# Eco-System services as evaluation criteria for sustainable and bio-based building materials

The construction sector, one of the most resource-intensive economic sectors, is responsible for around 40 per-cent of global greenhouse gas emissions, contributes to around 55 percent of national waste generation, consumes a considerable amount of materials and is a major contributor to soil sealing. In order to achieve the climate targets, a comprehensive transformation of this sector is required, which can be driven forward by new ideas and, above all, by sustainable building materials and construction methods.

When selecting building materials, it is crucial to consider not only their immediate properties and intended uses, but also their origin, the extraction and extraction process and their associated environmental impact. The extraction of mineral or metallic raw materials can cause significant damage to the environment, including land-scape destruction, soil and water pollution, water stress, loss of biodiversity, erosion and the degradation of entire ecosystems. In contrast, certain renewable resources can promote numerous positive attributes, also known as ecosystem services (ESs). These include the promotion of soil health, the preservation of biodiversity, the improvement of water storage and filtration, erosion control and the reduction of greenhouse gas emissions or carbon storage in the soil, among others.

The consideration of ESs can play a crucial role in promoting sustainability in the construction sector by influencing the selection of building materials and construction methods, as well as their origin and cultivation, which in turn has direct implications for environmental impacts and sustainability.

A promising approach that has gained increasing importance in recent years is the development and use of innovative construction and insulation materials made from bio-based resources. Particularly, plants grown in paludiculture, i.e., plant cultures cultivated in marshes / peatland, offer a promising solution for both climate protection and the transformation of the construction sector, shifting from conventional agriculture to wet agriculture. Paludiculture contributes to reducing greenhouse gas emissions, protecting biodiversity, and providing regional and sustainable building materials, while simultaneously revitalizing degraded wetlands and storing carbon in the soil. Establishing functional value chains with all stakeholders can thus provide a sustainable basis for a new bioeconomy.

Additionally, straw, hemp, or miscanthus also offer the opportunity to produce a wide range of building and insulation materials. These can replace conventional and energy-intensive building materials as low-emission, annually renewable resources, fulfilling a variety of ecosystem services and can be grown on marginal lands as well as conventional agricultural lands.

In a conventional life cycle assessment (LCA), which serves as the basis for assessing the sustainability and environmental impacts of building materials, essential ecosystem services such as soil improvement, erosion control, or water retention, or the improvement of the microclimate, are not explicitly considered. Hence, the idea arose to integrate these aspects as complementary information into an LCA or to document them elsewhere or integrate them into an assessment tool.

Such an approach could enable a more comprehensive assessment of the environmental impacts of building materials and may also be considered for financial compensation.

# 1 What are ecosystem services?

Ecosystem services (ESs) refer to the benefits that nature provides to humans through habitats and organisms such as animals and plants. Since the smooth functioning of ecosystems depends on the complex interaction of various organisms, biodiversity, with all its levels, forms an essential pillar of ecosystem services.

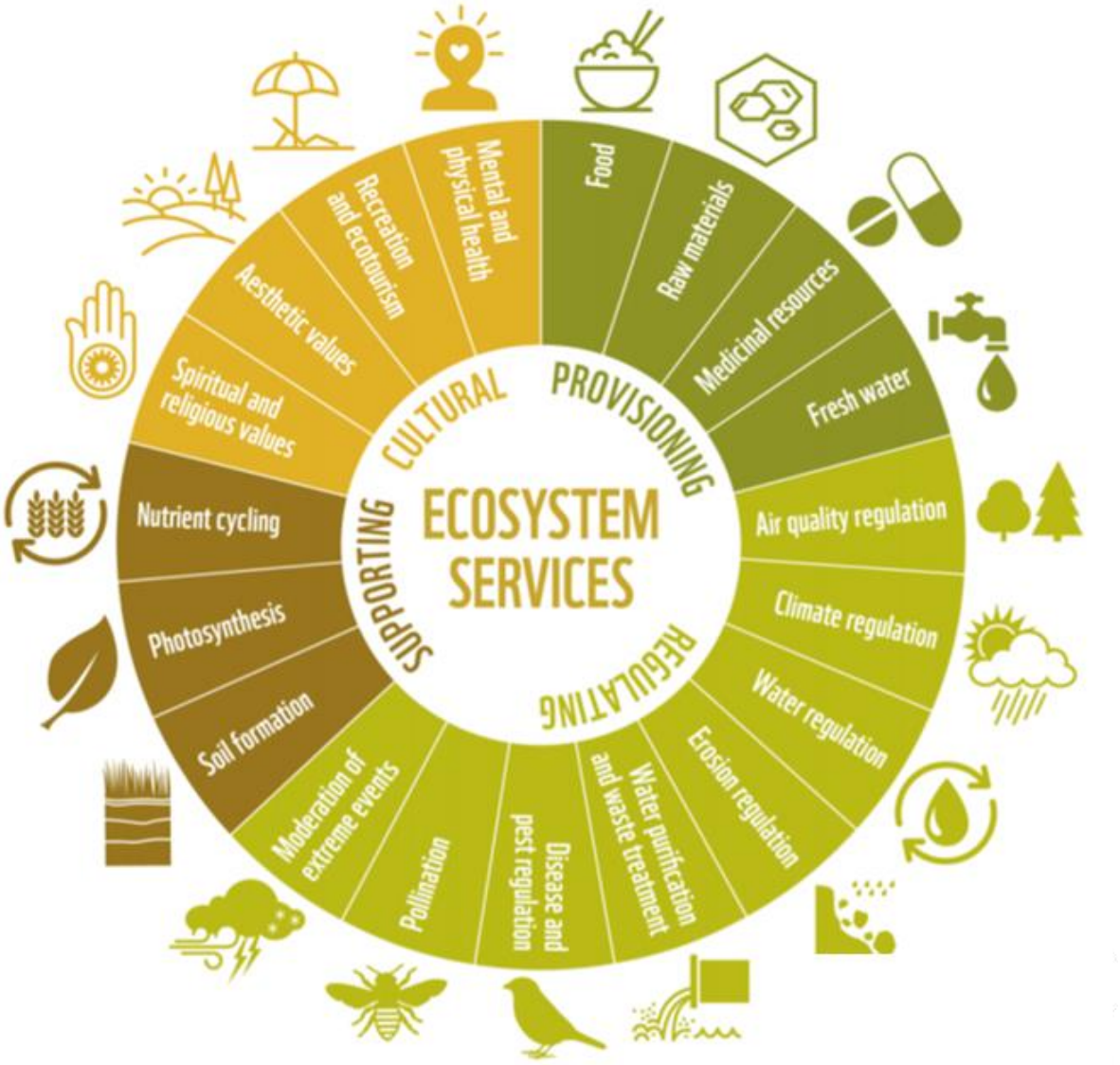
Ecosystem services can be divided into four categories based on the type of benefits they provide to humans:

Provisioning services:
Products obtained from ecosystems, such as food, water, wood/raw materials, and energy sources.

Regulating services:
Benefits resulting from the regulation of ecosystems, such as air and water purification, climate regulation, and the mitigation of floods and erosion.

Cultural services:
Non-material benefits derived from ecosystems, such as fulfilling aesthetic, spiritual, and intellectual needs, recreation, and cultural heritage.

Supporting services:
Services necessary to produce all other ecosystem services, such as pollination, primary production, soil formation, and nutrient cycles.
In a conventional life cycle assessment (LCA), which serves as the basis for evaluating the sustainability and environmental impacts of building materials, essential ESs such as soil improvement, erosion control, water retention, or microclimate enhancement are not explicitly considered. This has led to the idea of potentially integrating these aspects as supplementary information into an LCA or documenting them elsewhere or integrating them into an assessment tool.
Such an approach could enable a more comprehensive assessment of the environmental impacts of building materials and, under certain circumstances, may also be considered for financial compensation.




Range of ecosystem services provided by nature to humans.
Source: WWF, 2016 (adapted from Millennium Ecosystem Assessment, 2005)

# 2 Building Materials from Sustainable Ecosystems: An Innovative Approach for the Construction Sector

## 2.1 Lausitz Miscanthus as an Opportunity for Eco-Friendly Construction

In May 2021, a field trial began on approximately one hectare at the former Reichwalde open-cast mine (lignite mining plots) as part of the EU follow-up project Miscomar+ - Miscanthus for Contaminated and Marginal Areas. The result: Miscanthus, also known as Chinese silver grass, giant reed grass, or elephant grass, appears to thrive on the nutrient-poor soils of post-mining landscapes in the Lausitz region and under the climatic conditions characterized by heat and drought. It has shown promising development, yields, and the ability to act as a self-sustaining nutrient supplier, even aiding in the conversion of mine spoil heaps for agricultural use.

Miscanthus can be utilized to produce sustainable building materials such as high-performance insulation plaster, blow-in insulation, plant-based concrete, insulation and construction panels, among others.

https://www.leag.de/de/seitenblickblog/artikel/lausitzer-miscanthus-als-chance-fuer-oekologisches-bauen/

## 2.2 Paludiculture in practical testing: Optimization of cattail and reed cultures for building material production.

Within the framework of the Paludi-PRIMA project, an approximately 10-hectare area was cultivated for ecological and economic research with the cultivation of cattails, which was established in 2019. The aim is to derive recommendations for the targeted cultivation of reeds on rewetted peat soils.

As part of this research, real-world data on the establishment, management, harvesting, productivity, and biomass quality are collected to conduct an economic evaluation. Additionally, the ecosystem services of cattail cultivation are quantified, particularly regarding carbon, water, and nutrient cycling, as well as biodiversity. Another focus is on investigating the influence of water level fluctuations on biomass accumulation and decomposition processes.

From paludiculture, plants such as Typha (cattails), Schilf, reed canary grass, common club-rush, or sedges can be planted, from which various sustainable building and insulation materials can be produced.

https://www.fnr.de/projektfoerderung/ausgewaehlte-projekte/projekte/paludi-progress

These are just a few examples illustrating how diverse ecosystem services can be provided through various plant cultures and approaches. This targeted selection can contribute to maximizing and optimizing ecological as well as economic benefits in different environments or sectors.

# 3 Evaluation and Challenges of Integrating Ecosystem Services in the Construction Sector

Mr. Bas Spanjers, a researcher at the University of Greifswald, reports that the consideration of various ecosystem services (ES) is already quantified or rewarded in certain regions. For instance, this is done through CO2 certifications in the voluntary market. In the Common Agricultural Policy (CAP), rewards for biodiversity exist based on the presence of certain target species on the land. In the Netherlands, farmers are compensated for water retention on their lands, while in Brandenburg, payments are made for peat-friendly water management to improve landscape water management.

These incentives are relevant for farmers but integrating them into end products of the construction sector is complex, as the same product/building material can significantly differ in ESs depending on the method and location of cultivation. To create a unified basis for assessment, we need a tool to clarify these differences.

Currently, work is underway on a Paludi certification for products made from peat biomass. This certification aims to ensure that biomass for specific products originates from peat-preserving areas.

Products will only receive the certification if they meet these requirements, which also encompass several other ecosystem services.

For marketing purposes, it may be possible to describe ESs for building products without needing to quantify them. Alternatively, it could be indicated that a product comes from an area where certain bird species have nested or where they are provided with a habitat. At this point, the introduction of specific ESs certifications could also be considered. We welcome further suggestions and ideas from you in this regard.

For those who wish to delve deeper into the topic, here are further details on the international classification of ecosystem services.

At the EU level, a new classification called the Common International Classification of Ecosystem Services (CICES) has been developed by the European Environment Agency with the aim of defining standards for environmental-economic accounting. The latest version 5.1, can be found here.

This classification is intended to facilitate the integration of ecosystem services into reporting systems for national environmental-economic accounting (System of Environmental-Economic Accounting - SEEA), which are being revised under the leadership of the United Nations. In the future, this could expand the national accounting systems to include ecosystem services and related indicators. It is expected that this will significantly increase the visibility of nature within the traditionally economically-oriented systems for measuring prosperity.

# 4 Additional Links

Ecosystem services impacts as part of building materials selection criteria
This article highlights the significant negative ecological impacts of the built environment, particularly due to the extensive use of construction materials and the disposal of materials from construction and demolition activities. It emphasizes the importance of analyzing the impact of acquiring, using, and transforming building materials on ecosystems. While material use, energy use, and emissions are often considered, the article argues that the impacts on ecosystem services are rarely examined. It introduces the concept of ecosystem services in selecting construction materials and presents a methodology for applying ecosystem services analysis to material specification. The article concludes that integrating an understanding of ecosystem services into materials selection could lead to positive ecological changes across the lifecycle of building materials and in the design, specification, construction, and use of built environments.
https://www.sciencedirect.com/science/article/pii/S2589234718300290

Payments for Ecosystem Services Towards an Implementation Strategy

Payments for Ecosystem Services (PES) are considered economic instruments to maintain ecosystem functions. Here are the results from the workshop on the implementation of PES programs and the significance of policy guidelines and the need for targeted development.

https://www.bfn.de/sites/default/files/BfN/service/Dokumente/skripten/skript_326.pdf

Developing incentives for paludiculture to achieve the climate protection goals for 2030 and 2050

https://www.umweltbundesamt.de/sites/default/files/medien/479/publikationen/cc_44-2022_entwickeln_von_anreizen_fuer_paludikultur_zur_umsetzung_der_klimaschutzziele_2030_und_2050.pdf

The True Costs and Benefits of Miscanthus Cultivation

The study demonstrates that agricultural ecosystems provide diverse ecosystem services, but at the same time, farming operations can have negative environmental impacts such as greenhouse gas emissions. By combining production costs, the monetary value of ecosystem services provided, and the monetization of environmental impacts, the study enables a comprehensive assessment using Miscanthus as an example. Depending on the scenario, Miscanthus cultivation results in a net benefit ranging from 140 EUR to 3.051 EUR/ha/year, with the monetary value of provided ecosystem services significantly outweighing the costs.

https://doi.org/10.3390/agronomy12123071

Building Materials from Sustainable Ecosystems – Paludiculture in a Interface Function for Climate Protection

As part of a project within the Gebäudeforum Klimaneutral by dena in December 2022, we organized an initial interdisciplinary dialogue titled "Building Materials from Sustainable Ecosystems – Paludiculture in an Interface Function for Climate Protection" to link peatland conservation with the climate relevance of the construction sector and the potential of building materials from renewable resources (NaWaRo). In this multi-stakeholder workshop, we collectively discussed processes and framework conditions for possible development potentials of paludiculture and their use in the construction sector.

https://www.gebaeudeforum.de/fileadmin/gebaeudeforum/Downloads/Studie-Bericht/Gebaeudeforum_Hintergrundpapier_Paludikulturen.pdf

Monetary Valuation of Ecosystem Services for the Netherlands

This report presents the initial experimental results for the Netherlands on the monetary valuation of ecosystem services and goods using the SEEA EEA framework.

https://www.cbs.nl/en-gb/background/2020/04/monetary-valuation-of-ecosystem-services-for-the-netherlands

The Need for Biobased Building Materials - An Analysis of the Potential for Increased Use of Biobased Building Materials in Construction and Infrastructure.

An examination of the potential for accelerated deployment of renewable building materials in construction and infrastructure in the Netherlands.

https://circulairebouweconomie.nl/wp-content/uploads/2022/12/De-urgente-belofte-van-biobased-bouwen-Transitieteam-CBE-RVO-RWS-dec-2022.pdf

# 5 Conclusion

The idea of incorporating ecosystem services (ESs) into the selection and evaluation of building materials and construction methods is an additional approach for enhancing sustainability in the construction sector. By doing so, existing regulations and approaches can be complemented, and strategic collaboration between the construction sector, soil conservation, water, climate and nature conservation, and agriculture can be promoted.

One the next page you find a proposed process for incorporating ecosystem services impacts into materials selection from M. Pedersen Zari / Materials Today Sustainability 3 -4.

https://www.sciencedirect.com/science/article/pii/S2589234718300290#fig2

# 6 Notice

This report was translated to English with the assistance of ChatGPT from its original German version by Petra van der Wielen and may contain minor translation errors.

# 7 Contact

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