The structure of human well-being related to ecosystem services: A Japanese case study to confirm the repeatability of previous findings

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Abstract
Recognizing the structure of human well-being related to ecosystem services is an important first step to addressing the associated environmental issues. This paper aims to analyze the structure of human well-being related to ecosystem services in Japan (including coastal and inland areas). Satisfaction levels with the five components of human well-being (basic material for a good life, health, good social relations, security, and freedom of choice and action), as defined by the Millennium Ecosystem Assessment, were investigated using a questionnaire. Of the five components, structural equation modeling analysis indicated that “security” and “basic materials for a good life” functioned as explanatory variables, while “freedom of choice and action” acted as a dependent variable through its effects on the intermediate variables “health” and “good social relations”. This study obtained similar findings to previous studies regarding the structure of human well-being. The present results also indicate that the structural model of human well-being related to ecosystem services might be psychologically shared among people.

Key Words: human well-being, ecosystem services, Millennium Ecosystem Assessment, structural equation modeling, IPBES

Introduction
The term “ecosystem services” refers to the benefits people obtain from ecosystems. These benefits include provisioning services, such as food, water, timber, and fiber, as well as regulating services that affect the climate, flooding, disease, waste, and water quality. The ecosystem additionally provides cultural services that are used for recreation, aesthetic pleasure, and spiritual benefits. Further, there are supporting services, such as soil formation, photosynthesis, and nutrient cycling (Millennium Ecosystem Assessment, 2005). Since the publication of the Millennium Ecosystem Assessment (MEA) of the United Nations (2005), attention has been given to classifying the components of human well-being as a subjective aspect derived from ecosystem services (Díaz et al., 2015; Pascual et al., 2017). This assessment argued that healthy ecosystems support the ability of humans to survive and thrive, and that understanding the interactions between human well-being and ecosystem health is critical to promoting a healthy planet (Biedenweg, Stiles, & Wellman, 2016). Because ecosystems contribute to human well-being in a variety of ways, people require them as a matter of daily life. MEA (2005) established the concept of ecosystem services on the global agenda, and asserts that human well-being derived from ecosystem services is assumed to have multiple constituents, including the “basic material for a good life”, “health”, “good social relations”, “security”, and “freedom of choice and action”.

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including the opportunity to achieve what an individual values doing and being. However, structure of the human well-being and interactions between each component have not sufficiently understood.

In order to visualize the structure of human well-being related to ecosystem services, some recent studies have examined the satisfaction level of the five components of human well-being. The satisfaction levels of these five components defined by MEA (2005) were investigated through the use of a questionnaire survey. Then, a Structure Equation Modeling (SEM) analysis was conducted by using the resulting satisfaction scores as variables. Of the five components, the results of the analysis indicated that satisfaction levels for “security” and “basic materials for a good life” worked as explanatory variables, while “freedom of choice and action” was a dependent variable through its effects by the intermediate variables of “health” and “good social relations” (Hori, 2015; Hori & Makino, 2016; Hori, Tsurita, Tajima, & Makino, 2017). In these studies, a SEM analysis revealed hierarchical characteristics among the five components of human well-being that were related to ecosystem services in coastal areas. The most recent study also revealed the same model found in previous studies. The structures are very similar to those described in Maslow’s hierarchy of needs model, which was discussed as a theoretical background to the model (Hori & Makino, in press). However, these surveys were conducted only in coastal areas. The residential location of the respondents was restricted to areas that were within a one-hour drive by car from the coast. This stipulation was chosen to select for people who were more dependent on marine (and coastal) ecosystem services.

Recognizing that elements of human well-being are derived from ecosystem services and should be integral to environmental management goals is an important first step to addressing the surrounding issues (Collins et al., 2010). This paper aims to replicate the structure of human well-being related to ecosystem services in Japan (including its inland areas) by using the same questionnaire and analysis method. Thus, this study attempts to compare the structure of human well-being related to ecosystem services between inland areas and coastal areas.

Method

Sampling Design
Data for this study were obtained from 3,000 survey responses from individuals in Japan aged 20 years or above. This survey involved web-based questionnaires that were conducted in the 47 Japanese prefectures according to demographic statistics (Statistics Bureau of Japan, 2016). The questionnaires were randomly distributed by a research company, TFC Japan Co., Ltd., and the results were obtained in March 2017.

Questionnaire Items
Recent measures of human well-being related to ecosystem services were represented by simple questionnaire items (Hori, 2015; Hori & Makino, 2016, in press; Hori et al., 2017). This study used the same items employed by the above-mentioned 2005 MEA study, and was able to confirm that the results of the MEA study were sufficiently replicable. The questionnaire items were selected and grouped according to the five components of human well-being as defined by the MEA (i.e., basic materials for a good life, health, good social relations, security, and freedom of choice and action) (MEA, 2005). Three to five items were then selected for each component. That is, there were three items for “freedom of choice and action”, four for “health”, “good social relations”, and “security”, and five for “basic materials for a good life”. Thus, 20 questions were included in the questionnaire (see Appendix 1). Each question was scored by the respondent based on a five-point Likert-type scale according to their satisfaction level for each component (i.e., 5 = very satisfied, 4 = somewhat satisfied, 3 = neither satisfied or dissatisfied, 2 = dissatisfied, and 1 = very dissatisfied). Similarly, the respondents were asked to indicate the distance from their house to the sea (coastal area) by car by selecting one of five responses (i.e., 1 = within 30 minutes, 2 = within 1 hour, 3 = within 2 hours, 4 = within 3 hours, and 5 = N/A).

Reliability Analysis
Prior to running the model, a reliability analysis was conducted to evaluate the stability and consistency of each questionnaire item listed for the five components of human well-being. Thus, Cronbach’s Coefficient (α) was calculated. In the present reliability analysis, α was 0.80 for “security”,
0.89 for “basic materials for a good life”, 0.83 for “health”, 0.83 for “good social relations”, and 0.72 for “freedom of choice and action”. To elucidate the basic structure of human well-being, structural equation modeling (SEM) was run for the five components of human well-being by using average satisfaction scores as variables, and then using pooled data obtained from the 47 Japanese prefectures. Multiple-group SEM was then conducted to compare the structure of human well-being among the residents who lived at different distances from the sea (coastal area). This model was run by using the average satisfaction scores of the five components of human well-being as variables. All statistical analyses were conducted using SPSS Statistics Version 23 (IBM) and SPSS Statistics AMOS Version 23 (IBM).

Results

The SEM analysis performed on pooled data (n = 3,000) indicated that the model was reliable (Figure 1: chi-square (1) = 21.61, GFI = 1.00, AGFI = 0.96, CFI = 1.00, RMSEA = 0.08). In the model-based characterization of the components of human well-being, “security” and “basic materials for a good life” functioned as more fundamental variables that affected “freedom of choice and action”, while “good social relations” and “health” were mediating variables for the other components. Among the five components, there was a significant correlation between “security” and “basic materials for a good life”. In addition, “security” had a significant positive effect on the components of “good social relations” and “health”. A significant positive effect of “security” on “freedom of choice and action” was also detected, but this effect was slightly weaker. As well, “basic materials for a good life” had a significant positive effect on “good social relations” and “health”. Finally, both “good social relations” and “health” had significant positive effects on “freedom of choice and action”. The basic structure of human well-being as described in this study is the same as described in relevant previous studies (see Appendix 2).

The multiple-group SEM indicated a good fit to the model (Figure 2: chi-square (4) = 17.10, GFI = 0.99, AGFI = 0.90, CFI = 1.00, RMSEA = 0.06). The model was run using the responses for the question concerning driving time to the sea (coastal area) [i.e., “how long does it take driving by car from your house to the sea?” (30 min: n = 396; 1 h: n = 183; 2 h: n = 225; 3 h: n = 145)]. The linkage structure among the five components of human well-being for each area was expressed in the same manner as the pooled data results. The basic structure of the components of human well-being was similar to those derived from the analysis using pooled data. There is a significant positive effect between each component, similar to that shown in Figure 1.

Discussion

SEM analysis suggests the revealed hierarchical characteristics of the five components of human well-being related to ecosystem services. This study’s results confirmed the high replicability of the model (see Appendix 2). Results
further indicate that the structural model of human well-being related to ecosystem services may be psychologically shared among all people.

Additionally, the multiple-group SEM indicated that there were common features among the components. This analysis investigated the intensity of the interaction between the components as rated (β) by residents living in different areas (i.e., coastal or inland areas), but found that only a slight difference was present. The international comparison indicated that natural and social backgrounds affect the structure of the components of human well-being related to ecosystem services in each country (Hori & Makino, 2016, in press). For instance, all locations in Japan experience four yearly seasons (an example of the natural background), and infrastructure levels (an example of the social background) are mostly consistent for all Japanese residents when compared to other countries. Thus, the model appears to indicate the only slight difference between components. A study by Hori et al. (2017) visualized the structure of human well-being related to the marine ecosystem services of coastal areas, and conducted a comparative analysis between two regions in Japan. The study reported that differences observed in the structure of human well-being originated in the different utilization patterns of the marine ecosystem services, such as the fishing industry and tourism. However, this study indicated that virtually no difference was observed in the intensity of interaction between the components. From this point on, more specific variables, such as the participants’ characteristics, will be needed to solve this issue.

This study discussed the basic structure of human well-being related to ecosystem services, which was also illustrated in the Millennium Ecosystem Assessment of the United Nations (2005). It is suspected that human well-being is influenced by a variety of situations in the lives of people (Lucas & Lawless, 2013; Nakazato, Schimmack, & Oishi, 2011; Russell et al., 2013). This includes natural and social conditions, such as those of meteorology, the effects of climate change, and fishery (agricultural) production (Díaz et al., 2015; Pascual et al., 2017). Further research is expected to examine variations in the structure of human well-being across different groups of people (e.g., fishermen,
tour guides, or farmers) with different perceptions of nature’s contributions (Pascual et al., 2017) and cultures, and among countries with different natural and social backgrounds.

Acknowledgements

I’m grateful to the member of the SH”U”N project (FRA). This work was in part supported by the JFA, but the study contents do not necessarily reflect the views of the JFA.

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Appendix 1

Question items in relation to the five components of human well-being, which were scored by five levels depending on respondent satisfaction.

| Components of human well-being | Question items |
|-------------------------------|----------------|
| **Security**                  | · to live with peace of mind and safety  
                                 · to protect oneself from danger  
                                 · to use energy and resources appropriately  
                                 · to give an appropriate response when a disaster strikes |
| **Basic material for a good life** | · to secure the basics for a good life  
                                   · to regulate life-environment  
                                   (e.g., lifeline such as electricity, gas, and water)  
                                   · to have enough food  
                                   · to have somewhere comfortable to live  
                                   · to get daily necessities |
| **Health**                    | · to keep one in good health  
                                 · to have the capacity to live grow or develop  
                                 · to feel comfortable  
                                 · to secure clean air and water |
| **Good social relations**     | · to produce a good relationship  
                                 · to cooperate with the social community  
                                 · to hold someone in high esteem  
                                 · to be able to support someone |
| **Freedom of choice and action** | · to give a child a fair chance to succeed  
                                     · to have a chance to achieve a goal  
                                     · to enjoy one’s hobbies |

Appendix 2

Below is a table showing the goodness of fit index (GFI) of the multiple-group structural equation modeling used among relevant references. The GFI, adjusted goodness of fit index (AGFI), comparative fit index (CFI), and the root mean square error of approximation (RMSEA) were used as indices for determining the adequacy of the model. The model is reliable when GFI, AGFI, and CFI are close to 1, and RMSEA < 0.05.

| Relevant references | Hori (2015) | Hori & Makino (2016) | Hori et al. (2017) |
|---------------------|-------------|----------------------|--------------------|
| 30 min n = 396      | 17.10       | 29.90                | 16.78              | 0.34              |
| 1 h n = 183         | 0.99        | 0.99                 | 1.00               | 1.00              |
| 2 h n = 225         | 0.90        | 0.90                 | 0.92               | 0.98              |
| 3 h n = 145         | 1.00        | 1.00                 | 1.00               | 1.00              |
| n = 468             | 0.06        | 0.06                 | 0.06               | 0.00              |
| Indonesia n = 200   |             |                      |                    |                   |
| Japan n = 1,000     |             |                      |                    |                   |
| Korea n = 500       |             |                      |                    |                   |
| US n = 500          |             |                      |                    |                   |
| Indonesia n = 468   |             |                      |                    |                   |
| Japan n = 540       |             |                      |                    |                   |
| Korea n = 500       |             |                      |                    |                   |
| Hinase n = 38       |             |                      |                    |                   |
| Ishigaki n = 71     |             |                      |                    |                   |
| chi-square           |             |                      |                    |                   |
| GFI                 |             |                      |                    |                   |
| AGFI                |             |                      |                    |                   |
| CFI                 |             |                      |                    |                   |
| RMSEA               |             |                      |                    |                   |