the predicted |

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|---|---|---|
| Designing solutions that minimize negative impacts and, if necessary environmental compensation | 6. Mitigate impacts of project on priority ecosystem services | 6.1 Design measures to mitigate loss and enhance gain in ecosystem service benefit |
| Public consultations (21 days) | – | Possibility to support public consultations with the results of ES assessment |
| Agreements / opinions of Regional Directorate for Environmental Protection/ Regional Inspectorate of Environmental Protection | – | – |
| Analysis of the collected material as well as proposals and comments from the consultation | – | – |
| Release or refusal to issue a decision on environmental conditions of the project and the explanations | – | ES may be included in the reasoning part of the decision (e.g. the results of the cost-benefit analysis) |

„-" in the table means that in the method proposed by Landsberg et al. (2013) no main or detailed stage to which a step of the EIA procedure can be referred to has been identified

Source: authors' own work based on Landsberg et al. (2013) p. 34 and The act of 3rd October 2008.

the involvement of stakeholders and the assessment of the significance of the investment's impacts for affected communities.

## Integrating ES to the EIA report

Ecosystem services are directly related to the ecosystem condition and its capacity to provide ecosystem services. In table 2, we marked grey environmental components which are related to ecosystems. The impact on the following environmental components is compulsory to be assessed within EIA procedure (The act of 3rd October 2008):

- biodiversity, flora, fauna, protected areas including Natura 2000;
- soil and groundwater conditions;
- water (water resources and water quality);
- landscape.

We integrated the EIA report and related type of ecosystem services assessment on the basis of the act of 3rd October 2008, sample reports, expert knowledge, and CICES 4.3 classification (table 2). Ecosystem services can be divided after Millennium Ecosystem Assessment into four main groups namely: provisioning services, regulating services, supporting services and cultural services, or according to CICES 4.3 into 3 main types: provisioning (P), regulating& maintenance (R) and cultural (C).

**Table 2.** The scope of the report and related type of ecosystem services

| | EIA (information included in the report) | | Ecosystem services |
|---|---|---|---|
| **Environmental Components** | **Sources of data on the current state of the environment** | **Information on the anticipated impacts of the various scenarios of investment at the stage of implementation/operation/closing** | **Ecosystem service type related to the component of the environment/does not apply +comment** |
| Waters (hydrological conditions and water resources) | • Flood risk maps<br>• Environmental monitoring of surface water and groundwater<br>• GIS database of Wetlands<br>• Field measurements | • Change in the quality of water and its' chemistry (pH, BOD 5, COD, nitrate, phosphate, etc.).<br>• Assessment of the possibility of bacterial contamination<br>• Changes in physical conditions (transparency, suspensions)<br>• Changing quantity of water resources | P<br>R<br>C |
| Land cover and soil (soil and groundwater conditions, agricultural suitability of the soil) | • Soil maps<br>• Samples from Pits (rarely)<br>• Residual water table (from literature or own measurements)<br>• Digital Elevation Model (DEM)<br>• Corine Land Cover<br>• Orthophotomaps | • Land use change (area of the investment with soil sealing assessment)<br>• Assessment on projected land degradation by increased density (soil loses fertility)<br>• Assessment of soil condition under pollutant emissions and wastewater influence<br>• Changes in physiography (analysis of DEM) | P<br>R<br>C |
| Natural resources (geological structure and mineral deposits) | • Geological maps and the register of deposits<br>• Data on the geological resources and it exploitation<br>• Central Geological Database of Polish Geological Institute – National Research Institute | Information of the increased exploitation of natural resources | Does not apply |
| Air (air quality) | • Data from State Environmental Monitoring (Kostrzewski, Mizgajski, Stępniewska, Tylkowski, 2014) | • Change in the emission of pollutants (dust, gases)<br>• The results of modeling changes in air quality due to emissions | Does not apply<br>Decreasing air quality will negatively affect the condition of the ecosystem and its ability to provide ecosystem services |
| Noise (acoustic conditions) | • Acoustic maps<br>• Noise measurements | • The results of modeling the acoustic conditions<br>• The increase in sound intensity (dB)<br>• The increase in vibration | Does not apply<br>Structural landscape elements may provide ecosystem service of noise reduction |

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|---|---|---|---|
| Protected areas | • Central Register of Nature Conservation Forms<br>• Geodatabase of Nature Conservation Forms | • Analysis of the negative impact of pollution on protected areas | P<br>R<br>C |
| Flora, fauna | • Flora and fauna inventory,<br>• Data provided by The General or<br>Regional Directorate for Environmental Protection<br>• Maps of Ecological corridors by The Mammal Research Institute of the Polish Academy of Sciences<br>• The Forest Data Bank | • Collisions with location of habitats of flora and fauna<br>• Cutting trees and shrubs<br>• Habitat destruction<br>• The intersection of ecological corridors<br>• The formation of barriers to animal migration<br>• The impact of pollution of water, soil, and air on individual species of plants and animals<br>• The disturbance of animals as an impact of noise | P<br>R<br>C |
| Climate | • Data provided by the Institute of Meteorology and Water Management – National Research Institute | • The forecasted impact of investment on the local climate, mainly related to the emission of gases into the air and change of land use for non-forest. At a local scale, minor impacts are identified | Does not apply<br>Changing (topo) climate will affect the condition of the ecosystem and its ability to provide ecosystem services |
| Cultural elements (monuments, cultural landscape) | • Field visit<br>• Register of objects of cultural heritage | • Impact of vibrations on historic buildings<br>• The impact of air pollution on historic buildings | Does not apply<br>Only ecosystems can provide ecosystem services |
| Landscape | • Field visit<br>• Maps according to Kondracki<br>• Geoportal | • Negative changes in the landscape<br>• Introduction of invasive elements into the landscape | R<br>P<br>C |
| People (health conditions) | | Impact on human health (mainly by exceeding noise standards, pollutants emissions) | Does not apply<br>Ecosystem service beneficiaries |

Components associated with the ecosystem for which EIA and ES integration is straightforward are marked grey

Source: author's own work.

The ecosystem services are only produced by the ecosystems. Therefore, we linked types of ecosystem services to the related ecosystems that may produce them. It should, however, be acknowledged that ecosystem service may be negatively affected by the investment and the capacity of ecosystems to provide services may be hindered. Moreover, many regulating services, such as air quality regulation, mediation of smell/noise/visual impacts or global climate regulation by reduction of greenhouse gas concentrations are

closely linked to the environmental components that are required by the law. However, if ecosystem services are to be identified, they should be located at the place of provision, i.e. in the ecosystem.

The data gathered to assess the current state of the environment in EIA may be easily used as an input data to construct ES indicators and proxies. The level of details of data collected for the EIA reports differs significantly depending on the localization and type on investment. The use of more detailed data relates to new investments and those located on the environmentally valuable areas.

## Conclusions

The EU and national legislation have not introduced the obligation to assess the impact of the planned project on the potential provision of ecosystem services. The act of 3rd October 2008 does not specify what methods should be performed to assess the impact of the planned project on individual components of the environment. From a legal point of view, it is allowed to use the ecosystem service approach to performed EIA. From the methodological point of view, EA fits the EIA procedure and extends it. The practice of EIA clearly indicates the need to use modern methods and new approaches.

The results of this research indicate at which steps of the EIA procedures the ES assessment may complement and enlarge the impact assessment. We specified for which environmental components of EIA report the ES assessment is most suitable. We believe that the additional information resulting from the ecosystem services assessment may contribute to the more sustainable management of environmental resources and services.

## The contribution of the authors

Katarzyna Tokarczyk-Dorociak conceived the original idea, did literature review, performed the integration of the steps in assessments of environmental impact and ecosystem services, analized the scope of the report and related type of ecosystem services (60%).

Marta Sylla did literature review, performed the integration of the steps in assessments of environmental impact and ecosystem services, analized the scope of the report and related type of ecosystem services (40%).

Both authors discussed the results and implications and prepared the manuscript at all stages. Both authors contributed extensively to the work presented in this paper.

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