

# A Tool for Ecosystem Services Dependency Management Support through Quantitative Assessment and Treatment Knowledge Base Development

## A Case Study on the Japanese Economy

地球環境共生工学領域 08E09081 Jarkko HAVAS

**Abstract:** This thesis illustrates the development of a tool for ecosystem services dependency management. The tool is being developed in order to quantify industry's responsibility in ecosystem services conservation as recognized by Convention on Biological Diversity (CBD). The tool runs on MS Excel and consists of quantitative ecosystem services dependency assessment and a knowledge base. Japanese economic sectors and Japanese ecosystem services are used as a case study. The tool was evaluated by experts from academia and the private sector, and the evaluation results should be reflected in future development of the tool.

**Keywords:** ecosystem services dependency, I-O tables, knowledge database, Ghosh inverse matrix

### 1. Introduction

The Economics of Ecosystems and Biodiversity (TEEB) has been a pioneer study in showing the risks and opportunities in biodiversity and ecosystem services decline. Lately, based on TEEB, the necessity to include private sector in ecosystem services conservation policies has been demanded by CBD COP-10 and COP-11. Especially, methods for involving private sector into conservation policy making on regional and national level was highlighted. In order to support these attempts, this study proposed a nation-level ecosystem services dependency assessment method and a knowledge base for sustainable dependency treatment methods. The assessment results and the knowledge base are integrated into a dependency management tool tailored for industries and national governments. This study was a case study of the Japanese economic sectors.

### 2. Ecosystem services dependency assessment

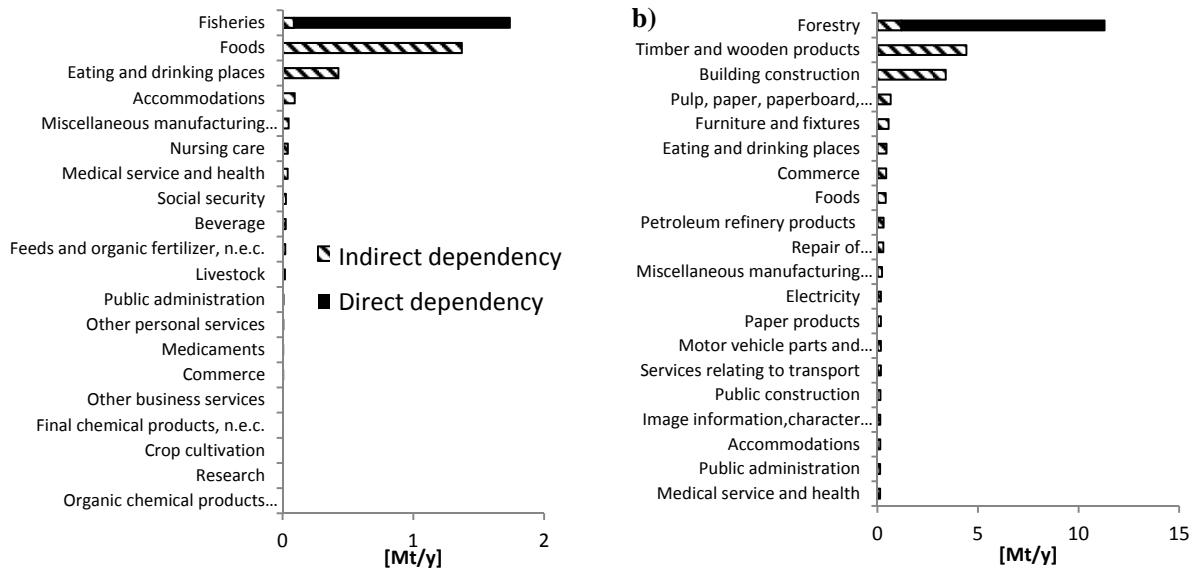
This study utilized the Ghosh inverse matrix method as introduced by Zhang et al.<sup>1)</sup> for assessing economic sectors' cumulative (direct and indirect) ecosystem services dependencies. Equation 1 shows cumulative dependency matrix  $\mathbf{X}$  for all sectors of the economy, where  $(\mathbf{I} - \mathbf{G}^T)^{-1}$  is the Ghosh inverse matrix and  $\mathbf{V}$  is the ecosystem service input matrix.

$$\mathbf{X} = (\mathbf{I} - \mathbf{G}^T)^{-1} \mathbf{V} \quad (1)$$

Here,  $\mathbf{G}$  is calculated from economic IO tables for 108 aggregated sectors of the Japanese economy<sup>2)</sup>. All the ecosystem services included into this study are provisioning services, and the annual consumption of five services were included; agricultural products, timber, fish and related species, water (public supply) and biomass. Example result for the 20 most dependent sectors on fish and related species, and timber is shown in Fig. 1. Only sectors to which each ecosystem service is input have direct dependency.

### 3. Knowledge base for ecosystem services dependency treatment

The knowledge base includes information supporting decision making on ecosystem services dependency treatment. This information was acquired from case study databases and was primarily collected for most dependent sectors to each ecosystem service. The knowledge base holds information also on common treatment methods that suit all sectors, as well as the current states and conservation needs of each ecosystem service. All information has hyperlinks to further knowledge in the internet.



**Fig. 1** Dependency assessment results for a) Fish and related species and b) Timber

#### 4. The tool interface

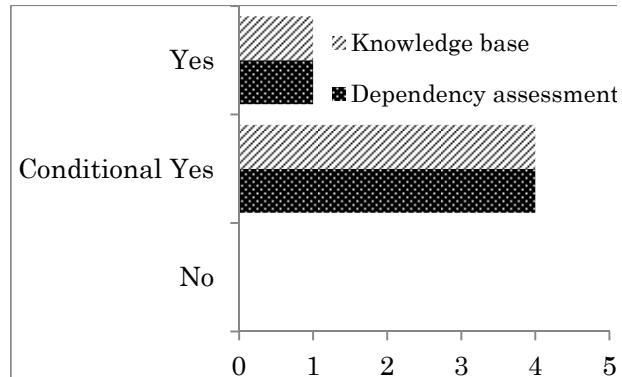
The ecosystem services dependency management tool proposed in this study combines the above mentioned assessment method and knowledge base. The tool interface allows the adjustment of results viewpoint (ecosystem services or economic sectors) and graphical representation parameters (graph types, number of sectors included, dependency unit: absolute value or shares of total). Embedded within the dependency assessment results are hyperlinks to the knowledge base for all sectors and ecosystem services represented in the results. The tool was programmed on Visual Basic for Applications within Microsoft Excel.

#### 5. Utility evaluation and future prospects

The utility of the dependency assessment and the knowledge base were evaluated by five experts of different fields related to environmental studies. The evaluation results are shown in Fig. 2. As can be seen, for both assessment topics 4/5 of the answers were 'conditional yes' with 1/5 'yes'. This result encourages further development of the tool. Comments received from the experts and issues discovered during tool development were used for discussion on the future development needs. The most pressing development aspects include adding information on ecosystem services supply chains to the dependency assessment results and structuring the data in the knowledge base for increased utility and data management.

#### References

- 1) Zhang, Y., Baral, A., Bakshi, B. R., *Accounting for Ecosystem Services in Life Cycle Assessment, Part II: Toward an Ecologically Based LCA*, Environ. Sci. Technol., vol. 44, pp. 2624-2631, 2010
- 2) 総務省統計局, 生産者価格評価表 108 部門表. [Online] [Cited: 2012.8.29] <http://www.e-stat.go.jp/SG1/estat/Xlsdl.do?sinfid=000002568523>



**Fig. 2** Utility evaluation results