

M4 生態系と産業の結合：日本産業部門における 森林生態系サービスのマクロ分析

Connecting Industry and Ecosystems: A Macro Analysis of Forest Ecosystem Services in Japanese Industry Sectors

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Abstract: The Millennium Ecosystem Assessment highlights the rapid changes in earth’s ecosystems and emphasizes the need for industry to reflect an understanding for ecosystems in its operations. Approaches to quantify the interaction between industry and ecosystems are lacking. To address this need, this research first presents a framework for connecting industry environmental interventions and ecosystem services. Taking the specific case of ecosystem services from forests, it quantifies the interactions to an ESSR (“Ecosystem Services Requirement”) value for industry. IO analysis is then applied to estimate the total requirement for Japanese industry sectors. The results showed large variations between sectors ranging from low requirements in the services sectors to high requirements from primary manufacturing and energy related sectors. For wood resources alone the “Pulp, paper and wooden products” sector had the largest ESSR, however assessing the total services received from forest shows a different profile. The results from this approach of considering diverse ecosystem services suggests that assessment of the flows of ecosystems is an important criteria within decision making for ecosystem services in industry.

Keywords: Ecosystem services, IO Analysis, Forest Ecosystems, Framework

1. Introduction

The findings in The Millennium Ecosystem Assessment and The Economics of Ecosystems and Biodiversity¹ are pushing the agenda of biodiversity and ecosystems in industry. Although environmental accounting at the national and industry level continues to grow, data for environmental interventions alone does not describe the flows between these environmental interventions and ecosystem services. Industry interacts with ecosystems services in both negative *and* positive ways, and a means to quantify the interactions is essential for decision-making on strategies to both maintain and enhance the flow of ecosystems services.

In response to this, the objectives of this research are to 1) develop a framework for identification of the interactions between environmental interventions and ecosystem services, 2) quantify the interactions for provisioning and regulating services in forest systems, and 3) evaluate by macro-analysis the forest service interactions across the Japanese economy.

2. Method

An ESSR (Ecosystems Services Requirement) framework to consider all classifications of ecosystems services was developed and then applied in identifying the services that industry received from forest systems (Fig.1). Direct linkages for the *provisioning* service of wood, and the *regulating* services of SO_x and NO_x assimilation, and CO₂ sequestration were quantified. The flow of each of these services was converted to a land stock equivalent (ha), and combined to give category level ESSR, and an overall ESSR value. Via this method of quantification, the

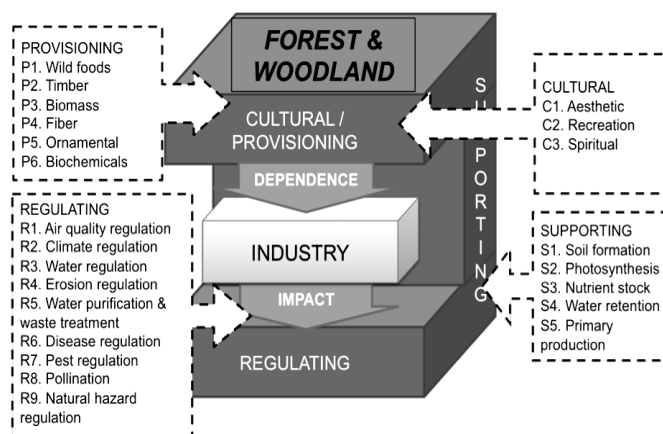


Fig.1 Forest ESSR Framework with ecosystem services

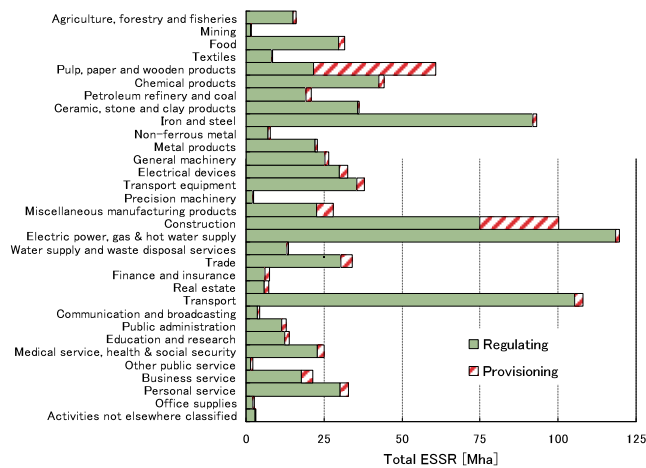


Fig.2. Total ESSR for 32 sectors

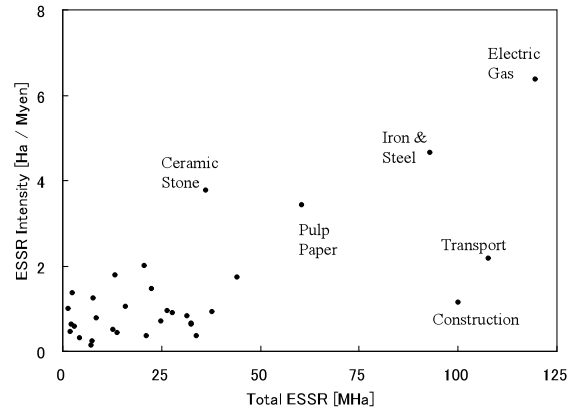


Fig.3. Total ESSR vs. ESSR Intensity for 32 sectors

wood resource use, and SO_x/NO_x and CO_2 emissions data from industry sectors were used to calculate the direct ESSR of each sector. IO analysis was then applied to evaluate the total embodied requirements for ecosystem services from intermediate and final demands. This generated results for the Total ESSR, i.e. direct and indirect requirements, and the ESSR Intensity, i.e. ESSR per million yen of economic activity.

3. Results

The Total ESSR for the 32-sector economy (Fig.2) shows that the “Electric power, gas supply, steam and hot water supply” is the largest, making up over 12% of the total induced activity from final demand. The breakdown into service component categories of ‘provisioning’ and ‘regulating’ highlights the dominance of the regulating service. This is largely due to the large stock equivalent required for carbon sequestration. Provisioning was only dominant in one sector, “Pulp, paper and wood products”. Results also reveal how the requirement for ecosystem services due to interventions upstream in the supply chain are the largest contributor to the ESSR for most sectors, and that imported requirements are prevalent in sectors with a strong dependence products of wood flows from overseas.

4. Discussion

Analysis of the Total ESSR against the ESSR intensity values (Fig.3), indicates the clear distinction in ecosystem service demands and intensity by primary manufacturing, energy and transport sectors. However, high ESSR values do not strictly translate to negative environmental impacts. This ESSR indicator uses a sum of services to show the total degree of integration of an industry sector with an ecosystem. Once the flows do not exceed a sustainable limit (e.g. maximum sustainable yield or assimilative capacity), traditional responses to high environmental indicator values such as mitigation may not apply. In fact, provisioning flows from sustainable sources could have overall net benefits (e.g. certified afforestation), suggesting the possible benefits of inclusion of this type of indicator into policy decision making.

5. Conclusions

The conclusions of this research are: i) the ESSR framework allows for identification of interactions between ecosystem services and industry environmental interventions, ii) the application of methods to quantify the flow of services between industry and ecosystems allows for a multidimensional approach towards understanding and assessment of interaction between industry and ecosystems, and. iii) macro analysis of Japanese industry sectors results in a comprehensive means of assessing the economy-wide requirement for ecosystem services.

1. TEEB (2008): The Economics of Ecosystems and Biodiversity: An Interim Report for National and International Policy Makers.