'IAIA15 Conference Proceedings'
Impact Assessment in the Digital Era
35th Annual Conference of the International Association for Impact Assessment
20 - 23 April 2015 | Firenze Fiera Congress & Exhibition Center | Florence | Italy | www.iaia.org

Developing a Quantitative Evaluation Method for Satoyama

Akira TANAKA and Masashi KOBATAKE

Keywords: Habitat Evaluation Procedure (HEP), Satoyama Evaluation Procedure (SEP)
Satoyama, Habitat, Landscape, Wise-Use

1. Introduction

In East Asia, human wise-use has ensured that Satoyama has been maintained as scenic landscapes and important ecosystems. In Japan, many Satoyama ecosystems are faced with both direct impact from development projects and indirect impact from disuse due to declining use-value. As a countermeasure, projects for recovering lost nature have been undertaken in Japan as well as in Europe and the US (Takeuchi, 1994). For example, Tanaka (2010) has proposed "Satoyama Banking," a biodiversity banking concept specific to Japan.

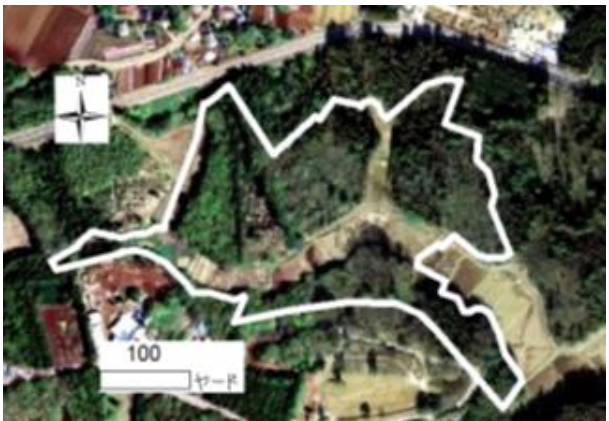
When thinking about nature restoration in Japan, we have to consider the peculiarities of the environment in Japan. According to Takeuchi (1994), the natural regeneration capacity in Japan is high compared to European countries. For example, in Germany, the action principle to maintain healthy wetlands is preservation, but in Japan, the action principle to maintain healthy nature such as second-growth forests and wetlands is conservation. In other words, it is "Wise-Use". In addition, it is clear that Japanese citizens favor the landscape of the preserved nature such as healthy second-growth forests to that under conservation. Anyway, more than 20 quantitative ecosystem evaluation methods have been developed in Japan with the purpose of evaluating corporate green spaces, seeing the recent increase in biodiversity conservation awareness after the CBD COP10 held in Nagoya. However, there is no comprehensive quantitative evaluation method incorporating habitat, landscape aesthetic value and human wise-use for Satoyama. This can be an obstacle to introducing biodiversity offset and banking into Japan.

Therefore, we developed an evaluation method called "Satoyama Evaluation Process (SEP)" based on the fundamental "Habitat Evaluation Procedure (HEP)" concepts of "quality" x "area" x "time". HEP is most widely applied in the USA and is the basis of other quantitative ecosystem evaluation methods all over the world. By comparison with HEP, we illustrate the validity of SEP.

2. Methodology

First, we marshal some HEP studies by our laboratory to introduce HEP studies into Japan.

Second, we developed SEP and three 30-year conservation plans for a 6.39-ha Satoyama comprised of former paddy fields and second-growth forests in a suburb of Chiba City in Chiba Prefecture, Japan. We evaluated these conservation results by HEP and SEP.



3. The study on HEP by our laboratory

The study on HEP has been considered and developed widely by governments, environmental consultants and strategists after the publishing of "Theory and Practices for Habitat Evaluation Procedure in Japan" by Akira Tanaka.

In 2008, we successfully applied HEP to Environmental Impact Assessment in Kanagawa, Japan for the first time and found a high possibility to apply HEP to Environmental Impact Assessment for Japan in the near future.

It is important to have the idea of conserving biodiversity and ecosystems and also quantitative evaluation of ecosystems in cases of EIAs or other processes in development. HEP is based on consideration of having multiple plans for conserving target species' habitats. Applying HEP in Japan is effective.

However there are some differences between U.S., which is the first country that developed HEP and is applying it more commonly, and Japan. Obviously there is a lack of HSI model data which indicates quality of habitat. We has developed HEP to be applied simply and easily.

Examples include the cases of HEP application to the dam removal, railway forest biodiversity assessment using simple HEP, and HEP accounting technique by using GIS and BDPM.

And in the process of developing HEP for easy use, we found various approaches to apply HEP to similar evaluation of company's green spaces. For example, KANTAN HEP, evaluation method for HEP application to simple green roofs. And after these developments of HEP for multiple uses in evaluation, we developed new method SEP for evaluating Satoyama with consideration of landscape, Wise-Use and not only habitat for conserving biodiversity in Japan.

Table1：Evaluation Methods of ecosystems and biodiversity based on HEP by our laboratory

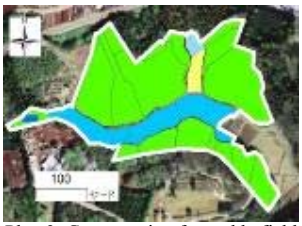
Year	Title	Summary
2008	Kamigo HEP "The first application of HEP to Environmental Impact Assessment in Kanagawa, Japan"	・ The first application of HEP to Environmental Impact Assessment in Kanagawa, Japan ・ Finding out possibility of adaptable management by applying HEP ・ Finding out possibility of improving objective and effective mitigation on development plans by applying HEP
2009	HEP applicaiton to the dam removal	・ Applied HEP to removal, not construction ・ Suggested to apply HEP to removal dams in the future
2010	Green Evaluation Method With GREEN WISE	・ Cultivating biodiversity ・ Evaluating with "Company habitat", "Human habitat" and "Wildlife habitat".
2011	KANTAN(easy,simple)HEP	・ Evaluating HSI score of target species by using "HSI model sheet" ・ Evaluating ecological network between target green area and around areas ・ Emphasizing conservation of ecological network for company and governmental plans by applying KANTAN HEP
2013	Railway forest biodiversity assessment using simple HEP	・ Simplified HEP to be encouraged to evaluate habitats ・ One species was set as a target ・ Possible to evaluate habitats and THU in short period
2012	Evaluation of biodiversity method for simplicity green roof applied HEP	・ Simple and quantitative evaluation of biodiversity on green roof ・ Three visions of evaluation;"Quality"as habitat requirements,"Space"as ecological network between target green area and around areas, "Time"as planning, constructing and managing
2010	HEP accounting technique by using GIS.	・ HEP accounting technique by using GIS ・ Quick survey for calculating hectares, distances and etc. ・ Possible to consider multiple plans of developments as layers on GIS
2011	BDPM	・ Easy and quick evaluation of habitat's potential By using existing environmental data. ・ Making potential map of target species by using existing HSI models and GIS data
2014	Evaluation System of Ecological corridor	・ Evaluation of ecological corridor in urban areas ・ Scoring of forest, grassland, waterfront and other elements by application of HEP and GIS ・ Easy to visualize Ecological corridors

Table 2: Three 30-year Satoyama banking working draft plans

Before activity

Plan 1: No action

Plan 2:Conservation for paddy field



Plan 3: Conservation for paddy field and second-growth forest

Legend

Conserved *Quercus serrata* forest

Not conserved *Quercus serrata* forest

Uncontrolled *Cryptomeria japonica* forest

Pleioblastus chino Makino vegetation

Wet-paddy rice agriculture field

Storage reservoir

Wet grassland

Dry grassland

Vegetation	Before activity	Plan 1	Plan 2	Plan 3
Not conserved *Quercus serrata* forest	3.90 (ha)	3.90 (ha)	3.90 (ha)	0.00 (ha)
Uncontrolled *Cryptomeria japonica* forest	0.80 (ha)	0.80 (ha)	0.80 (ha)	0.00 (ha)
Pleioblastus chino Makino region	0.25 (ha)	0.25 (ha)	0.25 (ha)	0.00 (ha)
Quercus serrata forest	0.00 (ha)	0.00 (ha)	0.00 (ha)	4.95 (ha)
Dry grassland	0.83 (ha)	1.16 (ha)	0.16 (ha)	0.16 (ha)
Wet grassland	0.25 (ha)	0.25 (ha)	0.09 (ha)	0.09 (ha)
Wet-paddy rice agriculture field	0.33 (ha)	0.00 (ha)	1.16 (ha)	1.16 (ha)
Storage reservoir	0.03 (ha)	0.03 (ha)	0.03 (ha)	0.03 (ha)

4. The study area and objects

The study area is a 6.39-ha Satoyama comprised of abandoned former paddy fields and second-growth forests in a suburb of Chiba City in Chiba Prefecture. The potential natural vegetation is *Camellietea japonica* vegetation. Since February 2015, a NPO has reestablished a 0.4-ha wet-paddy rice agriculture field and a small *Quercus serrata* region in the study area.

We developed three 30-year Satoyama banking working draft plans in the study area. “Plan 1: no action” is to leave the study area untouched. “Plan 2: conservation for paddy field” is to rehabilitate a 1.16-ha wet-paddy rice agriculture field. “Plan 3: conservation for paddy field and second-growth forests” is to rehabilitate both a 1.16-ha wet-paddy rice agriculture field and a 5.23-ha *Quercus serrata* area.

5. Results and Discussion

5-1. Methods of SEP

SEP is very similar to HEP. The only different point is how to evaluate “quality.” SEP evaluates “quality” with not only “Habitat index” but also “Landscape index” and “Wise-Use index”. In SEP, “Habitat index” is evaluated by the HSI model of HEP.

“Landscape index” is derived from the average of “Landscape from ground level” and “Ecological network status”. “Landscape from ground level” is derived from the average of eight-angle landscape from some readily accessible location on ground level. “Ecological network status” is derived through mapping the ecological network on regional biodiversity strategy such as existence or non-existence of the map and the quantitative or qualitative conservation target on the map.

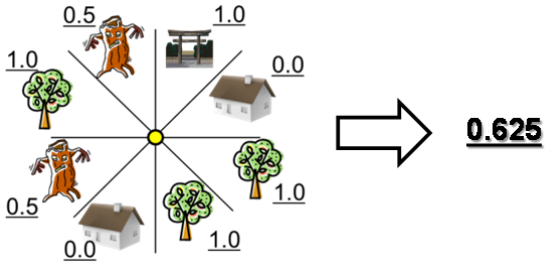
“Wise-Use index” is derived from the average of “primary industry potential” and “tertiary industry potential”. As in the case with HEP, SEP evaluated “the potentials of primary and tertiary industries” instead of the “actual activities of them” under each cover type. For example, under SEP, we evaluate that dry grassland doesn’t have “primary industry potential” and wet-paddy rice agriculture field does has “primary industry potential”.

Finally, we derived index of quality, “SSI (Satoyama Suitability Index),” by averaging “Habitat index”, “Landscape index” and “Wise-Use index”.

$$SSI = \frac{(Habitat\ index + Landscape\ index + Wiseuse\ index)}{3}$$

Figure 2: Mathematical formula for SSI

Table 3: How to evaluate of SSI on SEP

	Large category	Small category	How to evaluate
SSI	Habitat	HSI model	By HSI model of HEP
	Landscape	Landscape from ground level	By average of eight-way landscape from some readily-accessible location on ground level. 1.0:Conserved nature or cultural artifact such as shrine 0.5:Not conserved nature 0.0:Artifact Ex.) 
		Ecological network status	By a map of the ecological network on regional biodiversity strategy such as existence or non-existence and quantitative or qualitative conservation target on the map. 1.0:Mapping of the ecological network with quantitative conservation target on regional biodiversity strategy 0.5: Mapping of the ecological network with quantitative conservation target on regional biodiversity strategy 0.0:the Map is nothing Ex.) 
	Wise-use	Potential the primary industry	1.0:Area having potential the primary industry 0.0:Area having not potential the primary industry Ex.） 1.0: Wet-paddy rice agriculture field, *Quercus serrata* forest, *Cryptomeria japonica* region forest 0.0: Dry grassland, Storage reservoir, *Pleioblastus chino* Makino region and so on
		Potential the tertiary industry	1.0:Area having potential the tertiary industry 0.0:Area having not potential the tertiary industry Ex.） 1.0: Wet-paddy rice agriculture field, *Quercus serrata* forest, *Cryptomeria japonica* region forest, Storage reservoir 0.0: Dry grassland, *Pleioblastus chino* Makino region and so on

5-2. Evaluating conservation results of the 3 plans in accordance with HEP methods.

We evaluated conservation results of the 3 plans by HEP. We selected *Rana japonica* as the indicator species for wetlands such as wet-paddy rice agriculture fields and *Sasakia charonda* as the indicator species for second-growth forests such as *Quercus serrata* region. The two indicator species are chosen as the target species in this area by Chiba City and obtained from Red Data Books of Chiba Prefecture.

In this study, we calculated the Cumulative Habitat Unit (CHU) used in HEP for the 3 plans. CHU is the index for the concept of "quality" x "area" x "time". An HSI model for the two species has been developed by JEAS (2006) and KAMIGO (2007). So we adapted these models for the pilot study area. The HSI model is the index for the concept of "quality" in HEP. We use the total average CHU for showing the conservation result in this area (Table 4).

Table 4: CHU [ha/30year] of the 3 plans by HEP

	Rana japonica CHU	*Sasakia cheronda* CHU	Total average CHU
Plan 1	101.04	12.95	56.99
Plan 2	113.47	12.95	63.21
Plan 3	125.99	74.96	100.47

5-3. Evaluating conservation results of the 3 plans in accordance with SEP methods.

Table 5 shows the conservation results of the 3 plans by SEP. The evaluation results of "landscape" and "Wise-Use" of "Plan 3" are higher than "Plan 2". Since, the common conservation targets such as broad-leaved deciduous forest and wet-paddy field have high points on the "Landscape index" and "Wise-Use index" one the SEP.

Table 5: CSU [ha/30year] of the 3 plans by SEP

	CSU
Plan 1	51.11
Plan 2	66.97
Plan 3	127.97

5-4. The difference between HEP and SEP

The difference between HEP and SEP is only "Quality index." Table 6 shows the "Quality" evaluation results for the 3 plans by HEP and SEP, respectively. Figure 3 shows the total evaluation results for 3 plans with plan 3 scoring 100.

In the results, the twoevaluation results are very similar.

Table 6: Each evaluation results by "Quality" index

		Plan 1	Plan 2	Plan 3
HEP	HSI	0.30	0.33	0.52
SEP	SSI	0.27	0.35	0.65
	Habitat	0.30	0.33	0.52
	Landscape	0.50	0.53	0.66
	Wise-use	0.01	0.18	0.77

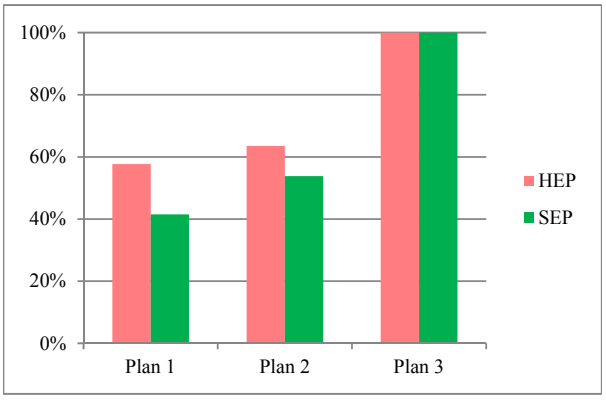


Figure 3: Comparison of the results between HEP and SEP

6. Conclusions

This study illustrated three advantages of SEP in comparison with HEP.

The advantages of SEP are:

1. SEP applies to the common conservation target of Satoyama in Japan.
2. Variability of the results is smaller than HEP due to difference of evaluator's professional ability. Everyone can evaluate "Landscape index" and "Wise-Use index"easily.
3. SEP advocates drawing up regional biodiversity strategies, since "Landscape from ground level" is evaluated by these strategies. In addition, SEP advocates that biodiversity offsets be the main engine for conservation of nature.

This study also suggests a possible beneficial effect of evaluating Satoyama with HEP. The evaluation results of HEP and SEP are very similar. In the other words, an evaluation of "Habitat" includes the concept of evaluating also "Landscape" and "Wise-use". In fact, they are not mutually exclusive.

References

Takeuchi K (1994) Spirit of the environmental creation (Japanese language). Tokyo: Tokyo University, pp200.

Tanaka A (2006) Theory and Practices for Habitat Evaluation Procedure in Japan (Japanese language). Tokyo: Asakura, pp280.

Tanaka A (2010) Novel biodiversity offset strategies: Satoyama Banking and Earth Banking. Conference of International Association for Impact Assessment 2010.

JEAS (Japan Association of Environment Assessment・Seminar Study Group Natural Environmental Impact Assessment Study the first working) (2006) HSI (Habitat suitability index) model: Great purple emperor, Japan, pp12.

KAMIGO HEP teem (2007) KAMIGO development Environmental Impact Statement. Pp342.